FEDERAL UNIVERSITY OF TECHNOLOGY
MINNA

SCHOOL OF ENVIRONMENTAL TECHNOLOGY
INTERNATIONAL CONFERENCE (SETIC 2016)

SETIC 2016
Conference Proceedings

EDITORS:

Yekeen A. SANUSI
Olatunde F. ADEDAYO
Richard A. JIMOH
Luqman O. OYEWOBI

THEME:

SUSTAINABLE BUILT ENVIRONMENT AND CLIMATE CHANGE: THE CHALLENGE OF POST 2015 DEVELOPMENT AGENDA

DATE:
TUE. 10TH - THUR. 12TH MAY, 2016

VENUE:
SCHOOL OF ENVIRONMENTAL TECHNOLOGY COMPLEX

TIME:
9:00AM - 5:00PM DAILY

CHIEF HOST:
PROF M. A. AKANJI
VICE CHANCELLOR, FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA

HOST:
PROF Y. A. SANUSI
DEAN, SCHOOL OF ENVIRONMENTAL TECHNOLOGY, FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA

SUPPORTED BY

URN
URBANISATION
RESEARCH
NIGERIA

School of Environmental Technology International Conference (SETIC) 2016

10-12 May 2016

Federal University of Technology Minna, Niger State, Nigeria

Conference Proceedings

Editors

Yekeen A. SANUSI,
Olatunde F. ADEDAYO,
Richard A. JIMOH,
Luqman O. OYEWOBI,

Conference Proceedings of the School of Environmental Technology International Conference (SETIC) 2016

Editors
Yekeen A. SANUSI, Federal University of Technology, Minna, Nigeria
Olatunde F. ADEDAYO, Federal University of Technology, Minna, Nigeria
Richard A. JIMOH, Federal University of Technology, Minna, Nigeria
Luqman O. OYEWOBI, Federal University of Technology, Minna, Nigeria

Published by:
School of Environmental Technology
Federal University of Technology
Main Campus, Gidan Kwano
Minna, Niger State, Nigeria.

Correspondence:
All correspondence pertaining to the SETIC 2016 should be sent to:
The Deputy Dean
School of Environmental Technology
Federal University of Technology
Main Campus, Gidan Kwano
P.M.B. 65
Minna, Niger State, Nigeria.
setconference@futminna.edu.ng
www.futminna.edu.ng

10th – 12th May 2016
School of Environmental Technology,
Federal University of Technology, Minna, Niger State, Nigeria.

TABLE OF CONTENTS

FOREWORD

The organising committee of the 1st School of Environmental Technology International Conference is pleased to welcome you to Federal University of Technology Minna, Niger State Nigeria.

The conference provides an international forum for researchers and professionals in the built and allied professions to address fundamental problems, challenges and prospects that affect the Built Environment as it relates to Climate Change and Sustainable Development. The conference is a platform where recognised best practices, theories and concepts are shared and discussed amongst academics, practitioners and researchers. The papers and scope are quite broad but have been organised around the sub-themes listed below:

- Infrastructure Development and Financing
- Sustainable Practice Theories
- Urban Resilience and Energy Conservation
- Waste Management and Sanitation
- Health and Safety Issues
- Climate Change and Threat to Sustainability of the Built Environment
- Climate Change Induced Disaster
- Designing the Human Settlement for Climate Change
- Conceptual Issues on Climate Change and Sustainable Development
- Sustainable Materials
- Cross Cutting Issues

The peer review process saw us making use of 48 senior academics and specialist as reviewers drawn from institutions in Nigeria and England. There were some papers were outside the theme of the conference but we had to create a cross cutting issues to accommodate such papers this is in spirit that every knowledge is important.

We hope you enjoy your time at our conference, and that you have the opportunities to exchange ideas and share knowledge, as well as participate in productive discussions with the like-minded researchers and practitioners in the built environment and academia.

Professor Yekeen Adeeyo Sanusi
Conference Chair
School of Environmental Technology International (SETIC) 2016
Federal University of Technology Minna, Niger State Nigeria.
May 2016

ACKNOWLEDGEMENTS

The success of the 1st School of Environmental Technology International Conference holding at the Main Campus of the Federal University of Technology Minna, Nigeria is predicated on the support and goodwill from Vice-Chancellor of Federal University of Technology and many other highly motivated people.

I sincerely wish to appreciate you for attending this maiden event and to warmly welcome you to the city of Minna the capital of the *POWER STATE.* It is a great honour to have you in the beautiful campus of Federal University of Technology Minna, Nigeria, **THE MOST PEACEFUL UNIVERSITY IN NIGERIA**. I am aware of the great sacrifices made by many of you to be present in this occasion and I will definitely not overlook the long distances some of you have had to cover to get to this conference venue. We genuinely appreciate all your efforts. It is our singular hope and desire that the conference meets your expectations and gives you unquantifiable experience and tremendous developmental networking opportunities for a life fulfilling career.

We are grateful for the presence of the Vice Chancellor of the Federal University of Technology Minna – Professor Musbau Adewumi Akanji whose leadership and distinguished academic career has served as inspiration and encouragement to many young academics. His desire to see the University compete at International level has led to the upsurge in the organisation of International conferences, Public lectures and Seminars on regular basis within and outside the university. We are happy to have you as the Chief host to declare the conference open and deliver the welcome address.

We are grateful to the Dean of School of Environmental Technology, Federal University of Technology Professor Yekeen Adeeyo Sanusi for providing the robust platform, academic support and leadership for the organisation of the conference. You threw the challenge and provided the required resources and strategies for achieving its success, it is a great honour of having the opportunity to learn at your feet. We are happy to have you as the host and keynote speaker at the conference. I wish to thank also all the special guests particularly leaders of the Industry, Built Environment and Academia.

SETIC is beginning at the foundation this year and for this I wish to thank all those who have supported us through various forms of participation. Specifically I wish to thank the delegates and the partners for contributing significantly to the conferences. I wish to thank Prof. Oluwole O. Morenikeji (DVC Academic), Prof. Stella N. Zubairu and Prof. A. M. Jinadu who genuinely and consistently monitored the progress of the conference preparations. It is my desire that SETIC becomes a constant feature in the calendar of the university and global conference listings.

Delegates to SETIC 2016 are from 39 different academic and research institutions that are spread across six different countries. This offers participants a wonderful opportunity for exchange of cultural, social and academic ideas during the conference periods. It is also an opportunity to create awareness about programmes and events at the participants' individual institutions. I encourage you all to make good use of the networking opportunities that are available.

We received a total of 226 abstract, based on a quick review we were able to accept 175 of them and the authors were communicated on what they needed to focus on while developing the full papers. A total of (129) full papers were received and reviewed, the reviewers report for the authors to make corrections and submit revised papers. It was after the process that we were able to accept 112 papers for presentation at the conference, I therefore congratulate all the authors whose papers made it to the conference. We acknowledge the amount of hard work you had all put in producing these papers. It is my sincere believe that the presentation of the different ideas in your paper would go a long way in improving the knowledge of the participants and also generate meaningful discussions at the tea beaks, lunch and beyond.

I wish to express my utmost gratitude to each reviewer for a wonderful job done and for tolerating our deadlines and Oliver Twist syndrome. It is your dedication and expertise that has ensured that the conference is a success.

Special thanks to all our keynote speakers, Prof. Oluwole O. Morenikeji (Deputy Vice-Chancellor Academics, Federal University of Technology Minna), Prof. Hussein Makun (Director, Directorate of Research Innovation and Development, Federal University of Technology Minna), Prof. Musa Aibinu (Director, Centre for Distance Learning), Prof. Mustapha Zubairu (Director, Centre for Human Settlement and Urban Development), Dr. Appolonia A. Okhimamhe (Director, WASCAL) and Prof. Yekeen Sanusi, (Dean School of Environmental Technology, Federal University of Technology Minna).

It is important to appreciate the roles and efforts of the following people for their selfless and very significant contributions made towards the successful organization of the conference: Adedokun John, Idowu Oqua, Akhabue Oriwoh and Ailoyafen Dorcas (for being available to run around at very short notice), Arc. Oyetola Stephen and Tpl Samuel Medayese (for typesetting the papers for the conference proceedings).

I have come to realise that it is not easy to organize conference without dedicated individuals offering to serve. My heartfelt gratitude goes to Dr. R.A. Jimoh, Dr. L.O. Oyewobi, Dr. Taibat Lawanson, Dr. P. Ayuba, Dr. J.J. Dukiya, Dr. A.I. Anunobi, Dr. N.I. Popoola and Dr. O.A. Kemiki for their unflinching support all through the process.

It is our sincere hope that this conference will serve as a forum for the advancement of research in the urban sphere towards achieving a sustainable environment. It is our sincere believe that academics and professionals in practices will continually participate in this forum.

Once again I wish to thank you all for creating time out of your busy schedule to attend this conference. Please do enjoy your stay at Federal University of Technology Minna, and the city as a whole. Ensure that you make use of the different fora created throughout the conference to build new relationships for the future and strengthen existing relationships. I look forward to seeing you all in future.

Olatunde Folaranmi ADEDAYO
Chairman SETIC 2016 Organising Committee
May 2016

COPYRIGHT STATEMENT

DECLARATION

PEER REVIEW AND SCIENTIFIC PUBLISHING POLICY STATEMENT

10th May 2016

TO WHOM IT MAY CONCERN

I wish to state that all the papers published in SETIC 2016 Conference Proceedings have passed through the peer review process which involved an initial review of abstracts, blind review of full papers by minimum of two referees, forwarding of reviewers' comments to authors, submission of revised papers by authors and subsequent evaluation of submitted papers by the Scientific Committee to determine content quality.

It is the policy of the School of Environmental Technology International Conference (SETIC) that for papers to be accepted for inclusion in the conference proceedings it must have undergone the blind review process and passed the academic integrity test. All papers are only published based on the recommendation of the reviewers and the Scientific Committee of SETIC

Names and individual affiliation of members of Review and Scientific Committee for SETIC Conference 2016 are published in the SETIC 2016 Conference Proceedings and made available on www.futminna.edu.ng

Olatunde Folaranmi ADEDAYO
Chairman SETIC 2016
Federal University of Technology, Minna, Nigeria

Papers in the SETIC 2016 Conference Proceedings are published on www.futminna.edu.ng.

REVIEW PANEL

We wish to express our deepest and sincere gratitude to the following people in no particular order who provided comprehensive scientific reviews and made commendable suggestions towards improving the over 200 abstracts and 100 full papers submitted to SETIC 2016. They provided constructive comments to authors regarding their papers, it is necessary to state that there was no reported case of conflict of interest by any of the reviewers or the authors.

Dr. J.J. Dukiya, Department of Transport Technology, Federal University of Technology, Minna

Dr. Naomi I. Popoola, Department of Estate Management, Federal University of Technology, Minna

Dr. Anthony I. Anunobi, Department of Architecture, Federal University of Technology, Minna

Dr. Philip Ayuba, Department of Architecture, Federal University of Technology, Minna

Dr. Taibat Lawanson, Urban and Regional Planning, University of Lagos, Lagos

Dr. Remi E. Olagunju, Department of Architecture, Federal University of Technology, Minna

Arc. Stephen Oyetola, Department of Architecture, Federal University of Technology, Minna

Arc. Oluwatoyin A. Adebayo, Department of Architecture, Bells University of Technology, Ota

Dr. Bala I. Muhammad, Department of Architecture, Federal University of Technology, Minna

Dr. Abubakar D. Isah, Department of Architecture, Federal University of Technology, Minna

Dr. Abdulkareem Saka, Department of Chemical Engineering, Federal University of Technology, Minna

Dr. M.T.A. Ajayi, Department of Estate Management, University of Ilorin, Ilorin

Dr. Olurotimi Kemiki, Department of Estate Management, Federal University of Technology, Minna

Dr. S. Ojoye, Department of Geography, Federal University of Technology, Minna

Dr. Abdulhameed D. Mambo, Department of Building, Federal University, Birnin Kebbi,

Mr. Abdulganiyu Oke, Quantity Surveying, Federal University of Technology, Minna

Dr. Nelson T.A. Abd'razack, Urban and Regional Planning Federal University of Technology, Minna

Dr. Emmanuel Umaru, Urban and Regional Planning Federal University of Technology, Minna

Dr. Emmanuel Daniya, Department of Crop Production, Federal University of Technology, Minna

Dr. Hassan Ogiri, Department of Building, Federal University of Technology, Minna

Mr. Ismail Ojetunde, Department of Estate Management, Federal University of Technology, Minna

Dr. Luqman Oyewobi, Department of Quantity Surveying, Federal University of Technology, Minna

Dr. Ifeanyi Onuigbo, Department of Surveying & Geoinformatics, Federal University of Technology, Minna

Dr. Rasheed Ojutiku, Department of Water Aquaculture & Fisheries Technology, Federal University of Technology, Minna

Dr. Adeiza Onumanyi, Telecommunication Engineering, Federal University of Technology, Minna

Dr. Paul Bajere, Department of Building, Federal University of Technology, Minna

Dr. Richard Jimoh, Department of Building, Federal University of Technology, Minna

Mr. Shien Kuma, Department of Estate Management, Federal University of Technology, Minna

Dr. Yakubu Mohammed, Department of Quantity Surveying, Federal University of Technology, Minna

Dr. Aishetu Abdulkadir, Department of Geography, Federal University of Technology, Minna

Dr. Kwasi Awuah, University of West England, UK

Dr. Rotimi University of West England, UK

Dr. Babatunde J. Olawuyi, Department of Building, Federal University of Technology, Minna

Dr. Bashir Nuhu, Department of Estate Management, Federal University of Technology, Minna

Dr. Olatunde F. Adedayo, Department of Architecture, Federal University of Technology, Minna

SCIENTIFIC COMMITTEE

Prof. Oluwole O. Morenikeji, Urban and Regional Planning, Federal University of Technology, Minna

Prof. Yekeen A. Sanusi, Urban and Regional Planning, Federal University of Technology, Minna

Prof. Stella N. Zubairu, Department of Architecture, Federal University of Technology, Minna

Prof. A.M. Jinadu, Urban and Regional Planning, Federal University of Technology, Minna

Prof. Dalha A. Muazu, Department of Building, Federal University of Technology, Minna

Prof. I. J. Nwadialor, Surveying and Geoinfomatics, Federal University of Technology, Minna

Prof. Mustapha Zubairu, Urban and Regional Planning Federal University of Technology, Minna

Dr. Naomi I. Popoola, Department of Estate Management, Federal University of Technology, Minna

Dr. Taibat Lawanson, Urban and Regional Planning, University of Lagos, Lagos

Dr. Anthony I. Anunobi, Department of Architecture, Federal University of Technology, Minna

Dr. Abdulkareem Saka, Department of Chemical Engineering, Federal University of Technology, Minna

Dr. Olurotimi Kemiki, Department of Estate Management, Federal University of Technology, Minna

Dr. Hassan Ogiri, Department of Building, Federal University of Technology, Minna

Dr. J.J. Dukiya, Department of Transport Technology, Federal University of Technology, Minna

Dr. Luqman Oyewobi, Department of Quantity Surveying, Federal University of Technology, Minna

Dr. Paul Bajere, Department of Building, Federal University of Technology, Minna

Dr. Richard Jimoh, Department of Building, Federal University of Technology, Minna

Dr. Kwasi Awuah, University of West England, UK

Dr. Rotimi University of West England, UK

Dr. Olatunde F. Adedayo, Department of Architecture, Federal University of Technology, Minna

PROFILE OF KEYNOTE SPEAKERS

SETIC 2016 organisers wishes to thank our keynote speakers for accepting to create time to share from their rich wealth of knowledge and interact with delegates and participants on varied issues being examined at this year's conference. A brief profile of each keynote speaker is provided here, this would allow for future interaction and networking with them.

Prof. Hussaini Anthony MAKUN

Federal University of Technology, Minna

hussaini.makun@futminna.edu.ng; +2348035882233

Hussaini Anthony Makun is currently working as Professor of Biochemistry in the Department of Biochemistry, Federal University of Technology, Minna where he has being since 1992. He completed his PhD in 2007 in Biochemistry (Toxicology) from same University. The researcher was a National Research Foundation Postdoctoral Fellow (PDF) with Food Environment and Health Research Group of the University of Johannesburg (UJ) between 2008 and 2010. He is teaching basic and advanced courses in biochemistry, and toxicology related courses at both undergraduate and postgraduate levels.

He has supervised and graduated over seventy B-Tech and ten M-Tech students and two PhDs. He is currently the Lead Researcher of the Food and Toxicology Research Group (FTRG) of the University which has 2 Senior Researchers, 3 M.Tech and 4 PhD students. FTRG conducts researches on environmental health monitoring and mycotoxins at national and international levels. The researches focus on detection and health impacts of mycotoxins and establishing novel integrated intervention strategies approach against mycotoxins. The intervention strategies include exploration of natural preservatives from African traditional medicinal plants with fungicidal effects for production of fungicides for storage of crops. Other approaches at animal farms include formulation of nanoparticle based multi-mycotoxin feed binder against exposure to common, toxic mycotoxins. The research group is also involve in studies to produce simple medicinal supplements encapsulated in nanoparticles with protective effects against diseases induced by mycotoxins from African traditional medicinal plants; such supplements will alleviate the adverse health impact of mycotoxins in animals and human beings. The research group is also interested in toxicological studies of medicinal plants used in the folkloric treatment and drug toxicology. Following the trend of drugs abuse in Nigeria, the research group is embarking on research titled "Elucidation of the chemical composition and biomonitoring of substances of abuse in the Northern region of Nigeria"**.** The focus of this research is to establish the current state of art of drugs of abuse in the Northern region of Nigeria; to elucidate the chemical composition and active ingredient of new psychoactive substances (NPS); to modify validated analytical methods for the detection of new psychoactive substances in blood, urine and hair.

In last 5 years, 6 research projects were granted with funding from NRF, South Africa and TETFUND, Nigeria. He is a member of Mycotoxicology Society of Nigeria (Vice President (North), Experts on Mycotoxins in Food, Food Hygiene, Food Import/Export Inspections and Certification System of the National Agency for Food and Drug Administration and Control (NAFDAC) of Nigeria, National Codex Committee of Nigeria, African Union Expert Committee on Contaminants in Food (2011 to date) and Joint FAO/WHO Expert Committee on Contaminants in Food (JECFA) (2012-2016). He coordinated the writing of the "discussion paper on fungi and mycotoxins in Sorghum" which was adopted as a document of the Joint FAO/WHO Experts Committee on Food Additives (JECFA) in 2012 and participated in the writing of "Proposed draft annex for "prevention and reduction of aflatoxins and ochratoxin A in sorghum" in the existing code of practice for the prevention and reduction of mycotoxin contamination in cereals (CAC/RCP 51-2003)".

Prof Makun has 57 publications, mostly on mycotoxins in peer review journals, technical papers and books and is currently the Director of Research, Innovation and Development, Federal University of Technology, Minna.

Dr. Appollonia A. OKHIMAMHE

Federal University of Technology, Minna

aaokhimamhe@futminna.edu.ng +2348034526128

Dr A. A. Okhimamhe is the Director of the Masters Research Programme on Climate Change and Adapted Land Use (MRP CC & ALU) of the West African Science Service Centre on Climate Change and Adapted Land Use (WASCAL), a German sponsored graduate research programme with its Headquarters in Accra, Ghana.

In collaboration with colleagues, 20 West African students from Nigeria, Ghana, Benin, Togo, The Gambia, Cote D'Ivoire, Mali, Niger and Burkina Faso graduated with Master of Technology (M.Tech) in Climate Change and Adapted Land Use from the University. Another Batch of 10 students are expected to commence their programme in mid 2016. Aside from her academic qualifications, her participation in various training activities organized by the United Nations in Regional Centre for Mapping of Resources for Development in Nairobi, Kenya (1992); University of Stockholm, Sweden (1994); Harare, Zimbabwe (1995); and European Space Research Institute in Frascati, Italy (1997, 1998) had prepared her professionally for her career. Additionally, in 2000, she secured a 6 months fellowship-traineeship for a colleague in the Department and herself at the European Space Research Institute in Frascati, Italy. Dr Okhimamhe is an alumni of the International Visitor Leadership Programme (IVLP), U.S. Department of State's Bureau of Educational and Cultural Affairs' (ECA) premier professional exchange program. Currently, she is an Associate Professor of Geography with a research focus on application of remote sensing and GIS in geographical sciences including climate change.

Dr Okhimamhe has served her country as a Technical Delegate at the UNFCCC COP in Cancun, Mexico (2010), Durban, South Africa (2011), Doha, Qatar (2012) and Warsaw, Poland (2013). She has supervised more than 30 postgraduate students and has several publications and is still publishing. In collaboration with her students in the last 3 years, she has focused on urban climate change studies using geospatial techniques.

Prof. Abiodun Musa AIBINU

Federal University of Technology, Minna

maibinu@gmail.com +2348132483940

Abiodun Musa AIBINU (PhD), is a highly motivated career driven achiever with over Eighteen (18) years working experience in the field of: Mechatronics Engineering; Telecommunication Engineering; Spectrum Management; Industrial Automation; Teaching; Research and Project Development.

He received: National Diploma award from The Polytechnic, Ibadan, Nigeria; B.Sc degree from Obafemi Awolowo University (OAU), Ile-Ife, Nigeria; M.sc degree from Blekinge Institute of Technology (BTH), Sweden and Doctoral degree award from International Islamic University Malaysia, (IIUM), Malaysia. He has been actively involved in teaching and research activities at various universities since the completion of his post-graduate studies. However, prior to that he has worked with: MTN Communication (Nigeria) Limited; GS Telecom (Nigeria) Limited; DCC Satellite and Networks Limited; Oganla Consulting and Investment (OCI) limited; Communications Associates (COMSAC) (Nigeria) Limited just to mention but a few.

Engr. Aibinu has participated and won several awards at various international and national exhibitions and was nominated for 2012 promising researcher award and best teacher award at IIUM Malaysia. He has also won several research grant awards in and outside Nigeria and has authored/co-authored several publications in both local and international journals and conferences.

He is presently, the Head of Department, Mechatronics Engineering Department, Federal University of Technology, Minna and the Director, Center for Open Distance and e-Learning (CODeL), Federal University of Technology, Minna.

Prof. MORENIKEJI, Olakanmi Oluwole

Federal University of Technology, Minna

oluwole@futminna.edu.ng +2348178114820

Morenikeji, Olakanmi Oluwole joined the services of the Federal University of Technology, Minna in 1990 as an Assistant Lecturer and rose to become a Professor of Urban and Regional Planning in 2006. He obtained his B. Sc in Geography and Regional Planning from the University of Calabar in 1983 and M. Sc Urban and Regional Planning from the University of Benin in 1998. He enrolled for his Ph.D in Transport Planning in 1992 at FUT Minna and won a Nigerian-Italian Ph.D scholarship which enabled him to do part of his Ph.D work at the University of Trieste, Italy. He bagged his Ph.D in 1998 and utilized his post-doctoral Commonwealth Fellowship at the Instrumented City, Institute for Transport Studies, University of Leeds, UK (2004/2005).

Morenikeji served as the Head of Department of Urban and Regional Planning from 1995 – 2002 and later, Director of the Centre for Human Settlements and Urban Development established in collaboration with the UN-Habitat in FUT, Minna. He was also the Dean of the School of Environmental Technology from 2008-2012. He has also participated in a number of internationally funded research projects and published several papers in learned journals. His areas of interest include transportation planning, human development studies, spatial analysis and Research Methods.

He is currently participating in a collaboratory research between The Construction and Property Research Centre, University of the West of England (CPRC-UWE), Bristol, UK and the Federal University of Technology (FUT), Minna being funded by DFID. He has been appointed by the West African Science Centre on Climate Change and Adapted Land Use (WASCAL) as a visiting Lecturer at the Joint Facility for Language and Common Courses (JFLCC) 2016 which is a collaborative programmes for Masters (MRP) and Doctoral Research Programme (GRP) students from 10 participating Universities.

He is currently the Deputy Vice-Chancellor (Academics) Federal University of Technology, Minna, Niger State, Nigeria.

Prof. Mustapha ZUBAIRU

Federal University of Technology, Minna

mustapha.zubairu@futminna.edu.ng +2348037024617

Mustapha Zubairu is currently a Professor in the department of Urban and Regional Planning and the Director Centre for Human settlement and urban development (CHSUD) in the Federal University of Technology, Minna. He received his B.Sc. and M.Sc. degrees in architecture from the Ahmadu Bello University Zaria, Nigeria, in 1975 and 1977 respectively. He also holds M.Sc. and Ph.D. degrees in urban and regional planning from the University of Strathclyde, Glasgow, Scotland 1983 and 1990. He is a Member of the Royal Planning Institute, Member, Nigerian Institute of Architects, Fellow, Nigerian Institute of Town Planners and a Member, Nigerian Institute of Management.

Prof. M. Zubairu was amongst others, a principal architect in the Ministry of Works and Housing, Minna, Niger State from 1979-1981, a Chief Architect/Planner in the Niger state housing corporation between 1983 – 1984 after which he became the general manager Niger State Housing Corporation, Minna between 1984 and 1992. He eventually became the General Manager, Urban Development Bank of Nigeria PLC, in charge of the Lagos Regional Office from 1992 to 1999 were he was trained by World Bank on Project development and appraisal.

In 1999 he was appointed the position of Managing Director/Chief Executive, Federal Housing Authority, Abuja where stayed until 2001. Through a large portion of his tenure (1995 till date) to be exact, he established and was also involved in private practice as principal partner in an architecture and urban planning consultancy firm. In 2003, he was appointed as director, Centre for Human Settlements and Urban Development in the Federal University of Technology, Minna and has retained this position till date. Since his appointment he has been servicing the department of urban and regional planning and architecture as mentor, supervisor and all round resource person.

His area of specialization includes; Housing, Urban design, Urban Management and Slum upgrading.

Professor Yekeen A. SANUSI

Federal University of Technology, Minna

yasanusi@googlemail.com +2347063848372

Yekeen A. Sanusi is a Professor of Urban and Regional Planning at the Federal University of Technology, Minna. His lecturing experiences span over 20 years and has lectured at both undergraduate and postgraduate classes. His academic works cover issues on urban environmental quality, urban dynamics, urban governance and green economy (poverty, service delivery and deprivations, water and sanitation, energy and climate change).

He also has studies and reports sponsored by international bodies and Research Board of the Federal University of Technology, Minna. His teaching areas cover planning theory, development control and settlement of disputes, urban governance, project planning and evaluation, energy planning, environmental impact assessment and tourism planning. He has successfully supervised many postgraduate theses (PhD, Master and Postgraduate Diploma). On administrative front,

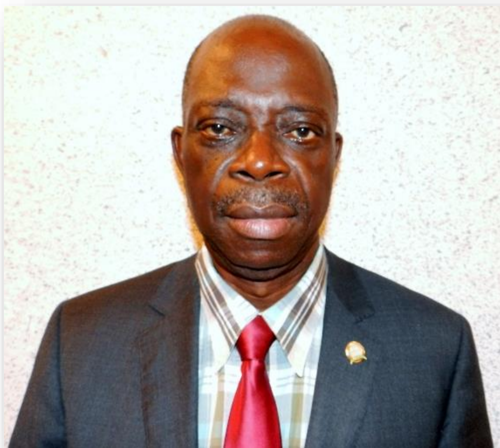
He was Deputy Dean, School of Environmental Technology of the Federal University of Technology, Minna between 2006 and 2008 and the Head of Department, Urban and Regional Planning between 2008 and 2012. Since 2012, he has been the Dean of the School of Environmental Technology. He is a Registered Town Planner (RTP) and a member of Nigerian Institute of Town Planners (NITP).

He is a member of many international research networks. Among these are Environment, Health and Development Network and Renewable Energy Policy Network for the 21st Century.

PROF Johnson Bade FALADE

Executive Director of the Foundation for Development and Environmental Initiatives (FDI)

He is currently the Managing Director/Chief Executive Officer of Gotosearch.Com Ltd and Executive Director of the Foundation for Development and Environmental Initiatives (FDI) from July 20012-date. He is currently a Senior Programme Advisor for the Urbanisation Research Nigeria Project.



Prior to this appointment, Prof Falade was the first Country Director of UN-HABITAT Programme Support office for Nigeria (2003-2012); UNDP (Programme Analyst in the Governance Team (2000-3), UNDP Zonal Officer for the North-West Zone of Nigeria (1998-2000); Programme Officer for Economic Management Team (1994-98); Programme Officer for Water and Sanitation (1992-94).

He was appointed Pupil Town Planner, County Planning Department, County Durham, Durham, UK (1977-78) and Air Mapping Assistant with the Photogrammetry Department, Ministry of Lands and Housing, Ibadan, Nigeria (1968-1970).

Professor Falade has a vast teaching and research experience. He was appointed Assistant lecturer (1982-83), Lecturer 1 (1985-87), Senior Lecturer (1987-91) with the Faculty of Environmental Design and Maanfgement fo the Obafemi Awolow University Ile-Ife. He was a Visiting Professor, Department of Geography and Regional Planning, Adekunle Ajasin University, Akungba, Akoko, Ondo State (2005-7); He was Visiting Associate Professor, Department of Urban and Regional Planning University of Lagos, Lagos (1998-90); Visiting Lecturer Department of Geography and Regional Planning Lagos State University, Ojoo (1998).

Professor Falade is member of several Professional Bodies: namely Nigerian Institute of Town Planners (1984-till now), Fellow of the Institute (1999-till date); Town Planners Registration Council (1986-till date); Nigerian Construction Industry Academy (1986-to-date); Nigerian Institute of Management (NIM) and International Union on Parks and Recreational (2004-to-date).

Professor Falade has been awarded many national and international awards. He has several publication to his credit in the areas of urban planning, landscape design and conservation and urbanization and urban governance.

SCHOOL OF ENVIRONMENTAL TECHNOLOGY INTERNATIONAL CONFERENCE (SETIC) 2016 PROGRAMME

DAY ONE	**TUESDAY**	**10TH MAY 2016**
	07.30 – 09.00	**REGISTRATION**
	09.00 – 10.50	**OPENING SESSION (SET LECTURE THEATRE)** **Chairman Opening Session: Prof. J.M. BABA Department of Geography, Federal University of Technology, Minna**
	09.00 – 09.10	Welcome and Introduction of Delegates and Guest – Olatunde Adedayo
	09.10 – 09.15	University Anthem
	09.15 – 09.25	Welcome Address by the Dean, School of Environmental Technology, Federal University of Technology, Minna **– Prof. Y.A. SANUSI,**
	09.25 – 09.40	Recognition of Conference Reviewers
	09.40 – 09. 55	Goodwill Messages from Sponsors and Partners
	09.55 – 10.20	**CONFERENCE LECTURE** **Integrating Climate Change Adaptation Strategies into Urban Designs: A Must for Today's Built Environment Professional - Dr. A.A. OKHIMAMHE** ***Director, West African Science Service Centre of Climate Change and Adapted Land Use***
	10.20 – 10.35	Conference Opening Speech and Declaration by the Chief Host: Vice-Chancellor of Federal University of Technology, Minna, Niger State, NIgeria - **Prof. Musbau Adewumi AKANJI**
	10.35 – 10.50	Close of Opening Ceremony and SETIC 2016 Group Photographs
	10.50 – 11.10	**TEA BREAK**
	11.15 – 12.40	**PLENARY SESSION I** **Chairman of Session: Prof. M.G.M. Kolo, Dean Postgraduate School, Federal University of Technology, Minna** **Session Rapporteur: Dr. R.E. Olagunju, Federal University of Technology, Minna**
	11.15 – 11.35	**Plenary Paper I** **Evolving An Effective Research And Innovation System For National Development And Unity In Nigeria -** ***Prof. Hussaini Anthony Makun, Director, Research, Innovation and Development***
	11.35 – 11.55	**Keynote Paper II** **Technological Trends IN ENGINEERING as Applicable to Environmental Technology** **- *Prof. M. Aibinu, Director CODEL Federal University of Technology Minna.***
	11.55 – 12.05	**Q&A Dr. R.E. Olagunju**
	12.05 – 12.25	**Plenary Paper III** **Future Trends for Research in Urban Development. –** ***Prof. M. Zubairu, Director Centre for Human Settlement and Urban Development, Federal University of Technology, Minna***
	12.25 – 12.35	**Q&A Dr. R.E. Olagunju**
	12.35 – 12. 40	**Session Chair Remarks**
	12.45 – 13.50	**LUNCH**

13.50 – 15.50	**PARALLEL SESSION 1**		
	STREAM 1 (LECTURE THEATRE)	STREAM 2 (PG SEMINAR ROOM)	STREAM 3 (SET BOARD ROOM)
Chair	**Prof. Y.A. Sanusi** **Federal University of Technology Minna**	**Dr. L. Oyewobi** **Federal University of Technology Minna**	**Prof. S.N. Zubairu** **Federal University of Technology Minna**
Rapporteur	**Dr. M. Dalil**	**Dr. N.I. Popoola**	**Dr. I.A. Olatunji**
Theme	**Urban Resilience and Energy Conservation**	**Infrastructure Development and Financing**	**Conceptual Issues on Climate Change and Sustainable Development**
13.50 – 14.00	Adaptation Of Passive Cooling Strategies In Hostels Of Tertiary Institutions, Niger State - *Bello Joseph Enesi, Oriwoh Akhabue & Adedayo Olatunde Folaranmi*	Assessment Of Real Estate Investment Activities Of Insurance Companies In Nigeria - *Mohammed Danlami Inuwa, Sidi Isah, Mohammed Umar Faruck & Ahmed Maimuna Larai*	Landscaping For Passive Security And Adaptation For Climate In Church Environment Niger State, Nigeria - *Ailoyafen, Dorcas, Adedayo, Olatunde Folaranmi & Adebayo Oluwatoyin Abiodun*
14.00 -14.10	Resilient Cities As A Pivotal Component Of Climate Variability Mitigation: Lesson For Nigerian Cities - *Medayese, O.B., Abd'razack, N.T.A, Medayese, S.O. & Dalil, M*	Examination Of Housing Investment Performance In Abuja, Nigeria - *Wahab, Babatunde M. Durosinmi, Wasiu A., Mustapha Adamu, I.A Olatunji & M.T.A Ajayi*	Retrofitting Faculty Building With External Balconies For Adaptation To Climate Change **-** *Onwuka, Bridget Nneoma, Yusuff, Taiwo Qasim & Adedayo, Olatunde Folaranmi*
14.10 – 14.20	Q&A		
14.20 – 14.30	Modeling The Energy Profiles Of Typical Buildings In Nigeria: A Case Study Of Sokoto, Oshogbo And Minna **-** ***Mambo Abdulhameed Danjuma & Mustapha Zubairu***	Infrastructure Development And Financing For Sustainable Housing Delivery In Nigeria: A Review - *Atamewan, E. E & Tabuko, B. D*	Soil Carbon Dioxideefflux In Three Different Canopy Densities Of Tropical Forest, Peninsular Malaysia - *Mande Kato Hosea, Ahmad Abdullah Makmom, Ahmad Zaharin Aris, Ahmad Ainuddin Nuruddin & Suleman, Ezekiel Nghai*
14.30 – 14.40	Day Lighting And Sustainability Of Office Complexes In Niger State - *Dauda Abubakar Dada, I. M. Kontagora, Ibrahim S.Mohoro, Abubakar Wuna & Yalwa Atukur*	Modeling The Effect Of Changes In The Price Of Construction Materials On The Rate Of Development In Abuja **-** *Olasanmoye, R. S. & Idiake, J. E.*	Sustainable Bus Terminal Design With Adaptation To Climate Change - *Abba Mark Terlumun & Anunobi, A.I.*
14.40 – 14.50	Q&A		
14.50 – 15.00	Walk-Though Energy Audit Exercise On Office Buildings Of Kaduna Central Bussiness District; Nigeria - *Salihu Murtala Muhammad, Ejeh David & Hassan Ozovehe Saliu*	Work-Life Balance Among Women Construction Workers: A Conceptual Approach - *Oyewobi, Luqman Oyekunle & Adeneye, Toyin Deborah*	Investigation Of The Effect Of Sea Level Variation On Vertical Reference Frames Based On A Designed Experiment - *Odumosu, J. O., Idowu, T. O., Adesina, E. A., Ajayi, O. G. & Ibrahim, P.*
15.00 – 15.10	Evaluation Of Passive Cooling Techniques In Government Office Buildings In Minna Niger State Nigeria - *Michael, B. U & Olaniyan, O.A.*	Bridging Communication Gap At Construction Sites In Abuja: The Pidgin English Advantage - *Bamgbade, Adebisi Abosede & Jimoh, Richard Ajayi*	Climate Change, Related Events And The Challenge Of Sustainable Environmental Quality: The Nigerian Experience - *Uyobong Sunday Etuk, Nyeneime Victor Raphael & Edidiong Elijah Usip*

	15.10 – 15.20	Q&A		
	15.20 – 15.25	**Session Chair Remarks**		
	15.25 – 15.40	**SNACK BREAK**		
	15.40 – 16.30	**PARALLEL SESSION 2**		
		STREAM 1 (LECTURE THEATRE)	STREAM 2 (PG SEMINAR ROOM)	STREAM 3 (SET BOARD ROOM)
	Chair	**Prof. A.M. Jinadu Federal University of Technology Minna**	**Dr. J.E. Idiake Federal University of Technology Minna**	**Dr. M.I. Bala Federal University of Technology Minna**
	Rapporteur	**Dr. N.T.A. Abdurazzaq**	**Dr. M. Yakubu**	**Dr. A.D. Isah**
	Theme	**Urban Resilience and Energy Conservation**	**Infrastructure Development and Financing**	**Conceptual Issues on Climate Change and Sustainable Development**
	15.40 – 15.50	Municipal Solid Waste Conversion To Energy And Derived Chemicals Using Pyrolysis - *Muhammad Abdul-Qdir, M.A. Olutoye, D.O. Agbajelola, O.D. Adeniyi & E.J. Eterigho*	The Challenges Of Cost Management Of Infrastructure Development In Nigeria - *Kasimu A. Muhammad*	Investigation Of The Impact Of Sunspots On Earth's Climate - *Ajayi, O. G.; Ibik, A. L.; Odumosu, J. O.; Babalola, K. H. & Adesina, E. A.*
	15.50 – 16.00	Assessment Of Quality Of Neighbourhood As Determinant Of Choice Of Location Among Residents In Bosso And Kpakungu Residential Areas Of Minna, Niger State - *Altine Maxwell Kyon, Sum Habila Ezekiel & Terzungwe Dugeri*	Examination Of Factors Affecting Accuracy Of Valuation For Secured Lending In Abuja, Nigeria - *Charles-Afolabi Christianah Yetunde & Olatunji Ayodele*	Assessment Of Bioclimatic Priciples In The Design Of Public Spaces In Minna - *D.O. Alonge, S.A. Oyetola, G.O. Adebisi, O.J. Onuwe, A.U. Attah & Tauheed, A.I.*
	16.00 – 16.10	Q&A		
	16.10 – 16.20	Lighting Performance of A Faculty Building: A Case Study Of Federal University Of Technology Minna - *Mambo Abdulhameed Danjuma & Opayemi Idowu Opeyemi*	**Arbitration As An Alternative Dispute Resolution In Real Estate - *Olatunji Olajumoke Omotola***	Review And Development Of An Algorithm For Carbon Dioxide Emission Monitor In Automobile - *Musa Nicholas Akhaze & Agajo James*
	16.20 – 16.30	Assessment Of Natural Ventilation In Public Office Buildings: Case Study Of Selected Public Office Buildings In Niger State - *Igwe, Echezona Chukwuebuka & Abdulrahaman, Mukaila El-Hussain*	Financial Risk Associated with Housing Estate Project Development - *Umar, Muhammad Kabir & Ibrahim Ahmad Doko*	Sustainable Built Environment and Climate Change; The Place of Neighbourhood Security and Effective Property Management in Neighbourhoods of Bida, Niger State - *Umar A. Saidu, Mamman Mathew & Maxwell Chidi Duru*
	16.30 – 16.40	Q&A		
	16.40 – 16.45	**Session Chair Remarks**		
	16.40 – 17.00	**CLOSE**		

DAY TWO	WEDNESDAY	11TH MAY 2016		
	08.40 – 09.00	**Highlights of Day One Dr. R.A. Jimoh**		
	09.00 – 09.55	**PLENARY SESSION II** **Chairman of Session: Prof. I.N. Mogbo, Department of Science Education, Federal University of Technology, Minna** **Session Rapporteur: Dr. I.C. Onuigbo, Federal University of Technology, Minna**		
	09.00 – 09.05	**Session Chairman Remarks**		
	09.05 – 09.25	**Plenary Paper IV** **Making a Good Research Presentation and Research Ethics.** **- *Prof. O.O. Morenikeji,* Deputy Vice-Chancellor Academics, Federal University of Technology, Minna**		
	09.25 – 09.45	**Plenary Paper V** **Managing Time and Resources for Research and Teaching.** **- *Prof. Y.A. Sanusi,* Dean School of Environmental Technology, Federal University of Technology, Minna**		
	09.45 – 09.55	**Q&A Dr. I.C. Onuigbo**		
	10.00 – 11.05	**PARALLEL SESSION 3**		
		STREAM 1 (LECTURE THEATRE)	STREAM 2 (PG SEMINAR ROOM)	STREAM 3 (SET BOARD ROOM)
	Chair	**Dr. A.A. Okhimamhe** **Federal University of Technology Minna**	**Prof. H. A. Makun** **Federal University of Technology Minna**	**Prof. M. Zubairu** **Federal University of Technology Minna**
	Rapporteur	**Dr. A.I. Anunobi**	**Dr. A.E. Abalaka**	**Dr. P. Ayuba**
	Theme	**Climate Change and Threat to Sustainability of the Built Environment**	**Waste Management and Sanitation**	**Sustainable Practice Theories**
	10.00 – 10.10	Review Of Changes In Climate And Sustainable Urban Develoment In Akure Metropolis – Akure *Josephine. O. & Zacchaeus, Mayowa. E*	Assessment Of Solid Waste Management In Akure, Nigeria - *Adebayo, Michael Adedayo and Mbazor, David Ngwoke*	Adaptation And Flexibility Of Space In Sustainable Hospital Design In Niger State - *Akerele Adesola Olaronke & Adedayo Olatunde Folaranmi*
	10.10 – 10.20	Adapting to Climate Change Flooding Impacts- A Guide For Achieving Sustainable Built Environment In Nigeria - ***Bello Nurudeen Akinsola, Adepoju Adetoye Sulaiman & Adeogun Adekunle Sunday***	Assessment of Solid Waste Management Practices in Makera Ward Of Minna Niger State - *Salihu, Suleiman, Suleiman, Aisha Nana & Shuaib, Iklimah*	Comparative Analysis Of Low-Tech Sustainable Housing Projects In Abuja and Environs - *Oluigbo Stephen Nwabunwanne & Danjuma Golesh Abel*
	10.20 – 10.30	Q&A		
	10.30 – 10.40	Confronting The Challenge Of Climate Change On Built Environment In Nigeria: Utilizing A Resilient Response - *Tauheed, I. A. & Alonge, D.O.*	Assessment Of Household Solid Waste Management Techniques In Some Selected Informal Settlements In Minna, Niger State, Nigeria - *Shuaib Iklimah, Salihu Suleiman, Aisha, Nana Suleiman & Dauda, Abubakar Dada*	Design Consideration For Ecological And Green Design In Shopping Centres In Minna Niger State, Nigeria - *M.I. Bala & Metu John*

	10.40 – 10.50	Climate Change And Its Threats To Sustainable Built Environment - *Onuigbo Ifeanyi Chukwudi*	Evaluating The Spatial Distribution Of Open Dumpsites And Their Effects On The Residents In Bosso-Minna, Nigeria - *Salamatu Kassah, Abdullahi A. Kuta, Nanpon Zitta, Oluibukun G. Ajayi, Semiratu W. Abdullahi & Idris M. Kontagora*	Green Architecture: The Perception Of Nigerian Architects - *Elimisiemon Monday Chris, Damen Moeduutman Raymond & Garba Hyeladzira Msheila*
	10.50 – 11.00	Q&A		
	11.00 – 11.05	**Session Chair Remarks**		
	11.00 – 11.20	**TEA BREAK**		
	11.20 – 12.55	**PARALLEL SESSION 4**		
		STREAM 1 (LECTURE THEATRE)	STREAM 2 (PG SEMINAR ROOM)	STREAM 3 (SET BOARD ROOM)
	Chair	**Dr. Aishatu Abdulkadir Federal University of Technology Minna**	**Dr. A. Saka Federal University of Technology Minna**	**Prof. S.N. Zubairu Federal University of Technology Minna**
	Rapporteur	**Dr. B. Olawuyi**	**Dr. H. Ogiri**	**Dr. E. Umaru**
	Theme	**Climate Change and Threat to Sustainability of the Built Environment**	**Waste Management and Sanitation**	**Sustainable Practice Theories**
	11.20 – 11.30	Emission Reduction At The Exhaust Of A Diesel Internal Combustion Engine By Partial Flow Technology - *Musa Nicholas Akhaze & Fatona Stephen Ayodele*	Assessment Of Storm Water Drainage System In Selected Housing Estates In Minna Niger State - *Dauda Abubakar Dada, Shuaib Iklimah, Makun Christopher Sunday & Nasiru Salihu*	Integration Of Key Design Elements For Play-Learning Environment In Elementary Schools In Minna, Nigeria - *Akpama, D. S. & Ayuba, P.*
	11.30 -11.40	Climate Change And Treats To Sustainability Of The Built Environment: The Impact Of Charcoal As A Source Of Domestic Cooking Energy On The Built Environment, A Case Study Of Niger State - *Ndawashi B. M., Morenikeji F. T., Salihu U. T., & Otijele G. O.*	Integration Of Organic Sloid Waste Recycling For Improving The Environmental Sustainability Of Hotels In Minna, Niger State, Nigeria - *Otomi Peter*	Mitigating Climate Change Through Green Architecture - *Elimisiemon, Monday Chris, Raymond, L. Damen* & *Hyeladzira, Msheila Garba*
	11.40 – 11.50	Q&A		
	11.50 – 12.00	Human Contributions Towards The Devastation Of Flood On Communities In Kaduna State - *Salihu Usman Tyabo, Morenikeji Fisayo Teniola, Muhammad Bello Ndawashi & Otijele Godwin Omachoko*	Assessment On Refuse Disposal Techniques In Housing Estates Of Minna, Niger State - *Morenikeji Fisayo Teniola,* *Salihu Usman Tyabo, Ndawashi Bello Mohammed & Otijele Godwin Omachoko*	Understanding The Role The Architect Plays In Attaining Sustainable Design And Construction - *Ajufoh Michael Onyemaechi, Dauda Ali, & Yaktor J. L,*
	12.00 – 12.10	Environmental Impact of Construction of Gen. M.I Wushishi Housing Estate On Vegetation and Climate - *Muhammad*	Effect Of Solid Waste Management On Residential Quarters In Akure, Nigeria - *Victor Olufemi Adegbehingbe & Sunday Adeluyi Bobadoye*	Use Of Open Spaces In Improving Office Building Sustainability In Tertiary Institutions - *Oqua, Idowu Titilope &* *Adedayo, Olatunde Folaranmi*

		Abdullahi ABDULSALAM & Abdulahi Sule ARGUNGU		
	12.10 – 12.20	Climate Change, the Segregational Application, the Gwagwalada Experience - *Ekweghariri, L. C., Shaibu, S. I., Owoyele, S.G. & Idowu, O. O.*	Factors Influencing Households' Waste Separation Behaviour In Lagos Metropolis - *Ilechukwu, Victor and Chukwukaora, Ebere*	Assessment Of The Impact Of Partition Materials On Flexibility Of Spaces In Selected Commercial Offices In Minna - *Muhammed, Bashir Ajala & Anthony I. Anunobi*
	12.20 – 12.30	Q&A		
	12.30 – 12.40	The Socio-Cultural Effect Of Changing From Traditional To Modern Architecture In Nigeria, 1915- 2015 - *Eze, Chukwudum J. & Zubairu, S. N.*	Assessment Of Explosion Protection Measures In Commercial Complexes In Abuja, Nigeria - *Ahmed Salawu & Lawal Mohammed*	Green Building Construction In Abuja: The Matters Arising - *Rasheed Babatunde Isa, Paul Abayomi Bajere, Richard Ajayi Jimoh & Usman Shittu*
	12.40 – 12.50	Q&A		
	12.50 – 12.55	**Session Chair Remarks**		
	12.55 – 13.55	**LUNCH**		
	14.00 – 15.55	**PARALLEL SESSION 5**		
		STREAM 1 (LECTURE THEATRE)	STREAM 2 (PG SEMINAR ROOM)	STREAM 3 (SET BOARD ROOM)
	Chair	**Dr. S. Oluigbo** **Ahmadu Bello University Zaria**	**Dr. M. Olutoye** **Federal University of Technology Minna**	**Dr. A. Onumanyi** **Federal University of Technology Minna**
	Rapporteur	**Dr. M.T.A. Ajayi**	**Dr. I. Babangida**	**Dr. B. Banki**
	Theme	**Sustainable Materials**	**Health and Safety Issues**	**Cross Cutting Issues**
	14.00 – 14.10	Effects Of Palm Kernel Shell As Coarse Aggregate Replacement On Strength Properties Of Concrete – *A. E. Abalaka, O. M. Enejiyon & J. Moses*	Effectiveness Of Froth Flotation Method For The Beneficiation Of Baban Tsauni (Nigeria) Lead-Gold Ore - *E.A.P. Egbe, E. Mudiare, O.K.Abubakre*[1]*, M.I. Ogunbajo*	3D Modeling of Structures Using Terrestrial Laser Scanning Technique: Case Study Faculty Of Engineering, University of Lagos - *Oseni, Ayokunle Ebenezer*
	14.10 – 14.20	Effects Of Waste Burnt Brick Powder On Strength Of Concrete - *A. E Abalaka, M. G Abubakar, N. Haruna & J. Moses*	Assessment Of Fire Safety Provisions In Tertiary Institution Hostel Buildings In Niger State - *Aliyu, Waziri Ibrahim, & Abdulrahman, Mukaila El-Hussain*	Assessment Of Insecurity Challenges In Nyanya Area Of Abuja, Nigeria - ***V. E** Matins, S.O Medayese, G. Danlami, S.I Shaibu & C.B Ohadugha*
	14.20 – 14.30	Q&A		
	14.30 – 14.40	Influence Of Oil Palm Plantation Age And Hydrology On Dissolved Organic Carbon Concentration Of Malaysian Tropical Peatland Water Resources - *Adesiji, R.A., Mohammad, T.A., Nik, N.N.D., Sayok, A.K., Padfield, R., Evers, S., Jimoh, I.O. & Gbadebo, A.O.*	Location-Allocation Analysis Of Public Health Site Selection Using P-Centre Model: (Case Study Of Chanchaga Local Government Area, Minna, Niger State) - *Adesina, E. A, Odumosu, J.O, Zitta. N, Ajayi, O.G, Kuta, A.A, & Adamu, G.M*	Assessment Of The Effect Of Communal Conflicts On Residential Segregation In Kaduna Metropolis, Kaduna State, Nigeria - *Dalil, M, Sulyman, A. O. & Dantudu, A. S. U.*
	14.40 – 14.50	Potential Of Compressed Earth Blocks For Large Scale Affordable Housing Development In Nigeria - *Obaje Juliet A., P. Bajere & P. Ayuba*	Assessment Of Wheelchair Accessibility In Faculty Buildings At The Federal University Of Technology Minna – *R.E. Olagunju, P. Ayuba, M.E Abdulrahman, S.A Oyetola, D.O Alonge & M.B Ajala*	Evaluation Of User Satisfaction In Selected Students Halls Of Residence, University Of Ibadan, Nigeria - *Akinluyi, Muyiwa Lawrence & Nasamu, Raphael*

	14.50 – 15.00	Q&A		
	15.00 - 15.10	Particle Size Distribution Methods As Adopted For Different Materials - *B.J. Olawuyi & S. Asante*	Public Transport Operations And Mobility Needs Of The Elderly In Lagos, Nigeria - *O.O.Agunloye & O.A. Adeniji*	Tenure Security Due To Unresolved Residential Land Disputes In Kaduna: Challenges And Way Forward - *Mamman Matthew, Saidu A. Umar & M. B. Nuhu*
	15.10 – 15.20	Recycling Of Deconstructed Building Materials From Selected Urban Renewal And Renovation Projects In Minna, Niger State - *Ayuba, P. & Albert, B. S.*	Viability Of Fire Escape Routes In The Student Hostels At Selected Katsina State Tertiary Institutions - *Shittu, Abdullateef Adewale, Idiake, John Ebhohimen, Oyewobi, Luqman Oyekunle, Tsado, Abel John, Bilyaminu, Badamasi & Mac-Barango, Dumo O.*	Design Consideration For Crowd Control In Religious Buildings: A Case Study Of Mosque Buildings In Niger State, Nigeria - *Oyerinde, Babatunde Rasheed*
	15.20 – 15.30	Q&A		
	15.30 – 15.40	Compressed Earth Bricks For Sustainable Built Environment In Nigeria - *Obaje Juliet A., M. Zubairu & Ryal-Net Marcus Balah*	Reducing Accidents and Health Hazards In The Nigerian Building Industry - *Eze, Chukwudum J., Ayuba, Philip &* ***Shittu,*** *Abdullateef Adewale*	The Adequacy Of Relaxation Spaces For Students In Selected Faculty Buildings In Niger State - *Afolabi O. M., Mustapha M., S.K. Goshi & A. I. Anunobi*
	15.40 – 15.50	Q&A		
	15.50 – 15.55	**Session Chair Remarks**		
	15.55 – 16.10	**SNACK BREAK**		
	16.10 – 16.40	**URBANISATION RESEARCH NIGERIA SESSION 1**		
	16.40 - 16.50	**Q&A Dr. O. A. Kemiki**		
	16.50 – 17.15	CLOSE		

DAY THREE	**THURSDAY**	**12TH MAY 2016**		
	08.40 – 09.00	**Highlights of Day Three Dr. L.Oyewobi**		
	09.00 – 09.45	**URBANISATION RESEARCH NIGERIA SESSION 2**		
	09.45 – 09.55	**Q&A Dr. O.A. Kemiki**		
	10.00 – 11.00	**PARALLEL SESSION 6**		
		STREAM 1 (LECTURE THEATRE)	STREAM 2 (PG SEMINAR ROOM)	STREAM 3 (SET BOARD ROOM)
	Chair	**Dr. P. Bajere Federal University of Technology Minna**	**Prof. A.M. Jinadu Federal University of Technology Minna**	**Dr. J.J. Dukiya Federal University of Technology Minna**
	Rapporteur	**Arc. S.A. Oyetola**	**Dr. A.I. Anunobi**	**Dr. P. Ayuba**
	Theme	**Designing the Human Settlement**	**Climate Change Induced Disaster**	**Cross Cutting Issues**

		for Climate Change		
	10.00 – 10.10	Assessing The Impact Of Kaduna State University, Kafanchan Campus On Its Host Community, Binzom – The Beginnings Of An Unsustainable Rural Transformation In Binzom Community - *Musa Sylvanus Hassan & Shamang Kasham*	Innovative Approaches To Flood Resilience In Vulnerable Urban Communities: Experiences Of Women In Makoko - Lagos, Nigeria - *Lawanson, T. & Odunbaku, O.*	Assessment Of Passive Security Design Considerations In Shopping Complexes In Minna, Niger State - *Yisa, Emmanuel Yisa & Anthony I. Anunobi*
	10.10 – 10.20	Assessment Of The Implications Of Urban Growth In Suleja Between 1987 And 2014 - *Adeleye, B. M., Sulyman, A.O., Medayese, S.O., Ayangbile, O. A. & Popoola, A.*	Flooding And The Livelihood Of Residents Along Benue River, Makurdi - *Nenger-John Danjuma E.T & Umar Haliru Vulegbo*	Integration Of Outdoor Relaxation Spaces In Hospital Buildings In Abuja For Staff Satisfaction - *Yusuff, Taiwo Qasim, Onwuka, Bridget Nneoma & Adedayo, Olatunde Folaranmi*
	10.20 – 10.30	Q&A		
	10.30 – 10.40	Users Perception On Landscape Features Of Office Buildings In Abuja Nigeria - *Adedokun Adebayo John, Adedayo Olatunde Folaranmi, Adebayo Oluwatoyin Abiodun & Anunobi Anthony Ikechukwu*	Impacts Of Climate Change On Flooding Incidence In Zaria, Nigeria - *Kubai Zonkwa*	Theoretical Evaluation of Art Elements and the Relationships with Design Activities in Architecture- *A.S.ALFA*
	10.40 – 10.50	Integration Of Recreational Spaces In Hotel Buildings To Improve User Comfort In Minna, Niger State - *Abubakar, Olaitan Abdulrazak*	Effect Of Flood Disaster On The Food Security Status Of Cassava Farmers In Kogi State, Nigeria: Emerging Issues For The Post 2015 Universal Sustainable Development Agenda - *Coker, Ayodeji Alexander Ajibola; Adebayo, Cornelius Owoniyi, & Chidiebere, Ezine Gift*	Assessment Of Spontaneous Physical Housing Changes In Urban Centres Of South West Nigeria - *Abdulrahman, M.E., Olagunju R.E., Morenikeji, O.O. & Jinadu, A.M.*
	10.50 – 11.00	Q&A		
	11.00 – 11.05	**Session Chair Remarks**		
	11.05 – 11.20	**TEA BREAK**		
	11.25 – 13.10	**PARALLEL SESSION 7**		
		STREAM 1 (LECTURE THEATRE)	STREAM 2 (PG SEMINAR ROOM)	STREAM 3 (SET BOARD ROOM)
	Chair	**Prof. Y.A. Sanusi** **Federal University of Technology Minna**	**Dr. S. Ojoye** **Federal University of Technology Minna**	**Dr. O.A. Kemiki** **Federal University of Technology Minna**
	Rapporteur	**Dr. R.E. Olagunju**	**Dr. A.I. Anunobi**	**Dr. B. Olawuyi**
	Theme	**Designing the Human Settlement for Climate Change**	**Climate Change Induced Disaster**	**Infrastructure Development and Financing**
	11.25 - 11.35	The Impact Of Housing Transformation On The Quality Of The Environment Of	Climate Change Induced Disasters - *Nwose, I.A., Gbedu, A.M. & Ibrahim P.O.*	Route Re-Alignment Survey For Cost Effective Construction Of A Connecting

		Residential Buildings In Government Estates In South Western Nigeria - *Victor Olufemi Adegbehingbe*		Bridge Over Suleja-Dam - *Ibrahim, O.P., Mark, Z., Isau, A.I., Samaila-Ija, H.A., Ajayi, O.G. & Nwadilor, I.J.*
	11.35 – 11.45	Assessment Of Neighbourhood Infrastructure Conditions In Minna, Nigeria - *Popoola, Naomi Ijadunola*	Distribution Patterns Of Federal And State Road Network In Imo State (2000 – 2014) - *Idike John Ebhohimen[1*], Shittu Abdullateef Adewale, Adaji Edna Eleojo & Akanmu William P.*	Building A Modern Land Administration System In Nigeria - *Kemiki O. A., Ayoola, A. B., Kuma, S. S., Ojetunde, I. & Fabunmi, F. O.*
	11.45 – 11.55	Q&A		
	11.55 – 12.05	Strategies For Improving Informal Interaction In Study Of School Of Environmental Technology, Federal University Of Technology, Minna, Using Isovist Visibility Graphs - *Oyetola, S.A., Zubairu, S.N., Adedayo, O.F. Alonge, D. O. & Eri, P.O.*	Assessment Of Ergonomic Factors Among Non-Academic Staff Of School Of Environmental Technology, Federal University Of Technology Minna - *Y.D. Mohammed, P.O. Alumbugu & R.A. Jimoh*	Evaluation Of Site Progress Records For Effective Project Management In Abuja, Nigeria - *Bajere, Paul Abayomi & Mohammed, Nasiru Abubakar*
	12.05 – 12.15	Residents' Intra-Urban Mobile Phone Usage and Travel Demand In Somolu Local Government Area, Lagos, Nigeria - *Peter Olulade FOSUDO, O.O. AGUNLOYE & O. A. BANJO*	Factors Affecting Project Planning Efforts In Akwa-Ibom State - *Olubajo .O. Oluseun, Godwin Idoro & R. A. Jimoh*	Challenges Of Property Rating Assessment In Karu Local Government Area Of Nasarawa State - *Celina, A., Kolo, M.Z. & Ajayi, M.T.A*
	12.15 – 12.25	Q&A		
	12.25 – 12.35	Assessment Of User's Perception Of Landscape Provided In Faculty Buildings In Tertiary Institution, Kogi State - *Otijele Godwin Omachoko, Salihu Usman Tyabo, Muhammad Bello Ndawashi & Morenikeji Fisayo Teniola*	Review of Effects of Variation Order on Total Cost and Schedule in Refurbishment Projects - *BABANGIDA Ibrahim, ABDULAZEEZ Abdulmumin & IDIAKE John*	Stratospheric Ozone Variability: An Implication For Climate Change Over Some Selectected Stations In Northern Nigeria - *Ojoye, S. & Sulyman, A.O.*
	12.35 – 12.45	Expanded Polystyrene (Eps) As Substitute For Traditional Fascia Materials - *Hassan, 1. O., Sani, D. O., Umar, A., Usman, B.W.*	Assessment Of The Availability Of Landscape Elements In Public Secondary Schools In Minna Niger State - *Adams Esther Amaka*	Built Environmental Factors Associated with the Spread of Vector-Borne Disease: The case of Malaria in Urban Areas of Nigeria - *Umaru, E.T., Martins, V.I., Shuaibu, S.I.*
	12.45 – 12.55		Impact of a Tertiary Institution on the Infrastructure Development of the Host Community. - *Olurotimi Kemiki, Adeyosoye Ayoola & Olusegun Idowu*	Evaluation Of The Effects Of Abandoned Buildings On Sustainable Development Of Residential Areas In Minna, Niger State *Otache, A.A. & Anunobi A.I.*
	12.55 -13.05	Q&A		
	13.05 – 13.10	**Session Chair Remarks**		
	13.10– 14.10	**LUNCH**		
	14.10 – 14.30	**Conference Summary - Dr. R.A. Jimoh**		
	14.30 – 15.00	**Presentation of Certificate**		
	15.00 – 15.15	CLOSING REMARKS Prof. Y.A. Sanusi, Dean School of Environmental Technology, Minna		

	15.15 – 15.25	Vote of Thanks
	15.30 – 16.00	**SNACKS AND CLOSE**

CONTENTS

SECTION 1: KEYNOTES

SECTION 2: CONFERENCE PAPERS

SECTION 1: KEYNOTE PAPERS

RESEARCH ETHICS: RESEARCHERS' CONDUCT AND ITS IMPLICATIONS ON RESEARCH PARTICIPANTS

Prof. Olakanmi Oluwole MORENIKEJI
Deputy Vice-Chancellor (Academics), Federal University of Technology, Minna

Every aspect of a research work is governed by some ethical considerations which are usually taken for granted. This paper gives an insight into some of the ethical issues that relate to conducting research, analysing data and reporting the findings. First approval to commence a research must be sought from Research Ethics Committee who will ensure that all requirements are met. Such requirements include proving that participation in the research is voluntary, clear communication of the purpose of the research to the participants, including the interviewees who may be local and uneducated people, getting informed consent and ensuring the anonymity of participants. Other requirements include explanations on how the participants will be selected, disclosure of any potential unintended consequences of the research report and assurance that no harm will come to the participants through the research report. Though all these requirements are geared towards protecting the rights of the participants and ensure independent and unbiased research work, passing the tests can be cumbersome and waste precious time.

oluwole@futminna.edu.ng

MORENIKEJI, O.O. (2016). **RESEARCH ETHICS: RESEARCHERS' CONDUCT AND ITS IMPLICATIONS ON RESEARCH PARTICIPANTS** Sustainable Built Environment and Climate change; The challenges of Post 2015 Development Agenda. School of Environmental Technology Conference, SETIC, 2016

TECHNOLOGICAL TRENDS IN ENGINEERING AS APPLICABLE TO ENIVIRONMENTAL TECHNOLOGY

Prof. Abiodun Musa AIBINU

Department, Mechatronics Engineering Department, & Federal University of Technology, Minna
Director, Center for Open Distance and e-Learning (CODeL), Federal University of Technology, Minna.

Several revolutionary advancements have been witnessed within the last three centuries. Currently, the world is witnessing the ‘Mechatronics’ revolution, characterised by real-time prototyping, dynamic innovation and high speed of information exchange. Mechatronics approach unlike other traditional approaches has brought about efficient and effective products and services delivery without quality degradation. More importantly, this revolution has continued to satisfy the need for a sense of feel and touch through advance manufacturing and prototyping techniques.

The traditional method of prototyping, architectural and urban planning techniques could not afford the present yearning of having a feel, touch and more detailed perspective of intending projects prior to commencement. Hence, preventing a luxurious touch of perfection that could have been added to the conceived idea. Recent technological advancement in Mechatronics Engineering has come handy in providing solution to the aforementioned problems by the introduction of 3D printing technique.

The 3D printing revolutionary approach has come as a succour in providing a feel, touch and more detailed perspective of intended projects prior to commencement. With a 3D printer, a 3D model of the intended project can be produced within minutes. The printed model has been shown to provide the desired sense of feel, touch and detailed perception, walk through, analysis and visual inspection of important aspect of the project even at the prototype stage. This definitely answers lots of questions than just showing paper work or 3D movie of the proposed project.

maibinu@gmail.com

AIBINU, A.M. (2016). **TECHNOLOGICAL TRENDS IN ENGINEERING AS APPLICABLE TO ENIVIRONMENTAL TECHNOLOGY** Sustainable Built Environment and Climate change; The challenges of Post 2015 Development Agenda. School of Environmental Technology Conference, SETIC, 2016

Furthermore, other Mechatronics approaches introduced recently as applicable to built environment include Unmanned Aerial Vehicle (UAV) and 3D map producing software, Embedded System Development etc. UAVs have been applied in various fields among which include surveying; urban planning; disaster response and management; estate management etc. Similarly, 3D map producing software have also been used in producing 3D maps of surveyed areas in a matter of minutes. Most of these software comes with user-friendly interfaces and can be used on portable devices.

In conclusion, architectural design, building technology, surveying, Urban and regional planning and other related fields in environmental technology can leverage on Mechatronics revolution in enhancing products and service delivery without loss of time and quality.

INTEGRATING CLIMATE CHANGE ADAPTATION STRATEGIES INTO URBAN DESIGNS: A MUST FOR TODAY'S BUILT ENVIRONMENT PROFESSIONAL

Dr. OKHIMAMHE, A. A.

Director, West African Science Service Centre of Climate Change and Adapted Land Use,
Master Research Programme on Climate Change and Adapted Land Use,
Federal University of Technology, Minna, Niger State, NIGERIA

The built environment, urban infrastructure systems and services and ecosystem services will be profoundly impacted by climate change through increased frequency, intensity, and/or duration of extreme weather events such as heavy rainfall, warm spells and heat events; drought, intense storm surges, and associated sea level rise (IPCC, 2007, 2012; Hunt and Watkiss, 2011; Romero-Lankao and Dodman, 2011; Rosenzweig et al., 2011). These will not only affect the economy and population, but also exacerbate the existing socio-economic and environmental drivers of risk for the most vulnerable. Thus adapting existing and new buildings to climate change requires knowledge and innovation in the provision of affordable housing with structural integrity that is climate resilient and can withstand extreme weather as well as incorporate health and safety considerations (UNISDR, 2009; 2011).

Studies have projected that, in Nigeria, climate change will lead to increase in annual rainfall in some areas, and a decrease in others; both temperature and rainfall extremes are predicted to increase, but with a degree of certainty for rainfall events (BNRCC 2011). Furthermore, simulation using models have predicted that temperature will be higher by 1–2 degrees in 2056-2065 with the extreme north having the highest values. This will be more evident in December to February, whereby temperatures in the north central part of Nigeria will increase by up to 3.5°C. Additionally, in 2020 - 2050, 41-53% of Nigeria is expected to be wetter, while 20-35%t will be stable and 10-14 % will be drier, and for the remaining 2 – 25 %, precipitation projections are highly uncertain (Cervigni, 2013).

aaokhimamhe@futminna.edu.ng

OKHIMAMHE, A. A. (2016). **INTEGRATING CLIMATE CHANGE ADAPTATION STRATEGIES IN TO URBAN DESIGNS: A MUST FOR TODAY'S BUILT ENVIRONMENT PROFESSIONAL** Sustainable B uilt Environment and Climate change; The challenges of Post 2015 Development Agenda. School of Environmental T echnology Conference, SETIC, 2016

With this in mind, two case studies, Minna and Abuja are discussed. Both cities are located in the north central Nigeria that is projected to experience an increase of 3.5°C by 2065. While Minna is far less cosmopolitan than Abuja, the town is known for its consistently high temperature during the dry season. It is recommended that built environment professionals should become more creative and climate savvy in adapting both existing and new buildings to climate change by, among others, enhancing poor quality housing through structural retrofitting, interventions that reduce risks and non-structural interventions; paying attention to buildings that provide protection from hot days; upgrading homes with poor ventilation and low thermal mass. Of course, it is expected that challenges will be encountered due to the range of actors in the housing sector, the myriad connections to other sectors and the need to promote mitigation and adaptation, as well as development goals, and these point to the importance of well-coordinated strategies that can support resilience (Maller and Strengers, 2011). The grave predictions for the future underscore the fact that efforts must be made to overcome these challenges, and the professionals must lead the way.

EVOLVING AN EFFECTIVE RESEARCH AND INNOVATION SYSTEM FOR NATIONAL DEVELOPMENT AND UNITY IN NIGERIA

Professor Hussaini Anthony MAKUN

Director, Research, Innovation and Development, Federal University of Technology, Minna

The United Nations Development Programme rates Nigeria as a country with low human development index. Out of the 187 countries evaluated, Nigeria with its abundant human and natural resources comes a distance 152nd after poorer countries and even war torn countries like Rwanda, Angola, Pakistan and Myanmar. On a scale of 1, Nigeria has a Human Development Index of 0.504 as compared to a world average of 0.702. The country has a life expectancy from birth of 52.5 as at 2015 as against a world average of 70.8 years. It has 630 deaths per 100,000 live births. About 46% (81.65 million of 177.5 million) of Nigerians are living below the poverty line of $1.25 (N250) per day with an infant mortality rate of 78 per 1000 live births. With regards to health care Nigeria has 4 physicians to 10,000 patients as against a world average of 13.4 per 10,000 patients. The country has one of the worst records of youth unemployment of 23.9% as against the world average of 7.5%. Yet we are one of the top ten countries with regards to annual population growth rates of 2.8%, the highest been 5.9% in Qatar while the world average is 1.1%. Also in regards to perception of wellbeing only 55% and 47 % of Nigerian are satisfied with the quality of education and health care respectively. These absurd development indices are complicated by many negative attitudes like corruption, abuse of power; arrogance, social inequity and blatant injustice which combine to suppress innovation, creativity and motivation in contemporary Nigeria. The nation is making no attempt to solve her problems but waits for solutions to her problems from the Western world. This is the only justification why Nigeria spends 0.2% of its GDP on research and development as against 2.5% of GDP by very high development countries like Europe.

hussaini.makun@futminna.edu.ng

Hussaini Anthony MAKUN (2016). **EVOLVING AN EFFECTIVE RESEARCH AND INNOVATION SYSTEM FOR NATIONAL DEVELOPMENT AND UNITY IN NIGERIA** Sustainable Built Environment and Climate change; The challenges of Post 2015 Development Agenda. School of Environmental Technology Conference, SETIC, 2016

Nigeria can only reverse these very poor development indices by evolving into a knowledge-based economy and this can only be achieved by creating and sustaining an effective national research, innovation and development system which is proposed in this paper.

Keywords: Research, Innovation, Development, Nigeria.

OVERCOMING THE CONSTRAINT OF TIME IN ACADEMIC RESPONSIBILITIES

Prof. Y. A. SANUSI

Dean, School of Environmental Technology, Federal University of Technology, Minna. Nigeria.

A major resource input for an academic is time. It is never available in the required amount; but it is a resource that is available to all at the same quantity; 24 hours daily for the 365 days in the year. But the academic is a multiple role player by his employment; teaching, research and service. Each is a bundle of activities that have no time limit to their conduct; within and outside the official working hours and within and outside the four walls of the institution. With the information technology and with the deepening of this global tool, the content and scope of the responsibilities of an academic are becoming wider and wider almost daily. Time is important to him not only because he wants to satisfactorily undertake these responsibilities but also because there are the demands of distinctiveness, competition; and niche cutting. This paper will explore the range of activities that need the attention of an academic, the constraints to effective discharge of academic responsibilities, the justification for time consciousness, the impacts of poor time planning and interrogate the various ways for time planning.

yasanusi@googlemail.com

Yekeen A. SANUSI (2016). **OVERCOMING THE CONSTRAINT OF TIME IN ACADEMIC RESPONS IBILITIES** Sustainable Built Environment and Climate change; The challenges of Post 2015 Development Agenda. School of Environmental Technology
Conference, SETIC, 2016

SECTION 2: CONFERENCE PAPER

INFRASTRUCTURE DEVELOPMENT AND FINANCING

ASSESSMENT OF REAL ESTATE INVESTMENT ACTIVITIES OF INSURANCE COMPANIES IN NIGERIA

Mohammed Danlami Inuwa, Sidi Isah, Mohammed Umar Faruck and Ahmed Maimuna Larai
Department of Estate Management, Federal University of Technology, Minna, Niger State, Nigeria

Purpose – The purpose of this paper is to provide an insight into the real estate investment activities of insurance companies in Nigeria. The authors attempt to identify the capital engagements in real estate investment by insurance companies. Design/methodology/approach – After collecting the aggregate data about insurance companies' financial results for the period 2004 – 2014 and the insurance companies' financial involvement in real estate for period 2004 – 2014, the authors analyzed the relationship between the two. This is meant to assess whether the insurance companies complied with the National Housing Fund act of 1992 which mandate all insurance companies to invest minimum of 20 percent non-life and minimum 40 percent of life funds in real estate development. Findings – The analysis revealed some negative correlations; an incompliance of the insurance companies to the National Housing Fund act. If this is true, the conclusion should be accepted with caution. It is therefore recommended that management of insurance companies and government should sit and find a solution to the problems identified that hinder the insurance companies from meet up with National Housing Fund Policies. These Problems are insurance policy, long recoupment period, inflations affecting building materials leading to cash flow problem, falling premium revenue, tenancy risk and unawareness of the companies operation.

Keywords: Investment, Insurance, Revenue, Risk, Housing

mdinuwa@yahoo.com
mdinuwa25@gmail.com

Mohammed el. al. (2016). **AN ASSESSMENT OF REAL ESTATE INVESTMENT ACTIVITIES OF INSURANCE COMPANIES IN NIGERIA** Sustainable Built Environment and Climate change; The challenges of Post 2015 Development Agenda. School of Environmental Technology Conference, SETIC, 2016

INTRODUCTION

The importance of real estate for human habitation cannot be over emphasized, real estate activities cover virtually all form of permanent improvement carried out on land. This is why is seen has an essential needs of mankind which occupies a central position. Subsequent to food, real estate is mainly the most imperative desire of man (Aliyu, Hamza and Muktar 2015, Adedokun, Akinradewo, Adegoke, and Abiola-Falemo, 2012, Udoekanem, 2012, Ogbonna, 2012, Olurotimi, 2009 and Sanusi, 2003). Boykin (1979) explained that the real estate touches the economic lives of all individuals and families. It is the cornerstone of community life, the center of family activities and reference point for societal esteem, as well as the most important, financial asset most household will ever acquire (Nevova 2010).

Investing in real estate involves huge capital expenditure. Finance is therefore an essential ingredient in real estate investment. The cost, extent of which capital is provided and availability of finance for real estate investment is something of serious concern that is why government strongly encourages financial institutions to veer in to real estate investment in order to make fund available. Real estate investment could be in form of property acquisition or modifying existing property through conversion, adaptations, alterations, renovation, refurbishment, development or wholesome redevelopment with the primary objective of improving its earning capacity. Underlying any course of action is that the anticipated return justifies the proposed investment.

It is clear from the foregoing that finance is a major factor in real estate investment. Proper financing is all-important to successful real estate investment. Various forms of finance on varying terms from diverse investing agencies are available to the property market but most of them are hinged with high interest rate on loan. (Adebamowo et al 2009), emphasized that the issues on real estate finance have deep historical underpinning with rudimentary approach such as assistance from friends, communal efforts and cooperatives which is more of the informal/non-specialized real estate finance. Onabule, (1990), opined that financing real estate development has become more problematic due to complex interaction of several factors such as huge capital outlay involvement in development, high interest rate being charged on loans, stringent repayment requirements etc.

From the caption, it is a clear that there is need to for the exploration of every known avenue for financing real estate. As such there is need to involved the insurance companies in the investment of real estate since they hold billions of naira as premium. However, various legislations have been established to force financial institutions to invest certain percentage of their capital into real estate which insurance companies are not excluded. But why with all this legislation do we still experience inadequate real estate development. ? As such this challenge prompts the study to assess the real estate investment activities of insurance companies to ascertain the percentage they due allocate to real estate

REAL ESTATE INVESTMENT OPPORTUNITIES

Real Estate has been proven to be one of the most profitable investment opportunities currently available in Nigeria with relatively low variability of return. According to David S (2013), there are numerous and diverse opportunities in real estate, include

1. Land. Of all real estate ventures, investment in vacant land probably proves the greatest opportunity for creativity and profit. It involved purchase of an improved lot in a subdivision to a more complicated accumulation of hundreds of unimproved acres to hold for future development and subdividing and the acquisition of a tract of land in anticipation of rezoning for a more intensive use. Property Location and Physical Quality will have a significant impact on the success of the investment
2. Residential. It is meant for living purposes. Shelter, it is said, ranks second in the hierarchy of human needs; being most important after food. Available statistics show that 87% of the total household population in Nigeria lives in rented apartments. This fact, no doubt, makes Nigeria a viable investment destination for local and foreign investors, given the mammoth size of her population
3. Industrial. These are used for manufacturing and production. Usually involves the construction of warehouses and factory floors. This sector of the industry is not so robust in Nigeria, due to the current low level of manufacturing activities in the country.
4. Commercial. These investments are used solely for business purposes and an investor (developer) usually owns the building and collects rent from each business that operates within the structure. Sometimes, the developer could build for outright sale and subsequently appoint a facility manager. Some of the major categories of commercial real estate include:
    - Ultra-modern malls and event centers
    - Office buildings
    - Recreational Centers
    - Concessions including Roads, bridges, Free Trade Zones and ports
    - Hospitality
    - Restaurants and fast food outlets

    About 70% of global investment in real estate is in commercial real estate.

ADVANTAGES OF INVESTING IN REAL ESTATE

David S (2013) identified the followings as the advantages of investing in real estate

Relatively high Yields

Bottom-line yields in excess of 20 percent are not unusual for many real estate investments. Yields can even exceed this amount, reaching infinity in those cases where 100 percent or more leverage—using borrowed funds to purchase property—has been achieved. More common, though, are realty investments that regularly develop 10 to 15 percent annual returns over the life of the investment. These profits reflect the opportunities that exist in real estate and, when compared to average yields on other types of investments, explain its popularity.

The return on a savings investment is the rate of interest paid by the bank or savings association. These rates currently run up to 5 percent, depending on the type and duration of deposit. These are before-tax yields, which are eroded by the taxes paid, in accordance with the investor's particular tax bracket. Stocks often pay dividends that average about 5 percent of the value of the investment; but unlike savings, for which the amount of deposit remains constant over time, the value of the stocks fluctuates in the market. As a result, an element of risk is introduced for a stock investor who analyzes yield in terms of dividends received plus growth in value. If this growth is 5 percent per year and the shareholder receives 5 percent in dividends, the yield is 10 percent before taxes. Bond yields fluctuate, sometimes dramatically, as a function of the money market. A bond owner may earn 7 percent interest but may have to take a discount when selling in market at more than 7 percent. Some bonds, such as municipals, are tax exempt, and their yields are commensurately lower, depending on the bond's rating.

It is axiomatic in real estate investment that high profits are positively correlated with high risk. Although yields on real estate investments do fluctuate from time to time and from property to property, there are guidelines on which objective decisions may be based. For instance, despite the fractured quality of the general real estate market, there are fairly definable submarkets. One such submarket is apartment projects. Depending on location, number of apartments in the complex, and their size and decor, an investor can usually find comparable projects, research competitive rents, and estimate the income possible from an anticipated investment. This analysis and others will provide data on which an objective decision concerning the profitability of the investment can be based. There are similar submarkets for houses, stores, office buildings, shopping centers, and other forms of real property.

Leveraging opportunities

Although most lenders allow a purchaser to borrow up to 50 percent of the value of securities such as stocks and bonds, real estate offers an investor the highest leveraging opportunities of any investment alternative. Many realty transactions require 20 percent to 40 percent of a property's value as a cash down payment, while others have 10 percent, 5 percent, or even no down-payment requirements. A few investors, after completing some highly sophisticated financing strategies, may even be able to enjoy the benefits of arranging their real estate investment portfolios with greater than 100 percent leverage and end up with cash in their pockets.

High-leverage situations include transactions involving carryback mortgages, land leases, subordination, joint ventures, syndication, sale-leasebacks, wraparound mortgages, participation mortgages, and other creative real estate ownership and financing arrangements. These concepts and their applications, among others, will also be examined in upcoming chapters.

Income Tax flexibility

Real estate allows its owner a high degree of tax flexibility, due in large part to the application of depreciation allowances and the ability to deduct the premises' operating costs from the gross income collected.

High degree of Personal Control

Real estate investments provide the opportunity for a high degree of personal control. Purchase terms can be designed to reflect specific financial circumstances. Often, rents can be arranged to anticipate changes in future realty cycles. Various bookkeeping techniques can be adopted to reflect individual needs as they change over time. Property can be periodically refinanced to capitalize on the equity accumulated. The investor usually retains the power to decide on when, how, and to whom the investment will be sold, under terms that satisfy personal economic requirements.

RATIONALE FOR RESOURCE ALLOCATION TO REAL ESTATE INVESTMENT

There are many recommendation regard to the proportion of resources that should be allocated to real estate investment. Different authors showed significant variations in what should constitute ideal or optimal allocation into real estate investment. . Hartzell (1986) suggested between 3 to 11 per cent, Fogler (1984), Giliberto (1992, 1993) suggested between 5 and 15 per cent and 19 per cent optimal allocations respectively. Gold (1986), Irwin and Landa (1987), Firstenberg, Ross and Zisler (1988) opined that between 15 to 20 per cent should be allocated to real estate while Brinson, Diermeier and Schlarbaum (1986) opined that 20 per cent would be ideal. Martin Hoesli, Jon Lekander and Witold Witkiewicz are on the option of 15 to 25 percent. . Ennis and Burik (1991), Ziobrowski and Ziobrowski (1997)came up with between 15 to 30 per cent. Timothy (2001) suggested 40 percent. Webb and Reubens (1987) suggested at least 43 per cent. Furthermore, Webb, Curico and Reubens (1988) indicated two thirds of any portfolio should be allocated real estate. While Kallberg, Liu and Greig (1996) however felt that real estate should compose of 9 per cent of optimal portfolios. Contrary to the different figures proposed by earlier studies, Chun, Sa-Aadu and Shilling (2002) found that all the available data on ownership of real estate reveal that institutional investors hold between 3 to 4 per cent of their assets in real estate. Dhar and Goetzmann (2005) in a survey of major institutional investors across USA observed that the modal allocation to real estate asset was between 3 and 5 percent. James, Richard, and Jack (2007), suggested 2/3 should be allocated to real estate.

Different reasons may be responsible for the lack of consensus and wide variation in what should represent an ideal allocation these may due to the advantages attached to real estate investment

EVOLUTION OF INSURANCE COMPANIES INTO REAL ESTATE INVESTMENT

The huge housing deficit in Nigeria estimated at about N49triillion provides key opportunities for growth in the real estate sector; this couple with the significant infrastructure gap estimated at about $510bn (N81.6trillion) makes the industry attractive to both public and private investors. The Nigeria's housing deficit of about 17million units as over 87% of Nigerians live in rented apartments. Likewise, only about 30% of the country's 193,200km total road networks are paved compared to 70% and 58% for Frontier and emerging markets respectively. The Nigeria estimated population of about 169 million. With a 4-year annual average population growth rate of 2.6%, the demand for new houses has continued to increase. According to the Federal Office of Statistics, the total number of households in Nigeria is estimated at 28.56 million, whilst there are only 12.8million numbers of housing units. This mismatch between the number of housing units and households underscores the housing problem in Nigeria.

Part of the challenge faced by government, corporate and individual providers of housing is the finance required for providing adequate number of housing units. Consequently, the need to provide individuals with access to long-term housing funds, for the purpose of real estate development and homes acquisition necessitated various initiatives by the government, one of which is the involvement of insurance companies in the real estate investment due to their huge capital realization in trillion as premium from insurance cover, as such various law where enacted at different time to mandate insurance companies to invest in real estate. Such laws are:

i. (National Housing Fund Act No. 3 of 1992), Section 5 mandated every registered insurance company to invest a minimum of 20 percent of its non-life funds and 40 per cent of its life fund in real property development of which not less than 50 per cent shall be paid into the fund through FMBN at an interest rate not exceeding 4 per cent. Nothing contained in the insurance act or relating to investment of insurance companies in real property shall affect the provision of this Act,

ii. National housing policy of Nigeria1991. Section 5 subsections 8 noted that a substantial proportion of insurance life fund, which are long term duration could make more active and effective in mortgage business than commercial banks.

iii. Insurance degree No 59 of 1976, section 18 has restricted the potential role the insurance companies could play in housing financial mobilization by limited non-life insurance investment in real property to 10% and 25% respectively.

iv. Insurance act 2003, section 25 stated explicitly that no insurance company can invest more than 35 per cent of its assets in real estate property.

Despite all this government interventions, the gap is still not filled. Why?

ASSESSMENT REAL ESTATE INVESTMENT ACTIVITIES OF INSURANCE COMPANIES IN NIGERIA

Despite different legislations involving insurance companies to invest in real estate activities, some legislation specifying the percentage of the insurance companies' resource to be allocated to real estate while some legislation given the limit in percentage to be allocated to real estate. We find out that

1. There is little or no impact of insurance companies in real estate investment when considering the large sum generated by the insurance companies

Table1. Show trend of income and expenditure of 29 Non-life insurance firms in Nigeria, 2004-2014

Year	Gross Premium (# millions)	Expenditure (# millions)	Net Premium (# millions)
2004	50,100.8	12,084.0	38,016.8
2005	67,465.6	12,402.4	55,063.2
2006	81,583.8	76,276.1	5,307.7
2007	89,104.9	15,843.7	73,261.2
2008	126,470.3	25,864.9	100,605.4
2009	153,127.1	49,498.9	103,628.2
2010	157,336.8	37,589.6	119,747.2
2011	175,756.8	39,389.2	136,367.6
2012	Not yet release		
2013	Not yet release		
2014	Not yet release		

Source: NAICOM Annual report 2008
CBN Statistical Bulleting vol. 20 Dec 2009
NAICOM annual report 2014

Table2. Shows trend of income and expenditure of 15 life insurance firms in Nigeria, 2004-2014

Year	Gross Premium (# millions)	Expenditure (# millions)	Net Premium (# millions)
2004	396.1	-	396.1
2005	280.7	-	280.7
2006	778.1		
2007	16,274.4	9,289.5	6,984.9
2008	30,735.7	11,547.7	19,188
2009	36,833.4	12,470.3	24,363.1
2010	43,039.2	16.225.8	26,813.4
2011	57,996.1	20,815.6	37,180.5
2012	Not yet release		
2013	Not yet release		
2014	Not yet release		

Source: NAICOM Annual report 2008
CBN Statistical Bulleting vol. 20 Dec 2009
NAICOM annual report 2014

Table3. Investment of Insurance Companies in Nigeria in real estate, 2004-2014

Year	Real Estate and Mortgage investment (# million)
2004	21,832.2
2005	33,788.2
2006	45,186.8
2007	45,331.9
2008	46,329.2
2009	47,348.5
2010	48,3290.1
2011	49,454.7
2012	Not yet release
2013	Not yet release
2014	Not yet release

Source: NAICOM Annual report 2008
CBN Statistical Bulleting vol. 20 Dec 2009
NAICOM annual report 2014

From the table1 and table2 shows the trend of premium realized annual by both non-life and life insurance companies which runs into billions.

2. While Table 3, shows trend of capital invested by all the insurance companies into real estate from 2004 to 2014. This amount is too small when considering the large sum of money realized. This amount range 3% to 5%.
3. Insurance Policy is the greatest problem militating against the effective participation of insurance companies to veer into real estate investment.
4. Insurance companies prefer to invest in other sectors such as stocks, bonds shares etc. than real estate
5. Most insurance companies involved in real estate investment for self-usage i.e. for the company operational activities
6. Some of the reason why insurance companies do not actively participate in real estate investment are, illiquid nature of property, tenancy risks and feeling premium revenue, tenancy risk most often is not always easy to get tenant whenever property is developed this uncertainly attached to property create a stringent in advancing loan from insurance companies.
7. Insurance companies are favorable dispose to residential and commercial property.
8. There is sufficient enlightenment program about insurance procedure to the concern personnel and the general public.

CONCLUSION AND RECOMMENDATION

Conclusion

One of the indices for measuring the development of an economy is the size and maturity of its insurance industry. This is because the insurance industry plays a very important role in the mobilization and utilization of invisible resources in the economy.

- In conclusion, the need for real estate investment in Nigeria calls for the financial institution in Nigeria most especially insurance companies to be involve in the financing real estate project.
- Efficiently in the administration of finance source is a primary factor that determines success. With the eradication of the problems militating against the administration for financing real estate investment, smooth administration will be guaranteed, the Nigeria economy will be developed, and more income will be generated by the insurance companies.
- Insurance companies have not played an active role in advancing loans or direct involvement in real estate investment in other to increase the present real property stock in the country. This is not to say the level of participation is insufficient in real property delivery in the country. In fact presenting a more detailed analysis of performance, we can conclude that a lot has to be done by institution and also investors in real estate i.e. property investment as completely been the absent unlike most other financial institutions that undergo real estate investment for onward sale to the public. Going by

this we stand to say that the institutions performance cannot be rated as excellent, Excellency would require diversity in all aspect concerning real estate financing and delivery.

Recommendations

Based on the findings on the study, it is worthwhile to make useful suggestions or recommendation with a view to encourage the insurance companies in investing in real estate in the future.

1. It is therefore recommended that management of insurance companies and government should sit and find a solution to the problems identified that hinder the insurance companies from meet up with the legislation requirement. Also The Government should ensure adequate compliance of the insurance companies to the proportion of the premium which are meant to be invested in real estate.
2. Despite the pitfall in participation of insurance companies' indirect investment of real estate, the insurance industry should try by all most as possible to partner with other institutions in real estate investment which will enhance economic growth.
3. The weak power of enforcement policies should be addressed by working towards amendment so that noncompliance can attract appropriate sanctions.
4. The management of the insurance companies and the Government should reach an alternative agreement that will soften the rigidity of the policies so as to be able to widen the scope of performance or activities of Nigeria insurance companies.
5. It is hereby recommended that the insurance companies from time-time carry out research to reveal the best time to develop a property when high demand of property by people.
6. The Government should ensure that risk associated with property is evenly distributed among the stakeholder and such should be reduce to bearest minimal.
7. Investment in other property aside residential and commercial should be improved by ensuring check and balance.
8. Post bill, media, newspaper etc. should be used for the advertisement of Nigeria insurance service in order to promote awareness.

REFERENCES

Adebamowo. M. E, Oduwaye, L, and Oduwaye. O.S. (2009). Problems mitigating housing finance through primary mortgage institutions in Lagos. *International Business and Management Journal:* vol. *4(1),* 126-134. http://www.cscanada.net/index.php/ibm/article.

Adedokun. O. A, Akinradewo .F. O, Adegoke .J. O, & Abiola-Falemo, J. O. (2012). Evaluation of the contribution of Nation Housing Fund toward Housing delivery in Nigeria. *Journal of Building Performance*.

Adeyele. (2012). *Repositioning the Nigeria Insurance Industry For Sustainable: Risk Management Vol 4,* No5, retrieve: www.iiste.org/1435.

Agbaje. (2005). *Analysis of Insurance Practice and Economic Growth in Nigeria*

Accounting For Specialized Transaction First Editions Akins Prints, Mokola,Ibadan ISBN: 9780406002-2.

Akinwunmi, A.A. (2009), "An Investigation into Factors Affecting Housing Finance Supply in Emerging Economies: A Case Study of Nigeria" A thesis Submitted in partial fulfillment of the requirements of the University of Wolver Hampton for the degree of Doctor of Philosophy

Aliyu A.Y., Hamza U. and Muktar U. A. (2015), Real Estate Developers Perception on Conventional Borrowing Financing Residential Development.

Boykin J. (1979), "Why Real Estate Projects Fail."

Brinson G.P., Diermeier J.J. and Schlarbaum G.G. (1986), "A Composite Portfolio Benchmark for Pension Plans." *Financial Analysts Journal* (42)2, 15-24

David S (2013). Essential of Real Estate Investment, Tenth Edition

Dhar R. and Goetzmann W.N., (2005), Institutional Perspectives on Real Estate Investing, the Role of Risk and Uncertainty." A Research Publication of Pension Real Estate Association

Ennis R. and Burik P., (1991), "Pension Fund Real Estate Investment under equilibrium pricing model." *Financial Analysts Journal* 47, 20-30

Firstenberg P., Ross S. and Zisler R. (1988), "Real Estate: The Whole Story." *Journal of Portfolio Management* 14, 22-34

Fogler H.R., (1984). "Twenty Percent in Real Estate: Can Theory Justify It?" *Journal of Portfolio Management* 10, 6-13

Friedman P. Jack C. & Lindeman J.(2004).*Dictionary of Real Estate Terms, 6th Edition,* Published By Barron's Education Series.

Giliberto S.M., (1992). "Real Estate Risk and Return: 1991 Survey Results." Real estate research Paper. New York: Salomon Brothers.

Giliberto S.M., (1993). "Measuring real estate returns: The Hedged REIT Index. "*Journal of Portfolio Management* (spring) 94-99

Gold R.B., (1986), Real Estate: Can Institutional Portfolios Be Diversified Without It? Chicago: JMB Institutional Reality Corporation

Hartzell D., (1986), Real estate in the portfolio; New York: Salomon Brothers. Irwin S.H and Landa D. (1987), "Real Estate, Futures and Gold as Portfolio Assets;" *Journal of Portfolio Management* 13, 29-34

Jimoh I (2006), *Legal Framework for Insurance In Nigeria:* Continuous Professional Development, Abuja Chapter.

Kallberg J.G., Liu C.H. and Greig W. (1996), "The Role of Real Estate in the Portfolio Allocation Process;" *Real Estate Economics* 24, 359-378

Martin H, Jon L and Witold W (2003), I n t e r n a t i o n a l e v i d e n c e o n R e a l E s t a t e a s a P o r t f o l i o D i v e r s i f i e r V o l. 2 6, No 2, 2 0 0 4

Naicom (2008), *Policy Guidelines for The Insurance Industry In Nigeria. Retrieved* From Http//www.Nicom Online Org/Document/Insurance 20% Statistic Life 20% Business.

Nevova T. (2010). Expanding Housing finance to the Underserved in South Asia-market review and forward agenda. *International Bank for reconstruction/World Bank.*

Nmadi D (2008) Nigeria *Recapitalization* NAICOM *to Liquidate Seven (7) Insurance Companies.* January 29th 2009

Ogbonna, A. C. (2012). *Vision 202020 and the Transformation Agenda: Towards a Modified Direct Intervention Framework for Housing Using the (L4C+SS+I)/P Partnering Combination Model*. A Paper Presented at the 42nd Annual Conference of the Nigeria Institution of Estate Surveyors and Valuers Held at Transcorp Hilton hotel, Abuja, 20th-24th March.

Ojo, O. (2007) *an Appraisal of Real Estate Investment Activities of Insurance Companies in Nigeria.* Journal of Nigeria Institution of Estate Surveyors And Valuers, Vol 30, No.1, Pp 13-21

Ojo, O.M., (2012), "Insurance Sector Development and Economic Growth in Nigeria" *African Journal of Business Management Vol. 6(23),* pp. 7016-7023, 13 June, DOI: 10.5897/AJBM11.2853

Okwor, E. (2005), "Nigerian Insurance Industry and the Challenges of the Future, *The Insurance Broker." – Annual Journal of the Nigerian Council of Registered Insurance Brokers No 10.*

Olayinka C. O, Olufemi D. D, and Ijeoma J.E (2015), Behavioural Analysis of Insurance Companies in Real Estate Investment in Nigeria. Journal of Economics and Sustainable Development, Vol.6, No.16,

Olurotimi, K. (2009). *Housing the Physically Challenged People in Nigeria: the Challenges and Way Forward*. Paper presented at 39th Annual Conference of the Nigeria Institution of Estate Surveyors and Valuers, held at Anambra 21st-26 April.

Olusegun, K. (2003). *Principles And Practice Of Property Valuation.*Volume. 2 Olusegun Kuye And Associates.Pp.260 – 278.

Onabule, D. (1990). Housing delivery in Nigeria: National workshop on housing delivery in Abuja.

Sanusi, J. O. (2003). *Mortgage Financing; Issues and challenges*. A paper Presented at the 9th John Wood Ekpeyong organized by Nigeria Institution of Estate Surveyors and Valuers, January, 29.

Timothy Craft (*2001*). The Role of Private and Public Real Estate in Pension Plan Portfolio Allocation Choices. Journal of Real Estate Portfolio Management: 2001, Vol. 7, No. 1, pp. 17-23.

Udoekanem, N. B. (2012). The Performance of Mortgage Institutions in Achieving Affordable Housing Financing in Niger State, Nigeria. *The Estate Surveyor and Valuer*, *36*(2).

Ujunwa A. & Modebe N. J. (2011), Repositioning Insurance Industry for Operational Efficiency: The Nigeria Case: *Journal of Applied Finance & Banking*, Vol.1, no.3, 2011, 15-32

Webb J.R. and Reubens J.H. (1986), "Portfolio Considerations in the Valuation of Real Estate." *A Journal* 14(3), 465-495.

Webb J.R. and Reubens J.H. (1987), "How much in real estate, A Surprise Answer." *Journal of Portfolio Management* 13, 10-14

Webb J.R., Curico R.J. and Reubens J.H. (1988), "Diversification Gains from Including Real Estate in Mixed- Asset Portfolios." *Decision Sciences* 19 432-452

Wozala E. Sirmans G.S. and Zietz E.N., (2000) "Risk and Return Perceptions of Institutional Investors." *Journal of Real Estate Portfolio Management,* April-June, Wurtzbach C.H., Mueller G.R. and Machi D. (1991), "The Impact of Inflation and Vacancy on Real Estate Returns." *Journal of Real Estate Research* 6, 153-168

Ziobrowski, B. J. and A. J. Ziobrowski, Higher Real Estate Risk and Mixed-Asset Portfolio Performance, *Journal of Real Estate Portfolio Management*, 1997, 3:2, 107–115.

EXAMINATION OF HOUSING INVESTMENT PERFORMANCE IN ABUJA, NIGERIA.

WAHAB, Babatunde M. DUROSINMI, Wasiu A, MUSTAPHA Adamu, I.A Olatunji, M.T.A Ajayi

Department of Estate Management and Valuation, Federal University of Technology, Minna Niger State Nigeria

Housing investment performance is an examination of total return from an invested capital in real estate market, vis-à-vis an associated market risk. The incessant failure of real estate investment is attributed to the lack of feasibility and viability forecast on future of investment and poor analysis of past and present market situations. The objective of the paper is to examine the performance of housing investment return with a view to determining the quantum of risk to be taken to earn an expected return and to establish the most secured investment market. The literature has revealed that the failure of most investment is due to poor analysis of economic and market conditions. The research concentrates on the analysis of Abuja property investment market with view to examining the returns from different real estate sub-markets. The research employed descriptive analysis (standard deviation, coefficient of variation and sharpe ratio) and ANOVA to analyze the data collected through systematic method of sampling. The result of analysis of variance showed a statistically significant difference in returns on investment, at p-value of 0.00013 less than 0.05 level of significant. The results of residential investment performance across three locations in Abuja showed high volatility in Maitama and Wuse residential submarkets at 4.81% and 4.04% respectively, and Gwarinpa market is less volatile at 1.41%. Gwarinpa market showed a stable return on the investment at 6.7% and 6.6% for arithmetic and geometric means respectively. Therefore the research concludes that Gwarinpa residential market exhibited steady and stable return on the basis of average returns, less volatile and performed better on the basis of risk-to-reward ratio than any other submarket at 0.21. Maitama submarket is described as the most risky and volatile submarket at 4.8% standard deviation.

Keywords: residential, investment performance, sharpe ratio

wahabbabatunde2@gmail.com

duwas11@gmail.com

Wahab et. al. (2016). **AN EXAMINATION OF HOUSING INVESTMENT PERFORMANCE IN ABUJA, NIGERIA** Sustainable Built Environment and Climate change; The challenges of Post 2015 Development Agenda. School of Environmental Technology Conference, SETIC, 2016

INTRODUCTION

Real property investment is concerned with giving up of a capital or financial sum to acquire the combination of all factors of production in form of landed property, in return for periodic annual income or benefits. Residential property investment performance is a measure of periodic return emanating from property investment, therefore, total return of a property investment is a function of net income, capital value at beginning and the end of the period (Hoesli and MacGregor, 2000; kalu, 2001). However, property return or yield is a key player in property investment market, and thereby the aggregate return within the country property market is determined by the aggregate demand and supply within the national economy.

Real property return as measure of performance is a constituent of two elements income and capital appreciation. Income from property investment is referred to rent and capital appreciation is referred to as the appreciation of property value over time.

The growing concern of institutional investors such as companies, banks, insurance and among others in real estate investment has therefore underscored the need for property investment performance, and also the pressing need for accountability and the improved performance of investment has required more than mere watch of rental movement (Udobi *et al* 2013).

Relative performance of property performance is a function of risk inherent. Most prudent investor usually diversified their investment portfolio as way of minimizing the effect of risk, therefore return to risk ratio is a measure of relative performance of different property investment portfolio in the market. This study examines the relative performance of residential property investment, with a view to determine the most profitable submarket in Abuja residential market in Nigeria.

Literature Review

Investment performance is an examination of annual total returns produced by an investment; it is basis of making comparative analysis among investment options (Udobi *et al* 2013). Return on capital investment is a good measure of performance of investment portfolio in that it represents success or otherwise of the investment and the rate of return on investment is defined as the amount of money earned or produced over the property investment period per the amount invested (Kalu, 2001). More importantly the need to measure the performance of housing investment leads to analysis of risk factor to which the return is exposed to (Kalu 2001). He therefore stated that variance, standard deviation and coefficient of variation are good measure of risk of an investment and other researcher include sharpe ratio as a best measure of performance.

Bello (2003) analyzed the performance of residential and securities' investment in Lagos. The performance was measured risk-adjusted return, income and capital growth. The using standard deviation and coefficient of variation, the result showed residential investment performed below securities and yielded low risk. Oyewole (2006) examined the direct and indirect residential investment of listed companies and UACN within a given period (1999-2004), having employed relative important index, standard deviation, coefficient of variation and sharpe ratio to calculate the mean return. the study showed indirect investment performed more than direct investment in absolute term of rate of return, conversely direct property investment performed relatively better than indirect property investment in risk adjusted return term. Oyewole (2013) examined the comparative performance of residential and commercial investment in Illorin, the research employed standard deviation, coefficient of variation and sharpe index, the result showed residential property with higher coefficient variation (0.74) as been risky than commercial property at 0.46 coefficient. The overall sharpe index showed commercial investment outperformed residential investment. Udobi *et al* (2013) analysed comparative performance of residential property in Anambra, analysis of risk on residential investment was carried out using standard deviation and coefficient of variation as tools used to determine the performance, the result showed property capital and rental values appreciate overtime, and the rate of return in residential investment is more stable in relative to bank shares. The study concludes that property investment is therefore a preferred investment portfolio than bank shares. Ade (2015) the study evaluated the performance of residential property investment in different locations in Ado. The result employed income return from residential property investment across locations, he discovered that rental and capital values grew overtime but the rate of growth was not static, therefore the return from property investment at GRA is higher than any location. Haw (2003) examined residential property investment performance in malaysia, adopting coefficient of variation and sharpe ratio, the result showed that terrace building better performed than any other types.Therefore the best method of measuring the performance is firstly to determine total return otherwise called money weighted rate of return, as described by Hargitay and Yu (1993) as sum of net income and capital returns, upon which the study hinges. Also the study measures the relative property investment performance through the coefficient of variation and sharpe ratio as it was done by Hwa (2003) in Malaysian market. On this basis, the study determines money weighted rate of return or total return as basis for estimating the coefficient of variation (risk to reward) and sharpe ratio (risk-adjusted) for performance measurement in Abuja residential market, Nigeria.

Money Weighted Rate of Return

Money weighted rate of return (MWRR) is otherwise referred as total return in many literature (Hargitay and Yu, 1993; Hoesli and MacGregor, 2000; Baum 2002). Money weighted rate of return is related to internal rate of return and can be defined as generic description applied to any calculation where income and expenditure are discounted over time to arrived at either internal rate of return or present value, and thereby the return arrived at is a return for the whole period known as total return (Dubben and Sayce 1991). Money weighted rate of return is also the interest or discount rate which equated the sum of all the realized cash flows and the capital value of the asset at end of the holding period to the initial capital outlay or the capital value of the asset at the beginning of the holding period (Hargitay and Yu, 1993) . This definition provides a basic claim for money weighted rate of return as true rate of return, equated yield and redemption yield.

Therefore, Hoesli and MacGregor (2000) identified money weighted rate of return (MWRR) with "total return" which is simply the sum of the income and capital return. they therefore described MWRR as a measure of return for a single period. Baum (2002) regarded MWRR as effectively the same measure as the internal rate of return and rightly point out that MWRR is only an approximation to the internal rate of return (IRR). Both rates equate only when the investment is held for one period, the whole income received at end of the period and there is no further capital injection or expenditure within the period.

Where there is no further capital expenditure on the investment during the measurement period, money weighted rate of return or total return is given by:

$$\mathbf{MWRR/TR = \{CV_t - CV_{t-1} + NI_t\}/CV_{t-1}} \qquad \textbf{equation 1}$$

Where CV_t is the capital value at the end of period t, CV_{t-1} is the capital value at the beginning of period t i.e at end of period t-1, and NI_t is the net income received. This study adopts MWRR method as a measure of performance.

METHODOLOGY

Descriptive Analysis: To examine the performance of residential investment, required the analysis of total return from each of the sub-markets using geometric mean, standard deviation, coefficient of variation and Sharpe ratio is required to determine the best investment submarkets. To determine the performance of residential investment across the sub-markets, the study adopted the use of coupon rate or yield on federal Government Bond referred to as free risk yield which is required by prudent investor (at 15.97% from Nigeria Stock Exchange and Nigerian Securities Commission). The research makes use of interest on 10years government bond. Sharpe ratio was used to determine risk adjusted return across the markets.

Annual holding period of return (total return) was determined as follows:

$$AHPR = \frac{(CV_t - CV_{t-1}) + NI}{CV_{t-1}} \qquad equation\ 2$$

Where CV_t is capital value at end of the year, CV_{t-1} is the capital value beginning of the year and NI represents net income or rent.

Measure of volatility in property investment was also determined using standard deviation expressed as follows:

$$S.D = \frac{\sqrt{\sum(X_1 - \bar{Ṛ})^2}}{N} \qquad equation\ 3$$

Where X_1 is individual observation and $\bar{Ṛ}$ is the mean and N is total number of observation.

Coefficient of variation which measure relative performance was determined as follows

$$C.V = \frac{S.D}{\bar{Ṛ}} \qquad equation\ 4$$

$Where\ S.D\ is\ standard\ deviation\ and\ \bar{Ṛ}\ is\ the\ mean\ return$

Sharpe ratio which measures the performance on the basis of risk adjusted return was determined as follows:

$$sharpe\ index = \frac{\bar{Ṛ} - RF}{S.D} \qquad equation\ 5$$

$\bar{Ṛ}$ is mean, RF is the free risk return on government bond at 15.97% and SD is standard deviation.

FINDINGS AND DISCUSSION OF RESULTS

The analysis of the data obtained through the questionnaire was carried out using descriptive analysis and analysis of variance. Descriptive analysis featured the use of arithemetic mean, geometric mean, standard deviation, coefficient of variation and sharpe ratio.

Table 1 showed the returns on three residential property investment across three location in Abuja. The table revealed the annual fluctuation in returns of three bedroom residential property investment across three locations in Abuja, this showed the effect of instability in the general economy on the property market.

Table 1: Return Three Bedroom Residential Property Investment in Abuja

Year	Maitama	Kwarinpa	Wuse
2001	20.24	5.23	10.43
2002	18.51	6.45	4.63
2003	15.42	8.32	13.43
2004	19.52	7.34	6.44
2005	11.35	4.52	12.5
2006	10.34	5.34	11.45
2007	9.56	6.32	5.53
2008	15.45	8.45	8.43
2009	8.56	5.54	15.25
2010	20.34	7.67	10.55
2011	8.45	9.35	3.45
2012	11.45	6.54	6.55
2013	6.67	5.65	12.33
2014	16.64	7.34	16.33

Source: Field Survey, 2015.

Table 2 showed the means, standard deviation, coefficient of variation (risk to reward ratio) and sharpe ratio. Table revealed that in term of average return, Maitama residential market outperformed both wuse and Gwaripa at 13.75% while that of Wuse outperformed Gwaripa at 9.81% and 6.72% respectively. On the basis of risk, Maitama and Wuse residential market exprieced high volatility at 4.81% and 4.04% respectively than Gwarinpa market, therefore Gwarinpa residential market is less volatile or risky in term investment as compared to other locations, the implication is that the return on investment from Gwarinpa market is more stable and realizable, this can observed as differences between arithemetic and geometric means is not pronounced. On the basis of risk-to- reward ratio, Gwarinpa residential market has been placed to be less risky at 0.21 while Wuse market has been placed as the most highly risky market than Maitama at 0.41 and 0.35 repectively. The implication is that for any investor to have 6.72%, 13.75% and 9.81% returns on investment must be prepared to take 0.21units, 0.35units and 0.41units of risk on every investment. On the basis of real performance index using the interest rate on Federal Government Bond (15.97%) which is referred to as free risk yield or coupon rate, it was observed that Maitama residential market outperformed other locations at -0.46, (the higher the sharpe ratio, the better the performance). Gwarinpa has stable and steady return and better perform on the basis of risk-to- reward ratio than other two submarkets.

Table 2: Descriptive Analysis Of Return On Three Bedroom Residential Property Investment In Abuja

Descriptive	Maitama	Gwarinpa	Wuse
Mean	13.7500	6.7179	9.8071
Std. Deviation	4.81118	1.41253	4.03738
Geometric Mean	12.9310	6.5806	8.9266
Coefficient of variation	0.35	0.21	0.41
Sharpe ratio	-0.46	-6.56	-1.52

Source: Computed From Table 1.

Table 3 revealed the analysis of variance in returns of residential property investment across three locations, the results showed a statistical significant difference in returns of three residential property investments across locations. This implies that returns from each of the submarket were not the same statistically, this due to the fact that the relative location is a major factor of residential property investment.

Table 3: showed the analysis of variance in returns of three bedroom residential investment in Abuja

Source of Variation	***SS***	***Df***	***MS***	***F***	***P-value***	***F crit***
Between Groups	311.6765	2	155.8382	11.59674	0.00013	3.259446
Within Groups	483.7719	36	13.43811			
Total	795.4484	38				

Source: Computed From Table 1

CONCLUSION

The residential housing investment performance in Abuja has a reflection of general economic outlook. The annual fluctuation in residential investment returns has therefore attributed economic condition. There is relative investment performance across the study locations, has shown that Gwarinpa submarket is better performed on the basis of average rate of return as it is steady and stable, and as well as on the basis of risk-to-reward ratio and it is therefore the least volatile (less volatile) or less risky than other two submarkets. Maitama submarket exhibited highest level volatility and is better performed on the basis of risk-adjusted and it is therefore described as the most risky submarket for three bedroom property investment. Wuse submarket as was least performed submarket. The returns across the study locations are statically different due to relative location factors that determine residential property investment.

The implication of these findings is that a prudent investor who is not willing to take risk is better advised to invest in Gwarinpa market because the return from the investment is relatively stable and steady and more secured against market risk. But a risk loving investor who desire higher and quick return should invest in Maitama and such investment is not secured and it may lead to loss of capital. Wuse is not better market to invest because it is the least performed market on the basis of risk-to-reward as compared to others.

REFERENCES

Ade .A (2015) Performance Evaluation of Residential Real Estate Properties in Ado Ekiti. *International journal of management and commerce innovation. 3(1):569-578*.

Baum A (2002) commercial real estate investment. Estate Gazette, London.

Bello O.M (2003) Comparative Analysis Of Performance Of Residential Investment And Investment In Securities In Lagos, Nigeria. *The Journal of Estate Surveyor And Valuer. 26(1) 7-14*

Dubben N and Sayce .S (1991) *Property Portifolio Management*. Routledge, London.

Hargitay .S and Yu .S (1993) *Property Investment Decision*. A Quantitative Approach. London

Hoesli M and MacGregor B (2000) *Property Investment*: Principles And Practice Of Portfolio Management. Longman Essex.

Kalu I.U (2001) *Property Valuation And Appraisal*. Bon Publication, Owerri.

Oyewole M.O (2006) A Comparative Analysis Of Performance of direct and indirect property investment in Lagos. *Journal of environmental science*, university of Lagos.

Oyewole M.O (2013) A Comparative Analysis Of Residential And Retail Commercial Property Investment Performance in Ilorin, Nigeria. *Journal of economics and sustainable development. 4(3) 199-208.*

Udobi A.N, Ugonabo .L U and Kalu I.U (2013) An Analysis Of Performance Of Real State Investment In Onitsha Metropolis And Investment In Bank Shares. Department of estate management, Awka, Anambra State. *Civil And Environmental Research .3(8) 11-18*

Haw K.T (2003) Investment Characteristics Of Malaysia Residential Market Sector. 9th *Pacific Rim Real Estate Society Annual Conference Brisbane,* Queensland Australia. 20-22 january 2003.

INFRASTRUCTURE DEVELOPMENT AND FINANCING FOR SUSTAINABLE HOUSING DELIVERY IN NIGERIA: A REVIEW

ATAMEWAN, Eugene Ehimatie & TABUKO, Bamidele Duke
Department of architecture, Cross River University of Technology, Calabar

The success of any sustainable housing delivery system depends on a wide range of factors among which are availability and accessibility to land, environmental security, safety, community interaction, availability of adequate infrastructure services and mortgage finance. Affordable Housing provision has remained elusive to an average Nigerian, in spite of several programmes put in place by various government of the country, past and present. The paper aimed to examine the impact of adequate infrastructure provision, availability and accessibility of mortgage finance towards sustainable housing delivery system in Nigeria. Methodology of study included review of secondary data. The secondary data involved are research data, official documents and other relevant secondary data obtained from existing literature, books and published journals articles. The paper observed that the key challenge of accessing housing finance in Nigeria is affordability challenge especially by the low-income urban dwellers. The affordability parameters inherent in the mortgage instrument limit access by the low-income population. These parameters include 20% - 30% equity contribution, maximum tenures of only 10-15 years, high interest rate of 22% and the non-availability of long-term funding for housing development which compels builders of residential accommodation to recover their capital within the shortest possible time. Findings revealed that sustainable housing delivery in Nigeria has been hampered by inadequate financing, inadequate infrastructure provisions which has resulted in many people living in substandard housing, unhealthy environment with its attendant social inequality, low standard of living, and poor health especially as it affects the low-income urban dwellers. Also, Changes in climate will stress current infrastructure, exacerbating existing weaknesses and forcing major programmes of renewal and replacement, well-supported with finance and technology and implemented by skilled workforces. This paper opined that infrastructure development through adequate mortgage financing will stimulate sustainable housing delivery process in Nigeria. Finally, it recommended massive investment in infrastructure development by Government at all levels to reduce cost of housing construction; Review of the Land Use Act; enhancing the accessibility of Nigerians to housing finance by relaxing the conditions attached for getting the housing funds through the NHTF and integrating climate change considerations into contracts on infrastructure

Keywords: *Infrastructure, financing, sustainable development, housing, climate change.*

geneatas@yahoo.com

ATAMEWAN, E. E and TABUKO, B. D (2016 **INFRASTRUCTURE DEVELOPMENT AND FINANCING FOR SUSTAINABLE HOUSING DELIVERY IN NIGERIA: A REVIEW** Sustainable Built Environment and Climate change; The challenges of Post 2015 Development Agenda. School of Environmental Technology Conference, SETIC, 2016

Introduction

Infrastructure development contributes to economic growth and development by increasing productivity and providing amenities which enhances the quality of life. Infrastructure is a broad term that embraces public investment in physical assets and social services. It is a term for many activities usually referred to as “social overhead capital” by development economist. According to Ogbuozobe, (1997), infrastructure refers to a network of transport, communication and public social services all functioning as a system or as a set of interrelated and mutually beneficial services provided for the improvement of the general well-being of the populace. These services include roads, electricity, water supply, healthcare, telecommunication, education. The term typically refers to the technical structures that support a society and can be defined as "the physical components of interrelated systems providing commodities and services essential to enable, sustain, or enhance societal living conditions" (Fulmer, 2009).

It is therefore a fact that social economic growth and development is a function of the availability of adequate infrastructure hence its absence or inadequacy is a measure of failure or otherwise of a country. This accounts for the reason why infrastructure development is one of the yardsticks for rating countries in the scale of development. However, there is a relationship between infrastructure development and climate change which is complex and multi-faceted. Climate change has far-reaching impacts on infrastructure and can put their operation and reliability partially at risk. Climate change affects the design, location and operations of infrastructure. Additional infrastructure is also required for climate protection, such as improved sea defenses and flood protection, interconnections in water supply, as well as retro-fitting to improve resilience of existing infrastructure and this has serious financial implications (African Development Bank (ADB), 2010).

According to the UN Habitat (1984), financing is the process of obtaining funds or capital generally for the purpose of supporting a development and/or investment by gaining control over assets. Housing finance system is defined as a superstructure of laws, institutions and relationships between institutional and non-institutional units that facilitate the process of financial intermediation and capital formation in the Housing sector. Currently in Nigeria, housing is financed by a number of institutional sources which includes formal institutions namely budgetary appropriations, insurance companies; commercial and merchant banks State housing Corporations and the Federal Mortgage Bank. Also, informal institutions such as credit societies, money lenders have been financing housing construction (Adedeji & Olotuah, 2012).

Sustainable development on the other hand has been defined by several authors but the meaning remain the same irrespective of the circumstances under which the concept is used. According to the National Affordable Housing Agency (NAHA) of Britain, sustainable development is described as a means of ensuring a better life for everyone, now and for generations to come (NAHA, 2006). However, in terms of housing delivery systems, Jiboye (2011) defines sustainability as the development that is economically, environmentally and socially sustainable through the provision of adequate social services including housing, functional and livable environment for both the present and future occupant of the environment. Several housing delivery policies by the Nigerian government have failed to yield the desired result hence the housing deficit in Nigeria is put at over 17millions. Previous report has shown that over eighty-five percent of the urban population lives in rented accommodation and spend close to 50% of their income on rents. Of these rented apartments, more than 90% are privately owned which is mainly due to inadequate mortgage financing (FinMark Trust, 2010).

It should be noted that the operation of an efficient housing finance system in any economy is one of the strategies adopted by Government to stimulate the increased construction and delivery of available housing stock in order to reduce homelessness and create job opportunities for wealth generation among others. Unfortunately, in Nigeria the formal sector only constitutes about 15% of the housing market which is grossly inadequate to meet the ever increasing housing demands and where there are supplies, it is usually targeted at the medium and high income groups (Olotuah, 2011)

Aim and Objectives of the study.

The aim of the study is to examine the effect of infrastructure and financing in sustainable housing delivery in Nigeria. The objectives of the study include (i) to examine the relationship between infrastructure and economic development (ii) to examine the effect of infrastructure development on the physical environment (iii) to examine effect of finance on housing delivery system and (iv) the impact of climate change on infrastructure development.

Research Methodology

Methodology of study included review of secondary data. The secondary data involved are research data, official documents and other relevant secondary data obtained from existing literature, books and published journals articles.

Results and Discussions

Infrastructure and Economic Development:

Socio-economic development can be facilitated and accelerated by the provision of infrastructure, as the services generated will translate to an increase in aggregate output. Investment in infrastructure services such as transportation, electricity and water supply are intermediary inputs to production. Also investments in infrastructure attract additional flow of resources and thus raise productivity of other factors. As Jiboye, (2009) puts it, "Adequate access to social welfare services such as health services, education, portable water supply, roads, electricity etc are strong indices of development.

In general terms infrastructure covers all facilities that makes life worth living. So in discussing the role infrastructure plays in economic development of a country like Nigeria, it will be pertinent to take some few essential infrastructural services such as transport (road, rails, drainage), telecommunication, water supply, waste disposal which are referred to 'as' physical infrastructure or economic infrastructure and education, health, housing etc which constitutes social infrastructure.

- Physical infrastructure such as transport (roads) stimulates increased productivity through agricultural expansion due to reduced transport production cost.
- Increase in stock of physical infrastructure leads to corresponding increase in gross domestic product (GDP) (World Bank, 1994)
- In developed countries of USA, Japan, telecommunication, electricity are used in the production process of nearly every sector and transport is an input for every commodity. These expand the productive capacity of these nations to enhance economic growth and development. Wherever development of economic infrastructure has followed such a rational and coordinated path, growth and development has been boosted (Ogbuozobe, 1997)
- Social infrastructure such as education affects the economic growth and development of nations in no small way. This is because it produces the much needed man-power to drive and stimulate the economy resulting in development hence it is regarded as an 'investment' infrastructure.
- Health is another important social infrastructure which is a major determinant of labour productivity and efficiency. A healthy nation is a prosperous and wealthy nation; hence an investment in the health sector infrastructure is an investment in the future and economic development and prosperity of a nation.

  From the above, the output of infrastructure to economic growth and development are wide and far reaching, the impact and effects cannot be underestimated.

Environment and Infrastructural Development

Infrastructures are at the very heart of economic and social development. The next decades are likely to see an accentuation of two facets of infrastructures. On the one hand, they will proof a vital tool in resolving some of the major challenges faced by societies – supporting economic growth, meeting basic needs, lifting millions of people out of poverty, facilitating mobility and social interaction. On the other, environmental pressures in the form of changing climatic conditions, congestion and so on are likely to increase, turning the spotlight firmly on the inherent tensions between the imperative for further infrastructure development and the quest for sustainability ((Ogbuozobe, 1997).

Thus, as development agencies pursue their efforts to promote economic development in poor countries and improve the lives of their people, they are warned to be cognizant of the need to ensure that development is achieved in ways that minimize environmental damage or – better still – improve environmental quality. This is nowhere more evident than in the intersection of environmental concerns with the need for developmentally important infrastructure – what we call the infrastructure-environment nexus.

Infrastructure is essential for growth, which is essential for poverty alleviation. Expanding infrastructure to meet expanding demands will absorb trillions of dollars of investment over the coming decades in the developing and transition economies. Many infrastructure investments deal effectively with their environmental impacts or directly promote environmental improvements, but many kinds of infrastructure also pose serious threats to the environment. The infrastructure-environment nexus addresses the challenge of meeting the demand for infrastructure services while maintaining or improving the quality of the environment.

Infrastructure services are vital for supporting economy growth and improving the quality of life by improving transport and communication, sanitation and home heating, access to education, health services, and etc. However, providing these services can have environmental impact that also have important implications for quality of life, including both bio-physical and social aspects. Well designed infrastructure project can produce positive environmental impact, e.g., by reducing water pollution, mitigate negative environmental impact, e.g., through emissions controls. However, when environmental consequences are not taken into accounts, infrastructure projects can pose serious threats to the environment and resultant quality of life. Land degradation, flooding, water and air pollution, and acid rain that results from poorly designed projects seriously degrades living conditions, especially for the poor who lack the resources to ameliorate the impact.

The construction and operation of infrastructure generally pose risks to local environments, which will result in environmental damage if not adequately mitigated or compensated. This is well documented in case of energy, especially where power plants or industries burn coal. In Nigeria, oil exploration causes land and water pollution, while gas flaring causes air pollution. Global damages from infrastructure-related fossil fuel emissions – such as climate change are additional to these local damages. Emissions are inherent in fossil fuel energy (power and transport), and the challenges are to minimize emissions, promote alternate energy, and encourage conservation. However, the challenge of infrastructure development in Nigeria as listed by Oyedele (2012) includes the following:

i. Development Matrix: The four development matrix of any physical infrastructure namely design, finance, technology and management are lacking in Nigeria.
ii. Tradesmen and other technical human resources needed for infrastructural development are scarce because of lack of training and motivation.
iii. Capital Flight, Capital Sink and Capital Stagnancy. Most materials and managerial services are procured outside the country. The contracts are full of loop-holes which encourages abandoned projects.

Finance and Housing Delivery

a. Housing Finance

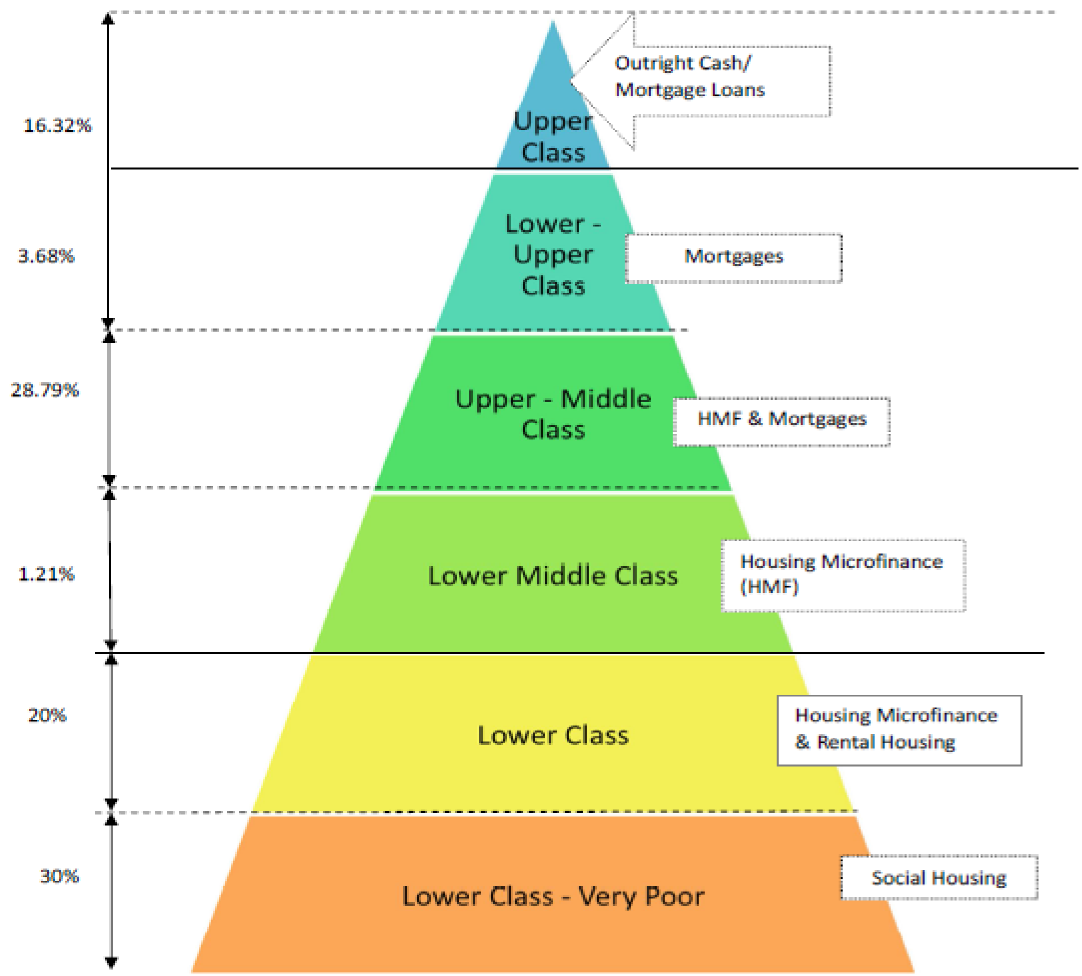
It is no longer strange to know that some Nigerians especially the low-income groups living in the cities are homeless. The reason is that the cost of constructing or renting an accommodation is simply beyond the reach of an average Nigerians. Thus, the Nigerian housing sector challenge is that of affordability. Several housing construction and delivery system is targeted mainly at the middle and high income group of the population that can either pay cash or access mortgage finance from the banks. Housing financing is done through mortgages which in Nigeria is the primary responsibility of the Federal Mortgage Bank of Nigeria (FMBN). But the provisions of these mortgages to the income earners are through the National Housing Trust Fund (NHTF). However, only very few proportion of the income earners have been able to access these mortgages. This is because the performance of the housing finance system in loan disbursement has dismal and discouraging. The primary Mortgage Institutions are unable to render a good measure of financial mediation in housing delivery due to inherent challenges such as inadequate capitalization, weak management practices and inability to generate mortgages to qualify for the National Housing Trust Fund (Olotuah, 2011). Also, the absence of clear property and security rights, mandatory Governors consent, high interest rates as well as inadequate source of long-term funding are other factors that inhibit mortgage lending (FinMark Trust, 2010). This is why the high income earners simply purchase their houses out rightly or mortgage while some few low-income acquire their lands through savings and build their houses incrementally over a period of some years. Thus, there is an indication of declining activities in the housing finance in Nigeria (FinMark Trust, 2010)

The large population of the low-income group in Nigeria, however suggest that housing developers and financial who are innovative have a potential growth opportunity in that sector of the economy.

b. Access to housing finance

Evidently, there is a drop in the low-income housing activity in Nigeria by most housing developers due to lack of capacity and expertise to develop housing products for the over populated low-income group in Nigeria housing market. Survey (FGN, 2007) has shown that access to housing finance is still very limited to a few individual who falls within the medium-income group which indicates that there is lack of access to housing finance. This problem has resulted in shortages of housing stock and increase substandard housing and homelessness among the poor in Nigeria.

The figure below is an income class pyramid showing the income levels and their access to housing finance.



Source: culled from FinMark Trust (2010)

From the pyramid, it is evidently clear that only about 30% in the upper and lower middle income group can access housing finance while a large portion of the population, the low-income group cannot access housing finance and would therefore require social housing.

Often times, most housing developers in the formal sector lack access to housing finance which adversely affect the supply and delivery of houses, hence they are left with the option of sourcing funds from deposit money banks with very high interest rates and other stringent conditions attached. Accordingly, the bulk of low-income individual home builders are compelled to source for housing finance from a more convenient and accessible classified as micro-credit organizations sources such as family, friends, "esusu" (traditional thrift societies), age/trade groups and traditional money lenders. The disadvantages of these sources of housing finance are that they are unsecured and very limited in their capital base (Nubi, 2006).

c. Challenges to Accessing Housing Finance in Nigeria.

The establishment of the National Housing Fund (NHF) in 1992 was aimed at addressing the constraint of mobilization of long-term funds for housing development as well as maintains a stable base for affordable housing finance for the purpose of building construction, purchasing and improving of houses. Since its establishment, the NHF has been faced with the problem of inadequate capitalization due its inability to mobilize contributions from the informal private sector made up of self-employed workers, the formal private sector (commercial banks and insurance companies) and inadequacy in the operational soundness and viability of the Primary Mortgage Institutions (Olotuah & Taiwo, 2013).

The major challenge of housing finance system in Nigeria is affordability. The affordability constraint inherent in the mortgage instrument limits access by the low-income population. These constraints include 20%-30% equity contribution, maximum tenures of only 10-15 years, high interest rate of 22%. Other challenges are macro-economic mainly high inflation; policy and regulatory (Land Use Act, Property Registration, Taxes, Stamp Duties); unavailability of secondary market other than the PMIs; lack of credit enhancement vehicles (insurance); inadequate skilled manpower in the mortgage market; high cost of building materials cum over dependence on foreign materials and inadequate infrastructure development(FinMark Trust, 2010)

Climate Change and Infrastructure Development

Climate change is one of the most significant threats to development during the 21st Century and beyond. Over half of Greenhouse Gases GHG emissions are associated with the infrastructure sector and the construction industry (World Bank, 2010), so reducing infrastructure-related emissions plays an essential part in efforts to prevent dangerous levels of global warming. Accordingly, the Intergovernmental Panel on Climate Change (IPCC, 2007) has predicted that the earth will be between 1.8°C - 4°C warmer by the end of the 21st Century compared to the end of the 20th Century. The principal cause of global warming is human activity that releases greenhouse gases into the atmosphere, particularly the burning of fossil fuels. (EC, 2011).

Climate change ultimately affects all people, sectors and infrastructure globally. But the severity of climate impacts on infrastructures will vary across various Nations, according to individual locations and their geophysical risk exposure, the existing adaptive capacity and resilience, and the level of regional economic development. This is why Developing countries, although less responsible for the emissions and climate change, suffer the consequences the most. The reasons are that first, the locations of most developing countries are in the region of lower latitudes where the impacts are more acute. Secondly, developing countries are more dependent on climate-sensitive sectors such as agriculture and fishing. Finally, these countries have lower capacity to adapt due to their weaker institutions, lower human and financial capital, and constrained access to technology and credit (ADB, 2010).

The impact of climate change on developing Nations also forestalls their opportunities for economic growth since traditionally; economic growth has been closely linked with increased greenhouse gases (GHG) emissions and those who bear the brunt of the impacts of climate change are the low-income the most vulnerable. (World Bank, 2010).

Changes in climate will stress current infrastructure, exacerbating existing weaknesses and forcing major programmes of renewal and replacement, well-supported with finance and technology and implemented by skilled workforces. However, the sectors of importance are transport, energy, construction/ buildings, water/sanitation and rural infrastructure (in relation to land use, agriculture and forestry).

Developing countries including Nigeria undoubtedly must grow and become developed. This development is hinged on huge investment in new and old infrastructure which must be well planned and managed along a low-carbon and climate-resilient path. Accordingly, infrastructure development planning will integrate new weather and climatic risk concerns through capacity-building and improved climatic information as advocated in the Climate for Development in Africa (ClimDevAfrica) programme.

The way out of these challenges is for infrastructure policymakers and practitioners in the developing world to play a crucial role in meeting the challenge of climate change. This will only be achievable through mitigation (reducing greenhouse gas emissions in ways that facilitate growth and sustained poverty reduction) and adaptation (protecting vulnerable populations from the impacts of climate change.). Nonetheless, this will require raising the required finance; developing and transferring technology; and developing the capacity of governments to formulate and implement climate change policy (Fankhauser, 2010).

Conclusion

Sustainable housing delivery is a function of the level of availability and accessibility to housing finance which is boosted by infrastructural development. Infrastructure development begets socio-economic development including housing delivery and increase the Nations GDP. Housing finance is pivotal to sustainable housing delivery. For sustainable housing delivery to be a reality in Nigeria, strategic investment in infrastructure and housing finance is non-negotiable and must be fully encouraged by government, as it is the foundation for economic growth.

According to Adedeji & Olotuah (2012), for a housing finance to be successful in sustainable housing delivery system, there must be a guaranteed continuous flow of funds. The authors opined in their study that the percentage of total beneficiaries of the NHF is infinitesimally small compared to the number of contributors which confirm the accessibility challenge to housing finance in Nigeria using the NHF Scheme as a yardstick. In their studies, (Chionuma, 2000; Bichi, 2002 and Fortune-Ebie, 2004) agreed that the NHF is faced with a lot of operational challenges which includes non disbursement of NHF application loans due to non fulfilment of some stringent conditions, non submission of acceptable security of existing mortgages by PMIs, delays in perfection of fund mortgages and inability of PMJs to fund 20% of loans as one of the statutory requirements.

Policy Implications and Recommendations

The Nigerian housing deficit has been put at over 17million and these require about N60 trillion funds to bridge this shortfall. This estimate was calculated based on N3.5 million as the unit cost of constructing a building (The National Housing Policy, 2012). Also, infrastructure has been seen as a major determinant in sustainable and affordable housing delivery system because it accounts for as much as about 25% to 30% of housing cost. This crucial area has been neglected by Government thereby transferring the burden to private developers which increase the cost of houses and thus making it unaffordable to most Nigerians (FinMark Trust, 2010). However, despite the inability of Government to meet the housing finance need of most Nigerians especially the low-income, they have still been able to have one form of shelter or another in some form through micro financing scheme and cooperatives. The effort of private developers and cooperative societies notwithstanding, the accessibility of millions of Nigerian to housing finance is still very low (Adedeji & Olotuah, 2012).

The National Housing Trust Fund (NHTF) has not lived up to the bid of providing housing finance to Nigerian workers despite the money it has collected from them and there are indications that most contributors are unable to meet the stringent conditions for accessing the fund. The implication is that sustainable and affordable housing delivery becomes unrealisable. This is a negation to the primary purpose of the establishment of the NHTF which is to mobilise long-term funds for housing development and ensuring that every Nigerian have access to housing loans at affordable interest rates (Alagbe, 2013).

The Nigerian housing sector is bedevilled with a lot of challenges among which are limited access to housing finance, slow bureaucratic procedures, high cost of land and building materials, and poor infrastructure development. Therefore, urgent intervention is needed to ensure sustainability of housing for the teeming populace living in substandard houses or homeless. One way to achieve this is through the introduction of housing microfinance, which has been successfully adopted in other countries with similar macroeconomic indices.

The African Development Bank (ADP) having realised the important role infrastructure development plays in a Nations growth and housing development and have made a cornerstone in its developmental agenda with regional member Countries by giving long-term loans for infrastructure financing (TMSA, 2012).

Therefore, this paper puts forward the following recommendations which it believes if implemented will enhance sustainable infrastructure development and affordable housing delivery system in Nigeria as well as manage the effect of climate change. These recommendations are:

1. There should be massive investment in infrastructure development by Government at all levels to reduce cost of housing construction. This could be achieved by setting up Housing Infrastructure Development Trust Fund (HIDTF).
2. Land titling, registration security and acquisition of certificate of occupancy (CO) should be flexible, cheap and quick. Permanent Secretaries of State and Federal Ministry of Lands should be empowered to endorse all land registration and issue of CO.
3. Housing micro finance should be developed and set up to provide small short term loans to low-income groups for incremental housing construction. Existing PMIs should be restructured and recapitalized to provide better funding and offer long-term funding for developers and other house builders.
4. Accessibility of Nigerians to housing finance should be enhanced and guaranteed by relaxing the conditions attached for getting the housing funds through the NHTF. Government should ensure that the FMBN is strengthened financially to be more responsive in financing housing development. Additionally, there should be reforms in the mortgage sector to involve both public and private sectors participation.
5. There should be development of local and indigenous building materials through the building research institutes to reduce cost of housing. The Government should promote its acceptability by using these materials for construction of some public buildings.
6. There should be planning processes reform which must include climate change information, with enforceable land- and water-use policies and practices, in harmony with regional circumstances;
7. All contracts on infrastructure must have climate change considerations integrated into it and access to quality climate information and climate risk-management processes enhanced.

References:

Adedeji, Y. M. D, Olotuah A. O. (2012), An Evaluation of Accessibility of Low-Income earners to Housing Finance in Nigeria. *American-Eurasian Journal of Scientific Research* 7 (1): 23-31, ISSN 1818-6785

African Development Bank (2010). Climate Change [Online] Available from: http://www.afdb.org/en/topics-sectors/sectors/climate-change/ [Accessed 29th November 2016]

Alagbe W, (2013). Exploring Indigenous Strategies for Affordable Housing Delivery for the Urban Poor. A paper Presented at 3rd ASO National Housing Exhibition and Conference International Conference Centre, Abuja from 11-13th April, 2013.

Bichi, K.M.(2002). Housing the Nigerian Population: Problems and Prospects. *Journal of the Federal Mortgage Bank of Nigeria*, 1(5): 30-31.

Chionuma, O.M. (2000). The role of Primary Mortgage Institutions in the Provision of Housing in Nigeria *A paper presented at a National Workshop on Finance and Procurement of Housing and Infrastructure* organized by the Institute of Quantity Surveyors on April 12, 2000).

European Commission (2013). Commission Staff Working Document: Adapting Infrastructure to Climate Change. *An EU Strategy on adaptation to climate change:* Brussels, 16.4.2013; SWD (2013) 137

Fankhauser, S. (2010), "The costs of adaptation", *Wiley interdisciplinary reviews:* climate change. John Wiley & Sons, Ltd., 1 (1), pp. 23-30.

Federal Government of Nigeria, FGN (2012). National Housing Policy for Nigeria. Federal Ministry of Lands, Housing and Urban Development, Abuja.

Federal Government of Nigeria, FGN (2007). National Bureau of Statistics. A publication of the National Bureau of Statistics, 2007, Abuja.

FinMark Trust (2010). Overview of the Housing Finance Sector in Nigeria. UK DFID; Bill and Melinda Gates Foundation 12(1), 1-52

Fortune-Ebie, S.P.O. (2004). National Housing Fund and the Housing Policy of the Federal Government as it affect the strength (weaknesses) Opportunity (threat) of the Nigerian Workers (A paper presented at a two-day Kaduna State Economic Summit organized by Kaduna Forum at Arewa House, Kaduna).

Fulmer, J. (2009). What in the world is infrastructure? *PEI Infrastructure Investor*. Investment Strategy Guest Article (July/August, 2009): 30–32

IPCC (2007). Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, Pachauri, R.K and Reisinger, A. (eds.)]. IPCC, Geneva, Switzerland, 104 pp.

Jiboye, A. D. (2011). Ensuring Sustainable Development through an Effective Housing Delivery Process in Nigeria. *African Journal of Social Sciences.* 1 (2), 36- 45.

Jiboye, A.D (2009).*The challenges of sustainable housing and urban development in Nigeria*, Being a paper presented at fourth International Conference on Research and Development. *International Research and Development Institute*, Unilag, Akoka, Nigeria.

National Affordable Housing Association (NAHA. 2006. Sustainability; Policy Areas. [Online] Available: http;//www.housingcorp. gov. uk. Accessed December 27, 2015).

Nubi, T.O. (2000). Financing Urban Housing. Paper delivered in a workshop organized by Nigeria Building and Road Research Institute (NBBRI)Abuja, Nigeria.

Ogbuozobe, (1997). “Infrastructural Development” in Nigeria. *Nigeria Institute of Social and Economic Research (*pp. 163-193, Ibadan.

Olotuah, A. O. and Taiwo, A. A. (2013). Housing The Urban Poor In Nigeria Through Low-Cost Housing Schemes. *International Journal of Physical and Human Geography* Vol.1, No 3, pp.1-8

Oyedele, O. A (2012). The Challenges of Infrastructure Development in Democratic Governance. *Construction Economics and Management* I, 6119, 1-15

TMSA (2012). Governance and Infrastructure in the continent. Available at http://www.trademarksa.org/news/governance-and-infrastructure-continent. Accessed on November 23, 2015.

United Nations/Habitat (1984). Promotion of non-conventional approaches to housing Finance for low-income groups. Nairobi: United Nation Centre for Human Settlements.

World Bank (2007). The Nexus between Infrastructure and Environment, Washington D.C

World Bank (2010). World Development Report 2010: Development and Climate Change. Washington D.C.: World Bank

MODELING THE EFFECT OF CHANGES IN THE PRICE OF CONSTRUCTION MATERIALS ON THE RATE OF DEV ELOPMENT IN ABUJA

OLASANMOYE, Rotimi. S. and IDIAKE, J. E.
Department of Quantity Surveying, Federal University of Technology, Minna, Niger State, Nigeria.

The ever increasing cost of building construction materials in Nigeria has been a major sour ce of concern to all the stakeholders in industry because of its overarching effects on infrast ructure development. Globally, persistent rise in the price of materials has been reported to have consequential effects on sustainable development. This study, therefore, determines to analyse the effects of an increase in the prices of construction materials on the rate of devel opment in Abuja. In order to achieve this, data were sourced qualitatively and quantitatively from Abuja using archival data, personal observations and Geospatial techniques which inv olve the use of Remote Sensing and Geographical Information System (GIS) to determine t he rate of development over the years. Some selected building materials were examined and compared with the rate of development. The growth rate for the period of study was based o n built-up area per square meter. The data were analysed using both descriptive and inferent ial statistical analysis, to determine the relationship between the increases in prices of select ed materials on the rate of development. The result of the research has shown that changes i n the prices of building materials have effect on the rate of development explaining an aver age 85% in the variation explained by the models. The changes in the built-up area and veg etation between 1990 and 2014 was found to be significantly high. The research has indicat ed that a reduction in the prices of building materials will lead to a significant reduction in t he cost of housing projects in order to improve housing affordability and sustainability. The study is expected to contribute largely to currently discuss and vision of Nigeria in achievin g sustainable urban development. It will also be of benefit to all the stakeholders in underst anding the essence of achieving sustainable growth through an effective price control mech anism.

Keywords: *Building materials, sustainable development and rate of development*

rolasanmoye@yahoo.com,

idiakeje@futminna.edu.ng

OLASANMOYE, R. S. and IDIAKE, J. E (2016). **MODELING THE EFFECT OF CHANGES IN THE PRICE OF CONSTRUCTION MATERIALS ON THE RATE OF DEVELOPMENT IN ABUJA** Sustainable Built Environment and Climate change; The challenges of Post 2015 Development Agenda. School of Environmental Technology Conference, SETIC, 2016

INTRODUCTION

The Nigerian construction industry remains one of the major contributor to the nation's economy most especially in the provision of housing to the teeming population. This is because it involves housing construction which forms the fundamental requirement of a man due to its influence on his welfare, health and productivity (Agbola and Kassim. 2007; Akintunde, 2008). However, the ever increasing cost of housing construction in Nigeria has being a major source of concern to all the stakeholders in the industry because of its overarching effects on infrastructure development. The persistent increase in the cost of building construction is frequently traced to the upsurge in cost of building materials which are very vital in realising any housing project (Udegbe, 2007). For example, research (e.g. Arayela, 2005) has established that that the cost of building materials constitute about 65 percent of the construction cost. Ogunsemi (2010) and Adedeji (2010) resonate this assertion by positing that building materials constitute the major factors that limits the provision of housing and established that they account for between 50-60 percent of the cost of buildings.

As stated by Windapo, Ogunsanmi, and Iyagba (2004), the continuous and incessant increase in the cost of building materials may give rise to a serious shortage in housing provision with high number of both middle- and low-income earners being schemed out of the housing market for home ownership all over the country. Hence, one of the main problems, which this paper intends to examine, is basically how housing delivery and its sustainability is being affected by the changes in prices of building materials in the delivery of housing process. However, researchers such as Jagboro and Owoeye (2004) argued that persistent increase in the prices of building materials has magnifying impacts on the industry. Idoro and Jolaiya (2010) for example, established that quite a number of construction projects were often not completed on schedule due to the hike in prices of materials. Idoro and Jolaiya (2010) stressed further that many projects were not completed in time due to the cost of materials which has been on the increase perhaps on daily basis. The unfortunate trend in the building material supply situation is that demand has increased over the years while local production has diminished (Jinadu, 2004). For instance, production of cement requires a huge capital and considering high forex component coupled with the devaluation of Naira in the last two decades, it has not been possible to make significant investment in local manufacturing (Makoju, 1995). Therefore, material becomes an indispensable resource in the building construction sector as it account for a higher percentage total cost of building (Omange and Udegbe. 2000).

Although, the visible rate of development noticed in Abuja municipalities cannot be denied, but there is still a huge housing deficit considering the urban growth noticeable in the capital due to high cost of building materials and pervasiveness of unskilled or old labour (Okoruwa, 2014). Hence, the expected rate of development in terms of houses constructed cannot be achieved without a drastic reduction in the cost of building construction and its attendant costs which determines the cost of owning a house. In spite of the plethora number of studies that have examined the nexus between the cost of building materials as against the total cost of building in Nigeria, little or no research exist that explores whether there is a link between rate of development and prices of building material. Few studies that populated the literature either identify causes of changes in the price of building materials or the consequences of the changes on project delivery (e.g. Jagboro&Owoeye, 2004; Mekson, 2008; Njoku, 2007; Oladipo& Oni, 2012). Hence, this study aims at examining the impact of changes in the prices of building materials on rate of development of urban centres- Abuja specifically.

Literature

Construction is the broad process for realising human settlement and the creation of infrastructure that support development (Du Plessis, 2007). This include the extraction and beneficiations of raw materials, and components, the construction project cycle from feasibility to the construction, the management and operation of the built environment'' (Du Plessis, 2007).The construction industry is generally responsible for the physical transformation or the development of the which makes the built very vital to socio economic development of the nation. Considering the relationship between construction industry and the national economy, it becomes necessary that the cost of construction be within the reach of the average citizen. Akanni, Oke and Omotilewa (2014) contended that building materials significantly contribute to the quality and cost of housing, as it forms part of the used for building right from foundation to roofing and finishes. Thus, the building materials industry considered as a vital contributor to the national economy of any nation as its output governs both the rate and the quality of construction work (Akanni et al., 2014).

Building materials and rate of development

Rate of development here depicts urban growth with respect the built up area. In other words, it is referred to the growth that make use of land for the construction of buildings. Urbanisation is mainly caused by urban growth, which could be due to material population growth, re-classification of urban and rural system and rural-urban migration (Agbola 2002). The existing data has shown that the Nigerian population has been growing at an alarming rate. The urban centres and towns are rapidly growing and this has resulted in overcrowding, below standard buildings as well as inadequacies in infrastructural development in the urban areas (Onibokun, 1985). Also, availability of building materials at affordable prices have become a key hindrance and making housing ownership an herculean task to be accomplished by most people that desire to own a house. Ihuah (2015) argued that the consequences of not addressing issues, such as the increasing costs of developments resulting from the high costs of building materials means that housing provision is inadequate. Adedeji (2002) asserted that building materials constitute the largest single input in housing construction and viewed that the cost of housing is one of the major obstacles to the realisation of housing delivery in Nigeria as indicated by the efforts of successive government in the country. However, Federal Ministry of Lands, Housing and Urban Development (FMLHUD, cited in Ihuah, 2015), reported that persistence upsurge in the costs of construction materials may be as a result national macro-economic causes which often lead to high cost of development and the reciprocal which outside the scope of this paper. Ihuah (n.d) identified among other things, overdependence on imported building materials as one of the most vital factor leading to high cost of building material which in his view contributed to the obstacles in sustainability urban development in the study area. Mainly, the rate at which building material prices changes in Nigeria is surprising and this has negative impact on the construction industry which often lead to lack of development due to change in the total construction cost, redesigning and modification with consequential effects such as abandonment of project; poor workmanship resulting from the use of inferior materials, and restrained innovations in construction methods (Elinwa&Buba, 1993; Windapo*et al*.,2004; Idoro&Jolaiya, 2010; Oladipo& Oni, 2012). This paper hence, argued that the rate of development is restricted by the continuous increase in the cost of building materials and that materials are unarguably responsible for the cost of any housing construction project.

The use of sustainable building materials for housing construction has substantial influence on rate of development and attention of home builders has been directed towards sustainable housing as it help in reducing the environmental impacts in terms of the extraction, transportation, processing, fabrication or installation, reuse, recycling, and disposing of these structure based materials (Austin 2012; Roux and Alexander, 2007). In addition, Ihuah (2015) asserted that the use of sustainable building materials can offer a reduced cost of maintenance over the entire life-cycle of the building, through improved energy conservation, enhanced occupant good health and increased productivity, lowering of costs related to changing space or shapes, and greater design efficiency (Austin, 2012; Isaac et al., 2010). Therefore, the merits of sustainable building materials can summarised to enormous as it leads to overall superior performance of housing in terms of some specific criteria. These criteria include the benefit of sourcing the materials locally; reduced cost of transportation including the environmental impact as well as thermal efficiency in meeting the occupants' needs and health considerations. Other benefits that can improve rate of development through the use of sustainable materials according to Roux and Alexander (2007) and Spiegel and Meadows (1999) includes financial viability; ability to recycle the building materials and the use of renewable resources; toxic emissions generated by the product and maintenance costs.

RESEARCH METHOD

This study focused on the rate of development of the Federal Capital Territory, Abuja, Nigeria and the total population of the study comprised of all the local area councils. Purposive sampling method was used in the selection of the study area. This is because non-probability technique according to Aje (2008) gives every subject in the study population a non-zero probability of being included in the sample and also gives a range of alternative techniques to select samples based on researcher's subjective judgment. Therefore, research approach for this study involves archival research method which is a type of primary research that involve seeking out and extracting evidence from original archival records. Archival research methods entail a wide range of activities applied to make possible the investigation of documents and textual materials produced by and about organizations (Ventresca and Mohr, 2001). The methods according to Ventresca and Mohr (2001), involve the study of historic documents produced at some point in the relatively distant past, giving us access and opportunity which researcher may not likely have to the organizations, individuals, and events of that earlier time.

Archival or secondary data comprises of a wide collection of empirical data compiled by some individuals for their own use were collected. The secondary data consist of building material prices over the period of 24 years and maps of the Area Councils. Cost of building materials were sourced from the National Bureau of Statistics and Builders' magazine while the maps of the area councils were sought from Federal Capital Development Authority. The building materials considered in this paper includes cement; sand, aggregate, reinforcement, blocks, aluminium and timber. The Geographic Information System (GIS) was used in obtaining primary data, which is the satellite imagery. The GIS was employed to obtain the rate of development (the built area) of all the six area councils in Abuja since 1990 to 2014. The collected data were analysed using descriptive statistics and regression analysis, conclusions and recommendations were drawn based on the finding thereafter. The software packages employed for the analysis of the imageries is Land Water Information System. The package was employed in the classification and processing of the image. The study used a classification which was supervised for all the imageries by adopting five parameters which includes: Built-up Area; Bareland/Surface; Vegetation; Cultivated and Water Body. The use of Geospatial methods were adopted in establishing the rate of spatial growth of all the six area councils in Abuja between 1990 and 2014, three imageries of 1990, 2000 and 2014 were obtained and processed using Thematic Mapper 30M resolution.

FINDINGS AND DISCUSSION OF RESULTS

This section presents the results, interpretations and discussion of results based on the analysis carried out. The descriptive measures were used to describe the characteristics of the sample based on the method used in gathering the data, to check if the research variables violate any of the underlying statistical assumptions required to address research questions and create a systematic understanding of the type of data and give a synopsis of the variables used as sample. From Table 1, it was shown that Bwari area council has the least mean growth rate (237810432m^2) followed by Abaji (317496814m^2) while AMAC has the highest growth rate of 790393388 m^2. This increase in growth may be as a result of the university located in the neighbourhood which often drives housing developers in providing housing for the students.

Table 2 shows the results of the correlational statistics employed to show the pattern and nature of associations among the variables included in the analysis. The statistical tool was used to assists in determining the strength of the relationship between the variables which can exhibit either positive, negative or no relationship (Hair *et al*., 2010). Statistical correlation was employed in this paper as an important step for further analysis such as the development of regression model(s) which will follow (Hair *et al*., 2010). From Table 2, the correlation matrix showed that the coefficient (r) ranges from 0.012 to 0.907. Changes in the price of cement has a high correlation with the rate of development in Kwali ($r = 0.846$; $p = 0.001$), follow by Kuje ($r = 838$; $p = 0.001$). Kuje ($r = 0.414$; $p = 0.001$) and Gwagwalada ($r = 0.403$; $p = 0.01$) has moderate correlational relationship with sand according to Dancey and Reidy's (2011) who categorised a correlational relationship with a coefficient of 1 to be a perfect correlation; 0.7 - 0.9 as a strong correlation; between 0.4 - 0.6 to be is moderate; 0.1 - 0.3 is weak; and that a coefficient 0 means that no relationship exists at all. Similar relationship exist between changes in prices of blocks, Kwali and Abaji. This may be as a result that those two local government are outskirt of Abuja where local income people resides and this invariable dictate the pace of development unlike the central area councils.

Table 1: Descriptive Statistics of material and rate of development

S/No		Mean	Std. Deviation	N
1	Cement	82954.16	73519.03	25
2	Sand	171847.64	190107.39	25
3	Aggregate	660754.60	787186.46	25
4	Reinforcement	399923.88	879556.96	25
5	Block	6103.80	5889.98	25
6	Aluminium	251398.20	252699.75	25
7	Timber	28606.00	20964.90	25
8	Kuje	596684702.00	128138296.53	25
9	Bwari	237810432.00	74412722.66	25
10	AMAC	790393388.40	254039772.28	25
11	Abaji	317496814.80	68585176.05	25
12	Kwali	366811060.00	153284830.63	25
13	Gwagwalada	346022146.80	122634405.15	25

Source: Author's Fieldwork (2015)

The summary of the results of regression analysis between the rate of development of the area councils and changes are presented in Tables 5. The models summary is shown in Table 5. Models 1, 2, 3, 4, 5 and 6 show considerably very high R square value of 90%, 90%, 88%, 89%, 89% and 89% respectively and these were significant at 0.01 level of confidence. The regression coefficient that is the values, one for each explanatory variable included in the equation, which indicate the strength and nature of relationship the explanatory variable has in relation to dependent variable ranged between 2 to 598 in absolute values. Changes in the prices of some selected building materials (cement, aggregate, blockwork and timber) exhibited positive and strong relationship with the rate of development in the study area. Changes in the prices of reinforcements also show the same positive effect except in Kwali area council. However, sand and aluminium show negative relationship to rate of development in some local councils (such as Kuje, Kwali etc.).

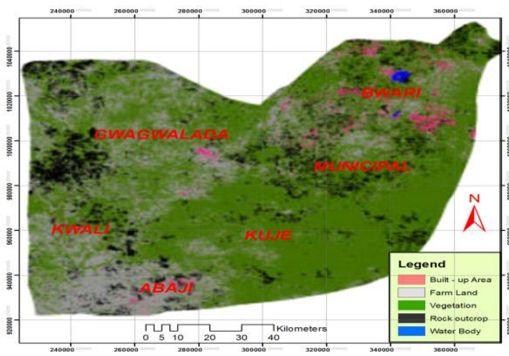
From the equations Table 3, the coefficient of correlation (R) which, according to Xiano and Proverbs (2005), measures the strength of a linear association is 0.95. This indicates that there is between 94-95% relationship between the dependent variable and the independent variables in all the models. The coefficient of determination (R^2) ranges 89 to 90% while the adjusted R^2 is 84-86% showing a high degree of fitness of the multiple regression model.

Table 2: Coefficients of the rate of development Models

Variables in the equation	Kuje Model 1	Bwari Model 2	AMAC Model 3	Abaji Model 4	Kwali Model 5	Gwags Model 6
(Constant)	438969122.11**	11706382.54**	458612472.37**	232864114.97**	207052317.71**	197556590.07**
Cement	334.796	246.126	570.202	179.015	598.405	197.195
Sand	-147.651	44.415	-177.090	-78.779	-232.491*	-136.143
Agg	46.295*	9.331**	94.705*	24.800*	34.637	54.567**
Rfmt	1.333	7.131	8.439	.921	-4.504	1.399
Block	16958.02**	2722.38**	29990.66**	9043.71**	20233.19**	17204.76**
Alum	-10.230	30.208	52.450	-4.969	-2.717	15.634
Timber	813.023	359.289	1842.919	440.955	215.681	347.610
R	.946	.948	.936	.945	.944	.942
R Square	.895	.898	.876	.893	.892	.887
Adjusted R Square	.851	.856	.825	.849	.848	.841
F Change	20.596**	21.334**	17.143**	20.208**	20.055	19.135

Source: Author's Fieldwork (2015)

The result of the GIS tools used is showing in Figures 1, 2 and 3 below indicate classified image representation of Land Use of Abuja between 1990, 2000 and 2014. The greenish area coverage is more compared to the pink colour areas. The state of land use coverage of Federal Capital Territory in 1990, 2000 and 2014 was generated from the supervised image classification of Land SAT Thematic Mapper 30M resolution. This indicates an increased in the pink mostly in Municipal area coverage as against the greenish colour area. The figures (1, 2, 3 and Table 1) showed that there was a considerable increase in the built-up area of the entire local councils with AMAC showing the highest increase. Urbanisation of Abuja accounts the increase in growth while human activities in the study area could explain the drastic reduction in the vegetation, bare area etc.



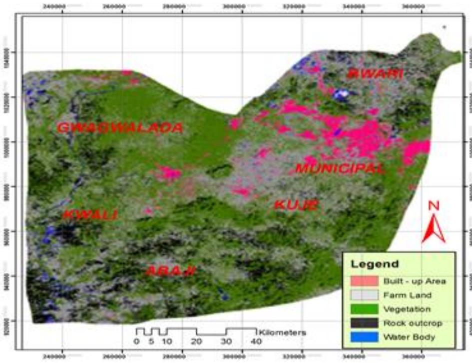


Figure 1: Abuja Land use 1990Figure 2: Abuja Land Use 2000

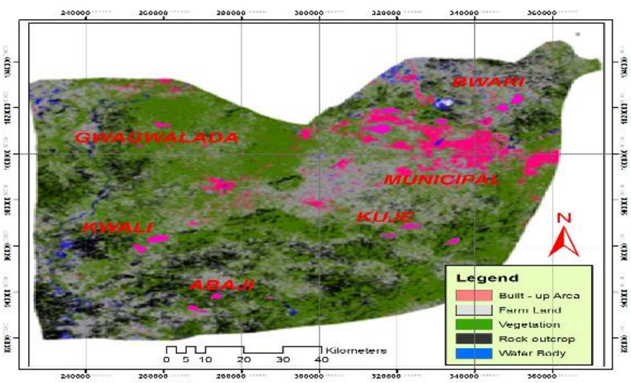


Figure 2: Abuja Land Use 2000

The results of the analysis affirmed the position of previous researcher who agreed that the cost of building materials have significant impact not only to the construction industry but also to people aspiring to own houses (Anosike, 2009; Mekson, 2008; Mohammed, 2008; Njoku, 2007). Anosike (2009) illustrated that if a bag of cement valued at N1, 350.00 in 2006, goes as high as N1, 850.00 in 2009 means that 37% increment; and the price still soar up as high as N2, 000.00 in 2015 during peak season but now around N 1, 400. The position of these researchers corroborated the view of Jagboro and Owoeye (2004) who had earlier posited that increase in the prices of building materials has resonating effects on housing development. Idoro and Jolaiya (2010) contended that many housing or construction projects were completed beyond and above cost of materials, which have been on the increase almost on daily basis. The findings on the rate of development is analogous to the findings reported by Adeleye (2015), who examined the consequences of urban growth in Suleja, a suburb of Abuja.

Table 2: Correlations between changes in the prices of materials and the rate of development (built up area)

	Cement	Sand	Agg	Rfmt	Block	Alum	Timber	Kuje	Bwari	Amac	Abaji	Kwali	Gwags
Cement	1												
Sand	.644**	1											
Agg	.169	.311	1										
Rfmt	-.109	-.011	-.199	1									
Block	.907**	.484*	.000	-.114	1								
Alum	.519**	.234	.131	-.314	.510**	1							
Timber	.324	.368	.430*	-.093	.328	.411*	1						
Kuje	.838**	.414*	.302	-.161	.880**	.515**	.484*	1					
Bwari	.822**	.444*	.353	-.184	.865**	.495*	.518**	.993**	1				
AMAC	.833**	.469*	.347	-.156	.854**	.553**	.530**	.983**	.977**	1			
Abaji	.837**	.415*	.303	-.159	.879**	.515**	.485*	1.000**	.992**	.984**	1		
Kwali	.846**	.338	.154	-.179	.909**	.517**	.349	.973**	.961**	.935**	.972**	1	
Gwags	.826**	.403*	.333	-.180	.866**	.533**	.454*	.990**	.989**	.978**	.989**	.972**	1

** Correlation is significant at the 0.01 level (2-tailed).* Correlation is significant at the 0.05 level (2-tailed).

Agg- Aggregate; Alum- Aluminium; Rfmt- Reinforcement;

Source: Author's Fieldwork (2015)

CONCLUSION

This study acknowledged that few studies have examined the causes of changes in the prices of building materials as well as their effect on the construction industry most especially in the developing nation's context. Most of the scholars have unanimous views concerning the influence of changes in the prices of building materials on housing construction. As a result, this study explored the impact of changes in the prices of building materials on the rate of development (built up areas) in Abuja area councils. The study covered the entire 6 local area councils in Abuja, Nigeria. The results of the analysis showed that there insignificant differences rate of development in all the area councils examined except Kwali with the incessant changes on prices of materials. These differences were noted on the changes in the prices of blocks and aggregate used as building materials in the area council. The result of the research has shown that changes in the prices of building materials impact on the rate of development explaining an average 85% in the variation explained by the models. The research has indicated that a reduction in the prices of building materials will lead to a significant reduction in cost of housing projects in order improve housing affordability and sustainability.

On a final note, the study is not without its limitations. The research only investigated the impact of building materials on the rate of development of 6 area councils in Abuja. The study did not considered the actual number of houses constructed within the period nor vertical sprawl but focused only on the built areas produced by the GIS. Therefore to generalise the result, further research is required into the factors that often lead to changes in the prices of materials and the effects of labour on the rate of development. Further research is also required to investigate the impact of the combine effects of labour, materials and macroeconomic variable on the rate of development in the local area councils studied.

REFERENCES

Adedeji Y. M. D. (2002). Achieving affordable housing in South-West Nigeria through Local building material. *Journal of Environmental Technology,* 1(2): 15- 21,

Adedeji Y. M. D. (2010). Technology and standardised composite cement fibres for housing in Nigeria. *Journal of Nigerian Institute of Architecture*, 1: 19-24.

Adeleye, B. M. (2015). Assessment of the consequences of urban growth in Suleja, Niger State (1987-2013). Unpublished Masters Degree Thesis, submitted to the Department of Urban and Regional Planning, Faculty of Social Sciences, University of Ibadan, Nigeria.

Agbola, T. &Kassim, F. (2007) .Conceptual and Theoretical Issues in Housing. Pp, 52-55.

Agbola, T. (2002). *The housing construction process in Nigeria: Implications for urban growth and development.* Center for Urban and Regional Planning, Faculty of the Social Sciences,University of Ibadan, Ibadan, Nigeria.

Aje, I. O. (2008). The impact of contractors' prequalification and criteria of award on construction project performance in Lagos and Abuja, Nigeria. An unpublished

PhD thesis submitted to Department of Quantity Surveying, Federal University of Technology, Akure, Nigeria

Akanni, P. O., Oke, E. A., &Omotilewa, O. J. (2014).Implications of Rising Cost of Building Materials in Lagos State Nigeria. SAGE Open October-December: 1–7

Akintunde, I. (1992) Manpower utilization for construction industry, Problem and prospects. *Seminar on construction and the national economy.*

Anosike, P. (2009, April 6). Nigerian groans under high cost of building material. *The Daily Sun*, pp. 38-39.

Arayela O. (2005). Laterite bricks: before now and hereafter. Inaugural lecture series 40 delivered at Federal University of Technology, Akure, 5-15.

Austin, G.W. (2012) 'Sustainability and income-producing property valuation: North Americanstatus and recommended procedures', *Journal of Sustainable Real Estate*,. 4(1),79–122.

Dancey, C. P., & Reidy, J. (2011). *Statistics without Maths for Psychology: Using SPSS for Windows*, (5th ed.). Pearson Education Limited, Harlow, Essex.

Du Plessis, C.D. (2007). A Strategic Framework for Sustainable Construction In Developing Countries, *Construction Management and Economics* 25(1) 67-76.

Elinwa, A. U., &Buba, S. A. (1993). Construction cost factors in Nigeria. *Journal of Construction Engineering andManagement*, *119*, 698-713.

Idoro, G. I., &Jolaiya, O. (2010). *Evaluating material storage strategies and their relationship with construction project performance*. Proceedings of CIB International Conference onBuilding Education and Research, University of Cape Town(pp. 103-113). Retrieved from http://www.rics.org/cobra

Ihuah, P. W. (2015). Building materials costs increases and sustainability in real estate development in Nigeria. *African Journal of Economic and Sustainable Development*, 4(3), 218-233

Isaac, D., O'Leary, J. and Daley, M. (2010) *Property Development: Appraisal and Finance(Building and Surveying Series)*, Palgrave Macmillan, UK.

Jagboro, G. O., &Owoeye, C. O. (2004). A model for predicting the prices of building materials using the exchange rate in Nigeria. *The Malaysian Surveyor*, *5*(6), 9-14.

Jinadu, A.M (2004) understanding the basis of housing Minna; 1st Edition. (Narren, M. (2002), Economic Analysis for Poverty and Business, bitter Worth London Heineman, Oxford.(Nannacott R. (1982), Economics 2nd Edition, Mc Grant-Hill, Tokyo, pp 389-390.

Makoju, J.O (1995) Cement Production in Nigeria and Options for Meeting National Demand. *Construction in Nigeria.* 10(4), 27.

Mekson, J. (2008, August). Prices change of building materials in developing communities in Nigeria. *The Professional Builders*, pp. 21-27.

Mohammed, H. Y. (2008, December 25). Nigeria: Builders groan on rising cost of building materials. *Daily Trust*, p. 29.

Njoku, J. (2007, April 9). Grappling with escalating cost of construction materials. *The Vanguard*, pp. 36-37.

Ogunsemi DR (2010). The use of enough quality and quantity materials for building a durable edifice. A Lecture delivered at Campus Transformation Network, Federal University of Technology, Akure.

Okoruwa, E. (2014, December 10). High construction cost, unskilled labour, bane of affordable housing. Available on http://leadership.ng/features/394066/high-construction-cost-unskilled-labour-bane-affordable-housing (retrieved 12 December, 2015).

Oladipo, F. O., & Oni, O. J. (2012). Review of selected macroeconomic factors impacting building material prices in developing countries—A case of Nigeria. *Ethiopian Journal ofEnvironmental Studies and Management*, *5*, 131-137.

Omange, G.N. and Udegbe, M.I. (2000) Government Involvement in Housing. In effective Housing in the 21st Century Nigeria. *The Environment Forum.* (Akinbamijoed) Federal University of Technology, Akure, 9-15.

Onibokun, P. (1985). "*Housing in Nigeria"*: A Book of Readings, Ibadan: NISER.

Roux, P. and Alexander, A. (2007) 'Sustainable building materials and what are sustainablebuilding materials', Paper presented at *US Green Building Council*, Washington, USA[online]http://www.sustainabledevelopmentnetwork.com/manual1/Chapter%203.pdf (accessed 30March 2015).

Spiegel, R. and Meadows, D. (1999) *Green Building Materials: A Guide to Product Selection andSpecification*, John Wiley & Sons, Inc., New York.

Udegbe, M. I. (2007). The Application of Transcendental Functions to Labour Optimization in the Building Construction in Edo State, Nigeria. *Journal of Social Science*, 15(1), 51-57.

Ventresca, Marc., & Mohr, John W. (2002). *Archival research methods*. In Joel A. C. Baum (Ed.), The Blackwell companion to organizations (pp. 805–828). Oxford, UK: Blackwell Publishers

Windapo, A. O., Ogunsanmi, O. E., &Iyagba, R. O. (2004, November). *Modeling the determinants of the demandfor housing construction in Nigeria*. In S. Ogunlana, Charoenngam, P. Herabat, & B. H. W. Hadikusumo (Eds.), *Proceedings of the CIB W107 & TG 23 InternationalSymposium on Globalization and Construction* (pp. 631 646).KlongLuang, Thailand: School of Civil Engineering, Asian Institute of Technology.

Xiano, H. and Proverbs, D. (2005) Factors Influencing Contractors Performance: An International Investigation. *Engineering, Construction and Architectural Management* 10(5), 322-332.

WORK-LIFE BALANCE AMONG WOMEN CONSTRUCTION WORKERS: A CONCEPTUAL APPROACH

OYEWOBI, Luqman Oyekunle & ADENEYE, Toyin Deborah
Department of Quantity Surveying, Federal University of Technology, Minna, Niger State, Nigeria.

Work life balance is a 'fit' between multiple responsibilities in an individual's life both at home and workplace. The concept of Work-Life balance is not entirely new in the construction lexicon, it has advanced over time. The idea of work-life balance developed from the fact that an individual have varying roles which often places mutually exclusive demands on one another; for instance, wife versus worker. However, striking a balance between work and personal life among female construction employees has been a herculean task confronted by women due to the nature of roles being played at home and the overflow of personal life over work life. This paper presents a literature review of past studies relating to work-life balance with specific focus on the construction industry. An extensive review of existing literature assist in identifying constructs such as work life balance of women employees, organisational commitment, organisational strategies for improving work-life balance and their influence on organisational performance. Findings from the literature on the links between these constructs provided the basis for the development of a conceptual approach used in demonstrating the hypothesized interaction among the constructs and their influence on organisational performance. The developed conceptual model forms the basis for further empirical study aimed at quantitatively demonstrating the nature of relationship that exists among the constructs and their joint influence on organisational performance in the context of the Nigerian construction industry.

Keywords: Work-life balance, women workers, construction industry, organisational performance

adegoketoyindee@yahoo.com,
l.oyewobi@futminna.edu.ng

Oyewobi, Luqman Oyekunle[1] and Adeneye, Toyin Deborah[2] (2016). **WORK-LIFE BALANCE AMONG WOMEN CONSTRUCTION WORKERS: A CONCEPTUAL APPROACH** Sustainable Built Environment and Climate change; The challenges of Post 2015 Development Agenda. School of Environmental Technology Conference, SETIC, 2016

Introduction

Construction industry globally is characterised by traditional work patterns which are often founded on gendered conjectures regarding the type of work and the continuous availability of workers (Dainty and Lingard, 2006; Lingard *et al.*, 2007). The construction industry is gender sensitive based on the perceptions that construction is "men's job" and sometimes discourages the participation of women. Streams of evidence that suggests that women who chose to pursue career in the industry often leave from it prematurely abounds in literature (e.g. Amaratunga et al., 2007; Lingards et al., 2007). The causes of this early turnover stems from the employment conditions, long working hours and the inability of the industry to adjust and accommodate family demands of female workers (Byrne et al. 2005; Fielden et al. 2000).Construction jobs in Nigeria however, falls under the categories of economic activities where women have been underscored not to have the privilege to make a successful career. However, Dlamini *et al*. (2013) argued that these traditional challenges and stereotypes confronting women with respect to their success in the industry are being broken globally, as plethora numbers of women are entering into the construction industry. More women than ever before are entering into the construction workforce, reflecting rising educational attainments, changing societal attitudes and increasing need to meet family socio-economic demands. In fact, as shown in Table 1, the total number of persons engaged in construction's formal sector increased by 3.21% in 2011 and 4.42% in 2012. Male employees constituted a very large portion of the total number of persons employed in the sector with a percentage share of 91.38% in 2010, 91.61% in 2011 and 91.52% in 2012. While there was a steady increase in the number Nigerian male employees for all three years, the females saw a decline in their numbers by 0.45% between 2010 and 2011, but an increase by 6.10% for 2012.

Table 1: Nigerian Construction Industry Workforce by Gender 2010-2012

NATIONALITY	GENDER	2010	2011	2012
Nigerian	Male	5,861,845	6,065,033	6,327,377
Nigerian	Female	398,403	396,602	420,779
NonNigerian	Male	147,633	150,719	157,664
NonNigerian	Female	7,202	8,488	7,716
TOTAL		**6,415,082**	**6,620,842**	**6,913,536**

Source: National Bureau of Statistics, (2015)

Thus, one of the main challenges confronting women in any sector construction inclusive today is maintaining a fit between work responsibilities and life most especially amongst women employees who are interested in the quality of working life and its interaction to broader quality of life (Guest, 2002). According to Kamenou (2008), women do struggle to manage concurrently the complex demands of life to a greater degree relative to their male counterpart. This is as a result of numerous household responsibilities been undertaken by women and sacrifices being made with respect to child bearing (Broadbridge, 2009). In spite of the fact that the contributions of women workforce is being recognised in the construction industry as major contributor to economic wealth of nations and the associated growing population of women participation in the industry, globally and in Nigeria, the issues relating to work-life balance which has been a major drawback influencing the performance of many construction organisations has not been given adequate attention (Francis, 2003; Lingard et al., 2007).

However, no any known study has been undertaken to specifically consider the pressures that work exert on family as well as life of female construction workers (e.g. Devi and Kiran, 2013; 2014) and explore the impact of work-life balance on the performance of the construction industry generally in Nigeria. Nonetheless, inferences could be drawn from studies undertaken in different countries (e.g. Francis & Lingard, 2004; Lingard et al., 2007; Devi and Kiran, 2013; 2014). Many of these studies were undertaken in the context of developed countries mainly in Europe and Asia and some of the findings are country specific.

Therefore, it is considered imperative that research be undertaken to explores the extent to which work-life balance influence the performance work systems in the context of the Nigerian construction industry. However, the main aim of this paper is to develop and present a conceptual model that is empirically testable to depict the nature of relationships that exist between the demographic characteristics of respondents, organisational commitment, work-life, strategies for improving work-life balance and their joint effects on the performance of organisations within the context of the Nigerian construction industry. Precisely, this paper explains the stages of the development of the conceptual model and present the hypothesised statements based on an extensive review of relevant literature. The next section presents the conceptual framework and the hypotheses.

Theoretical perspectives of work-life balance and hypotheses

Theory has been described as a scientific approach of explaining pragmatic observations relating to a natural occurrence to give an understanding, which can be employed in the prediction of likely future behaviour of the experience being considered (Oyewobi, 2014). In explain the concept of work-life balance, quite a number of theories have been propounded by scholars such as Zedeck and Mosier (1990) and O'Driscoll (1996). This theorist postulated that there are five models that can be employed in explaining the relationship between work and life beyond work. These theories include the *segmentation* theory which suggests that non-work and work are two separate sphere of life that are lived distinctively and exhibit no influence on each other. Guest (2001) argued that the model only provide hypothetical possibility than empirical support. A *spill over* theory in contrast to segmentation theorises that work and non-work life can influence the other in either positively or negatively. This assertion has been supported by ample study; however, Guest (2001) contended that the proposition generic in nature, hence more detailed propositions regarding the nature, causes and consequences of spill over is required. The third theory is referred to as *compensation* theory which suggests that what may be lacking in one domain, with respect to satisfactions or demands can be compensated for in the other domain. The fourth theory is an *instrumental* theory through which activities in one domain assists in achieving success in the other. Finally, the last theory as explained by Zedeck and Mosier (1990) and O'Driscoll (1996) is a *conflict* theory which proposes that with increased levels of demand in all domains of life, some hard decisions have to be made; some of these choice may conflict and possibly some significant overload on an individual may occur. However, Guest (2001) considered the five theories discussed above to be basically descriptive in nature and stressed further that for the theories to add values, there is need to integrate an assessment of their causes and consequences. Guest (2001) suggested that *border theory* propounded by Clark (2000) is another approach that can assist in the analysis of the boundary between work and the rest of life. The theory hypothesised that individuals are daily border-crossers by moving between home and work, thus with respect to the analysis of work-life *balance*, the theory can assist in clarifying how far individuals are in charge of issues that determine balance. This study is hinged on a fusion of *border*, *spill over* and *conflict* theories by supporting the argument that if individuals do not sense they have a 'good' mix and integration of work and non-work responsibilities, they may experience negative or conflicting outcomes, which means that a bi-directional relationship exists between the two domains; whereby work can influence non-work responsibilities (work/life conflict) and vice versa (life/work conflict) (Frone, Russell & Barnes, 1996; Frone, Yardley & Markel, 1997;Frone& Carlson, 1999).

Work-Life Balance and organisational performance

Work-life balance has been defined variously in literature. For instance, Greenhaus *et al*., (2003) defined work-life balance as the degree to which an individual is equally engaged in – and equally satisfied with his or her work role and family role. This definition re-echoed the assertion of Clark (2000) who defined work-life balance as the satisfaction and good functioning at work and at home with a minimum of role conflict. As seen in the definitions above, the terms work-life balance have been used by researchers in explaining the extent to which people are equally engaged in work and non-work responsibilities. According to, Fu and Shaffer (2001) work-life can be categorised into two distinct dimensions based on role interference; family–to work and work-to-family interference. The determinants of these interferences have been identified in literature. However, in this research, the work-life balance of all employees (female) who are single, married and/or child-free, including older employees whose children have left home is the focus. This is because most of the work-life policies are considered to be more beneficial only to female employees most especially in a male dominated industry such as construction. The fragmented nature of the construction industry which allows multiple stakeholders to come together on *ad hoc* basis requires employees balancing the possibility of role conflict within the job (Francis & Lingard, 2002). The construction industry is traditionally characterised with argumentative ethos in which conflicts and disputes are unexptional, and these features often give rise to conflict between employees' work and personal lives (Francis & Lingard, 2004). Maintaining balance between work and personal lives led to the concept of work-life balance which stems from recognising the fact that a person's work-life and personal/family life may bring to bear conflicting demands on each other. Hence, the need to balance the work and non-work sphere of lives of construction employees has led to an increase in interest in work-life balance related studies amongst construction management researchers in order to examine how maintaining balance influence their work-family relationship. Lingard *et al*., (2007) argued that high quality work is a characteristic of high-performance work systems. However, Lingard *et al*. (2007) reported that the factors impacting on the quality of work consist of the degree to which workers enjoy job decision latitude and autonomy, as these two components are consistently linked to positive work attitudes, psychological comfort, and worker performance. Also, Lyness and Judiesch (2008) reported that a positive relationship exist between work- life balance and work performance while, Cunha and Rego (2008) stressed that a successful achievement of life responsibilities (family or parental responsibilities) results in better work performance. Moreover, a study of civil engineers and work-family conflict by Francis (2003) provide evidence that work-life balance initiatives are linked to organizational performance. Based on the foregoing this study hypothesised thus;

Hypothesis 1: work-life balance is positively related to organisational performance.

Work-life balance and work-life policies/strategies

In today's business world, employers of workforce most especially in construction business can no longer afford to ignore the importance of Work-Life balance in achieving organisational effectiveness. The work tradition within the construction industry is characterised with long hours of work as well as weekend work (Lingard *et al*., 2007), this culture has made project staff to suffer from significantly higher levels of work-family conflict and burnout than their counterpart in either the head or regional office (Lingard and Francis 2004). This was revealed in a survey conducted in the Australian construction industry, where average working hours of site-based project staff is 62.5, office-based staff 56.1 hours and 49.0 hours among staff based in regional or head office per week. Considering the impact of this long working hours on employees performance, it could be said that introduction of an effective Work-Life balance strategy will be a major distinguishing factor that can promote talent retention and attractiveness. Although, many work-life balance strategies have been developed such as flexible work arrangements which can give support, ensure business continuity and permit workers to have work autonomy and efficiency, however, how the implementation of this will yield better outcome in the construction context remain unexplored. Yasbek (2004) contended that introduction of work-life balance policies can influence business performance in a variety of ways. Yasbek (2004) stressed further that an effective work-life strategies can assist organisations in a competitive labour market in attracting better recruits by providing effective work-life balance policies vis-à-vis competitive remuneration packages. It was also, posited that work-life balance policies is capable of reducing costs through improved rates of staff retention, this invariably will can enhance productivity (Yasbek, 2004). These arguments is well entrenched by proponents of work-life models (Zedeck& Mosier, 1990; O'Driscoll, 1996). Some according to Yasbek (2004) contended that work-life policies will reduce negative spill-overs from workers' personal life to work life, leading to productivity gains and effective strategies can also reduce extended work hours and fatigue, which have a negative effect on productivity. Other researchers (e.g. (Hunt, 1993; Konrad &Mangel, 2000; Russell, 1993; McCampbell, 1996; Baltes, et al., 1999) also provided evidence to support that the presence of effective work-life policies can be linked to increased organisational productivity, higher levels of organisational performance and high morale of workers.

This study hence proposed that:

Hypothesis 2: Work-life balance policies and strategies will positively relate to organisational performance

Organisational commitment, work-life balance and performance

Organizational commitment is viewed as the strength of a person's identification and involvement in a particular organization which is characterized by a strong belief in accepting the organization's goals and values (value commitment) as well as readiness to exert considerable effort on behalf of the organization and to remain a member (commitment to stay) (Zeinabadi, 2010). Various attempts have been made by many researchers in examining the relationship between work-life balance and organisational commitment and the results have been inconclusive. For example, Vloeberghs (2000) explore the relationship between the direct and indirect influences of work life balance (WLB) practices on hospital's stakeholders; the result revealed that greater use of work-life balance among multiple employees in hospital leads to an improved outcome. In a similar research conducted by Choudhry (2011), examination of the relationship between work-life balance and organizational commitment indicated significant positive relationship between work life balance and employee performance. Sakthivel and Jayakrishnan (2013) investigated the relationship between work life balance and organisational commitment among nurses from public and private hospitals, the findings suggest that nurses performed better and more committed to their organisation when they experience better work life balance. This affirmed the argument of Mathieu and Zajac (1990), who posited that employees satisfaction is directly proportional to their organisational or work performance, which invariably means high levels of organizational commitment may positively influence both the organization and the workers. All these findings were in consonance to the findings reported by Meyer and Allen's (1991), who reported that positive relationship exists between work-life policies and organizational commitment. However, Norton (2009) who examined examines the relationship between work-life balance and Meyer and Allen's (1991) three components of organisational commitment found that no significant relationship exists between continuance or normative commitment and perceived work-life balance while a positive correlation exists between affective commitment and perceived work-life balance. Research efforts has shown that presence of work-life balance practices, often yield positive results with regards to work-related attitudes (e.g. Nelson et al., 1990; Scandura & Lankau, 1997). For example, Beauregard and Lesley (2009) reported that readiness of organizational resources inclusive of flexibility in work hours, has been linked to effective organizational commitment and job satisfaction for all employees especially women with family responsibilities, irrespective of whether or not these resources are being put into used.

The study therefore suggests that:

Hypothesis 3: there is a positive relationship between organisational commitment, work-life balance and policies

Conceptual framework and hypotheses

The focus of this section is to give details of the concepts used in this study and to present the position of the researcher regarding the current discuss on the influence of work-life balance literature in general and construction specifically. The findings from the review of literature form the basis for the development of a conceptual framework. The proposed framework is as indicated in figure 1 will be used to examine and illustrates the hypothesized relationship amongst the constructs discussed above and their impact on performance. The study will use hierarchical multiple regression to examine the nature of the relationships amongst the constructs in the framework as shown below. The proposed framework will offer primary support and form the basis for further empirical research that will focus on explaining the nature of association and joint effects of these constructs on the performance of both employ and organisation within the context of the Nigerian construction industry.

Figure 1: Conceptual Framework

Conclusion

The issue of work-life balance and its impact as supported by many researchers hinges on ability to attract better recruits and lessening work-life conflict amongst the current employees in an organisation so as to improve organizational performance. The reviewed literature showed that work–life balance is hypothesised as a constant but non-objective subjective evaluation of job satisfaction derived by employees from multiple roles being played with respect to the significance attached by an individual at a given point in time. However, the review also indicates that there is a limited stream of evidence to corroborate the concept that work-life practices enhance performance through a reduced work-life conflict. From the review it is observed that most the studies were either undertaken in the context of Europe, America or Asia. It is believed that there is a lessons to be learned from these research efforts and pertinence of the study to our society will be examined quantitatively and qualitatively amongst people within the Nigerian construction industry especially Abuja.

The next stage of the research would involve refining the conceptual framework to achieve the main objective of the research whereby the targeted population will be encouraged to verify the existence of the proposed links and influence direction among the constructs. Findings from this study will offer an invaluable managerial data to assist organisations in applying suitable strategies that can enhance the work–life balance experience of their employees which will invariably lead to improved wellbeing of employees, their job satisfaction and commitment. Finally, it contributes to the emerging body of knowledge with respect to work–life balance with experience from Nigeria and provides a unique context-specific perspective to the conceptual understanding of the construct.

References

Amaratunga, D. Haigh, R. Lee, A. Shanmugam, M. and Elvitigala, G. (2007). Construction industry and women: A review of the barriers. Built Environment Education Conference, University of Salford and Construction Industry Board, London.

Baltes, B. B, Briggs, T. E., Huff, J. W., & Wright, J. A. (1999), Flexible and compressed workweek schedules: A meta-analysis of their effects on work related criteria, *Journal of Applied Psychology*, 84, 496-513.

Beauregard, T. Alexandra and Henry, Lesley C. (2009) Making the link between work-life balance practices and organizational performance. *Human resource management review*, 19. pp. 9-22.

Broadbridge, A. (2009), "Flexible Work Practices: Women Only?" The International Review of Retail and Consumer Research, Vol. 19, Jul, Iss. 3; pp. 289

Byrne.U (2005), "Work Life Balance: Why are we talking about it at all?" Business

Information Review, Vol 22, No.1, 53-59.

Chaudhry, A.A. (2011). Examining the relationship of work-life conflicts and employee performance: A case from NADRA Pakistan. 6(10)

Clark, S.C. (2000). "Work/family border theory: A new theory of work/life balance". *Human Relations,* 53(6),747-770.

Dainty, A. and Lingard, H. (2006). Indirect discrimination in construction organisations and the impact on women's career. Journal of Management in Engineering, 22(3), 108-118.

Devi, K. and Kiran, U.V. 2013. "Status of female workers in construction industry in India: A Review." *IOSR Journal of Humanities and Social Science (IOSR-JHSS).* 14 (4):27-30.

Devi, K. and Kiran, U.V. 2014. Work Life Balance of Women Workers in Construction Industry. *European Academic Research* Vol. II, Issue 4, 4932-4946.

Dlamini, G., Shakantu, W. and Kajimo-Shakantu, K. (2013). The impact of the construction industry culture on the work – life balance of women employees: A case of South Africa. *Proceedings of the CIB World conference 5-9 May, Brisbane, Australia.*

Fielden, S. L., Davidson, M. J., Gale, A. W., & Davey, C. L. (2000). Women in construction: the untapped resource. *Construction Management and Economics, 18*(1), 113-121.

Francis V E (2003) “Civil engineers and work-family conflict: The role of workplace support on their work and non-work satisfaction and well-being”. *Proceedings of the Second International Conference on Construction in the 21st Century (CITC-II) “Sustainability and Innovation in Management and Technology”*, HongKong, 10–12 December 2003, pp.324–330.

Francis V E and Lingard H (2002) “The case for family-friendly work practices in the Australian Construction Industry”. *The Australian Journal of Construction Economics and Building*, Vol.2(1), pp.28–36.

Francis V E and Lingard H (2004).A quantitative study of work- life experiences in the public and private sectors of the Australian construction industry. A report published by Construction Industry Institute, Australia Inc, Queensland University of Technology.

Frone, M., & Carlson, D. (1999), *Development of a four-factor measure of work–family interference*, presentation at the annual meeting of the Society for Industrial and Organizational Psychology, Atlanta, Georgia.

Frone, M., Russell, M., & Barnes, G. (1996), Work–family conflict, gender, and health-related outcomes: A study of employed parents in two community samples, *Journal of Occupational Health Psychology*, 1, 57-69.

Frone, M. R., Yardley, J. K., and Markel, K. S. (1997), Developing and testing an integrative model of the work–family interface, *Journal of Vocational Behavior*,50, 145-67.

Fu, C.K. & Shaffer, M. A. (2001). The tug of work and family. Personnel Review, 30 (5), 502-522.

Greenhaus, J. H., Collins, K. M., and Shaw, J. D. (2003), The relation between work–family balance and quality of life, *Journal of Vocational Behavior*, 63, 510-31.

Guest, D. E. (2001). Perspectives on the Study of Work-Life Balance. *A Discussion Paper Prepared for the 2001 ENOP Symposium*, Paris, March 29-31.

Guest, D.(2002) ‘Perspectives on the study of work-life balance’, *Social Science Information*, Vol 41(2), pp. 255-279.

Hunt, L. (1993), *A practical guide to implementing permanent part-time work*, Work and Family Unit, Canberra.

Konrad, Alison M and Mangel Robert (2000) “The Impact of Work-Life Programs on Firm Productivity” *Strategic Management Journal* 21:1225-1237

Lingard, H., Brown, K., Bradley, L., Bailey, C., and Townsend, K. (2007). Improving Employees’ Work-Life Balance in the Construction Industry: Project Alliance Case Study. Journal of Construction Engineering and Management, 133(10), 807–815.

Lyness, S. K. And Judiesch, K. M. (2008). Can a Manager have a Life and a Career? International and Multisource Perspective on Work-Life Balance and Career Advancement Po-tential,” *Journal of Applied Psychology*, Vol. 93, No. 4, 2008, pp. 789-805. http://dx.doi.org/10.1037/0021-9010.93.4.789

Mathieu, J., and Zajac, D. (1990). A review and meta-analysis of the antecedents, correlates and consequences of organizational commitment. *Psychological Bulletin*, 108(2), 171-94.http://dx.doi.org/10.1037/0033-2909.108.2.171

McCampbell, A. S. (1996), Benefits achieved through alternative work schedules, *Human Resource Planning*, 19(3), 31-7.

Meyer, J. and Allen, N.(1991) ‘A three-component conceptualization of organizational commitment’, *Human Resource Management Review*, Vol 1(1), pp. 61-89.

Nelson, D. L., Quick, J. C., Hitt, M. A., &Moesel, D. (1990). Politics, lack of career progress, and work/home conflict: Stress and strain for working women. Sex Roles, 23(3/4), 169-185.

Norton, J. (2009). Employee Organisational Commitment and Work-Life Balance in Australia. *Carpe Diem, The Australian Journal of Business & Informatics*, 4, 1.

O'Driscoll, M. (1996). "The interface between job and off-job roles: enhancement and conflict". In C. Cooper and I. Robertson (eds).*International Review of Industrial and Organizational Psychology, Volume 11***.** Chichester: John Wiley.

Pina E., Cunha, M. and Rego, A. (2009). Do the Opportunities fo Learning and Personal Development Lead to Happiness? It depends on Work-Family Conciliation," *Journal of Occupational Health Psychology*, Vol. 14, No. 3, pp. 334-348. http://dx.doi.org/10.1037/a0014248.

Russell, G. (1993), Work and family audits of Australian workplaces: An employee perspective, in Russell, G. (chair), *Work and Family: The Corporate Challenge*, symposium conducted for the Australian Institute of Family Studies, Melbourne.

Sakthivel, D. and Jayakrishnan, J. 2012. Work life balance and organizational commitment for Nurses. *Asian Journal of Business and Management Sciences*. 2 :1-6

Scandura, T. A., &Lankau, M. J. (1997). Relationships of gender, family responsibility and flexible work hours to organizational commitment and job satisfaction. *Journal of Organizational Behavior*, 18, 377-391.

Vloeberghs, D. (2002). An original and data based approach to the work-life balance, Organization and Management Quarterly, 2(1):35-47.

Zedeck, S. and Mosier, K. (1990). "Work in the family and employing organization". *American Psychologist*, 45, 240-251.

Zeinabadi, H. (2010). Job satisfaction and organizational commitment as antecedents of Organizational Citizenship Behavior (OCB) of teachers. *Procedia Social and Behavioral Sciences*, 5, 998–1003.http://dx.doi.org/10.1016/j.sbspro.2010.07.225

BRIDGING COMMUNICATION GAP AT CONSTRUCTION SITES IN ABUJA: THE PIDGIN ENGLISH ADVANTAGE

BAMGBADE, Adebisi Abosede & JIMOH, Richard Ajayi
Department of Building, Federal University of Technology, Minna, Niger State, Nigeria.

Communication among different cultures is very vital in workplace and in the society as a whole. Negative occurrences of misunderstanding due to breakdown in communication often occur on construction sites with the attendant consequences on productivity and well-being of the site workers. Hence, the study assessed communication among diverse workers on construction sites in Abuja through the use of unobstructed observation in ten selected sites in Abuja; In addition to this, ten managers/supervisors were interviewed. The study showed that interactions among the workers basically were in English and Pidgin English. Furthermore the study revealed that although 71% of the selected construction firms operate formal organisational structure which entails standard communication in English Language, but in reality, there are informal interactions among the diverse workers within the organisations which give room for informal mode of communication. Despite this unanimous communication in Pidgin English majority of the Hausas could not communicate with other tribes in either English or Pidgin English except with the assistance of an interpreter. Needful to say that the communication bridge among the diverse tribes is not sufficient since majority of the Hausas are yet to assimilate into the Pidgin English mode of communication culture. This therefore call for concern from construction firms to create awareness and also ensure proper training of the affected tribes on the use of Pidgin English as a means of effective communication among diverse workforce on construction sites in Abuja.

KEY WORDS: Culture, Ethnicity, Communication, Pidgin English, Construction firms.

bisbam@gmail.com
rosney@futminna.edu.ng

BAMGBADE, A.A. and JIMOH, R. A. (2016). **BRIDGING COMMUNICATION GAP AT CONSTRUCTION SITES IN ABUJA: THE PIDGIN ENGLISH ADVANTAGE** Sustainable Built Environment and Climate change; The challenges of Post 2015 Development Agenda. School of Environmental Technology Conference, SETIC, 2016

Introduction

Communication is a very powerful tool in the world today. Ability to interact and communicate with one another is a great asset for humanity (Can and Patton, 2010). Language is a means by which we communicate and the world is filled with various languages as we move from one place to another. There has also been the transformation or transition of languages as the world progresses over time from one place to the other (Altintas, Can, and Patton, 2007).

Organisations all over the world can achieve nothing without an effective communication structure;information from one person to the other should be well encoded and decoded respectively for it to have positive impact on productivity thereby sustaining the organisation. Imagine a construction site without an effective communication, there will be confusion and hardly will anything be done properly and effectively.

There are arrays of languages being communicated by people of similar and dissimilar tribes in Nigeria (Lera, 2009). For inter-tribal communication, official means of communication-English language is used for formal setting. However for ease of communication between members of dissimilar tribe with no understanding of English language, the language devise – Pidgin English is being used by many Nigerians, with different versions depending on the tribal language intonation structure.

Although Pidgin English is well spoken in our society, yet its use within the construction industry inspired another level of exploration and adaptation. Generally some people think that Pidgin English is spoken by the low people in society as well as the semi-illiterate or illiterate people in the society (Funke, 2012), but today its fast becoming popular among the generality of people in our society. Nigerian Pidgin, as a contact language, is right now witnessing a shift in its status. Because of diachronic development over the years, the use of Nigerian Pidgin English is now becoming very popular among many speakers than ever before. Nigerian Pidgin English has gone through a lot of adjustment and transformation over the years by drawing its rich lexicons from various Nigerian indigenous languages as well as the contact language (English). The historical contact of the indigenous languages with English language has metamorphosed into what we know today as Nigerian Pidgin English (Balogun, 2013).

The Pidgin English is growing out of the negative views to a more positive use for the purpose of easy but effective communication in our society. At the moment literacy activity are on-going on its development as we now find Pidgin English dictionary, Pidgin English on Nigerian Google site. There is a very popular radio station in Abuja known as WAZOBIA FM (Balogun, 2013), it is tuned to by a very large population in Abuja and its environ. Their major medium of broadcast is Pidgin English, ordinarily it would not have been thought to gain such an enormous popularity but it did, showing the acceptance and popularity of the language in the society.

Construction workers are made up of different categories of people with different level of mastery of the Standard English language. However, those in the lower cadre responsible for works such as digging, carrying of materials like moulding blocks, mixing of cements, or those generally referred to as labourer are usually people with less formal education or for some no education at all. This category of workers has less understanding of the formal Standard English language and yet need to communicate on construction site. Also those that are more skilful handling more specialised areas such as mason, carpenters, welders and the likes are made up of some with formal education up to secondary school level, some without formal education beyond primary school and some with none at all. This category makes up a very large proportion of construction workers and as part of the general society, majority of them speak the easier Pidgin English for effective communication within the society and also on site. Therefore it is important to assess the current trend in communication modes adopted among construction site workers in Abuja where people from all over the country and beyond converge in search of work. To this end answers are sought to the following research questions:

1. How do these people communicate effectively despite differences in educational background and language?
2. What are the strategies that can be adapted to bridge communication gap on construction sites?

Literature review

Nigeria is a highly multi-ethnic state of about 177 million inhabitants according to the CIA world fact book (2014), and the 8^{th} largest country in the world Okala (2014). Roger (2012), findings show that there are about 550 different languages in Nigeria. Communication in such an environment like this is a complex one because of the extent of this diversity. It is worthy of note that the coming of the colonial era brought about the use of the English language and since everyone cannot and will not be fully involved in the mastery of the English language, there has to be a way out of the complexity of learning such a language, thus the emergence of a mixture or transformation that brought about the pidgin English.

The dynamic and generative abilities of Nigerian Pidgin to generate from a finite set of lexical items have maintained to foster communication process and interaction among Nigerians. The Nigerian Pidgin English has brought about mutual interest and understanding between foreigners and indigenous citizens. Nigerian Pidgin has become known as the most widely spoken language of intra and inter communication among Nigerians and across various ethnic groups that do not share a common language. But quite disappointedly, some people display negative attitude towards this language, not accepting it as viable means of communication among dissimilar tribes that should receive formal endorsement by the Government (Balogun, 2013).

All humans no matter how isolated they are or how primitive their society is have language, and the languages of primitive societies are not more complicated than those of more technologically advanced cultures (Michael, 2006). Generally, looking at language, it is important to note that language enables us to make our needs, opinions and ideas known. Without language we will not have the raw materials needed for thinking and reasoning, social interactions among people is highly dependent on effective communication and language ability. Language is very necessary for regulating our responses and behaviour (Westwood, 2003).

English language is a prominent language today and it is widely spoken in many countries all over the world (McAuthur, 2002). It is the language of the English people, that is, the people of England of the United Kingdom (Simpson, 1989). The age of exploration of the earth eventually ushered in massive migration of people across the world and the colonial era played a major role in bringing the English language to Africa in general and Nigeria in particular.

English language itself has experienced a lot of transformation from one form to the other. The pre-historic era of the English language has its root in the Germanic language which belongs to the Indo-European languages. Then came the era of the primitive old English which features between 450-700AD, this was followed by the old English era between 700-1100 and then middle English era between 1100-1500 and finally the modern English from 1500-till date (Deutschmann, n.d). There has been a lot of transformation or evolution of the English language from one era to the other, in fact the modern English is a combination of other primitive languages and adjustments for acceptable suitability (Deutschmann, n.d)

Words were coined from Latin, Greek, French and so on to make up for the current Standard English (Algeo, 2010). There seem to be no end to transition of language (Joseph, n.d) for ease and more comfortable communication among people from one place to the other. The American seeking a unique identity transformed the original British English to what is now known as the American English (Jackson, 2007) with lots of changes especially to spellings. So also Pidgin English is a modern localised transformation of the English language for ease of communication among people of dissimilar tribes. Going down memory lane, Balogun (2013) found various schools of thought that coined the word “pidgin” firstly, that it arises from business interaction between the West Africans, the Chinese and European traders while the Chinese were trying to pronounce the word “business”. Secondly, from the Portuguese word ocupaciao this means occupation and lastly from a Hebrew word Pidjom which means bater. It is very important to understand that pidgin is a product of trade or business, contact of migration of two hetero-cultural sets of people.

In the world generally communication between people of tribe with no common language ground has been a great problem to the people and organisations that employed them. Lots of efforts have therefore been made on the part of organisations to bridge this communication gap. Some organisations engaged the use of language facilitators (interpreters), while others trained their workers on use of common language (Jaselskis, Strong, Aveiga, Canales, & Jahren, 2008). America Construction firms are not left out of this communication problem between the educated and uneducated sites workers (The Hispanics workers). This necessitates some kind of training on communication skills for the supervisors and the Hispanics workers to bridge the communication gap (Jaselskis et al, 2008). In bridging the communication gap many people in organisations have resorted to an informal way of communication among themselves for ease of communication. This has given birth to the use of Pidgin English on sites; a reflection of what is obtainable in the larger society. Many countries of the world such as in West Africa, speak Pidgin English. Although the tone may differ from one tribe to the other. However all have the same object of simplifying the English language to the form that can easily be communicated among them (Igboanusi, 2008).

The Nigerian Pidgin English came about from the coming of the British to Nigeria and the subsequent colonisation of the later (IIIah, 2001). The need for communication between the duo cultures despite the wide gap in language and culture necessitated a bridge. Pidgin English was formerly known as broken English as it deviate from the Standard English and was initially prominent in Edo, Delta axis but today it has spread to other parts of the country (Onuigbo, 1999).

Examining the Nigerian Pidgin English, it varies from one place to another with one form of adjustment or the other (Igboanusi, 2008). For example the Igbos have their adjustment adding some Igbo words to it. The Yorubas also have their own version of addition and adjustment to it. There are other adjustment using French words and so on, the point is anyhow and with any form of adjustment the language is well understood and accepted. The Pidgin English removes the complexity of rules of the Standard English and is more flexible and easier form of communication in our society today (Ifeyinwa, 2014). It can be learned naturally like any local language through listening and speaking without any speciality of learning. Somehow the society found it easy to learn and speak and it is growing. Before now Pidgin English is pre-dominantly regarded as an oral language, but now it is gradually becoming a written language with research focusing on its literary potentials (Ifeyinwa, 2014).

Pidgin has reached a level of recognition among many Nigerians in formal and informal organisational settings, despite it isot being officially ratified (Akande and Salami, 2010). Virtually all governmental advertisements and campaigns have Pidgin English version of it; this shows the informal official approval of it and an easy way of communicating to the masses at the grassroots level. Nigerian Pidgin English promotes peace and unity as well as reveals national identity of the country (Akande and Salami, 2010). It is an inter-ethnic code available to Nigerians, who have no other common language (Akande, 2008).

Examining organisations set up such as construction firms the mode of communication among diverse workforce depends on their organisational structures operating at the particular point in time which could either be formal or informal organisational structures. Nonetheless organisations are established on formal organisational structure but subsequently informal organisational structures sprang up indefinitely in which workers creates their own ways of life, and ways of communications (Saritha, 2015) based on culture and conveniences. The resultant effect is that an atmosphere of cordial relationship which promotes informal interactions between the low cadre and high cadre is created (Saritha, 2015). Such informal languages such as their tribal languages and or Pidgin English are being used by many diverse workers at sites.

Research Methodology

This research used qualitative methodology which involved unobstructed observation of ten sites, and interview of ten managers with the use of purposive sampling technique. Ten construction sites in Abuja were observed for about 20 minutes each; the observation checklist was used as a guide basically to know how the diverse workers interact at site and their mode of communications. This instrument seems appropriate for this study because the researcher was able to observe the interactions among the diverse workers as it is in reality on the selected sites without any bias from both ends leaving no details out. Ten managers of ten selected construction sites in Abuja were interviewed for about 45 minutes accordingly. The managers were selected based on their experience on sites coupled with their close interactions with the diverse workers were deemed in good position to disclose the condition of the diverse workers in terms of communication issues. Content analysis was undertaken to analyse this qualitative research and results presented in tables.

RESULTS AND DISCUSSIONS

Site Observation and interaction

The form of communication commonly used whether official or vernacular was observed on the selected multicultural sites. It was discovered that the main, connecting common language of interactions among the diverse workforce was Pidgin English. There was also little of English language during communication with member of dissimilar tribes, Hausa and other local dialects such as Tiv, Ebira. The interaction in local languages was conspicuous during break time; Most of the tribes especially the Hausas segregated in group to interact among themselves in their language. Nonetheless in spite of this social identity, there was cross cultural friendly interactions among the tribes.

The Interviews

Interaction between managers and the other site workers that constitute the majority on most sites was done in Pidgin English. A site manager said use of Pidgin English is being enforced at site meetings involving all site workers for all to understand. Interactions among the site workers themselves are mostly in Pidgin English.

Opinions of selected Managers/Supervisors were sought on the mode of communication and interactions among the diverse workers. Although their presentations differ their views were related. The following views are culled from the interview conducted for the Managers/supervisors on the ten selected sites:

Manager one: “Basically English language and Pidgin language are the mode of communication but then most of the site workers communicate among their tribal workers in their local languages”.

Manager two: “We speak English language and Pidgin English language here on the site. Those that understand Hausa among the site workers revert to Hausa language when interacting with the Hausas; most of the Hausas cannot communicate in any language other than their own language which poses a challenge to other tribes that could not speak Hausa language”. Often times someone has to serve as an interpreter between the Hausas and other tribes.

Manager three: “Means of communication is Pidgin and Hausa language, majority of the Hausas cannot speak English/Pidgin language. As far as this part of Nigeria is concerned you cannot really make a good head way in construction work without an understanding of Hausa language because you need them most and their services are cheaper compared to other tribes”.

Manager four: “English language, Pidgin and Hausa with a bit of Chinese language are the mode of communications on this site.

Manager five: “English language is the means of communication among the workers and interpreters are engaged to interpret to the workers that can neither speak nor understand English language”.

Manager six: “English language and Pidgin English are the two general languages of interactions on this site”.

Manager seven: “We speak mainly Benin republic tribal language on this site. Workers were recruited from Benin republic because of their expertise.

Manager Eight: Nine and Ten: The diverse workforce communicates in English and Pidgin language outside their tribal clique.

Table 1.0: Communication gap

Interviewees	Communication Bridge
Manager one	English language, Pidgin English, Hausa, other local languages.
Manager two	English language, Pidgin English.
Manager three	English language and Hausa.
Manager four	Mix of English language, Pidgin English, Hausa and Chinese work language.
Manager five	Pidgin English and Hausa.
Manager six	Pidgin English and Hausa.
Manager seven	Speaks mainly Benin republic tribal language.
Managers eight, nine & ten	Pidgin English, Hausa and English language.

Source: Field survey (2013)

Table 1.1:

Interviewees	Organisation Structure
Manager one, Manager two, Manager four to six, and Manager eight to ten	Formal
Manager three	Informal
Manager seven	Semi-formal

Source: Field survey (2013)

Findings from the field survey show that71% of selected construction firms operate formal organisational structures; this implies that communication in such sites is more or less in Standard English language, and the possibility of loss in original information being disseminated through an interpreter (language facilitator) to site workers that do not understand English language is high. The organisational structure as claimed by many of the managers was formal organisation structure, by comparative analysis, majority of them are in real sense operating informal organisation structure where informal communication among the workers is allowed. This therefore agreed with the findings of Saritha(2015) who stated that although organisations are established on formal organisational structure, but, subsequently informal organisational structures sprang up indefinitely in which workers created their own ways of life, way of doing things, and communications based on culture and conveniences. Despite the fact that the workforce has been able to informally adopt

Pidgin English to bridge the communication gap on sites, the study revealed that majority of the Hausas cannot communicate in language other than their own language. Although most times Pidgin English is mixed with English language and other languages for ease of communication. This research reveals hat Pidgin language is one of the major bridges in communication gap on construction sites in Abuja for those that cannot relatively communicate in English language.

Conclusion

Effective communication is vital for organisations such as construction firms with diverse workforce, whose ultimate aim is productivity. Communication is said to be effective and complete when there is transverse encoding and decoding of information between people. There are flow of languages at sites among similar tribes but bottled necked during interaction with dissimilar tribes creating gap which necessitated a bridge. Pidgin English apparently is used virtually in the society and organisations such as construction firms to bridge this gap especially among the low cadre workers. The bridge is still insufficiently used among all the tribes; not all the tribes at site can communicate in Pidgin English, thus such breeds misunderstanding, misinformation which impact negatively on the work and self-esteem of the those that cannot communicate well with the other tribes. Suffice to say that the effective communication channel culture that will foster cohesive language independency among all the category of workers at construction sites in Abuja is lopsided since the majority of the Hausas are still cut off from mutual interactions with others because of language barrier.

Recommendation

People of different cultural background irrespective of their status interact in Pidgin English with ease; the days of belittling the Pidgin English and looking down on it as the language of the uneducated and low people in the society is over. Today all categories of people use it. It is therefore recommended that the Pidgin English be further developed and transformed into written form to make it more useful among workers in the construction industry. And also the Hausas should be encouraged to master the Pidgin English as this have come to be acceptable means of communication among diverse workers at sites. Therefore priority should be given by construction firms to the workers (Hausas) at this stage on communication proficiency training in Pidgin English.

Reference

Algeo, J. (2010). *Origins and Development of the English language*sixth edition. Pub: Michael Rosenberg.

Akande, A.T. (2008). The Verb in Standard Nigerian English and Nigerian Pidgin: a sociolinguistic approach Ph.D Dissertation:Universityof Leeds.12/06/2015.http://ethos.bl.uk/OrderDetails.do?uin=uk.bl.ethos.493713

Akande, A.T., &Salami, L.O. (2010). Use and Attitudes towards Nigerian Pidgin English among Nigerian University Students, In Millar, Robert McColl (ed.) Marginal Dialects: Scotland, Ireland and Beyond. Aberdeen: Forum for Research on the Languages of Scotland and Ireland70-89. https://www.abdn.ac.uk/pfrlsu/documents. Accessed 12/06/2015

Altintas, K., Can, F., Patton, J.M. (2007). "Language Change Quantification using Time-separated Parallel Translations". *Literary and Linguistic Computing* 22 (4) 375-393 Doi: 10.1093/11c/fgm026

Balogun,T. A. (2013). In defense of Nigerian pidgin. Department of Languages and Linguistics, Osun State University, Nigeria. *Journal of Languages and Culture* 4(5), 70- 89

Can, F., Patton, J.M. (2010). "Change of Word Characteristics in 20th Century Turkish Literature A Statistical Analysis". *Journal of Quantitative Linguistics* 17(3), 167-190 doi:101080/09296174.2010.485444

Deutschmann, M. (n.d). A (very) Brief History of English. Department of Humanities Mid Sweden Universityhttp://www.durov.com/study/file-1209.pdf

Funke, T.D. (2012). "The Rise and Popularity of Pidgin English Radio Stations in Nigeria".https://ng.linkedin.com/groups/Rise-popularity-pidgin-English-Radio-3766250.S.111035631. Accessed 15/03/2015

Ifeyinwa, O.E. (2014). Language Attitude and Nigerian Pidgin. *International Journal of Arts and Humanities*. 3(4), 34-46.

Igboanusi, H. (2008). Empowering Nigerian Pidgin. A Challenge for Status Planning. *World Englishes* 27: 68-82

Jackson, T. (2007). The Frontier in American.Project Gutenberg ebook History.http://www.gutenberg.org/files/22994/22994-h/22994-h.htm.Accessed 12/06/2015.

Jaselskis, E.J., Strong, K.C., Aveiga, F., Canales, A.R., & Jahren, C. (2008). Successful Multinational Workforce Integration Program to Improve Construction Site Performance. *Safety science* 46, (2008).

Joseph, M. W. (n.d). "The Origins of the English Language: A Social and Linguistic History"www2.gracenotes.info/topics/English.pdf accessed 03/09/2015

Michael, D.C. (2006). A History of the English Language Wheaton College Recorded Books, LLC.http://www.recordedbooks.com/courses_pdf/UT088.pdf

Okala, A. P. (2014). The Nigerian Experience on Negotiation of Investment Promotion and Protection Agreements (Ippas). Nigerian Investment Promotion Commission (NIPC) Conference on Bilateral Investment Agreements and Investor State Dispute ArbitrationApril 23-24, 2014. Vienna, Austria.

Onuigbo, S. (1999). Pidgin in Nigeria: Status and features. *Nsukka Journal of the Humanities*, 10, 208

Roger, B. (2012). An atlas of Nigerian languages Kay Williamson Educational Foundation,8, Guest Road,Cambridge CB1 2AL ,United Kingdom 3rd. Edition

Simpson, J. (1989). Oxford English Dictionary 2nd edition. Oxford university press.

Saritha, P. (2015). Formal and informal organisation: Features, Advantages and Disadvantages Accessed 20/06/2015 3:33am www.yourarticlelibrary.com/organisation/formal-and-informal-organisartion-features-advantages-and-disadvantages/8654/

Westwood, P.J. (2003). *Commonsense Methods for Children with Special Needs*: Strategies for the Regular Classroom. London: RoutledgeFalmer.

World Facts Books. https://www.cia.gov/library/publications/the-world factbook/geos/ni.html

Illah, E. (2001). Re-Reading Pidgin Literature: The Neo-Colonialist Construct, Azuike MN (ed.), In Studies in Language and Literature. Lagos: Joel Publishers.

Lera, B. (2009). How does our Language Shape the way we think. Conversation at edge.https//edge.org/conversations/how-does-our-languages-shape-the-way-we-think

McAuthur, T. (2002). Oxford Guide to World English. Oxford: Oxford University Press

THE CHALLENGES OF COST MANAGEMENT OF INFRASTRUCTURE DEVELOPMENT IN NIGERIA

Kasimu A. Muhammad
Department of Quantity Surveying, Federal Polytechnic, Bida. Niger State.

The failures recorded in the infrastructure projects in Nigeria were as a result of the poor cost management right from the inception of the projects. This had led to the exploration of the major causes of poor cost management of infrastructure projects and the possible mitigation measures were proposed to improve the poor cost management of infrastructure projects. A questionnaire survey approach was adopted, because of the nature and the type of data required. A total of 150 numbers of questionnaires were distributed to Engineers, Quantity surveyors, Project Managers, Construction Managers, Contractors, Consultant and Stakeholders in the construction industry. In addition, the respondents were also requested to propose and classify mitigation measures for poor cost management that goes with any of implementation strategies. 15 measures were proposed in line with the implementation strategies and arranged using a likert scale format for the respondents to make choice. The descriptive analysis was used to analyse the data obtained from the responses of the respondents. The results obtained from the analysis shows the followings as the major causes of poor cost management of infrastructure projects delivery. These are improper planning and inadequate engagement of quantity surveyors in infrastructure project delivery right from the inception stage, wrong method of estimation, lack of proper monitoring by cost managers and cost engineers, slow decision making, cash-flow problems during construction, etc. The other results shows that among these 15 measures, five measures are classified as pro-active strategy and four measures are classified as organizational strategy. However, other six measures are classified as fluid measures which can be adopted in more than one strategy. Therefore the paper recommends that **the management of construction industries should apply the strategies mentioned above to improve the poor cost management of infrastructure projects, since the infrastructure projects are keys to accomplish the country's dream of vision 20:2020.**

Keywords: Cost management, infrastructure project, implementation strategy, mitigation measures.

kasimualfa@gmail.com
kasimumohammed@yahoo.com

Kasimu A. Muhammad (2016). **THE CHALLENGES OF COST MANAGEMENT OF INFRASTRUCTURE DEVELOPMENT IN NIGERIA** Sustainable Built Environment and Climate change; The challenges of Post 2015 Development Agenda. School of Environmental Technology Conference, SETIC, 2016

INTRODUCTION

The vision 20: 2020 is a dream statement that Nigeria will be become one of the first twenty economies in the world by the year 2020 (Eneh, 2011). This dream will only become reality with adequate infrastructure development in place, but Nigeria is facing the challenges of infrastructure development as a result of poor cost management of infrastructure projects in the following areas: road, railways, school, hospital, airport, seaport, power, water treatment plant, dams etc. Knowing very well that infrastructure projects plays a key role in economic and social development in terms of poverty reduction by improving access to basic services (Energy, Water, and Transportation, etc) whilst creating numerous employment opportunities (Makarfi, and Ibrahim, 2010). In addition, infrastructure development fosters economic growth and defines the strategic positioning of a nation's wealth and as well as serves as a vehicle for enhancing competitiveness, productivity, economic recovery and sustained growth. As a result of the importance attached to the infrastructure development to attain the vision 2020, various techniques, tools, guidelines and methods have been developed over the years to facilitate the management of infrastructure projects. In spite of these tools and techniques infrastructure projects continue to be dogged by poor performance, in adequate planning and budget provisions and failure to deliver within the stipulated time and cost in Nigeria. The literature has shown that majority of the infrastructure projects in developing countries like Nigeria are characterised by poor performance, cost and time overrun and projects abundant as a result of poor cost management right from the inception to completion stage ((Abdul Azis *etal*, 2013; Artto and Kujala, 2011; Chan, 2005; Doloi, 2011; Flyvbjerg and Buhl, 2003; Kaliba and Mumba, 2009; Olawale, 2010). However, the major challenge faced in terms of infrastructure projects in Nigeria is poor cost management for example, the on-going construction project of Lokoja – Abuja express road have over 200% cost and time overruns, Ibadan- Lagos express way have over 180% cost and time overruns, the same with construction of Gurara water dam etc (Kasimu *et al.,* 2013). In spite of the efforts made by previous researchers, much is still expect to be done in the area of effective cost management of infrastructure projects in Nigeria (Kasimu, 2015). Therefore, this paper is aim at investigating the challenges of cost management of infrastructure projects in Nigeria. The above aim is achieved through the accomplishment of the following objectives. Namely: examine the causes of poor cost management of infrastructure projects and to establish the mitigation measures and implementation strategies to improve the poor cost management of infrastructure projects.

COST MANAGEMENT

Cost management is the process used to minimize the cost of the project while maintaining acceptable levels of quality as well as the scope of the deliverables for the duration of the project. The ideas of the cost management is to track progress, compare actual values to planned values, analyze the impact of variances, and make adjustments in light of these variances. Dong, (2003) added that cost management is the totality of all the process required in cost planning, controlling and monitoring of a project cost from inception, completion and commissioning stages. Feng (2000) added that cost management is the application of the tools within an overall project management structure. The cost estimating, value engineering and life cycling cost are the useful tools used for cost management. However, effective cost management enables all involved in a project to respond to project challenges and to understand the interrelationships that result from serious decision about cost (Abdul Azis *et al*, 2013; Hansen, 2006). Although, effective cost management is achievable for most organisations, if they have a clear objective to align scope, user/owner expectations, and budget from the outset and overtime (Hao, 2002; Kern, 2004). Walker and Wilkie, (2006) argued that effective cost management can be achieved through effective management of the followings factors: fluctuation of prices of materials; proper planning; adequate engagement of quantity surveyors in infrastructure project delivery right from the inception stage; good method of estimation; proper monitoring by cost managers and cost engineers; effective decision making and cash-flow during construction; adequate supply materials and skilled labours. However, Li, (2003) conducted a similar study and adopted the followings as factors affecting poor cost mamanegement, poor communication; inadequate production of raw materials; poor financial control on site; indicative of experiences; conflicts in work schedules of subcontractors; absent of construction data; late deliveries of materials and equipment's; duration of contract period; currency exchange; social influence (feedback from resident); political interferences; mistakes during construction; negligence and contractual procedure. Iyer, and Jha, (2005) added that the followings factors affected cost performance in the construction industry: fraudulent practices and kickbacks; insecurity; economic conditions; changes of design; design errors; liquated and ascertain damage; executive bureaucracy in the owners' organizations; disputes; weather condition (*Force-Marjue*); inexperience of project team. Qin, (1999) with different opinion that there are some steps necessary to implement and maintain a cost management process to achieve efficient project delivery as shown in Figure 1 below.

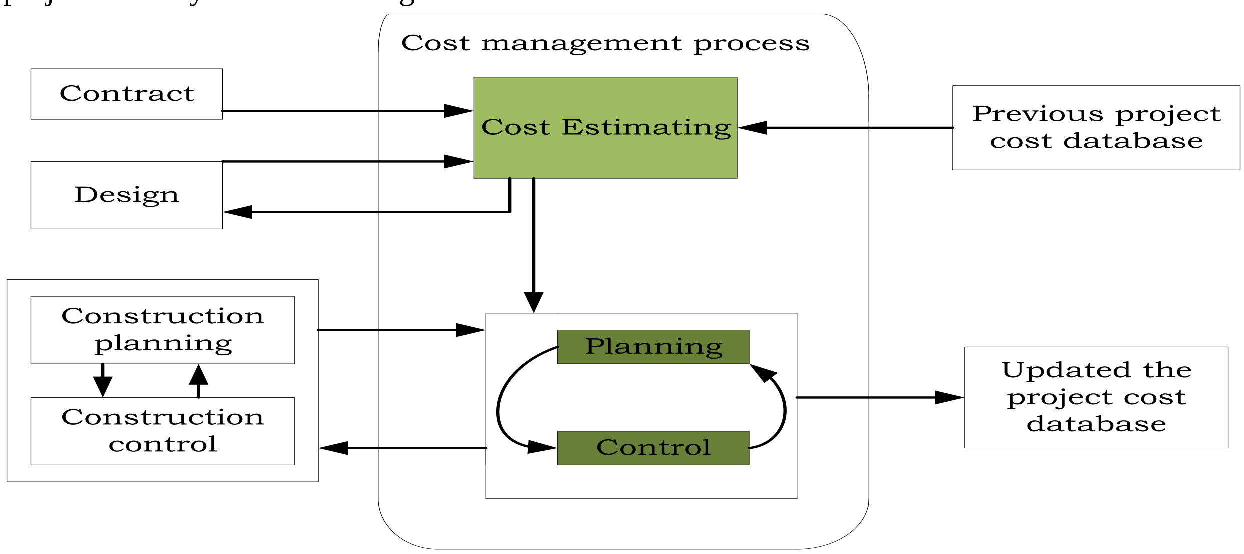


Figure 1 cost management process (Qin, 1999)

The Figure 1 above shows the overview of the cost management process. It shows that the cost management processes uses information from existing cost databases, contract; design and production plan. In addition, the information generated by the cost management supports the design and production planning and control process and are used to update the cost database. However, the production planning and control, cost planning and control is a cyclical process. It uses information from the cost estimating and production control processes to provide feedback to the cost database that will be used in future projects. As contracts, designs and production planning and control the dynamic, cost management systems should assume a pro-active character and be flexible to absorb changes that may occur.

COST MANAGEMENT TOOLS

The followings are cost management tools: cost control, budgeting and cost estimating.

Cost control: Cost control is a process where the construction cost of the project is managed through the best methods and techniques so that the contractor does not suffer losses when carrying out the activities of the project (Olawale, 2010; Omoregie, 2006). One of the aims of cost control is to construct at the cheapest possible costs in consistent with the project objectives. Eventually the decision of the manager that something should be done differently and the translation of that decision into practice are the actions to achieve control (Flyvbjerg & Buhl, 2003; Kaliba & Mumba, 2009). Cost control is achieved by selecting the right man for the right job, the right equipment and tools for the right work and the right quality of materials, in the right quantity, from the right source, at the right price and delivered at the right time. Managers are expected to be well equipped to execute the project, with due consideration to the quality of work, yet within the estimated cost and time limits. Ali (2010) highlighted the problems faced in controlling costs on the construction sites, which include poor project preparation, lapse in management and control, over budgeting, poor materials, labour shortages, increased cost of materials, delays in deliveries, wastage of materials, unexpected weather changes, loss of materials, insecurity and poor communication. This results into cost and time overruns, conflicts, and sometimes abandonment of the projects.

Budget: A budget is an estimate of anticipated company activity and performance for the coming twelve-month period. Once a budget has been established its figures are not changed so that it can be used as a benchmark against which to monitor actual performance; companies will usually review their budgets on a quarterly basis.

Cost estimating: cost estimating involves developing an approximation (estimate) of the cost of the resources requires to complete project activities (Al-jibouri, 2003; Chan, 2005). The objective of cost estimating process is to estimate the cost of products and processes involved in production. However, this require a thorough understanding of the design, contracts and production in order to properly model the consumption of resources by transformation and flow of activities (non-value adding). In approximating cost, the estimator should consider the causes of variation of the final estimate for the purposes of better management of the projects. Olawale (2010) asserted that cost estimating includes identify and considering various costing alternatives, for example, in most application areas, additional works during a design phase is widely held to have the potential for reducing the cost of the production phase.

COST MANAGEMENT SYSTEM

Qi (2000) describe cost management system as a framework for project cost information. Qin (1999) further highlighted that those systems consist of a set of principles, methods and tools whose main objectives are to estimate cost and to generate information in order to support different managerial decision during distinct phase of a project. However, Hansen (2006) argues that cost management should not be isolated from other managerial functions, and should play a key role in the implementation of the company strategies. As a consequence of the peculiarities of the construction environment, cost management systems should be dynamic, proactive and able to support different decision making processes, as well as to protect the business from the harmful effects of uncertainty. Chen (2001) asserted that in the construction industry, cost management system should include the process required to ensure that the project is completed within the estimated budget. These processes include cost estimating, cost control and cost projection.

PROJECT COST MANAGEMENT

The task for the cost management function is to produce information for internal users who need accurate, detailed and frequent economic information for making decisions (Oforeh, 1997). Specifically, cost management "identifies, collects, measures, classifies, and reports information that is useful to managers for determining the costs of products, customers, and suppliers, and other relevant objects for planning, controlling, making continuous improvements, and decision making (Hansen, 2006). Li (2003) further expressed that project cost management includes three major functions called cost estimating, budgeting and cost control. The goal of these functions is to ensure that the project is executed in a cost efficient, profitable manner, according to business principles and from the perspective of the entire company (Artto & Kujala, 2011). The three major functions and sub-functions covering the entire project lifecycle cost as presented in figure 2.

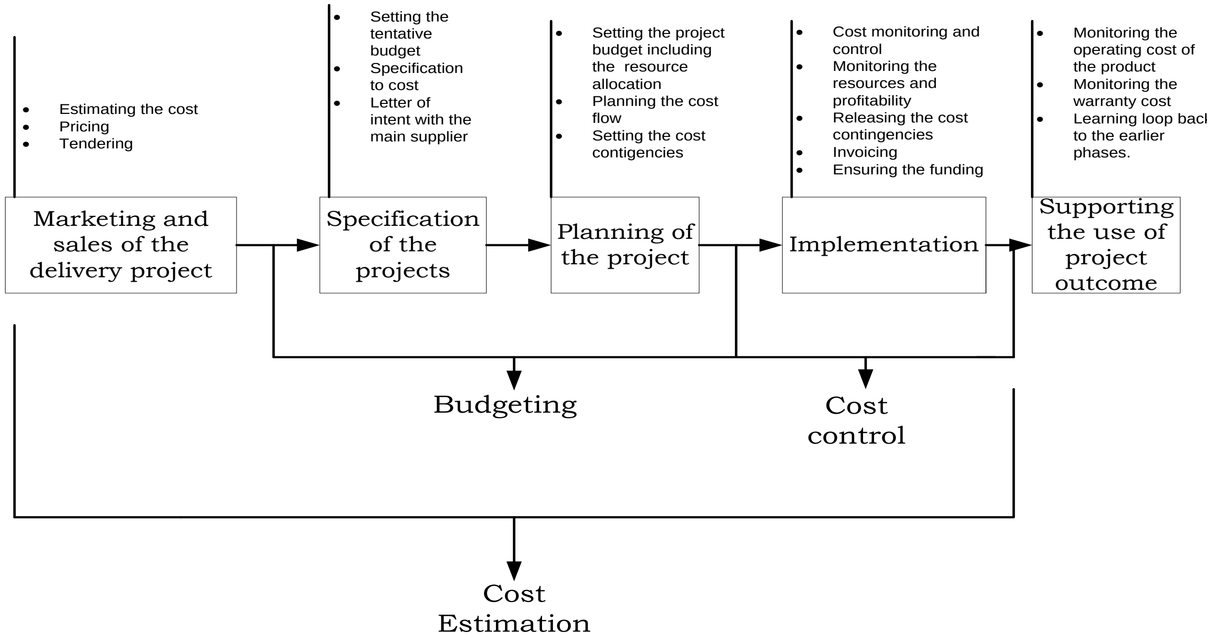


Figure 2: Cost management through the project lifecycle (Hao, 2002)

Managing a project's cost starts early during the marketing and sales phase of the project when tentative cost estimates are created. During this phase, estimates are expected to provide accurate and reliable information to be used in tendering and pricing the delivery projects. During the project specification phase, a tentative project budget is set, a specification-to-cost approach is exploited to ensure cost-effective specifications and, typically, the letters of intent with the main suppliers are signed. Before the implementation phase, the project budget is created based on the latest cost estimates. In the project planning phase, the resources for the work tasks are allocated, cash flows are planned and typically cost contingencies are set. During the planning and implementation phases, the actual costs of the project are monitored. In addition, cost estimates and forecasts are constantly updated and then compared with the project budget. In the implementation phase, the project revenues are monitored, invoicing is performed and cost contingencies are released. In some projects, funding is also ensured during the implementation phase. After system delivery, the operating costs of the delivered system are monitored in co-operation with the customer, warranty costs are monitored and a learning loop back to the earlier phases should be created.

RESEARCH METHOD

This study adopted a questionnaire survey approach, since the questionnaire survey was used in the field of studies the sample of individuals from a population with a view towards making statistical inference about the population using the sample (Groves *et al.*, 2009). It also used to pull out about public opinion, such as beliefs, perception, ideas, views and thought about some things. The questionnaire survey is mostly used for scientific purposes as it provides important information for all kinds of research fields, for example, the current situation on the ground, psychological perception and views of the population. In order to obtain the require population for this study, the stratified random sampling technique was adopted for the selection of the construction companies that participated in this study based on the concept of Creswell and Tashakkori, 2007. The choice of stratified sampling was also based on the type of respondents needed to answer the questions in the questionnaire. A stratified sampling technique is an approach of dividing the population into smaller groups known as strata (Creswell and Tashakkori, 2007). 15 construction firms that are actively participated in the construction projects in Abuja was selected for this study based on their experiences, annual turnover, capabilities and willingness to participated in the study.

The questionnaire that was used to record the responses of each respondents contained mainly closed ended questions using a five- point Likert scale ranged from none=1, low=2, moderate=3, high=4 and very high=5. The scores of the respondents were computed based on the variables used in the questionnaire. Moreover, the variables used in designed questionnaire were obtained from literature part of this study. However, the questionnaires were distributed to followings professionals in the construction industry. These are Quantity Surveyors, Architects, Engineers, Project Manager, Construction Manager, Contractors, Consultants and Stakeholders. 150 questionnaires were distributed and only 107 questionnaires were filled correctly and returned, which represent 71% of the Questionnaires used for the analysis. The ranking analysis was adopted for the paper and it was conducted based on the 71% questionnaires filled correctly and returned

Average Index

Average Index (AI) was used in measuring the average value of the data gathered from the questionnaire. It is a measure that testifies a set of observation data into a single value. The range of the value was tabulated in Table 1. AI is applied in this research to determine the significance of each variable from the view of respondents. The calculation for AI is based on the equation as started below:

Average Index $= \frac{\sum a_i x_i}{\sum x_i}$

Where:

a_i = constant expressing the weight given to *i*

xi = number of response for *i* = 1,2,3,4,5

x_1 = number of respondents who answered none

x_2 = number of respondents who answered low

x_3 = number of respondents who answered moderate

x_4 = number of respondents who answered high

x_5 = number of respondents who answered very high

The method of averaging individual rating to a discrete value or index is easy, but extra care is required during its analysis and interpretation of these values so that they reflect the overall respondents rating.

FINDINGS AND DISCUSSION OF RESULTS

The results obtained from the descriptive analysis was summarised in tabular form for clear understanding. The decision on the results of the descriptive analysis was based on the class range in Table 1. The class range was obtained from the five point Likert scale adopted in obtaining the data.

Table 1: Class range of Average Index

Mean Range	Likert Scale
1 ≤ Average index <1.50	None
1.5 ≤ Average index < 2.5	Low
2.5 ≤ Average index < 3.5	Moderate
3.5 ≤ Average index < 4.5	High
4.5 ≤ Average index <5.0	Very high

Source: Kasimu *et.al.* (2013)

Table 2: Challenges of cost management of infrastructure projects

S/NO	Factors that causes of poor cost management	Mean	SD
1	Improper planning	5.0	0.3
2	Inadequate engagement of quantity surveyors in infrastructure project delivery right from the inception stage	4.7	0.4
3	Wrong method of estimation	3.8	0.4
4	lack of proper monitoring by cost managers and cost engineers	3.8	0.4
5	Slow decision making	3.7	0.5
6	Cash-flow problems during construction	3.7	0.5
7	Shortage of materials and skilled labours	3.6	0.9
8	lapse in management and control	3.6	0.9
9	Fraudulent practices and kickbacks	3.5	0.8
10	Insecurity	3.5	0.7
11	Bureaucracy in tendering method	3.4	0.8
12	Poor communication	3.4	0.5
13	Changes in site conditions	3.3	0.8
14	Lack of productivity standard	3.3	0.5

S/NO	Factors that causes of poor cost management	Mean	SD
15	Inadequate production of raw materials	3.2	0.7
16	Poor financial control on site	3.2	0.7
17	Indicative of experiences	3.1	1.0
18	Conflicts in work schedules of subcontractors	3.1	1.0
19	Absent of construction data	3.1	0.8
20	Late deliveries of materials and equipment’s	3.0	0.6
21	Lack of sharing of knowledge among the parties	3.0	0.8
22	Duration of contract period	3.0	0.8
23	Currency exchange	3.0	0.8
25	Social influence (feedback from resident)	2.9	1.0
26	Fluctuation of prices of materials	2.8	0.8
27	Political interferences	2.8	1.0
28	Mistakes during construction	2.8	0.7
29	Negligence	2.8	0.8
30	Contractual procedure	2.8	0.9
31	Economic conditions	2.7	0.9
32	Changes of design	2.7	0.8
33	Design errors	2.6	1.2
34	Liquated and ascertain damage	2.6	0.6
35	Executive bureaucracy in the owners' organizations	2.6	1.0
36	Disputes	2.3	0.9
37	Weather condition (*Force-Marjue*)	2.2	0.6
38	Inexperience of project team	2.2	0.7

Source: Author fieldwork (2016)

The decision of the results obtain in Table 2 was based on the class range in Table 1. The results show that the followings: Improper planning and inadequate engagement of quantity surveyors in infrastructure project delivery right from the inception stage were very high in terms of causes of poor cost management of infrastructure projects. However, wrong method of estimation, lack of proper monitoring by cost managers and cost engineers, slow decision making, cash-flow problems during construction, shortage of materials and skilled labours, lapse in management and control, fraudulent practices and kickbacks and insecurity were high in terms of causes of poor cost management of infrastructure projects. In addition, bureaucracy in tendering method, poor communication, changes in site conditions, lack of productivity standard, inadequate production of raw materials, poor financial control on site, indicative of experiences, conflicts in work schedules of subcontractors, absent of construction data, late deliveries of materials and equipment’s, lack of sharing of knowledge among the parties, duration of contract period, currency exchange, political interferences, social influence (feedback from resident), fluctuation of prices of materials, mistakes during construction, negligence, contractual procedure, economic conditions and changes of design were moderate in terms of poor cost management of infrastructure projects. Similarly, design errors, liquidated and ascertain damage, executive bureaucracy in the owners' organizations, disputes, weather condition (*Force-Marjue*) and inexperience of project team were low in terms of poor cost management of infrastructure projects.

The Mitigation Measures to Improve Cost Management of Infrastructure Project

Cost management is one of the important tasks in achieving successful project completion. Based on the findings in Table 2, the followings mitigating measures were proposed to improve cost management of infrastructure project. A total of 15 mitigating measure were assess through structured questionnaire and also distributed to the same respondents as mentioned above. The measure were group into three approaches of implementation strategies, these are proactive, re-active and organizational strategy (Olawale, 2010) Pro-active (Pro) strategy is the measure used for the adoption of planning stage of project to overcome the challenges of cost management. Re-active (Re) strategy is the measure used to mitigate the effect of constraining factors of ineffective cost management. However, Organizational (Org) strategy is the measure that is normally used for company's belief, orientation, management style or philosophy. The respondents were asked to make judgement of the above mitigation measure. The result were analysis based on the outcome of the respondents as shown in Figure 3

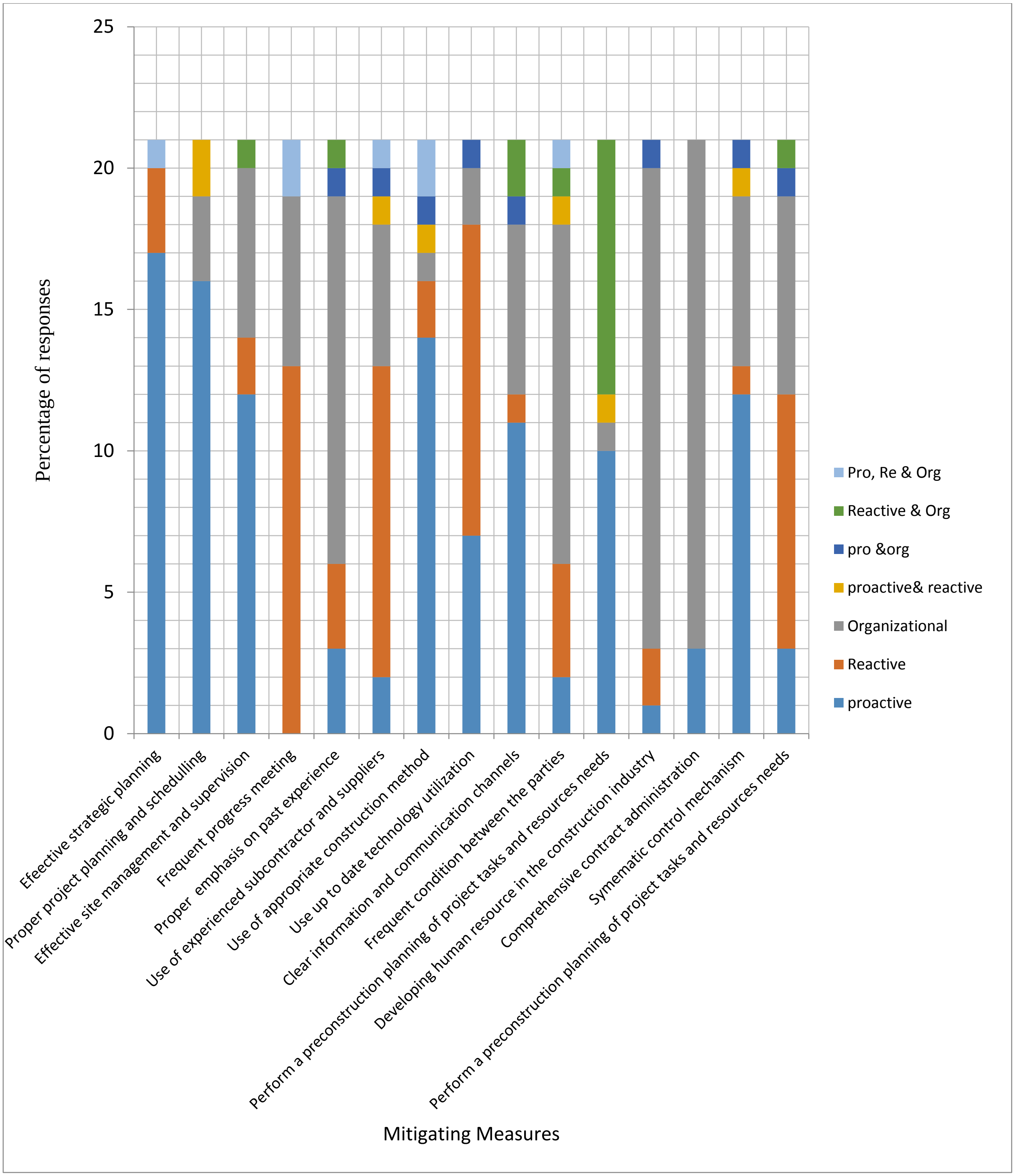


Figure 3: The mitigation measures to overcome the challenges of poor cost management. (Source: Author fieldwork, 2016)

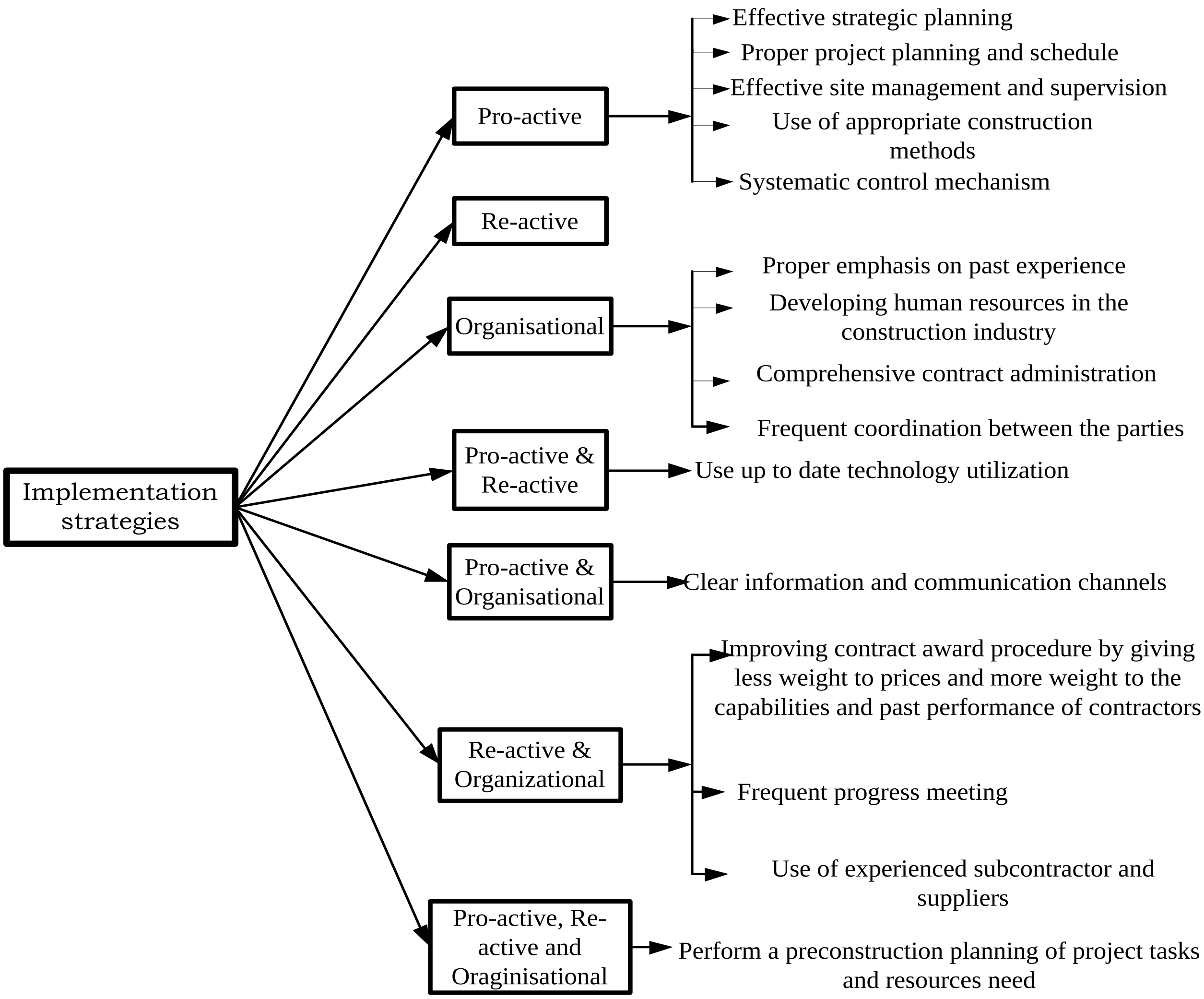


Figure 4: Implementation strategies (Source: Author fieldwork, 2016)

Figure 4 above, shows the implementation strategies to overcome the challenges of the poor cost management of infrastructure projects delivery in Nigeria. The measure were organised based on the implementation strategies as shown in Figure 4 above. The organisation of the measures was based on the outcome of the analysis conducted with the responses of the experienced professionals of construction industry engaged in the questionnaire activities. However, pro-active and organisational strategies are the major implementation strategies to overcome the challenges of cost management of infrastructure project. Since the results shows that among these 15 measures, five measures are classified as pro-active strategy and four measures are classified as organizational strategy. While other six measures are classified as fluid measures which can be adopted in more than one strategy.

CONCLUSION

The mitigation measure to improve the poor cost management of infrastructure projects is important based on the outcome of the results obtained from the analysis in Table 2. The result shows that improper planning, inadequate engagement of Quantity Surveyors in infrastructure projects, wrong method of estimation, lack of proper monitoring by cost manager and cost engineers, slow decision making, cash flow problem during the construction, shortage of materials and skilled labours, lapse in management control, fraudulent practices and kickbacks , insecurity, bureaucracy in tendering method, poor communication and changes in site condition are the major factors that causes poor cost management of infrastructure project in Nigeria. As a result of these factors, the measure proposed for the improvement of cost management of infrastructure projects were analysis and the followings measure were considered significant: effective strategic planning, proper project planning and scheduling, effective site management supervision, frequent progress meeting, proper emphasis on past experience, use of experienced subcontractor and suppliers, use of appropriate construction method and etc. These measures are implemented through the following strategies: pro-active, re-active and organisational strategies as shown in Figure 3. Therefore, the study recommend that, the management of construction industry should apply the strategies mentioned above to improve the cost management of infrastructure projects delivery, since the infrastructure projects are key to accomplish the country dream of vision 20:2020. The professional Quantity surveyors should be engage in infrastructure projects right from inception to completion stage to avoid poor cost management.

REFERENCES

Abdul Azis, A. A; Abdul Rahman, I and Karim, A.T. (2013). Controlling Cost Overrun Factors in Construction Projects in Malaysia. *Research Journal of Applied Sciences, Engineering and Technology* 5 (8), 2621-2629.

Al-jibouri, S. H. (2003). Monitoring Systems and their Effectiveness for Project Cost Control in Constructions. *International Journal of Project Management* 21, 145-154.

Ali, A. S, (2010). Cost performance for building construction projects in Klang valley. *Journal of Building Performance*. 1(1), 110-118.

Artto, K. M; and Kujala, J (2011). Project business. *Project Management Association Helsinki, Finland:*.

Chan, S. P., M (2005). Project cost estimation using principal component regression. *Construction Management Economics*. 23, 295-304.

Chen, J. (2001). Project Measurement and cost management. Shanghai: Tongji University Press.

Creswell, J. W. and Tashakkori, A. (2007). developing publishable mixed methods *Journal of Mixed Methods Research*. 1(2), 107-111.

Doloi, H. K. (2011). Understanding stakeholders' perspective of cost estimation in project management. *International Journal of Project Management,*. 29 (5), 622–636.

Dong, S. (2003). Status Quo of Construction Cost Management Theory and Its Developmental Trend. *Construction Cost Management*. 5(2).

Eneh, O. C. (2011). Nigeria's vision 20: 2020 issues, challenges and implications for development management. *Asian Journal of Rural Development*. 1(1), 21-40.

Feng, J. (2000). Study on Counter Measures of Project Cost Management. . *Technical and Economic Development*. 6(1), 123-136.

Flyvbjerg, B. H. and Buhl, S.L. (2003). How common and how large are cost overruns in transport infrastructure projects?. *Trans. Rev.* 23(1), 71-88.

Groves, R. M., Fowler, F. J., Couper, M. P., Lepkowski, J. M., Singer, E. and Tourangeau, R. (2009). Survey Methodology. *New Jersey: John Wiley & Sons. ISBN 978-1-118-21134-2*.

Hansen, D. R, (2006). Cost management: Accounting and control (6th ed.). Mason, USA:South-Western College.

Hao, J. (2002). American Construction Cost Management. Tianjin: Nankai University Press, 1, 51.

Iyer, K. and Jha, K. (2005). Factors Affecting Cost Performance: Evidence from Indian Construction Projects. *International Journal of Project Management*. 215(3): 344 - 354

Kaliba, C. M and Mumba, K. (2009). Cost escalation and schedule delays in road construction projects in Zambia. . *International Journal of Project Management*. 27(522-531).

Kasimu M.A (2015) Cost Reduction of Construction Projects in Nigerian: Knowledge Management as an Antidote. *Journal of Environmental Sciences and Resources Management.* Vol 7, Number 1, 2277-0097.

Kasimu, M. A., Roslan, A. and Fadhlin, A. 2013. Project Knowledge Management in Civil Engineering Construction Firms In Nigeria. Australian Journal of Basic and AppliedSciences. 7(2), 54-62.

Kern, P. A (2004). Guidelines for improving cost management in fast, complex and uncertain construction projects. *Proc. of 12th Annual Conference on Lean Construction, Denmark*.

Li, T. (2003). Study on Cost Management Model and Countermeasures of Construction project after China's entry into the WTO. Construction Cost Management.

Makarfi, Y. I. Ibrahim A.D. (2010). Evaluation of resource requirement for infrastructure development in Nigeria. *NIQS International conference,* .

Oforeh, E. C. (1997). Cost Management of heavy Capital Project; Lagos: Cosines Nigeria Limited.

Olawale, Y. A (2010). Cost and time control of construction projects: Inhibiting factors and mitigating measures in practice. *ConstructIion Management Economics*. 28(5), 509-526.

Omoregie, A, (2006). Infrastructure delays and cost escalation: Causes and effects in Nigeria. . *Proceeding of 6th International Postgraduate Research Conference, Delft University of Technology and TNO, Netherlands*.

Qi, A. (2000). Total Cost Management for Engineering Project. Tianjin: Nankai University Press.

Qin, A. (1999). Study on Construction Cost Management. . *Economic Tribune*. 22.

Walker, I. and Wilkie, R. (2006) *Commercial Management in Construction*. Blackwell Science Ltd, oxford.

EXAMINATION OF FACTORS AFFECTING ACCURACY OF VALUATION FOR SECURED LENDING IN ABUJA, NIGERIA.

CHARLES-AFOLABI Christianah Yetunde & OLATUNJI Ayodele.
Department of Estate Management and Valuation, Federal University of Technology, Minna,

Collateralized property interest is a major requirement in financial lending. There already exists a consensus among the academia, the professionals, and the judiciary, that inaccuracy in valuation is inevitable. Also the various regulatory bodies of real estate practice including the Royal Institution of Chartered Surveyors, the International Valuation Standards and even the Nigerian Institution of Estate Surveyors and Valuers, have asserted that the valuer and most informed users of valuation, particularly financial institutions recognize that there will be a degree of uncertainty attached to valuation figures. This study therefore seeks to examine those factors that may affect the accuracy of valuation for secured lending in a developing economy like Nigeria and specifically in Abuja the capital city and one of the leading economic regions of the country; the factors that could undermine the objectivity and possibly influence the opinion of value from the lender and borrower's perspectives. The paper is basically a literature work based on non-empirical study and review of previous studies by eminent academics; random interviews with some officials of banks in Abuja were conducted but no questionnaire was administered. Summary of factors include professional knowledge and expertise, clients' influence, country's economic and political situations and valuation standards are some of the factors affecting the accuracy of valuation for secured lending. It is recommended that there should be continuous specific training in valuation, industry-academia partnerships in estate surveying and valuation and the use, enforcement and continuous review of Valuation Standards.

***Keywords**: Secured lending, Valuation, Accuracy, Influencing factors*

talk2yet@yahoo.co.uk

CHARLES-AFOLABI Christianah Yetunde & OLATUNJI Ayodele. (2016). **EXAMINATION OF FACTORS AFFECTING ACCURACY OF VALUATION FOR SECURED LENDING IN ABUJA, NIGERIA**
Sustainable Built Environment and Climate change; The challenges of Post 2015 Development Agenda. School of Environmental Technology Conference, SETIC, 2016

INTRODUCTION

It is a well-known fact that financial institutions are key players in the redistribution of the wealth of a nation; they help to allocate national resources to the most valuable and productive uses. Financial institutions by way of definition are establishments or organizations that process monetary transactions, including business and private loans, customers' deposits and investments and other services that include various banking products extended to both private individuals and corporate bodies. One of the major roles of financial institutions, specifically commercial banks, is the granting of loan facilities. The banks evaluate the borrower status by considering the financial history and background, the credit-worthiness and capacity to deliver on the loan obligations as will be required. In the bid to enhance the performance of the financial institutions and the economy, the government will provide a platform that encourages them and sometimes compels them to give loans for business and property development. This is because when the key players in an economy have ready access to credit funds, consumer spending is enhanced and the economy will grow.

Financial institutions in assessing borrower's credibility do examine the previous financial activities, the business cash flow, balance sheet, the asset-capital base, and the equity to be contributed. The borrower and his business having passed the credit check, is adjudged financially healthy and capable to repay the loan. However, the lending institution will further request for additional security for the loan repayment by seeking a tangible asset called collateral. Such loan potentially becomes a "secured lending" if the credit advance is underpinned by collateral of the borrower's real property interests. However the loan can be in form of a mortgage or loan with fixed or floating interest rate or charge. In either of the cases, the property pledged as collateral will serve as another source of loan repayment in case the cash flow fails and the borrower is unable to meet up with the installments. As such the lender, that is the financial institution can take over the pledged asset or collateral which can be disposed in order to recover the loan. This implies that granting a loan with collateral serves as a form of financial risk security to the lending institution. Having fulfilled these prerequisites, the borrower may be granted more comparatively favorable terms than for an unsecured loan: for instance the lending institution can give a lower interest rate and relatively flexible amortization schedule.

Usually the loan amount is a function of the value of the pledged property, therefore it is expected that the collateral value should have parity with an amount that will cover the repayment of the loan in the event that the borrower is unable to pay from his cash flows. Thus determining the value of the pledged assets professionally is vital to the loan process best practices.

Valuation an expression of opinion of value for property interest may be needed for different important purposes ranging from property sale or acquisition, financing, taxation, investment appraisal and so on. Although, estimating opinion of value of a property for sale is the principal essence of property valuation, it is much more than that. Secured lending which involves the provision of real property as collateral requires such property to be valued as well. Given this situation, it means the financial sector should be well guided and protected to prevent inaccurate valuation estimates. Therefore factors affecting the valuation for their secured lending should be examined considering the roles of the parties involved, valuation of the collateral, and factors that affect the accuracy of the valuation.

This study is significant because the consequences of valuation inaccuracy can go beyond credit failure, to financial and economic crises as witnessed in the most recent financial crisis of 2008-2012. Inaccurate valuation can go a long way to trigger the failure of loan transactions, be it mortgage or any form of commercial loans. Thus it is expected that valuers fulfill their professional duties by ensuring a diligent, comprehensive and accurate estimation of opinion of value of property at any point in time. Valuation as required in secured lending should be such that the opinion of value is independent and objective, free from any form of influence from either the borrower or the lender.

Secured lending agreement requires the use of collateral when the borrower pledges his asset to the lending party as an alternative source of the loan repayment. The essence of this collateral asset is that it will be a form of back up for the lender such that in case the borrower fails to meet up with the loan obligation, the lender can take over the asset to make up for the loan amount. An example is a mortgage loan; a property asset is the collateral and in the circumstance that the borrower does not pay up as specified in the loan documents, the lending financial institution will take ownership of the property until the outstanding loan is fully amortized.

Banks tend to be exceptionally conservative in determining the value of the pledged assets. Thus they engage the services of a professional to do an appraisal of the property rely on the report of such exercise to be of accurate opinion upon which their decision will be based, because the property valuation is a vital part of their risk management techniques (Crosby, Hughes and Murdoch, 2004). However, it has been noticed that commercial banks are not absolutely satisfied with valuations from valuers because the banks are often unable to realize the valued amount in the market.

Therefore, the valuer, in stating the opinion of value for secured lending purposes, should be extremely careful and mindful of factors that may impact on the value. The valuation of pledged property in secured lending is central in the risk management of the loan, as such the valuer should take into consideration the professional standards and regulations, socio-economic factors, political factors, trends and events, government interventions (in form of control or regulations) and environmental factors that affect opinion of value.

Inaccurate valuation has far-reaching implications for the Valuers, the valuation profession, and for the efficient workings of the property and financial markets. Valuation inaccuracy either in the form of over-valuation or under-valuation is indeed undesirable. Over-valuation creates a credit risk because the property sales price will end up not covering the loan amount whereas undervaluation may result in the borrower being short-changed with respect to the amount of the loan he could have accessed given the true value of the collateral asset (Babawale and Alabi, 2013). Hence, accurate valuation is of utmost importance to the banks.

The Concept of Valuation

Valuation, as defined in finance is the estimation of the worth of an asset. Thus valuation of real estate can simply be defined as the determination of the opinion of the value of an interest in property. Property consisting of land and the development on it can be held for use or occupation as well as an investment. Therefore valuation of real property is to estimate the worth of the owner's interest in the property. Valuation according to Kalu (2001) is the art or science of estimating the value of property interest. Baum and Crosby (1988) also defined valuation as the estimate or prediction of the most likely selling price of a property. This means that valuation is an estimation of how much it will cost to purchase an interest in property.

Just as valuation is essential in finance, so is property valuation important in real estate activities and transaction. This is because real property in itself is peculiar in terms of its nature and characteristics as much as the property market is. The property market is such that information is not readily disclosed or made available and more so no two properties can be exactly the same. Therefore an expert opinion of the value of property is required in real estate dealings (Aluko 1998).

Valuation is the estimation of value, so an understanding of the term "value" is important as well. Value can be defined as the worth of something, however, the worth of an asset extends beyond the present moment; value is inclusive of the future benefits that can be derived from the asset. Specifically, property valuation means discounting the value of the future earnings of the property at a particular date to its present value at an appropriate rate of return. This may not be so difficult to understand because in the actual sense, the benefit of owning real property is the income yield over time or the enjoyment of use or occupation over time as well. Therefore property valuation according to the definition by Baum and Crosby (1988) is estimating the exchange price of a property interest.

The International Valuation Standard Council (IVSC) (2011) has stated the definition of market value as:

> *"the estimated amount (price) for which a property should exchange on the date of valuation between a willing buyer and a willing seller in an arm's length transaction*

after proper marketing wherein the parties had acted knowledgeably, prudently and without compulsion".

Purpose of Valuation

The opinion of value of property interest can be required for various reasons including real estate investment analysis, sale or acquisition, taxation and insurance. However, it has been noted that determination of sale or purchase price of property interest is the most common application of property valuation. According to Babawale and Alabi, 2011, they remarked that property valuation provides the basis for opinion of value which is used to measure performance with respect to making financing and investment decisions such as securitizations, portfolio analysis and management, analysis of credit and collateral even when the property is not actually for sale. For instance, mortgage valuation is the estimation of the value of property to be used as collateral (Ajayi 2009). Failure to ascertain clearly the purpose of valuation would expose the valuation process to ambiguities and possibilities of generic errors.

Methods of Valuation

Valuation has been defined as the art or science of estimating the value of property interest. This means it requires some calculations and sense of judgments; more so valuation requires the use of specialized skills and expertise because of the peculiarities of property as a resource and the market for its transactions. Therefore there will be need for data collection or information gathering and application of mathematics to arrive at the opinion of value. With respect to this, three basic methods or approaches are identified for valuation. These are the sales comparison approach which is premised on assessing the value of an interest in property by comparing and adjusting values of similar properties.

Cost approach is used for properties that do not readily exchange hand in the market; it has to do with cost of improvement of the property in question. This means that opinion of value is estimated by deriving the cost of erecting the building and then added to the value of the land. The effect of depreciation is also factored in the calculations.

The third approach is the income capitalization method; this method assesses the investor's rate of return with respect to the net income from the property. This method requires higher degree of calculations and is most often used for estimating value of income generating properties such as office spaces, shopping complex, flats etc. The valuer in estimating the opinion of value will apply the rate of return or what is called the capitalization rate to the net income realizable from the property.

The Profits and residual methods of valuation, recognized in the Commonweath countries, are basically variants of the Investment and Cost methods respectively.

Accurate valuation is important to the various users as such it is required that the valuer must be highly skilled and use an unbiased professional sense of judgment in the application of these methods to arrive at an opinion value. Errors could creep into the valuation process through the use of inappropriate valuation method.

Regulation of Real Estate Practice: Valuation Standards

In the absence of well-articulated regulatory guidelines, there is bound to be disorder in practice. In a profession like real estate practice concerned with management and valuation of property interests or rights, a lacuna in rules and regulation will tend to create irrationality, inconsistency and lack of transparency in transaction dealings. The practitioners would be under no obligations to apply the best of professionally judgments nor act in the best interest of their clients.

Real estate valuation has to do with deriving estimates, the use of assumptions and sometimes rule of thumb, therefore absence of laid down principles or guidelines to streamline these activities, the opinion of value arrived at may be subject to reliability test. This is a major reason why there has to be valuation standards, measures or set rules that must be complied with so that the valuation exercise or procedure is taken beyond casual levels.

In U.K where Nigerian valuation tradition originated from, the Royal Institution of Chartered Surveyors (RICS) regulates the practice. However in Nigeria, there are two distinguished regulating bodies namely, the Estate Surveyors and Valuers Registration Board of Nigeria (ESVARBON) and the Nigerian Institution of Estate Surveyors and Valuers (NIESV). For valuation exercises, a major aspect of real estate activities, rules and guidelines have been set to ensure transparency, consistency and rationality in the process. As expressed by Babawale (2012), that absence of standard means there is no professionalism and there is every tendency for abuse, conflicts, mediocrity and complacency. The subject of standards in valuation practice has been studied by scholars like Ogunba and Ajayi(1998) Babawale(2012) and Koleosho.

They have sought to examine the adaptation of valuation standards in the practice of real estate valuation in Nigeria, and their works include assessing the level of standards attained in Nigeria. For instance, the work of Babawale (2012), aims at ascertaining how the Nigerian professionals are applying the international standards and adopting best practice. He remarked that assessing the level of compliance will help to give reliability to valuation exercises in both property and financial markets. The International Valuation Standard

Committee (IVSC 2003, 2014) also asserts that the fast growing rate of globalization in the investment market requires that valuation be consistent, easily understood and transparent.

The two professional regulatory bodies for the real estate profession in Nigeria (NIESV and ESVARBON) have worked on establishing valuation standards and guidelines for Nigerian practice; the "NIESV valuation standards and guidance note" was revised in 2006 to replace the first edition of 1995. This valuation standard was modeled after the International Valuation Standards and the International Accounting Standards as it is clearly stated therein that valuers should adhere to all the sections of the International Valuation Standard Code of Conduct with respect to ethics, competence, disclosure and reporting (Babawale 2012). International Valuation Standards have been produced from collective efforts of the various national valuation associations. The International Valuation Standards (IVS) are formed by representatives of the valuation associations being delegates to constitute the International Valuation Standard Council (IVSC) which produced the IVS. The IVSC has continued to be the body responsible for setting valuation standards and its global acceptance by the professional bodies has also continued to be on the increase (Babawale, 2012).

Secured Lending

The term "secured lending" is disambiguated by the RICS Red Book (2014), VGPA 2, incorporating the IVSC International Valuation Standards. It provided four most common varieties where valuation is required, including properties that are owner-occupied, held as investment, for trading or subject to redevelopment. It also specifies four issues relating to valuation for secured lending among which are instructions and disclosures, objectivity and conflict of interests, basis of value, methods and special assumptions.

Lending is adjudged to be secured when backed by full collateral. Ordinarily, the borrower is expected to pay back; to move the transaction further to a comfort-zone, the lender may require that collateral be pledged to guarantee repayment of the loan. Then, the much-needed secured lending would be achieved should the move be attained. A collateral security is defined as anything of value that can be accepted as a replacement for debt and most often, the collateral is a personal belonging of the borrower which can be automobiles, real estate, business assets or anything that has worth that can repay the amount borrowed. A typical example of secured lending is a mortgage where the borrower pledges a property and in case of loan default, the lender can take over the property and have it sold to recoup the loan amount.

On the other hand, an unsecured lending is that in which no collateral security is provided. This means that the lender only has the promise of the borrower to repay which may not be followed through. A typical example is a credit card transaction. Secured lending is usually better because the risk of the lender is reduced and the borrower can enjoy lower rates as well; thus obeying the fundamental rule "the higher the risk, the higher the rate of return and vice versa". Also, a secured lending allows for more flexible loan conditions. This is because of the surety provided by the pledged collateral as the lender knows there is a form of backup in the case of loan default by the borrower, and concomitantly, the borrower tends to enjoy some benefits too because of the provision of collateral support for the loan.

Secured Lending in Nigeria and Use of Real Estate as Collateral

Eyre (2010) argued in Nwuba et al(2013) that secured loan or credit transaction is the practice in which the borrower creates an interest or right in an asset in favour of the lender as a guarantee to repay the amount borrowed. In case of default, the lender can take possession of, or sell the asset to settle the loan obligation. Lending-borrowing relationships are inevitable to leverage capital intensive projects in the business environment where corporate savings and equities fall short of funding requirements. Thus contracual lending relationships are commonplace in developing economies. Asides borrowing from family and friends, financial institutions are the alternate channels of institutional lending; in fact it is one of their core functions and at times, government compels financial institutions to lend as a way to regulating cash flow in the economy.

Nwuba, Egwuatu and Salawu(2013) carried out extensive literature reviews of Flesig(1996), Boots (1996), De Soto(2000) and Gan (2007) on the determinants of secured lending.

Their study reveals that the financial institutions are of different categories but commercial banks are the major ones in the business of lending. Flesig (1996) cited in Nwuba et al, (2013) affirmed that much as lending is essential for business and economic growt the use of collateralsized lending is very important in the lending process. The Nigerian financial sector in recent past has witnessed some turbulent crisis resulting from lack of due diligence in lending. The system became weak as a result of high volume of non-performing loans and so-called toxic assets coupled with poor corporate governance and insider financial abuses. These have led to reforms of this financial sector and the reforms have helped to reduce the inefficiencies and strengthen the institutions. One of the reforms is the adequate and efficient security of loans (Nwuba et al, 2013). This reform has emphasized the necessity of secured lending, which is the inclusion of acceptance of collateral in the loan process. Nwuba et al (2013) cited Boot et al (1996) wherein it was stated that collateral is widely used in loan contracts to serve as a powerful instrument in dealing with financial hazards. Gan (2007) was quoted by Nwuba et al (2013) as affirming that collateral support plays a huge role in lending by banks all over the world and real estate is regarded as an important collateral. In the same source, Flesig (1996) also remarked that banks in developing countries only give loans secured with real estate and only in rare cases do they give loans with movable assets. Notwithstanding, the borrower must also be known to own real estate which the lender can claim in addition to already pledged movable asset in the case of default.

Therefore it can be concluded that while different types of asset can be used as collateral for lending, real estate is considered the most valid in secured lending in a developing country like Nigeria. However, some requirements must be fulfilled for unit of real estate to be used as collateral for lending. One is that due diligence must be ensured in the use of real estate collateral so that the purpose or essence of the use does not get defeated. One of such requirements is the possession of a valid title (De Soto 2000 cited in Nwuba et al 2013).

This means that regardless of the fact that real estate invariably has a global acceptance as the most important collateral, there may be challenges or impediments to its use; for instance low level of land titling and poor documentation of transactions are great challenges. De Soto (2000) remarked that rights to assets in the third world are not properly documented and so the validity of using such assets as loan security can be questioned. Kozolchyk, (2007) as cited in Nwuba et al, (2013) also stated that the importance of title in real estate for secured lending is questionable.

Nwuba et al, (2013) in their study found that just as in previous studies, real estate is not only an important collateral instrument, but also the most widely accepted in the Nigerian banking sector. Their result goes further to acknowledge that possession of valid and verifiable title is a key requirement in the loan process. More importantly, the study also affirmed that the key requirement in secured lending decision is professional valuation of the real estate asset to be used as collateral. This then means that given the general acceptance of real estate as collateral in loan granting, real estate valuers too have an important role to fulfill in secured lending in that the opinion of value of the real estate used as collateral will be required in making the lending decision.

Valuation for secured lending

Although there may be several parties in a secured lending transaction, the two basic and most important parties involved are the lender and the borrower. These parties have different obligations as will be defined in the loan contract document. Valuation of asset for collateral security is one of the basic requirements of the loan granting process; hence a professional valuer becomes a participant in the secured lending process. The choice of the valuer is usually a function of the lender; this means that it is the financial institution giving the loan that is often responsible for engaging a valuer to give an opinion of value of the collateral assets.

According to Nwuba et al, 2012, the valuation process starts with the instruction given, gathering of information, analysis and calculations, report drafting, preparation of final report and submission. This means that the lending institution initiates the valuation processes which starts when the instruction or requests for valuation is given to the valuer. The valuer is expected to visit the property, get the necessary information and apply the appropriate valuation mathematics as required. The valuer develops a draft and the final report for submission. Although these activities seem to be simple and straightforward, in actual sense, they are complex and sensitive. Any flaw or undue influence in any step can alter the outcome of the valuation exercise.

The valuer is expected to identify the property type and apply the correct valuation approach to achieve the best result. Another important consideration in secured lending valuation is the basis of valuation. Valuation for secured lending is very paramount as it will be the basis of the loan decision making. The essence of the collateral is that it can be taken over for sale to recover the loan amount in the event of loan default; as such the basis of the valuation must be right and appropriate. Aluko (2004) in his research stated that valuation for secured lending such as mortgage is based on the same principle as if for sale, so open market value (OMV) should apply. Although he went further to recognize and define Estimated Realization Price (ERP) and its variant Estimated Restricted Realization Price (ERRP) to be more appropriate for secured lending. However he said that they are yet to gain acceptance in Nigeria unlike in the UK, as such valuation in Nigeria are still done on OMV basis.

Also worthy of note in the valuation process is adaptation and the application of valuation standards. The International Valuation Standards Committee (IVSC) has prepared guidance for valuation including valuation for loan security, mortgage, debentures etc. The IVSC has offered guidelines as to the valuation process, disclosure and reporting so as to ensure a quality report in terms of its consistency, transparency and reliability. Therefore valuers are expected to work by the rules in order to achieve the desired result.

Factors affecting Accuracy of Valuation for Secured Lending

It has been agreed among valuation practitioners that there are bound to be errors in valuation outcome. The fact that valuation involves an art; the use of skill and judgment means valuation may be subject to a degree of uncertainty or a margin of error. In Aluko (2004), it was remarked that uncertainty in valuation exists. With respect to other relevant and previous studies (RICS, 1997; Bowles, Mc Allister and Tarbert, (2001) as quoted in Aluko, 2004), he further stated that uncertainty in valuation exists in form of variation inaccuracy. Valuation variance occurs when different valuers come up with different opinion of values on the same property. Valuation inaccuracy is an error in valuation because the sale price of a property differs from the given opinion of value. Although it is argued that there is a possibility of slight difference between property sale price and estimated value given the imperfect nature of property market, it is still expected that if valuers do a good and diligent job, the opinion of value should not differ so widely as to call for concern on the reliability of the valuation.

Accuracy in valuation has long been a subject of debate originating from UK (Hager and Lord (1985) and Brown 1985 quoted in Aluko 2004). A lot of studies have been conducted since then in the UK and most of the outcomes concluded that there is a high level of valuation accuracy although there are certain levels of inaccuracy. Meanwhile studies in the

US including Cole, Guilkiy and Miles (1986), Ferguson (1988), Plattner (1990) revealed that there is a low degree of reliability in the valuation. The various studies indicated that valuation inaccuracy exists in the US for different reasons (Aluko, 2004). In Nigeria, there has not been so much work done on the subject as the exposure to this area of concern is relatively new. However the studies conducted so far in Nigeria starting with Ogunba (1997), Ogunba and Ajayi (1998), revealed that the practice of valuation in Nigeria is subject to bias and error.

Wyatt (2003) quoted in Babawale and Omirin (2011) noted that inaccuracy can emerge in valuation exercise at any of the stages. Valuation process as earlier stated involves a lot of activities ranging from information gathering, analysis and computation to reporting. So it is expected that the valuer is careful and observes due diligence in order not to undermine the process and jeopardize the result. Although it has been accepted that inaccuracy is unavoidable in valuation, it should be noted that valuation inaccuracy can pose a great threat to the practice of real estate profession. This is because if there is an integrity issue with the valuation exercise, then the request for it will tend to be disregarded (Babawale and Omirin 2011).

RESEARCH METHODOLOGY

Basically, this study adopts a theoretical research approach; it is a non-empirical study of factors affecting accuracy of valuation for secured lending in Abuja, Nigeria and the world at large. Nigeria is one of the fast growing and developing economy and Abuja which replaced Lagos as the administrative capital city in 1991 has continued to witness lots of growth in recent years. Economic activities including borrowing and lending for various purposes are expanding. While there have been some studies to examine the factors affecting valuation for secured lending purpose in Lagos, such studies have not really been conducted in Abuja. This study thus seeks to identify and examine some of the factors affecting the accuracy of valuation for secured lending and how they play out in Abuja.

The limited studies on real estate valuation practice in Nigeria (Ogunba, 1997; Ogunba and Ajayi 1998; Ogunba 2004) among others have reported that there is low level of accuracy. While they have been able to establish that there is a level of inaccuracy, few studies have examined the cause of the phenomenon. Babawale and Omirin (2011) in the study of likely factors responsible for valuation inaccuracy remarked that earlier research have probably stopped at establishing inaccuracy rather than finding out why the inaccuracy exists because valuation users or clients are more particular about the final opinion of value and not interested in the process. They went further to say that questions of valuation inaccuracy can only be answered when the factors causing inaccuracy are identified and addressed and this is the focus of this study.

Although some random interviews were conducted with some staff members of some commercial banks in Abuja, questionnaires were not administered.

FINDINGS

Babawale and Omirin (2011) quoted some authors like Diaz (1990_a and 1990_b); Harvard (1999 and 2001), Wyatt (2002) amongst others that worked on causes of inaccuracy in valuation. Meanwhile, such study in Nigeria is still very minimal, we have very few ones like Amidu (2006), Amidu and Aluko (2007).

The nature of property

The real issue or the underlying factors in valuation accuracy itself is the nature of property. Property, unlike other forms of investment, is heterogeneous in nature, fixed and unique in location; therefore placing an exact value may not be achievable. Basically it is the interplay of market forces of demand and supply that can place a value on property at any given time (Babawale and Omirin 2011). This demand-supply value can be likened to its market value, more so property market differs markedly from other markets that have easy access to information in a centralized place where the goods are on display for ready buyers. As such the virtual nature of the market can add to inaccuracy in valuation. In the case of Abuja, the property market is volatile and susceptible to changes within short time given the fast growing rate and condition of the city which also leads to constant adjustments in property values.

Fundamental issue of science content of Valuation theory and practice

Academics and professionals of property valuation have agreed that valuation cannot be as exact as science. However, if there is bound to be a degree of error, it has to be minimal and within acceptable limit or margin error. The question is then what is the acceptable margin of valuation error? The answer to this question can be premised on the court case of UK, Singer and Friedland Ltd V John D. Wood and co. (1977) illustrated by Gambo and Anyakora, (2013). The case was about establishing negligence of the valuer who should have exercised reasonable care and expertise in a valuation exercise to ensure valuation accuracy. With an independent expert witness's opinion and agreed by the defendant, it was decided that 10% is ideal permissible margin of error, extended to 15% by the courts. Today, there has continues to be debate on this permissible margin of error because it said that the permissible margin will be dependent on the peculiarity of each case and with respect to the nature and complexity of the property. The English courts and some other courts have adopted this concept of permissible error in establishing a negligence case against valuation professionals (Crosby, Lawers and Murduck, 1986; Brettens and Wyatts, 2002 as quoted in Gambo and Anyakora, (2013).

While the concept of a margin of error with regards to value-added accuracy has been used as basis of charging professional in UK, Australia and US with negligence, the case in Nigeria has been different because there are no records of court cases with respect to property valuation. This means that valuation practitioners in Nigeria are still getting away with issues concerning valuation exercise (Babawale 2007 and Ifediora 2010 quoted in Gambo and Anyakora 2013). According to Babawale 2007, there are few negligence cases against valuers in Nigeria but they are usually resolved within the regulatory professional body. Literally one can say that the practitioners of estate surveying and valuation in Nigeria are still enjoying a level of security in practice.

However, given the increasing level of awareness of investors, globalization, and the demand for real estate services and challenges faced by users of valuation report like financial institution, the Nigerian valuers may be called to answer for the shortcomings in their expert opinion of value (Gambo and Anyakora, 2013). The studies on valuation accuracy have revealed different levels of errors and just as in the UK and other countries, there has not been a consensus on the acceptable or permissible margin of error. The pioneering studies by Ogunba (1997), Ogunba and Ajayi (1998) suggested ± 5% while more recent study by Ogunba and Iroham (2010) tried to establish it + 10%. The later study of Adegoke, Olaleye and Oloyede (2011) is of the opinion that it is ± 5% because they found out that majority of the financial institutions accepted the ± 5% position against the ± 10% in literature.

However in a much more recent and broader study of Gambo and Anyakora (2013), it was revealed that most of the responses were between ± 5% to ± 20%. So in their analysis and corroboration with previous studies, they concluded that given the volatile nature of Nigeria's property market and other issues like lack of an established data bank, the acceptable margin of error should be between ± 5% and ± 15% depending on the circumstance and peculiarities of the property being considered for valuation. This means that any valuation measured against the sale price with difference above 15% is considered inaccurate (Gambo and Anyakora, 2013).

Although these lines of argument have been established in the Nigeria valuation practice, it is found out that most valuations still fall beyond this ± 5% to ± 15% permissible or acceptable margin error. This study therefore summarizes some of the factors causing this valuation inaccuracy. The findings of various studies have revealed that market data, incompetence or lack of training on the part of the valuers are some of the causes of valuation inaccuracy (Ayedun et al, 2012). The imperfect nature of property market makes it difficult to validate market data, and may cause valuation inaccuracy. The market is such that information are not readily available, therefore it is the information that the valuer can get that he will work with.

Absence of professional culture of specialization in practice

Also it is known that most firms practising in Nigeria, including Abuja, engage in general practice, because the culture of specialization is not yet profound. Therefore a valuer may not have the adequate knowledge required for a job as such the efficiency of the valuation process may not be achieved. The establishment of distinctive faculties by NIESV to which members, based on their skills, practice, training and experience and interest, can align or specialize in, is a step in the right direction.

Client's Influence

Another factor affecting the accuracy of valuation for secured lending is client's influence. Depending on the type of client and how big, they are able to command an influence on their valuation, like in Abuja, most of the clients are big influential people. This influence most times is from the borrower because they want a high valuation figure so that their loan amount can be enhanced. The clients are also able to influence valuation because of the characteristics of the valuer and the valuation firms (Amidu and Aluko, 2007). Most times, valuation firms are small to medium scale one man organization, such that if there is no highly upheld integrity on the part of the valuers, they may succumb to client's influence in their valuations practices. Some clients are familiar with the valuation industry as well and so they are able to use business pressure, financial pressure, their expertise or high level of knowledge to coerce the valuer or the valuation firm to give in to their request.

Valuation Standards, Enforcement and constant review.

One other major factor affecting valuation accuracy of secured lending is the valuation standards. Inadequacy or absence of standards in any profession will lead to variation, contradiction and inconsistency which will lead to lack of trust or confidence by clients. For valuation inaccuracy to be checked in the property valuation profession, there has to be standards to ensure best practice in quality and consistency. The regulating bodies of real estate valuation should clearly define what should be and not be in the profession with provision of adequate sanctioning and measures that will compel practitioners to be of their best professional behavior. Although the Nigeria valuation standards have been fashioned in line with the International Valuation Standard (IVS), the laws need to be enforced by the regulating bodies, Nigerian Institution of Estate Surveyors and Valuers (NIESV) and the Estate Surveyors and Valuers Registration Board of Nigeria (ESVARBON).

Political and Economic environments

Lastly, in the random interview conducted with some bank officials in Abuja, it was revealed that the influence of economic and political situations in the country form an integral part of the determinants of valuation inaccuracy in Abuja. The changing events and circumstances in the country impact on valuation for secured lending. Most often when the valuation is done and the loan is given, everything seems in order. With the passage of time, if the loan goes bad and the Bank calls in the credit the valuation conducted becomes the reference point for the lending to be secured. However, unforeseen political and economic factors could render the valued amount unrealizable. Typical situations include the monetization policy, Naira deprecation against foreign currencies and the current drop in price of crude oil, Nigeria's monolithic product. The location of the city has also had a part of the insurgency situation. These have caused businesses to decline and even completely fold up, resulting into borrowers not being able to meet up their loan obligations and the collateral assets could not be disposed because of the existing circumstances.

CONCLUSION AND RECOMMENDATIONS

The practice of real estate valuation has received so much attention in recent times and this has extended to the various studies on the accuracy of valuation. This aspect of valuation has called for extensive research because if appropriate measures are not put in place to check valuation inaccuracy, the continuous existence of the profession could be threatened. This is because if the current situation persists, the confidence and the demand for this professional service will continue to decline.

The various initial studies have established that there exists valuation inaccuracy in our practice. Further and more recent studies have tried to examine the cause of valuation inaccuracy. This they have done from different perspectives including studies that tried to establish an acceptable or margin of error of $\pm$5% to 15%.

The study has affirmed that factors affecting accuracy of valuation for the purpose of secured lending in Abuja include the availability of data, the knowledge and expertise of the valuer, the influence of clients on valuation as well as valuation standards and its enforcement by the regulatory bodies. Beyond having the information, the way forward should be how the profession will seek to address these shortfalls in order to prevent the practice of valuation from going into extinction.

This paper thus recommends continuous and in-depth study of these aspects of valuation given the gravity of what could happen. It also suggests a follow-through approach by working on the various recommendations from previous studies including establishing a centralized data base accessible to all valuers. There should be continuous professional development programs on how to improve property valuation practice. This study seeks to add that there should be smooth collaboration between practice and the classrooms, whereby the academia works hand in hand with valuers in the field of practice. As the academia are working hard to discover more about the practice of the profession, they should pass the knowledge on to the people on the field while imparting the students with the right and updated knowledge so that quality graduate practitioners are produced.

Another recommendation is that practitioners of real estate should master the entire art and be ahead of the client so that the level of influence by client can be reduced to the barest minimum. Specialization should be encouraged in practice such that adequate expertise and high knowledge is possessed in each faculty including valuation.

Also the compromise in the use of the valuation standards should be eradicated completely. The Nigeria valuation standard should be first reviewed and updated to most recent internationally recommended standards. Then the regulatory bodies ESVARBON and NIESV should ensure strict compliance and enforcement of the standards. Their position with respect to the compliance of the valuation standard should be communicated clearly to the professionals in practice and punitive measures in the case of non-compliance should be upheld without any fear or favour.

REFERENCES

Adegoke O.J., Olaleye, A. and Oloyede, S.A.(2011). A study of Valuation Clients'Perception on Mortgage Valuation Reliability. *The Estate Surveyor and Valuer, 35(1), 89-96.*

Ajayi, C. A. (2009). International Valuation Standards as Applicable in the Use of the Investment Methodof Valuation and in Mortgage Valuation. Valuations in the Residential Property Market in Lagos. *The Estate Surveyor and Valuer , 21 (2).*

Aluko B. T. (2004). Reliability of mortgage valuation for institutional lending in nigeria, *International Journal of Strategic Property Management, 8:4, 193-203. http://dx.doi.org/10.1080/1648715X.2004.9637517 retrieved 16/10/2015.*

Amidu, A., and Aluko, B. T. (2007a). Client influence on valuation: perceptual analysis of the driving force. *International Journal of Strategic Property Management, (2007). 11,*, 77 - 84.

Amidu, A., & Aluko, B. T. (2007b). Client Influence in Residential Property Valuation: an Empirical Study. *Property Management, 25(5),* 447 - 461. DOI 10.1108/02637470710824720.

Anyanwu, C. M. (2010), An overview of current banking sector reforms and the real sector of the Nigerian economy. Central Bank of Nigeria Economic and Financial Review, Volume 48/4, December, pp. 31 - 56.Retrieved from http://aaujms.org/ The Financial System in Nigeria.pdf.

Ayedun, C.A., Oloyede, S.A., Ogunba O. (2010). The Accuracy of Nigerian Property Valuation Revisited. *Built Environmental Journal Vol. 7, No. 2, 1-11, 2010. Retrieved 16/10/2015.*

Ayedun, C.A., Oloyede, S.A., Durodola O.D. (2012). Empirical Study of the Causes of Valuation Variance and Inaccuracy in Nigeria. www.ccsenet.org/ ibr International Business Research Vol. 5, No. 3; March 2012 Retrieved 16/10/2015.

Babawale, G.K. and Alabi, A.A. (2013). The Nexus between Valuation Accuracy and Mortgage Finance: A Nigerian perspective. *CPS Journals Journal of Transformative Entrepreneurship Centre for Postgraduate Studies ISSN: 2289-307*, Universiti Malaysia Kelantan Vol. 1, Issue 1, pp: 1-13 (2013) Retrieved 8/10/2015.

Babawale, G.K. and Omirin, M.M. (2011) Valuers' and Valuation Firms' Characteristics as Causes of Inaccuracy in Valuation in Nigeria. *Mediterranean Journal of Social Sciences*. Vol. 2 (3) pp. 11-23. Retrieved 16/10/2015.

Babawale, G. K. (2012). An assessment of the current standard of real estate valuation practice in Nigeria. *www.elixirpublishers.com (Elixir International Journal) Elixir Soc. Sci. 47 (2012) 9094-9102 retrieved16/10/2015.*

Babawale, G. K., and Omirin, M. (2012). An assessment of the relative impact of factors influencing inaccuracies in valuation. *International Journal of Housing Markets and Analysis, 5 (2)*, 1 - 1.

Baum A.E. and Crosby, N. (1988). *Property Investment Appraisal.* London: Routledge.

Crosby, N., Hughes, C., and Murdoch, J. (2004). Influences on Secured Lending in the UK. *11th European Real Estate Society Conference, 2 5 June.* Milan, Italy. Retrieved from www.reading.ac.uk/LM/LM/fulltxt/0404pdf on 16/10/15.

De Soto, H. (2000), The Mystery of Capital. London: Transworld Publishers (Black Swan Books).

Gambo Y.L. and Anyakora M.I. (2013). Margin of Valuation Error Among Nigerian Valuers: Postyulating an Acceptable Limit. *ATBU Journal of Environmental Technology* retrieved 16/10/2015.

Iroham, C. O., Ayedun, C. A. And Oloyede, S. A.(2012). A Preview of Non-Client Influence in Property Valuation in Nigeria. *Business Management Dynamics Vol.1, No.9, Mar 2012, pp.22-29 www.bmdynamics.com retrieved 16/10/2015.*

IVSC (2001). *International Valuation Standards Committee 2001*. London. International Valuation Standards Committee.

IVSC, (2003). International Valuation Standards (6th Ed.), International Valuation Standards Committee, London.

IVSC (2011). International Valuation Standards, International Valuation Standards Council, London.

Kalu I.U. (2001). Property Valuation and Appraisal. Bon Publication. Owerri.

Nwuba, C., Egwuatu, U.S. & Salawu, B. M (2012). Client influence on valuation process: Means, motive and impact. In Laryea, S., Agyepong, S.A., Leiringer, R. & Hughes, W. (Eds) *Procs 4th West Africa Built Environment Research (WABER) Conference*, 24-26 July 2012, Abuja, Nigeria, 979-993.Retrieved 16/10/2015

Nwuba, C., Egwuatu, U.S. & Salawu, B. M (2013). The Application of Real Estate as Loan Collateral in Nigeria's Banking Sector. *Research Journal of Finance and Accounting ISSN 2222-1697 (Paper) ISSN 2222-2847 (Online) Vol.4, No.11, 2013 www.iiste.org retrieved 16/10/2015.*

Ogunba, O.A (1997) A Study of Valuation and Pricing Practices in the Residential Property Market in Lagos Metropolis, *an Unpublished M.Sc. Thesis, Obafemi Awolowo University, Ile-Ife.*

Ogunba, O. A., & Ajayi, C. A. (1998). An Assessment of the Accuracy of Valuations in Residential Property Market in Lagos. *The Estate Surveyor and Valuer, 21 (2)*, 39 - 48.

Ogunba, O. A., & Iroham, C. O. (2010). A Search for an Acceptable Margin of Valuation Error: a Case Study of Valuers and their Clients in Nigeria. *Sri Lankan Journal of Real Estate, 4*, 54 - 73.

Olafa S. A. (2015). Clients Perception on the Accuracy of Valuation Reports in Ibadan Metropolis. *Journal of Educational Policy and Entrepreneurial Research (JEPER) ISSN: 2408-770X (Print), ISSN: 2408-6231 (Online) Vol.2, N0.4. April 2015. Pp 9-209 www.jeper.org. retrieved on 16/10/15.*

RICS NOTES, (2014) Royal Institution of Chartered Surveyors, Practice Statements and Guidance Notes. London, Estates Gazette.

Udoekanem N.B., Olatunji I.A. and Oko J.A. (2015). The need for Entrepreneurial Skills Development in Property Valuation Education in Nigerian Universities. *Journal of Research and Development in Education. 5(2). Pp. 128-139.*

Wikipedia. Abuja Retrieved on 12/02/2016.

Wikipedia. Financial Crisis of 2007-08 Retrieved on 27/08/2015.

Wikipedia. Secured Loan Retrieved on 27/08/2015.

ARBITRATION AS AN ALTERNATIVE DISPUTE RESOLUTION IN REAL ESTATE

OLATUNJI Olajumoke Omotola
Department of Estate Management and Valuation, Federal University of Technology, Minna,

Litigation is one of the methods aggrieved people can explore to seek redres s for a wrong committed against them. Though with the passage of time, the litigation system has been encumbered with a lot of cases that will not be re solved anytime soon. The truth of it is that the Litigation system is becomin g complicated, with regards to costs and time spent in resolving cases. Disp utes arising from real estate are not exempted from these complications. He nce, the examination of arbitration as an alternative dispute resolution in rea l estate. The aim of this paper is to identify areas in real estate where arbitrat ion can be and has been applicable in resolving disputes. The study is a theo retical research that used secondary sources of data collection such as journa ls and text books. The study found that there is need for professionals in the industry (real estate to be precise) to embrace this ADR. The study conclude s that if arbitration is properly fine-tuned to fit various needs in real estate it would be a valuable tool for resolving whatsoever disputes that can arise the re in.

Keywords: *dispute, litigation, arbitration, real estate dispute.*

homotola@gmail.com ,
vickysageola@gmail.com.edu.ng

OLATUNJI Olajumoke Omotola (2016). **ARBITRATION AS AN ALTERNATIVE DISPUTE RESOLUTION IN REAL ESTATE** Sustainable Built Environment and Climate change; The challenges of Post 2015 Development Agenda. School of Environmental Technology Conference, SETIC, 2016

INTRODUCTION

Disputes are inevitable processes of life, as they will continue to occur between family members, friends, professionals and their clients, government and government, government and her citizens, communities and communities. Unresolved differences are bound to arise in our normal everyday dealings with one another as a result of our interactions, dealings and our background differences.

Another prerequisite for exclusion of various disputes and controversies at its source is by ensuring the provision of every individual needs. Of course, that might not be plausible, as the resources to meet these needs are scarce while the needs on the other hand are quite unlimited. Some of these needs are shelter, water, food, security, health care, education (the list is inexhaustible). So then if that be the case, how feasible is it for individuals and possibly communities to dwell together in peace and unity, when their most basic needs are not being met by the government of the nation (Gunther, 2008). According to Gunther (2008), who identified the individual pursuit of goals and the journey of fulfilling these dreams of individual essential needs surely, leads to controversies especially as there is a perception that resources are scarce in meeting these needs. Furthermore, there are bound to be clashes when individuals pursue their dreams since the fulfilment of one person's dreams is the disallowance of another's.

There is no doubt about it that disputes can come from anywhere. More so, a Yoruba adage rightly says "the tongue and the mouth constantly fight."

So if these differences are bound to happen in life, out of foreknowledge it makes sense that there should be ways these differences can be resolved that would not lead to unnecessary conflict and fight. One major way of resolving conflict is through litigation. The problem with this method of resolving disputes is that the litigation system in Nigeria is saddled with innumerable number of cases. They are inundated with disputes of enormous dimensions that they are obviously incompetent and inept to sufficiently deal with especially disputes particular to real estate.

The technicalities included, the red tape, and bottleneck encountered all are setbacks to the litigation system. Where papers must be filed, peculiarities must be strictly adhered to serve to compound the technicalities problem. The technicalities faced have a direct influence on the time spent in resolving disputes. It is not a secret that the path to the justice system is filled with bottleneck of all sorts and bureaucratic red tape just as clearly stated above. These red tapes are slow process that take time and ultimately finance. Some issues take close to fifty years before they get to trial and still nothing is yet to come out of them. Makes you wonder if justice delayed isn't really justice denied?

Perhaps of all disturbing disadvantage of the litigation system is the cost attached to it. Going to court is extremely expensive. Lawyers' fees and expenses must be considered, unless of course it is a pro bono case which has other implications like time implications. It's no wonder, other avenues to resolve disputes have been made available for people who would rather live without the stress of the court system. Hence, the introduction of arbitration as an alternative dispute resolution in resolving disputes that will arise from real estate. The other types of ADR are negotiation, mediation and collaborative law. 'Alternative' dispute resolution is usually considered to be an alternative to litigation. It can also be used as an informal mode for allowing a dispute to drop or as an alternative to violence. The aim of this study is to identify the applicable areas where arbitration can be effectively used to achieve best results in resolving disputes.

The school of environmental technology international conference come May, is set to examine the sustainability of the built environment and changes in climate. Sub themes that will be examined as well include infrastructure development and financing, sustainable practise theories, urban resilience and energy conservation, waste management sanitation and so many other subthemes. It's no secret that we are in a 'sustainable generation'. There is a thirst to better the state of things for the benefit of the present generation and consecutively the coming generation.

Sustainable development was first propounded by Brundtland (1987) who referred to sustainable development as the provision of all that is needful and essential to the well-being of the present without necessarily endangering and jeopardising the capacity available to the future generations to meet and provide their needs. If the definition of the built environment is anything to go by – our man made surroundings that provides the basis for all human activity which includes parks, buildings, parks, cities with their buttressing facilities such as water supply, electricity, road network, and communication network. The buildings we live in are all part of the built environment. Of course we know that a building is a combination of a series of processes, from the acquisition of a site, to carrying out preliminary survey to sourcing for finances to the construction process and then of course the finished stage and then that welcomes the questions of leasing or selling off these properties in the case where the building is either a residential or a commercial property. For every of the construction process of development, it is normal that conflicts will arise between parties domiciled in this process. Parties could be the owners of these properties, they could be users, they could be bank managers, and they could be property developers. As stated earlier there is need for a mechanism to be developed and fine-tuned in which issues arising from infrastructure development can be appropriately dealt with and in time too without necessarily recourse to litigation.

There are various reasons why disputes can arise between two disputing parties for example; a landlord could have issues with a tenant renting his property as a result of misuse of property. Instead of resolving this issue in a court of law, arbitration can be used to settle issues between the tenant and the landlord. There will be no sustainability if there are no fine-tuned platforms in which disputes can easily be resolved without wasting time and money.

It should be noted that these is a new topic in the field of real estate, one that is yet to be properly harnessed and fine-tuned to guarantee best results. It is my hope that this publication will bring an awareness that was not present before to estate surveyors and valuers, in order to enlighten them on the numerous advantages of arbitration in resolving real estate disputes.

CONCEPT OF ARBITRATION

Arbitration is a derivative of the word "ARBITRATRY", which means decision is based on the opinion of a neutral person rather than by rules or law. Arbitration can be defined as the deference of a dispute to one or more impartial person(s) for final and binding determination. It is private and informal designed for quick, practical and inexpensive settlements. But at the same time, arbitration is an orderly proceeding governed by rules of procedure and standards of conducts prescribed by law.

In addition we can also describe arbitration as a legal procedure in its own right that decides the legal relationship (liabilities and rights inclusive) between parties with an air of finality that is legally binding as well as enforceable (subject to statutory appeal or relieved process). It determines the law as well as the feuds in dispute in a judicial manner.

In his book (Evidence and procedure in Arbitration) William H.G. referred to Arbitration as "The reference of a dispute or difference between not less than two persons for determination after hearing both sides in a judicial manner by another person or persons, other than a court of competent jurisdictions". It should be noted that there are significant differences between arbitration and litigation, although the reference will be heard by an arbitrator in a judicial manner, and the ordinary rules of court procedure and of evidence will be enforced at the hearing. According to Gerald M. Levy, in his book "The Arbitration of Real Estate Valuation and Related Disputes" who referred to Arbitration as "The reference of a dispute to one or more impartial persons for final and binding determination." As earlier stated that arbitration is private and informal, designed for quick, practical and inexpensive settlements. But at the same time, arbitration is an orderly proceeding governed by rules of procedure and standards of conduct prescribed by law.

The Nigerian Arbitration and Conciliation Act describe the concept of arbitration at best as its entirety cannot be defined. It is the process which involves the two disputing parties choosing an impartial third party who is the arbitrator and decisions are final and binding on both disputing parties.

Arbitration, according to Prof. A.S. Asaju in his Discussion Paper No1 of 1994 is "The referral of a dispute between two disputing parties to a mutually acceptable, neutral third party for adjudication." These days litigation is the first and fastest channel for persons who are seeking redress for a wrong done them either through injury or failure of a partner to keep to terms of a binding agreement. Many a times this decision is made into much of a hurry without proper understanding of what they are getting themselves into. It is only sensible that at first direct negotiation should be explored as an avenue to seek settlement. The injured person as much as possible calmly speaks to the wrong doer about the import of their action on them. As the Bible rightly says "a soft answer turns wrath way." The two of them can often reach a mutually acceptable solution". In fact if the erring party still proves stubborn, litigation sometimes isn't necessarily the next course of action. There are alternative dispute resolutions options to be explored to determine how to go about settlement. Litigation should be the last resort in seeking settlement.

Arbitration is a binding rule of the involved parties' right to be determined by a neutral umpire 9known as an arbitrator) or group of arbitrators. The arbitrators' final decision or award is ultimately binding on the parties just as if it were decided through litigation by a court as final judgment (Cardozo, 2006)

Arbitration has been defined as a process whereby two disputing parties agree to resolve and settle their disputes by a third party tribunal chosen and handpicked by them (Orojo and Ajomo, 1999).

Halsbury laws of England defines arbitration as the referencing of a dispute or difference between not less than two parties for determination, after hearing both sides in a judicial manner, by a person or persons other than a court of competent jurisdiction.

To put it in a more simplified way, Otuturu (2003) says arbitration is the wiling submission of a dispute to a third neutral person or body of persons selected by the disputing parties that they may give a binding decision. Disputing parties submitting their disputes to an umpire may be as a result of an agreement between the parties to the dispute or from a statute which requires the settlement of certain disputes by arbitration. It may further arise by order of court.

The act of settling a dispute between two disputing parties in order to reach an end that is both mutually acceptable and satisfying to both parties is carried out by an "Arbitrator". An arbitrator as stated by Robert Raymond C.J. in the middle of the eighteenth Century as described by William H. GILL is a private extraordinary judge between two disputing parties, chosen with the mutual consent of both disputing parties, to determine controversies between them. Arbitrators are so called because they have been vested with arbitrary powers, for if they observe the procedures as stated (arbitration agreement) and keep within due bounds, their sentences are definite and final from which there lies no appeal. Arbitration is not to be confused with mediation and conciliation. Where conciliation involves a third party interacting with disputing parties so as to reach a resolution of a dispute through persuasion and compromise, mediation goes beyond that process, such that the third party that attempts to restore peace actively proposes terms of concession and means where solution is arrived at. The two alternative dispute resolutions are different from arbitration in the sense that an arbitrator makes the final decision for disputants, while the mediator and conciliator don't. Of course decisions in arbitration are binding on parties involved.

From its inception, some certain level of control has been exerted on arbitration by the King's Court which has been inevitable ever since. The growth of British overseas trade, and the expansion of the empire from the time of the Treaty of Paris (1763), enlarged greatly the work of merchants and traders and consequently matters in dispute between such persons became increasingly frequent, and of the Realm. At first, these disputes were decided in practice under the common law, and related originally to chattels personal, or torts to the person.

One important feature of modern life is Arbitration, so much so that every business man will find it of service and is advised to at least have some knowledge of the law and practice under which they are regulated and managed. Thus if a business man is desirous of such knowledge how much more doubly necessary it is for estate surveyors and valuers, for the preparation of quantity surveyors and the other professionals of the built industry. Arbitration is a time tested and proven method of disputes settling between two or more grieving parties, by which one or more persons are selected for the purpose of dispute resolution after a hearing in a quasi-judicial manner, either instead of having recourse to an action of law, or by order of the Court, after such action has been commenced.

It should be noted that there are wide ranges as well as broad and varied disputes which can be submitted to arbitration for settlement

Concept of a Dispute

It is true that the word "dispute" is synonymous to the word "controversy." Its meaning according to the Webster New 20th Century Dictionary is "an attempt to prove and maintain one's own opinions, arguments or claims of another controversy in words. Dispute appropriate for judicial determination includes suits of civil nature in which legal right must be questioned so as to determine extent and existence.

Thankfully, most disputes that occur in the construction industry are minor disputes that can be sorted out among the parties involved. Generally, the origin of most disputes are a result of failure and default of the concerned parties to the Contract, one of the professional advisers or some other party connected with the contract to do his work efficiently, to express himself clearly or to understand the full implication of the instructions issued by him and received by him. Disagreement on extension of time, delays in performance of contractual obligations instruction by architects or variations, claims and professional negligence and incompetence are all cause of disputes.

In the course of building operations, many disputes are encountered many of which are of a minor nature that could be settled fairly and easily by the concerned parties. However, there are times when some matters come into dispute which cannot be easily settled and subsequently become the subjects of claims by one party to the contract against the other. It is not possible to consider in details what matters might have given rise to disputes and how they should be dealt with, as each case's uniqueness should be considered. Therefore, most disputes and claims can be traced back to a break out between the parties to the contract, could be one of the professionals or some other connected party who failed to do a copasetic work, or the owner failing to express himself clearly or the professional failing to understand the full implication of instruction issued to or received by him.

In the event of a serious dispute arising, every effort should be made to reach a fair settlement either through negotiation or arbitration. Though, it should be noted that, in the case of negotiation failing, arbitration must be clearly expressed in the conditions of the contract containing an agreement that matters in dispute shall be referred to arbitration and this written request for the appointment of an arbitrator automatically refers the matters in dispute to arbitration.

In the events that disputes are encountered, there are four types of disputes which can be referred and submitted to arbitration during the progress of the work, and they are:

- A dispute arising in connection with the appointment of a new architect or quantity surveyor in accordance with the article of agreement
- A dispute as to whether an architect's instruction is valid.
- A dispute as to whether a certificate has been improperly withheld or has been properly prepared in accordance with the conditions of contract.
- A dispute arising in connection with an outbreak of hostilities or war damage.

In addition dispute may arise as a result of misunderstanding in the design stage between the architect and the planner pertaining to the issue of uses being compatible in line with the existing or adjacent uses which do not conform to the rules and regulations of the town planning Authority as well as the issue of zoning building code, Daylight angle, set back method used by the planner to control the development of building in an area, also disputes may arise as design complexity between the architect and the building surveyor when there is conflict in construction pattern or knowledge about the project may result into dispute. Disagreements can also arise between two or more disputing parties to a contract as a result of clashes when it comes to role requirements of one of the participants. Role disputes arise when an individual experiences disagreement regarding what he is expected to do.

Common Disputes in Real Estate

It has been suggested that real estate disputes appeals might be suitable for the arbitration process. In the dispensing of their professional roles, appraisers who have come into contract with experts in the real estate field or industry and who have come to understand the functions and roles these experts play. These experts include: sales and mortgage brokers, leasing agents, property managers and developers and not to forget an appraiser who carries out real estate valuation work. To arrive at a fair estimate of market value, the appraiser must take into account all factors that affect value; many involve knowledge of other specializations within the industry. Additionally, a formal or informal value estimate serves as a pivot on which judgments are made by others in real estate field. There are general real estate industry disputes in which an appraiser could make a valuable contribution as a member of the arbitration team.

1) Commission claims often develop between owner and broker as to whether or not a commission has been earned, or between participating brokers concerning the proper basis for sharing a commission.

2) When a landlord employs a management form to operate a property, disagreement may occur about the scope, nature or extent of the work to be performed or about services that may call for additional compensation.

3) Controversies between landlord and tenant with regards to each person’s obligations and duties

Scope of Arbitration

According to Oyegbile (2004) arbitration can hold at different major levels, the levels are:

1. Domestic or local arbitration:
   This can be described as arbitration that takes place within the confines of a nation and are restricted to the confines of that nation-state. Examples are Nigeria, Australia, and Ghana. The act of arbitration can take place at different levels of the government, be it the local government level, state level and federal level.

2. International arbitration:
   When diplomatic negotiation or conciliation has failed in settling disputes between independent states, arbitration can be used to resolve conflicts that could either arise

between traders or professionals of different countries. Usually a third neutral party is brought in to resolve disputes and the disputing parties are bound by the ruling of the third party.

It should be noted that arbitration can be also be at private and public levels. Private level involves individuals or groups of people which do not have any government connections or affiliations. These groups of people decide to arbitrate within themselves. On the other hand it is public where a governmental body which could be locally or internationally is engaged in arbitration.

Advantages of Arbitration

The advantages attached to arbitration are numerous. Over the years, it has been advocated that people should explore alternative dispute resolution before resorting to litigation. This is due to the several advantages in ADRs and the innumerable number of cases the litigation system is saddled with. Thankfully, people are accepting arbitration as an alternative dispute resolution in resolving conflicts as opposed to before when people were still sceptical about it. The principal advantages are when:

- **Arbitration is cheaper**
  One of the banes of the litigation system of resolving dispute is the financial cost attached to it. In fact, it's been said that most poor people will rather not seek justice, because of the huge financial commitment attached to litigation system. A problem rich people do not face. The cost of engaging the services a lawyer is on the high side, compared to what arbitrators are paid. If then this is one of the principal advantages of arbitration, it should be encouraged as an alternative dispute resolution that people should explore before considering litigation.

- **Arbitration is Quicker**
  The litigation system of resolving dispute takes a whole lot of time. The some lawsuits take years to get to trial, then there is the case of adjourning (even after trial, the parties involved can appeal a case in another higher court, which may take on years). The reason is not far-fetched as the court is barraged with a lot of cases coming before it. Arbitration last for a shorter time as compared to the litigation system. More so in the case where special opinion of the court does not need to be stated. Therefore, where time is a critical factor, arbitration has proved to be an effective tool in the quick resolution of disputes. Statistically, land cases referred to the litigation system take an average of four to five years to be settled. On the other hand cases in arbitration are settled in a year or even less. Isn't that relieving? And why won't people want to be involved in this process rather than the tedious process of the litigation system?

- **Arbitration Is More Convenient**
  Arbitration puts the ease and convenience of its participants/claimants into consideration in resolving disputes. This is very important as this will go a long way

in setting the tone of the atmosphere. Sometimes a court room and its proceedings might create or elicit a hostile feeling between the two disputing parties, with its entire structured establishment and the technicalities involved as well. For example the court session takes place at the court chambers; the time of meeting must be within official working hours, the convenience of the learned judge and the lawyers are most pertinent in proceedings, though all of this is understandable so as to create orderliness and stability. In arbitration, the convenience with regards to time and place of disputing parties is considered. The time frame is flexible so as to satisfy both parties. The place of meeting is also flexible so as to create an amiable environment that will enable quick resolution of disputes.

- ## Arbitration Permits The Use Of Experts

It is normal practice for two disputing parties to bring on board the services of a trusted professional who is capable of handling their cases. For example, cases involving the fixing and reviewing of rent can protract the professional services of a Valuer who gives his expert opinions on such case. The same goes for other cases needing the expert opinions of the professionals in the built environment. Without any iota of doubt, the openness of this ADR helps in the quick resolution of dispute and better professional judgement. In court this is most often than not, not feasible as judges are usually lawyers who sit on cases of such professional tendency, are not capable of handling these cases effectively. This is a big problem as lawyers are just specialized in their field with no knowledge on other human endeavours that come before them. It is however a fact that in arbitration, professional expertise of arbitrators is taken advantage of. In fact, it is encouraged that arbitrators in disputes pertaining to the built environment be presided over by a third party who is also a professional. What's more exciting is that arbitration doesn't just sit on its own, it takes it source (if the need be) from the law by seeking legal interpretation when the need arises. The advantage being that, arbitration as an alternative dispute resolution is properly positioned to take advantage of the proceedings of a court.

- ## It's Conciliatory Nature

One of the reasons people are enthusiastic about arbitration is because in arbitration it is easy to avoid war and fighting. Arbitration gives disputing parties opportunity to harmoniously resolve disputes In a way that will not resort to war and heated exchange of words by creating an enabling environment for both parties to air their mind on whatever issues are been resolved. By nature litigation and its establishments connotes a symbol of battle between disputing parties. A trip to the court of law reveals a little of the tension that litigation elicits among disputing parties which frankly speaking is detrimental to future interaction between these people. It goes without saying that disputing parties once they step into the court of law no matter how close in friendship they were before become sworn enemies. This trend is downplayed in arbitration as all proceedings that will take place will place emphasis on future friendship no matter the outcome of the proceedings.

The increasing advantage of arbitration can be seen in its growing usage in commerce, trade and even the legal profession. The primary advantages of arbitration which are its speed, convenience and use of experts have made people more receptive to this alternative dispute resolution. It is no longer a hidden fact that the American arbitration association arranges hearings for about 6,000 disputes of the commercial type. Though the rate at which people resort to arbitration in resolving disputes in developing countries, Nigeria to be precise is on the low side, almost tending towards non-existent. Professional associations should encourage her members to explore the option of arbitration in resolving disputes and conflicts rather than resorting to litigation.

Disputes in Real Estate that can be resolved by Arbitration

According to Asaju (2015), this can be classified under the following two party disputes:

- Lessor and Lessee: A lessee and a lessor are parties to a lease agreement between these two. Therefore dispute can arise between the lessee and the lessor when the lessee fails to comply with the terms of the lease agreement binding him/her or when the lessor fails and refuses to perform certain assigned obligations due to the lessee as stated in the lease agreement.
- Mortgagee and Mortgagor: The mortgagee lends money to the mortgagor to buy a property as the mortgagor is not able to raise the adequate amount to do so on his own. If upon receiving this specific amount of money from the mortgagor and he expends the money on something different as against what was specified in the agreement between these two, dispute can arise. That is parties to the mortgage agreement of the property not complying or deviating from the terms of the mortgage.
- Vendee and Vendor: Dispute can arise between a vendor and vendee from the sale of vendee's landed property. These disputes include disagreement over the term of the sale, quality of the property being sold, disagreement over the bargaining condition of the property, defects in the property.
- Dispute arising from building contract: These include but certainly not limited to disputes over the material used for construction of the building, dispute arising from amount payable in a contract.
- Dispute arising from payment of compensation for acquired property: it was HELD in Turnover V. Goulden (1873) L.R.9 C.P. 57 that it was Arbitration.

  In Turnover V. Goulden (1873) L.R.9 C.P. 57, the lease of a farm stipulated that if the premises were sold during the term the tenant should quit and yield up the premises, and each party should appoint a valuer to assess the compensation to be paid to the tenant. These circumstances having in fact arisen, the parties by deed referred the question of compensation to A and B or their umpire.

Cases of Other Disputes That Can Be Settled/Resolved By Arbitration in Real Estate

- **Lewis V. Rossiter (1875) 44 L.J. EX 136**

A landlord who was the owner of a watermill was sued by his tenant who was leasing the watermill for breach of a covenant in the lease, which made the landlord responsible for repairs of the mill, weir and the milk bank. The dispute was referred to an arbitrator who had the power to decide all matters and questions arising there in and in addition make sure justice was issued between the two disputing parties through ordering and directing the parties on the necessary steps and actions to take immediately.

HELD: It was held that the arbitrator had power to award damages for the continuing breach of covenant up to the date of the award.

- **May V. Mills (1914) 30 T.L.R. 287**

A lease between two disputing parties stipulated that whatever differences that arose between these two which pertains to the agreement in any way or the premises should be submitted for arbitration by appointing two arbitrators and an umpire. A dispute having arisen, the defendant refused to appoint an arbitrator and the plaintiff accordingly appointed his arbitrator to act as sole arbitrator. The arbitrator decided that the dispute arose during the tenancy and that in consequence he had jurisdiction to deal with it, and made an award in favour of the plaintiff.

HELD: It was held that the arbitrator did not have the power according to the terms of the submission to make a decision as to whether or not a condition precedent to his jurisdiction had been fulfilled and that as he had done so, the award was bad.

- **Thorpe V. Eyre (1834) 1 AD & EL. 926**

An action between W.T, owner of the land, and E.T, holding the land by W.T's permission was referred to an arbitrator, who awarded that the holder was indeed a tenant and that the tenancy should cease and the land be delivered up to W.T.E, the real owner, an execution creditor of E.T. for work done as attorney in the former action seized the crops on the land.

- **Whitehead V. Tattersall (1834) 1 AD. & EL. 491**

In an action for damages for breach of covenant to repair premises, it was shown that the parties had agreed to arbitration and an award of 55.55 Euros was made.

- **Furser and Bond V. Prowd (1618) C.O. JAC 423**

An award was made after being subjected to arbitration pertaining to a controversy about the lease of a house. The award was reached by fixing the rent and duration of the tenancy. In an action on a bond condition and for the performance of the award for rent unpaid, the premises and that none was there to receive it.

HELD: That it was a sum in gross and payable by the defendant at his peril who ought to seek out the obligation and to pay it.

RESEARCH METHOD

This paper seeks to identify the various areas in which Arbitration has been used to resolve disputes particular to real estate. The study followed a non-empirical research approach with its data being derived from secondary sources. These data were derived from the review of literature, which were gotten from journal articles, publications on arbitration as well as relevant textbooks on arbitration. Though of the most useful source of data were relevant textbooks. These publications were gotten mostly from the internet. The issue of Alternative Dispute Resolution is something that is being fully explored from the point of law, that is to say many scholars have penned down their thoughts on these issues, and hence sourcing for data is quite easy in this direction. Although In the noble profession – Estate Management and Valuation, the issue of arbitration and how it can be used to resolve disputes is yet to be fully and effectively explored.

FINDINGS

The study identified and examined the several advantages and merits of arbitration which are: it saves cost, saves time, it's more convenient, makes use of exerts, and of course its conciliatory nature. The study was able to explore to a certain degree the extent and kind of disputes which can be referred to arbitration. For example disputes arising from the construction industry, disputes arising from business transactions in real estate. Though the use of this alternative dispute resolution is not so widespread especially when it comes to resolving disputes in real estate, it is understandable as arbitration is only beginning to gain acceptance from the public and the involved professionals.

CONCLUSION

In conclusion the study has shown the merits arbitration as an alternative dispute resolution has over litigation. Arbitration should be encouraged considering its many advantages. If the professionals in the build environment can fine tune this tool, to suit their various sectors, it makes sense to say that disputes will easily be resolved without necessarily resorting to litigation. It's not that litigation does not have its merits; it's just that arbitration has worked on the demerits of the litigation system and people are beginning to understand that they do not have to subject themselves to hassles of the court system, if it's something that can be avoided. Estate surveyors and valuers should and can fine tune this ADR. In fact seeing that one of the merits of arbitration is its use of experts in giving awards, I see no problem with estate surveyor and valuers being arbitrators. But this cannot be possible if these professionals know nothing about this or better still shy away from the use of arbitration in settling disputes. From the study above, almost all disputes in real estate can be arbitrated. This will also open up further research into this area, as there is not much on this area of interest, at least in Nigeria.

REFERENCES

Arbitrations & Awards by David M. Lawrence

Asaju, A.S. (2015): Resolving Real Estate Disputes through Arbitration. *Being a monograph presented at a workshop held at the Department of Estate Management and Valuation, Federal University of Technology. (Pp 6-30)*

Brundtland,1987. Our Common Future, World Commission on Environment and Development (WCED) Oxford: Oxford University Press.

Gerald M. Levy: The Arbitration of Real Estate Valuation and Related Disputes – The Appraisal Journal (1978)

Hailsham V. (1978) *Halsbury's law of England*, 4ed, Vol. 2, London: Butterworth and Co. (Publishers) Ltd, para 501

Land Law made Easy/simple for Estate Management Students by O.Y. Adeyinka

Law of Arbitration by W.H. Gill, Second Edition

N.Y. C.P.L.R. 7501 (Consol. 2010); Adam Fisher, Helping Those Who Are Helping Us:Sarbanes-Oxley Whistleblower Protection and its Interplay with Arbitration, 8 CARDOZOJ. CON-FLICTRESOL. 305, 329 (2006).

Orojo J.O. and Ajomo M.A. (1999) *Law and practice of arbitration and conciliation In Nigeria*, Lagos: Mbeyi and Associates (Nigeria) Limited, p.37.

Otuturu G.G. (2003) *The Legal Environment of Business in Nigeria*, Port Harcourt, Ano Publication, pp. 77

Oyegbile, S.O. (2004): An Introduction to Arbitration and Conciliation

Real Estate Appraisal Journal (Jan. 1984)

Russel on the Law of Arbitration 1970 Eighth Edition by Anthony Wallon O.C.

The New York Law Journal (June 28 1982)

FINANCIAL RISK ASSOCIATED WITH HOUSING ESTATE PROJECT DEVELOPMENT

UMAR, Muhammad Kabir and IBRAHIM Ahmad Doko
Department of Quantity Surveying, Federal University of Technology, Minna, Niger State, Nigeria

Construction industry is a highly risk prone industry, with complex and dynamic project environments creating an atmosphere of high uncertainty. Effective risk management can bring greater rewards to project performance by enhancing productivity. The objectives of this paper is to identify the major financial risks associated with housing development projects and to appraise the practical measures that various construction industry do take to manage those risks. Forty structured questionnaire was self-administered to private housing estate developers in Abuja to examine the current trend of financial risk management implementation. The preference of the housing estate developers were collated and analysed using descriptive analysis technique on SPSS. The results from the analyse data indicate that inflation, excessive approval procedure due to bureaucratic bottlenecks in government departments and inadequate programme scheduling were found to be the major financial risks. Thus this paper suggests rationalisation of housing estate project approval procedures to enhance housing delivery projects and to eliminate construction risk.

Keywords: *Construction Industry, Financial Risk, Risk, Risk Management, Risk Management Technique.*

umpkabir@gmail.com

UMAR, Muhammad Kabir and IBRAHIM Ahmad Doko (2016). **FINANCIAL RISK ASSOCIATED WITH HOUSING ESTATE PROJECT DEVELOPMENT** Sustainable Built Environment and Climate change; The challenges of Post 2015 Development Agenda. School of Environmental Technology Conference, SETIC, 2016

INTRODUCTION

The development of infrastructure is one of the most important activities that can boost up the business of various industries, thereby increasing the gross domestic product (GDP) of the country. Thus, the construction industry is responsible for the construction of roads, bridges, houses, subways and dams. According to Odeyinka and Iyagba (2000) housing sector plays a more critical role in a country's welfare as it affects not only the well-being of the citizenry, also the performance of other sectors of the economy. Ajanlekoko (2001) noted that among other things, housing is one of the three basic needs of mankind, while other things are food and clothing. In a related development Akeju (2007) assert that, housing is a very important consumer item, which impacts positively on productivity – as a decent house significantly increases workers health and well-being and consequently growth. Akeju (2007) further opine that, it is one of the indices for measuring the standard of living of people across societies. Authors notably Ojo, Adeyemi and Fagbenle (2006) acknowledged housing as one of the basic needs of human race.

It is worth mentioning that Nigeria with a population of about 167 million still suffers from inadequate housing provision since independence in 1960 (Akeju, 2007; National Population Commission, Nigeria, 2011). Adequate housing provision has since the early 1970's consequently engaged the attention of the country though Nigeria is not left in this problem alone; other developing countries are confronted with housing inadequacy, Ojo, Adeyemi and Fagbenle (2006).

Construction projects are always unique and risks arise from a number of different sources. Compared to other industries, the construction industry is at or near the top in the annual rate of business failures and resulting liabilities (Barrie & Paulson, 1992; Chapman, 2001). This is because it is a risky business with too many uncertainties that management has to deal with. These uncertainties stem from a variety of external and internal factors (Chapman, 2001). The decision to embark on a building project therefore has inherent element of risk (Adelusi, 2009). Similarly, Perry and Hages (1985 as cited in Odeyinka and Iyagba, 2000) opined that certain risk elements are associated with construction works, among which are environmental, financial, logistic, and physical and construction risks. Risk management in the construction industry is fundamentally employed to deal with risk in construction process; it is an essential tool for project management. The risk inherent in the construction delivery has been identified as major problem that bring about time and cost overruns in Nigeria construction industry (Dada, 2010). Jagboro (2007) concluded that, these overruns always invalidated the economic case for a project and turn the investment into a loss-making venture. It is against this background that this paper aimed at identifying financial risk associated with housing estate project due to the important role housing play in the well-being of the population.

The Nature of Risk

Risk often varies in the likelihood of its occurrence and its impacts from one project to another. Risk changes its nature during the project life cycle, lack of project information, particularly in the early stage of a construction project, always leads to a higher degree of risk associated with cost, time and quality. The level of risk, however, may decrease with the project development. When risks are being realised as the project progresses, the increased level of certainty reduces the level of risk in the project (Smith, Merna& Jobling, 2006).

Project risks often tend to be interrelated, but they can sometimes be considered in isolation. Risks can not only affect the achievement of project objectives but also influence the occurrence of one another. According to Loosemore, Raftery, Reilly and Higgon (2006), the perception of risk varies at both individual and organisational levels because different people hold different views and have different understandings of a particular risk's components, sources, probabilities, consequences and preferred actions. People's beliefs, attitudes, judgments and feelings are believed to influence risk perception to a certain extent (Akintoye& Macleod, 1997).

Risk, however, does not necessarily involve only bad outcomes and negative consequences; it also refer to the chances of positive events (Jaafari, 2001; Hillson, 2002; Baloi& Price, 2003; Project Management Institute (PMI), 2004; Loosemore*et al.*, 2006; Jannadi, 2007). PMI includes both threats (negative risks) and opportunities (positive risks) in the definition of risk. Loosemore*et al.* (2006) also holds the view that risks and opportunities are complementary in their nature, i.e., every risk can be regarded as an opportunity and every opportunity has an associated risk. Bunni (2003) advocates that risk in Chinese, *weiji*, combines the meanings of "danger" and "opportunity", thus confirming the interchangeable nature of risk between threat and opportunity. Risk is hence defined as a possible future event, the occurrence and consequences of which are uncertain, but which could affect the company's ability to achieve its project objectives (Loosemore*et al.*, 2006). Risk is regularly expressed in terms of probability of occurrence and magnitude of the consequences for loss or gain, i.e., risk is equal to the probability of occurrence multiplied by the consequences (He, 1995; Ward, 1999; Kerzner, 2003; Jaafari, 2001).

Types of Financial Risks

Kolhatkar and Dutta (2013) identified the following types of financial risks:

i) Bankruptcy of Project Partner

Bankruptcy is a legal status of an entity or a person who cannot repay the debts it owes to creditors. Bankruptcy in most of the jurisdictions is imposed by a court order, which is often initiated by the debtor. Bankruptcy is not merely a legal status that an insolvent person or other entity may have, and hence the term bankruptcy is for that reason not a synonym for insolvency.

ii)Fluctuation of Inflation Rate. In economics, inflation is a persistent increase in the general price level of goods and services in an economy over a period of time. Whenever there is a general price level rises, a unit of currency can buy fewer goods and services. As a result, inflation reflects in reduction of purchasing power per unit of money, a loss of real value in the medium of exchange and unit of account in the economy negative effects of inflation comprise an increase in the opportunity cost for holding money, future inflation uncertainty in future may discourage investment and savings, and if inflation is rapid at an adequate amount, goods shortages as consumers begin hoarding out of concern of prices will increase in the future. Positive effects is to be ensured, that central banks can adjust real interest rates (to mitigate recessions), and to encourage investment in non-monetary capital projects.

iii) Fluctuation of Interest Rate

Interest rate will affect the project in terms of borrowing and debt payments. Any fluctuation in the interest rate will directly or indirectly affect the lenders. A fixed/appropriate interest rate should be agreed upon for the project duration. The lenders generally have to pay extra cost if the interest rate is far high or benefit them if the interest rate is low. More foreign investors or private sector could be attracted by providing interest rate guarantee.

iv) Fluctuation of Exchange Rate

Fluctuations in currency affect the value of the firm’s income statement operating cash flows, and competitive position, hence market share and stock price. Fluctuations in Currency also affect a firm's balance sheet by changing the value of the firm's assets and liabilities, payable account’s, receivable account’s, inventory, loans in foreign currency, investments in foreign banks; this type of economic exposure is called balance sheet exposure. The most common definition of the measure of exchange-rate exposure is the sensitivity of the value of the firm, profit by the firm’s stock return, to a change in an exchange rate which is unanticipated. Partial derivative functions are used to calculate it, where the dependent variable is the firm’s value and the independent variable is the exchange rate (Adler & Dumas, 1984). A key assumption in the concept of foreign exchange risk is that exchange rate changes are not predictable and that this is determined by how efficient the markets for foreign exchange are.

However, Project finance debt is often sourced from foreign lenders, and in foreign currencies, yet project revenues are generally denominated in local currency. The cost of debt can increase and often very dramatically, where the exchange rate between the currency of revenue and the currency of debt diverge. Though under the theory of purchasing power parity, inflation pressures on the currency devalue will eventually bring the foreign exchange rate back to parity. The project finance lenders are generally not prepared to wait quite so long (with average periods of about 10 years).

v) Rise in Fuel Prices

Contractors use diesel to power earthmoving and other off-road equipment as well as construction vehicles such as concrete mixers dump trucks, and pumpers, and, JCB’s, proclaims, tower cranes, etc... In addition, contractors pay fuel surcharges on deliveries of equipment and materials to job sites and on backhauls of dirt, debris, and equipment. Diesel costs and fuel surcharges also work their way into the prices of many materials that require fuel to mine, manufacture, mill, mix, and move throughout the production process.

vi) Insurance Risk

As construction projects become larger and more complex, the risks associated with them are also more complex and harsher. The utter scope, size, and timing of today's projects pose significant challenges in risk management, including risk identification, determining the allocation of risks among the involved parties, developing mitigation and risk treatment plans and opportunities for cost savings in single project applications or across an entire portfolio of projects. Increase in complexity and size of project risks, sponsors view risk on an enterprise-wide project or portfolio basis to properly and consistently identify risks, development of optimal risk allocation strategies, and, if necessary, obtain "project specific" insurance.

vii) Liquidity Risk

Commercial Real Estate(CRE) loans are customarily illiquid. The exchange of CRE loans to cash can be accomplished by

(1) Refinancing the loan amount with an another lender;

(2) Through the sale of the loan to an investor (either on a participation, whole-loan, or portfolio basis);

(3) By securitizing the loan;

(4) Through normal repayment of loan by the borrower; or

(5) By serving as collateral for borrowings.

viii) Change in Bank Formalities and Regulations

Bank regulations are a form of government regulation which subject banks to certain requirements, guidelines and restrictions. This regulatory structure creates transparency between banking institutions and the individuals and corporations with whom they conduct business, among other things. A rule is sometimes defined as a standard or an instruction or custom. Issuing of regulation is the act of providing rules for the way that individuals, companies or organisations should behave. Regulations could possibly be regarded as being a sub-set of rules, but the demarcation of these two concepts is difficult to define.

Risk Classification

Risk classification is a significant step in the risk management process, as it attempts to structure the diverse risks affecting a construction project. In the effective management of risks, several many methods have been suggested for the classification of risks. Bhandari and Gayakwad (2014) classified risks according to their sources into the following:

- Technical risks: Improper and inadequate site Survey & investigation, Incomplete and faulty design, Appropriateness of specifications and Uncertainty over the source and availability of materials.
- Logistical risks: Non availability of sufficient transportation facilities and Non availability of construction equipment spare parts, fuel and labor.
- Management related risks: Uncertain productivity of resources and Industrial relations problems.
- Environmental risks: Weather and seasonal Changes and Natural disasters
- Financial risks: Availability and fluctuation in foreign exchange, Delays in Payment, Inflation and Local taxes.
- Socio-political risks: Customs and import restrictions and procedures, Difficulties in disposing of plant and equipment and Insistence on use of local firms and agents.

RESEARCH METHODOLOGY

This paper employs quantitative research approach. Thus, in other to achieve the objective of the paper, structured questionnaire was designed and administered to relevant stakeholders in the housing development sector of the Nigerian construction industry. Statistical Package for Social Science Research (SPSS) version 20 was used for data analysis. Forty (40) questionnaires were distributed among clients/developers, consultants, contractors, architects and engineers in the construction industry within the Nigeria Federal Capital Territory (Abuja) to source their perception on risks in housing projects and to ensure that the right risk which is the focus of this paper are identified. A total of 20 responses were received from the total number of questionnaires distributed, which represent 50% response rate.

RESULTS AND DISCUSSION

Financial Risk Associated with Housing Estate Projects

The results of analysis on table 1, shows the ranking of the financial risk associated with housing estate projects. Inflation, excessive approval procedures in administrative government departments/bureaucratic bottlenecks and inadequate programme scheduling ranked 1st, 2ndand 3rd respectively. Price inflation of construction materials and delayed payments on contracts both ranked 4th, financial failure of the contractor ranked 6th, incomplete approval and other documents and incomplete or inaccurate cost estimate both ranked 7th. Local taxes and fluctuation of interest rate both ranked 9th.While, exchange rate fluctuation, low market demand, Design variations, Improper estimation, Commercial risk (law demand), Unsuitable construction program planning, unmanaged cash flow, monopolizing of materials due to closure and other unexpected political conditions, Technology risk (new method), Variations by the client, Physical risk factors like flooding, Occurrence of dispute, Bankruptcy of project partner, Tight project schedule, Ecological damage, Insurance risk, Liquidity risk, Political factor like instability, unrest/war, repatriation of fundsranked11th, 11th, 13th, 13th, 15th, 16th, 16th, 18th, 18th, 18th, 18th, 18th, 23rd, 23rd, 23rd, 26th, 26th, 26th, 28threspectively.

The average mean score for financial risk associated with housing estate projects was calculated as 2.6. This implies that any variable with mean score below the calculated average mean score of 2.6 is eliminated from the Table .Therefore, the following variables fall within this category: unmanaged cash flow, monopolizing of materials due to closure and other unexpected political conditions, Technology risk (new method), Variations by the client, Physical risk factors like flooding, Occurrence of dispute, Bankruptcy of project partner, Tight project schedule, Ecological damage, Insurance risk, Liquidity risk, Political factor like instability, unrest/war, repatriation of funds, Commercial risk (low demand) and Unsuitable construction program planning.

Table 1: Financial Risk Associated with Housing Estate Projects

Variable	Very Often (5)	Often (4)	Neutral (3)	Rarely (2)	Never (1)	Mean Score	Rank
Inflation	40	16	24	-	-	4.0	1st
Delayed payments on contracts	20	24	12	8	2	3.3	4th
Financial failure of the contractor	20	24	6	12	2	3.2	6th
Unmanaged cash flow	-	16	18	8	6	2.4	16th
Exchange rate fluctuation	-	40	6	4	6	2.8	11th
Monopolizing of materials due to closure and	-	16	18	4	6	2.2	18th
other unexpected political conditions	-	32	6	12	2	2.9	9th
Local Taxes	-	8	6	4	10	1.0	28th
Repatriation of funds	10	32	6	-	8	2.8	11th
Low market demand	10	-	24	16	2	2.6	13th
Improper estimation	-	16	6	12	8	2.1	23rd
Bankruptcy of project partner	30	8	6	8	6	2.9	9th
Fluctuation of interest rate	-	8	6	8	8	1.9	26th
Insurance risk	-	16	-	12	10	1.9	26th
Liquidity risk	-	8	18	8	8	2.1	23rd
Tight project schedule	-	16	6	16	6	2.2	18th
Technology risk (new method)	10	8	24	4	6	2.6	13th
Design variations	-	16	12	4	10	2.1	23rd
Ecological damage	20	-	6	8	10	2.2	18th
Variations by the client	10	-	12	16	6	2.2	18th
Physical risk factors like flooding	-	16	18	8	6	2.4	16th
Unsuitable construction program planning	-	-	12	20	6	1.9	26th
Political factor like instability, unrest/war	-	8	18	12	6	2.2	18th
Occurrence of dispute	10	-	30	4	6	2.5	15th

Commercial risk (law demand)	30	4	24	-	4	3.3	4th
Price inflation of construction materials	10	56	6	-	2	3.7	2nd
Excessive approval procedures in administrative							
	20	8	24	8	2	3.1	7th
government departments/bureaucratic bottlenecks	10	16	30	4	2	3.1	7th
Incomplete approval and other documents	20	32	6	8	2	3.4	3rd
Incomplete or inaccurate cost estimate							
Inadequate program scheduling							

CONCLUSION

From the results of the analysis, it was concluded that inflation, excessive approval procedure in administrative bottlenecks and inadequate programme scheduling were the major financial risks associated with housing estate project development, while other factors like tight project schedule, bankruptcy of project partner, ecological damage, insurance risk, liquidity risk, political factors like instability, war/unrest and repatriation of fund are not associated with housing estate project development. Thus it is recommended that housing estate project approval procedures be rationalised to enhance housing delivery projects and to eliminate construction risk.

REFERENCES

Adelusi, A. K. (2009). Assessment of risk and risk management stages in Nigerian Construction Industry. Unpublished B. Tech degree thesis, Department of Quantity Surveying, Federal University of Technology, Akure, Nigeria.

Adler, M. & Dumas, B. (1984). Exposure to Currency Risk: Definition and Measurement. *Financial Management*, 41-50.

Ajanlekoko, J.S. (2001). Sustainable Housing Development in Nigeria: The financial and Infrastructural Implication. *A paper presented at workshop on housing and urban development* organized by Nigeria Institute of Quantity Surveyors at University of Lagos on 4th– 5thApril 2001.

Akeju, A. A. (2007).Challenges to Providing Affordable Housing in Nigeria. *A Paper Presented at the 2nd Emerging Urban Africa International Conference on Housing Finance in Nigeria*, Held at Sehu Yar'adua Centre Abuja, 17th – 19thOctober, 2007.

Akintoye, A. S. & Macleod, M. J. (1997).Risk analysis and management in construction. *International Journal of Project Management*, 15(1), 31–38.

Barrie, D. & Paulson, B.C. (1992).*Professional construction management*. USA: McGraw-Hill.

Bhandari, M. G. & Gayakwad, P. G. (2014). Management of Risk in Construction Projects in Maharashtra.: *International Journal of Engineering Science Invention*, 3(1), 14-17. Retrieved on November 29, 2015 from: www.ijesi.org

Bunni, N.G. (2003). *Risk and Insurance in Construction* (2nd ed.). London: Spoon Press.

Chapman, R. J. (2001). The Controlling Influences on Effective Risk Identification and Assessment for Construction Design Management. *International Journal of Project Management*, 19, 147-160.

Dada, J. O. (2010). Strategies for mitigating risk in construction projects.Risk Management in Construction. *Proceedings of the 40th Annual General Meeting/ Conference of the Nigerian Institute of Building*.

He, Z. (1995).Risk management for overseas construction project. *International Journal of Project Management*, 13(4), 231–237.

Jaafari, A. (2001). Management of risks, uncertainties and opportunities on projects: Time for a fundamental shift. *International Journal of Project Management*, 19(2), 89–101.

Jagboro, G. O. (2007). An evaluation of the impact of risk on project cost overrun in the Nigerian Construction Industry. *Journal of Financial Management of Property and Construction*, 12, 37 – 44.

Jannadi, O. A. (2007). Risks associated with trenching works in Saudi Arabia. *Building and Environment,* 43(5), 776–781.

Kerzner, H. (2003). Project Management: A System Approach to Planning, Scheduling and Controlling (8th ed.). New Jersey: John Wiley &Sons.

Kolhatkar, M. J. E. & Dutta, A. B. (2013). Financial Risks and Construction Projects. *International Journal of Application or Innovation in Engineering & Management (IJAIEM),* 2(11), 235-238. Retrieved on November 29, 2015 from: www.ijaiem.org

Loosemore, M., Raftery, J., Reilly, C. &Higgon, D. (2006).*Risk Management in Projects* (2nd ed.). Oxon, UK: Taylor and Francis.

National Population Commission, Nigeria (2011). Nigeria's over 167 million population: Implications and challenges. Retrieved on November 26, *2015 from: http:llwww.population.gov.ng.*

Odeyinka, H.A. and Iyagba, R.I. (2000). Risk Management in Construction to Avoid Cost Overrun, Nigeria Institute of Quantity Surveyors, 31, 14 – 21.

Ojo, S. O., Adeyemi, A.Y. & Fagbenle, O. I. (2006). The Performance of Traditional Contract Procurement on Housing Projects in Nigeria. *Journal Civil Engineering Dimension,* 8(2), 81-86.

Project Management Institute (2004). A Guide to the Project Management Body of Knowledge (3rd ed.). Newtown Squire, USA: Project Management Inc.

Smith, N. J., Merna, T. & Jobling, P. (2006). *Managing Risk in Construction Projects.* Oxford: Blackwell.

Ward, S. (1999). Assessing and managing important risks. International Journal of Project Management, 17(6), 331 – 376.

FACTORS AFFECTING PROJECT PLANNING EFFORTS IN AKWA-IBOM STATE

Olubajo .O. Oluseun[1], Godwin Idoro[2] and R. A. Jimoh[3]
[2]Department of Building, University of Lagos, Akoka Lagos, Nigeria.
[1 3] Department of Building, Federal University of Technology Minna, Nigeria.

All construction projects are unique and the amount of effort invested into planning activities will depend on the nature or the character of that project; as no two construction projects are identical. This prompted an investigation to evaluate the factors affecting the efforts invested into project planning activities at the pre-contract stage in Akwa Ibom state. The aim of the study is to evaluate the factors affecting efforts invested in project planning amongst selected consultants. A field survey involving 92 project consultants was adopted to achieve this objective. Data was collected using structured questionnaires and analysed using mean and relative importance index. It was discovered that the demands of the client, the clients budget and the construction method to be adopted ranked highest amongst others as having more impact on the measure of efforts invested in planning and indirectly on the performance of the construction Projects. The study suggests that all stakeholders collaborate more frequently by building stronger partnerships and aligning all actors as an integrated supply chain.

Keywords: *Project lifecycle, Nigeria, Project planning, Pre-contract planning and planning effort.*

builderolubajo@gmail.com

Olubajo .O. Oluseun *[1], Godwin Idoro*[2] and R. A. Jimoh *[3] (2016). **FACTORS AFFECTING PROJECT PLA NNING EFFORTS IN AKWA-IBOM STATE** Sustainable Built Environment and Climate change; The challenges of Post 2015 Development Agenda. School of Environmental Technology Conference, SETIC, 2016

INTRODUCTION

Project planning efforts has become an issue of growing concern amongst professionals in the construction industry, for two reasons: firstly, because project planning efforts is the measure of how much resources are invested into construction planning activities at the pre-contract stage (pre-contract planning). Secondly, how these efforts invested in planning activities have impacted on the successes or failure of construction projects, (Faniran et al 1994a). Project planning activities in this study includes all actions/activities involved in the preparation or production of plans or contract documents used in carrying out construction. Hore *et al* (1997) opined that, every construction project is unique, though all projects essentially involve the same basic resources. Frank and McCaffer (2001) also opined that each project has its own characteristics and requirements and for each project to be successful, the procurement process must address the technicalities of the project features alongside the client and contractor's needs. It can be said that all things being equal, the measure of resources employed in every construction project is also unique. Previous research have shown diverging opinions on how much effort should actually be invested in project planning activities and how planning efforts should be organised to achieve success in project objectives. (Faniran, *et al*.1999).

Project planning is applied in varying degrees of details when procuring a construction project, depending on the stage at which it is carried out in the process. The essence is that adequate resources are available at the right time for each stage in the process. Patrick and Geffner (2001) described resources invested in planning to be of two types namely: renewable resources and consumable resources. Renewable resources are needed during the execution of an action, but are not consumed in the process e.g. machines, computers. Consumable resources on the other hand are consumed or used up in the process e.g. fuel and time .To effectively plan projects, an investigation is required to forecast, manage, direct, control, monitor the resources required (people, materials & equipment) and financial requirements. However the challenges in spite of the progresses made in construction are the effects of the projects characteristics (factors) on the measure of how much resources is invested in pre-contract planning, previous research have shown that construction projects failure to meet its objectives is as a result of too little planning efforts. This inability of Construction project's to meet its objectives regardless of the advances in information technology is a growing concern. Concerns of overruns in project cost, delays, rework and poor quality of work in construction can be tackled and the major task before stakeholders is what factor weighs heavily on the amount of efforts invested in planning of construction projects at the pre contract stage.

The aim of this study is to find ways of improving the performance of construction projects by evaluating the factors affecting project planning efforts amongst selected consultants at the pre contract stage. The most successful projects are characterised by having a well-considered plan developed by an outstanding and committed team, and not just by the project manager, project planner, or some independent consultants, (Muhamed, 2010).The resources required to procure a construction project (materials, plants, capital and labour) and the construction methods that are involved, require adequate planning for the achievement of the project objectives..

Kharbanda and Pinto (1996) stated that, most, if not all major failures of projects can be traced to inadequate and inaccurate planning and or blind adherence to originally formulated plans regardless of how the environment has changed in the interim. There are several cases of failure in building and civil engineering projects, few are reported while many are not, the challenge before all the stakeholders in the construction industry and researchers is what is responsible for this problem and to provide ways of decreasing it. There are several tools for ensuring the delivery of a project is successful. One and perhaps the most important tool for achieving this is, planning. A wise adage says that'' anyone who fails to plan only plans to fail''.

Poor project definition and planning are two major causes of project failures. Ashley *et al*, (1987), maintained that, the identification of the strategic needs of project stakeholders is a significant stage in the development process and further described the project definition stage or initiation as the stage where the stakeholders' needs, objectives and requirements are clarified into the definition of a project, or projects.

Project Planning

The purpose of project planning is to define the exact parameters of a project and ensure that all the pre-requisites for project execution and control are in place. Project planning aims to identify and resolve any remaining issues and answer outstanding questions that may undermine the goals of the project or threaten its success. It is an opportunity to plan and prepare, as opposed to react and catch up. (IFRC & RCS, 2000).

Planning involves identifying project needs and opportunities, discussing and testing the various possible courses of action, choosing the most appropriate one (or ones), agreeing on what you can expect to achieve, calculating the human and material resources needed to achieve your objectives, anticipating possible problems and getting agreement among all concerned about clear targets and deadlines for the work in view. Good planning can therefore increase the chances of success as well as decrease them. Good plans always allow for flexibility to adapt to changing circumstances (Larry, 2003). Faniran *et al*. (2000) described project planning as the systematic arrangement of project resources in the best way so as to achieve project objectives. Idoro (2010b) opined that project planning is the process of defining project objectives, determining the framework, methods, strategies, tactics, targets and deadlines to achieve the objectives and the techniques of communicating them to project stakeholders. The objective of planning according to Faniran *et. al,* (1998) in construction projects is the completion of a prescribed amount of work within a fixed time, at a previously estimated cost, and to specified standards of quality.

Dvir *et al.(*2003) identified three levels of project planning namely: the end-user level where planning focuses mainly on the functional characteristics of the project end-product; the technical level which focuses on the technical specifications of the project deliverables that are needed to support the functional requirements and the project management level which focuses on planning the activities and processes that need to be carried out to ensure that the technical work proceed effectively. These three levels of planning can otherwise be regarded as project conception planning, project design planning and contract planning.

Project Lifecycle

Chitkara, (1998) opined that each project has a predetermined duration with a definite beginning and identifiable end; the starting point is the time when the idea is conceived by the client and the end marks the time when the mission is accomplished. The time span between the start and the completion of a construction project represents the project lifecycle. Although construction project differ in many regards, the lifespan of a construction projects follow a similar pattern. After the conception there a gradual build up in the use of project resources (construction), followed by a long duration plateau and towards the end, a rapid run-down till completion.

They activities in a construction project are commonly categorized into five main stages namely: opening or conception, design, tendering, construction and closing or handing-over based on the parties (Puthamont and Charoenngam, 2004). These stages make up the project life cycle (Duncan, 1996). From the perspective of planning, these five stages can be further categorized into two phases namely: pre-contract and contract phases. Pre-contract phase consists of the opening, design and tendering stages of project development while contract phase involves the construction and the closing of project development (Oxley & Poskitt, 1971; Ward, 1979). Pre-contract planning therefore describes project plans prepared at conception, design and tendering stages while contract planning refers to project plans prepared at the construction and close-out stages of a project.

PRE - CONTRACT PLANNING

Project Conception Planning (Stage)

The conception stage is the first phase in the project life cycle otherwise known as the inception stage or formulation stage, undertaken to meet the particular needs of a client. If a client is well informed and clear about what he needs better, but in most cases what he thinks he wants and what he really needs may actually be different. The success therefore, of any project will depend on how precisely and accurately the client's need is articulated and understood, (IFRC & RCS, 2000). At this point, to accurately capture the client's needs a feasibility study and report is required. Chitkara, (1998) opined that the feasibility study evaluates the project potentials by examining the technical feasibility, economic viability and the financial implications, and an appraisal of the feasibility report enables the client to decide on project concept, to outline the approach needed to tackle the project, to appoint key persons like project or construction project manager to act as his representative, nominate specialist associated agencies such as the architect, designer and consultants as per requirement. The process of formulation of needs, collection of information, critical examination of concepts and re-examination of needs, may have to be repeated several times over before a project inception finally takes shape. Finally, the feasibility studies and its appraisal leads to the definition of the following aspects relating to the project: scope of work, project objectives, methodology of execution, preliminary time plan, resource forecasts, cash flow pattern and sources of funding, potential risk involved.

Project Design Planning (Stage)

This stage is the second phase in the project life cycle otherwise known as the definition stage; this stage aims at processing the project preliminaries so as to enable the commencement of the construction stage. Chitkara, (1998) identified that the composition of the design team at this stage depends on the many factors such as the size and nature of the project, project characteristics and the time and cost objectives. This team is led by a project manager and consists of participants such as, architect, design engineers, construction engineers, quantity surveyors, contract manager, and specialist consultants, such as town planners, geologist. Frederick and Ricketts (2001) opined that after approval of the design development documents, the architectural-engineering team, together with the applicable specialty consultants, prepares construction documents, consisting of working drawings and technical specifications for the project components. These include architectural, structural, mechanical, electrical, hydraulic, and civil work, together with general and supplementary conditions of the construction contract for use in preparing a final detailed estimate of construction costs and for bidding purposes.

Project Tender (Stage)

This stage is the third phase in the project life cycle otherwise known as the tender or bidding stage. Jack .R. & Simon B.(1976), Stated that when an offer is made by a contractor who tenders to carry out a specified construction work in return for a money (payment) and upon the acceptance of that offer by the client promoting the project, a binding contract comes into being. The number and nature of the contract documents will normally correspond with those of the tender documents, and the number and nature of tender documents include: the conditions of contract, bill of quantities, specifications, contract drawings, form of tender.

Pre Contract Planning Efforts

How much effort should actually be invested in planning activities and how should planning efforts be organised to achieve success in the performance of construction projects is very important. Faniran *et al.* (1999), examined the impacts of planning efforts on the probability of achieving project success, and suggested that additional planning efforts beyond optimal levels results in a high probability that the project will achieve its intended objectives. Furthermore, it was also recognised that there is a high degree of uncertainty in construction project environments, and that several other factors apart from construction planning contribute to project success (or failure).Firdman (1991) Also proposed relationships that demonstrate the value of investing the ‘‘correct’’ amount of planning effort into a project. This relationship indicates that too little planning effort results in implementation failures, delays, and reworks. Therefore when the correct amount of planning effort is invested, the project implementation time is optimised, and there is a higher probability that the project will achieve its intended objectives.

Faniran *et al ,(*1999), demonstrated that, although too little planning is likely to result in poor project performance, increasing the efforts invested in planning would increase the chances of good performance, however excessive planning, beyond an optimal level increases the probability of a deterioration in project cost performance. A linear relationship was seen to exist, with the probability of project success increasing (or decreasing) at a constant rate as the planning input increases. A curvilinear relationship with the probability of project success increasing (or decreasing), at a changing rate as the planning input increases was discovered. Findings from research have indicated that construction project performance, can be improved by increasing the amount of resources invested in construction planning activities (Laufer *et al* 1990)

Different types of buildings, and indeed different types of construction projects, would require different levels of planning input depending on the particular characteristics of the project. The amount of time invested in construction planning was also evaluated on this basis. Some of the factors identified by Faniran, *et al.* (1999),that affect planning efforts were differences in project size, the cost of planning including personnel costs, training costs, data processing costs, and administrative costs, and cost of employing planning engineers.

RESEARCH METHODOLOGY

To achieve the research objective a descriptive approach was adopted for this study and a questionnaire was developed and administered. Akwa Ibom state was the study area which is situated in the southern part of Nigeria and is bounded by neighbouring states of Abia to the north and Cross River to the east, Rivers state to the west and the Atlantic Ocean to the south with a population of about 4 million (NPC, 2006). Three types of consultants were selected and adopted as the study population working in both consulting and contracting firms. A Pilot study was initially conducted to identify recently completed projects and the consultant involved. Architects, quantity surveyors and civil/structural engineers formed the sample of the study population**.** A total of 135 questionnaires were administered to the consultants during the field work; 45 to each profession, and a total of 92 were returned. Data collected was analysed using mean item score and ranking.

VARIABLES OF THE STUDY

16 variables were identified in this study from previous literature as factors affecting project planning efforts; these are classified based on the time of its occurrence in the project life cycle.

Table 1: Factors Affecting Project Planning Efforts

Project conception planning (stage)
Type of Client organization
Type of project
Client demand
Client budget
Construction method
Complexity of the project
Location of the project
Project design planning (stage
Time invested in planning by client
Awareness of project consultants
Experience of the planning team
Local Availability of Construction materials
Planning and Approval authority
Project tender (stage)
Type of contractor
Type of Contract
Policy of Client

Source; Faniran et al 1999, author 2013

RESULTS AND DISCUSSION

The response of the consultants to the questionnaire administered is presented in Table 2

Table 2: Distributions Of Respondents.

Consultants	No. Distributed	Response level	Percentage
Architect	45	31	68.9
Quantity surveyor	45	31	68.9
Civil/Structural Engineer.	45	30	66.7
Total	135	92	68.15

Source: Authors field work 2013

Table 2, shows that 45 questionnaires each were distributed to the 3 groups of consultants selected for the study .It further reveals that 31 questionnaires which represents 68.9 % were returned by the architects and quantity surveyors; and 30 questionnaires which represents 66.7 % were returned by the civil/structural engineer. A total of one hundred and thirty five research questions were distributed and ninety two were completed and returned representing 68.15 % response rate.

The characteristics of the consultant in this study were analysed and presented in Table 3

Table 3: Percentage Characteristics Of The Respondents.

Parameter	Sub-parameter	N	%
Educational Background	M.Sc	28	30.43
	B.Sc	34	36.96
	HND	24	26.09
	OND	6	6.52
Working Experience (in years)	1-5	48	52.17
	6 - 10.	27	29.3
	11 -15	11	11.96
	15 Above	6	6.57
Professional Registration	MNIA	8	8.7
	MNSE	7	7.6
	MNIQS	12	13.04
	MEMBERSHIP IN PROGRESS	65	70.65
Respondent Age	(18 – 28)	24	26.1
	(29 - 39)	50	54.35
	(40 – 50)	17	18.5
	(51 – Above)	1	1.1
Respondent Sex	Male	74	80.43
	Female	18	19.6
	Total	92	100

N=Number of respondents Source: Authors field work 2013

Table 3, shows that respondents with OND are 6.52%, those with HND are 26.09 % and those with B.Sc. are 36.96% while respondents with M.Sc. are 30.43%. These results show that majority of the respondents that are involved in planning are degree holders, The analysis of the consultants shows that 52.17 % of respondents have 1-5 years construction experience while 29.3% of the respondents have 6-10 years' experience, 11.96% of respondents have 11-15 years of experience while 6.57 % have 15 years' experience and above; These results indicate that the sample covers respondents with short and long experience. The analysis of the professional qualifications of the respondents shows that respondents who are registered architects are 8.7%, those that are registered engineers are 7.6 %, and those that are registered quantity surveyors are 13.04 % while those with professional registrations in progress are 70.65%. These results indicate that a greater portion of the personnel involved in planning are not fully registered .The analysis of the ages indicates that 26.1% are between the ages of 18-28 years while those that are between the ages of 29-39 years are 54.35%, 40 -50 years are 18.5 % and 1.1 % are 51 and Above. Both male and female respondents were used in the study however; male respondents constituted the majority with 80.43 % and female 19.6%, these results indicate that the male respondents constituted the majority.

Factors Affecting Project Planning Efforts

The objective of the study was to determine the relative importance of selected factors affecting the level of planning efforts of consultants**.** For this objective, sixteen factors stated above as the variables of the study discovered from previous studies were used. The importance of the factors on project planning efforts were measured using five ranks as described in the research methodology. Respondents were requested to indicate the rank that represented their perception of the importance attached to each factor in the amount of effort committed to project planning. Since each of the three consultants covered by the study is responsible for preparing specific and distinct project plans, their perceptions of their importance attached to the factors were analysed separately .The Mean Score (M.S.) of the perception of importance of the factors by each consultant was analysed and ranked.

Table 4 presents the mean scores (M.S.) of the perception of the importance of factors that affect project planning efforts by architects, engineers and quantity surveyors and their ranks.

Table 4: Ranking assessment of the importance of the selected factors affecting the level of project planning efforts

Factors	Arch. Mean	Arch. Rank	Engr. Mean	Engr. Rank	Q.S. Mean	Q.S. Rank
Experience of the planning team	3.94	1	3.23	14	3.06	16
Client budget	3.94	1	3.53	1	3.52	10
Construction method	3.90	3	3.47	9	3.52	10
Planning and Approval authority	3.90	3	3.63	1	3.26	13
Client demand	3.84	5	3.57	4	3.71	2
Type of project	3.77	6	3.33	11	3.26	13
Local Availability of Construction materials	3.71	7	3.53	5	3.52	10
Complexity of the project	3.68	8	3.47	9	3.58	6
Type of Contract	3.61	9	3.53	5	3.68	4
Type of Client organization	3.48	10	3.53	5	3.68	4
Type of contractor	3.48	10	3.53	5	3.16	15
Policy of Client	3.42	12	3.63	1	3.71	2
Location of the project	3.39	13	3.33	11	3.58	6
Time invested in planning by client	3.16	14	3.07	15	3.55	9
Awareness of project consultants	3.10	15	3.03	16	3.58	6
Level of I.T Use	3.06	16	3.30	13	3.94	1

Source: Authors field work 2013

From Table 4 the results shows that the experience of the planning team (3.94) and the client budget (3.94) rank first amongst architects as factors affecting efforts invested in planning, while the policy of the client (3.63), planning and approval Authority (3.63) as well as the client budget (3.63) rank higher among engineers. The level of I.T. Use (3.94), client demand (3.71) and client's policy (3.71) ranked highest among the quantity surveyors.

From the bottom, The Level of I.T. Use (3.06), the awareness of the project consultants (3.10) were ranked least by architects as affecting efforts invested in planning. Time invested into planning by the client (3.07) and awareness of the projects consultants (3.03) ranked least among engineers as affecting efforts invested into project planning. Lastly the experience of the planning team (3.06) and the type of contractor (3.16) rank least by quantity surveyors as factors affecting project planning efforts.

Table 5 presents the mean scores (M.S.) of the perception of the importance of factors that affect project planning efforts by consultants and their ranks.

Table 5: Ranking consultants assessment of the importance of the selected factors affecting the level of project planning efforts

	Consultants	
Factors	**Mean**	**Rank**
Client demand	3.71	1
Client budget	3.66	2
Construction method	3.63	3
Type of Contract	3.61	4
Planning and Approval authority	3.60	5
Local Availability of Construction materials	3.59	6
Policy of Client	3.59	7
Complexity of the Project	3.58	8
Type of Client organization	3.57	9
Type of Project	3.45	10
Location of Project	3.43	11
Level of I.T Use	3.43	12
Experience of the Planning team	3.41	13
Type of contractor	3.39	14
Time invested in planning by client	3.26	15
Awareness of project consultants	3.24	16

Source: Authors field work 2013

From Table 5, the results shows that the demands of the client (3.71), the clients budget (3.66) as well as the construction method (3.63) adopted ranks highest among all the consultants as factors affecting the efforts invested into project planning; These results implies that most clients play a major role in determining the amount of efforts invested in planning. Followed by the type of contract (3.61), the planning and approval authorities (3.60) where the project would be situated , the availability of materials locally (3.59), and the policy of the client (3.59); These results indicates that consultants require extensive knowledge of the local planning authorities as well construction materials to effectively and efficiently prepare project plans .The experience of the planning team (3.41),type of contractor (3.39), the time invested in planning by the client(3.26) and the awareness of the project consultants(3.24) ranked least as factors affecting the efforts invested in project planning; These results indicate that the type of contractor , the experience of the planning team and the awareness of the consultants have less impact on the amount of efforts invested in planning .

CONCLUSION

In Conclusion, the study has shown that clients have greater influence on the efforts invested in project planning activities at the pre-contract stage; this implies that project consultants need to develop effective and efficient means of interacting with all stakeholders in the procurement process through innovations to deliver. Supply chains should be put in place to improve coordination amongst all actors to address incoherence in design and construction. It is also recommended that clients consider planning as essential and give planners adequate time to prepare project plans before proceeding to construction. It is also recommended that consultants collaborate more frequently, build stronger partnerships and continuously update themselves with the latest developments in ICT and that are widely accepted as a means of dealing with other consultants and contractors to ensure effective communication as planning does not stop until the project is completely constructed.

REFERENCES

Ashley, D. B., Lurie, C. S., and Jaselskis, E. J. (1987). ‘‘Determinants of Construction Project Success.’’ *Project Management Journal*, 18(2), 69–79.

Chitkara K. K.(1998*),Construction project management-planning ,scheduling and controlling.* 11th Ed. New Delhi :Tata McGraw-Hill Publishing Company Ltd.

Duncan, W. (1996*). A guide to the project management body of knowledge*. Project Managemet Institute. Retrieved < www.uib.cat/facultat/ciencies/prof/victor.martinez/assignatures/ofitec/material/pmbok1996.pdf. *Accessed on the 25th May 2011*

Dvir, D; Raz, T. and Shenhar, J. (2003), An Empirical Analysis of the Relationship between Project Planning & Project Success. *International Journal of Project Management,* 21(2), 1-7.

Faniran, O. O., Love E. D., and Li. H. (1999) Optimal allocation of construction planning resources ’’*Journal Of Construction Engineering and Management,* 125(5), 311-319.

Faniran, O. O, Love, P. E. D. and Smith, J. (2000), Effective front-end Project Management. A Key Element in achieving Project Success in Developing Countries. *Proceedings of 2nd International Conference of CIB Task Group 29(TG29) On Construction in Developing Countries*, Retrieved http://www.irbnet.de/daten/iconda/CIB8846.pdf *Accessed on the 25th May 2011*

Faniran, O. O, Oluwoye, J. O. and Lenard, D. (1994a) Effective Construction Planning. *Journal of Construction Engineering & Management*, 12(4), 485-499.

Faniran, O. O, Oluwoye, J. O. and Lenard, D. (1998) Interactions between Construction Planning and Influence Factors. *Journal of Construction Engineering & Management*, 124(4), 245-256.

Frederick S. Merritt and Jonathan T. Ricketts (2001), *Building design and construction handbook —6th- Ed.* London : McGraw Hill Publishing Company Ltd.

Firdman, H. E. (1991). *Strategic information systems: Forging the business and technology alliance*. New York: McGraw-Hill.

Harris.F & R. McCaffer, (2001). *Modern Construction Management*.5th ed. London: Blackwell Science.

Hore, A. V., Kehoe, J. G., McMullan, J. and Penton, M. R. (1997) *Construction Management Finance Measurement*. 1st ed. London: Macmillan Press Limited.

Idoro ,G. (2011). The influence of project documents on the outcome of construction projects procured by traditional contracts in Nigeria, *Journal of Construction in Developing Countries.* 17(1), 1-19.

Idoro ,G. (2010a) Evaluating the Content of Bar and its Impact On Project Performance in The Nigerian construction industry, *International Journal of Project Planning and Finance.* 1(1), 84-101.

Idoro ,G. (2010b) Project Planning as a Correlate of Project Outcome in the Nigerian Construction Industry. *International Journal of Project Planning and Finance.* 1(1),39-59.

International Federation of Red Cross and Red Crescent Societies, (2000). *Disaster Preparedness Training Programme, Resource module* Retrieved ≤ http://www.ifrc.org/Global/Disproin.pdf Acessed on the 25th May 2011.

Jack S.F and Raymond, H (1976) Structure and Fabric –Part 2, 2nd Ed. London: Macmillian Press Limited.

Kharbanda, O. P. and Pinto, J. K. (1996) *what made Gertie gallop? Learning from Project Failures.*1st ed. New York: Von Nostrand Reinhold.

Larry. W. Smith (2003), *Guidelines of Successful Acquisition and Management in Project Planning –Handbook.* London: Chartered Institute of Builders.

Laufer, A. and Cohenca, D. (1990) Factors affecting Construction planning outcomes, *Journal of construction Engineering management*, ASCE, 116 (1), 135- 156.

Muhamed A., (2010) Project planning manager's contribution. ''*Journal of Project Management World Today,* 12(4), 1-7.

NPC (2006), National Population Commission of Nigeria-census results.

Oxley, R. and Poskitt, J. (1971) *Management Techniques applied to the Construction Industry*. 2^{nd} ed. London: Witham Chowes & Sons Limited.

Patrik Haslum & Hector Geffner (2001), *Heuristic planning with Time and resources*. In : *Proceedings of the International Conference on Artificial Intelligence Workshop on planning Resources.* Retrieved < http://www.rakaposhi.eas.asu.edu/ese574/tp4.pdf Accessed on the 25^{th} May 2011.

Puthamont, S. and Charoenngam, C. (2004) Strategies Project selection in Government Organisations.*Proceedings of International Symposium on Globalization & Construction. CIB 2004, W107, TG23 School of Civil Engineering*, Asian Institute of Technology, Thailand. Retrieved < http://www.irbnet.de/daten/iconda/CIB6067.pdf Accessed on the 25^{th} May 2011.

Ward, P. A. (1979) Organisation and Procedure in the Construction Industry, 1^{st} edition. London : MacDonald & Evans Limited.

ASSESSMENT OF SPONTANEOUS PHYSICAL HOUSING CHANGES IN URBAN CENTRES OF SOUTH WEST NIGERIA

Abdulrahman, M.E.[1], Olagunju R.E. [2], Morenikeji, O.O.[3] and Jinadu, A.M.[4]

1, 2. Department of Architecture, Federal University of Technology, Minna, Nigeria

3, 4. Department of Urban and Regional Planning, Federal University of Technology, Minna, Nigeria

The paper assesses the spontaneous provision of unplanned physical modifications within the overall residential housing areas in south west, Nigeria and how this affects overall primary function of housing quality in the zone. The study employed descriptive survey using observation schedule, questionnaire and hypothesis testing. The study distributed 784 questionnaires among three (3) urban centres and 557 questionnaires were returned representing 71%. The findings show that spontaneous physical housing changes occurred in all the houses-types and the transformation is purposely for economic pursuit. The paper suggests a transformation policy frame work to regulate the urban housing transformation activities in south west Nigeria.

Keywords: *Satisfactory, Spontaneous, Housing, Transformation, Policy.*

elhussainimukaila@futminna.edu.ng

Abdulrahman et. al. (2016). **ASSESSMENT OF SPONTANEOUS PHYSICAL HOUSING CHANGES IN URBAN CENTRES OF SOUTH WEST NIGERIA** Sustainable Built Environment and Climate change; The challenges of Post 2015 Development Agenda. School of Environmental Technology Conference, SETIC, 2016

1.0 INTRODUCTION

Housing is a physical structure which provides shelter and comfort for human habitations (Mohammed el al, 2012). The housing encompasses all ancillary services and community supporting facilities which are necessary to human wellbeing. The housing environment has the profound impact on the physical, culture, mental, health, economic and social wellbeing as well as the productivity of the household (Olatubara, 2007). Housing represents a major capital investment and reflects cultural, social and economic values of a milieu (Bello, 2003 & Olatubara, 2007). Desire to own a house has been observed by Ozon (1990) to constitute one of the needs for savings and capital formation among the people. Housing is environmental components that influence the health, efficiency, social behaviour, satisfaction general wellbeing of the community (Onibokun, 1985). Empirically housing is essential human physical life asset through which the society determines the social, economic and cultural wellbeing of the household. The importance of housing brought about the 1948 Universal Declaration on housing rights (Olatubara, 2007). The essential elements of the declaration are the right to decent housing which include the access to housing of adequate standard and elimination of homelessness. The UN general assembly also emphasises the promotion of the right to adequate housing as one of the habitat Agenda 6 key commitments and strategies for shelter.

The housing quality is the standard and state of general satisfactory performance of the facilities of the structure (Jones, 1979). Housing satisfaction is an evaluation of the quality of the essential services rendered by the building (Wiesenfeld, 1995) and it is a subjective assessment based on individual perception (Amerigo, 1997). Housing quality is a product of residents' perception, attitude and experience (Jiboye, 2014). Housing satisfaction is an important criterion in descriptions of the quality of life of the inhabitants of a society and a factor affecting residential mobility (Amerigo, 1997). When housing no longer guarantee the satisfaction of the users several reasons could be responsible; one of such is far reaching degree of physical housing transformation. (Sheuya, 2009) and due to population increase (Morenikeji, 1991). Housing transformation has been defined as a situation where house-owners embark upon far reaching degree of physical alterations in form of additions and modifications of the original forms and patterns of the existing building (Alagbe, et al, 2014 & Sheuya, 2009). Housing transformation creates unrelated, undefined, complicated and hybrid housing composition in urban centres (Tipple, 2000).Spontaneous physical housing change is unplanned housing transformation initiated without any external influence. Due to immigrants and the natural population growth the urban housing need is on the increase on a daily basis. The spiral growth of population has affected many urban facilities, especially in the housing sector. The urban housing is therefore vulnerable to uncontrollable spontaneous physical changes. The urban housing transformation has been observed to be an alternative means of providing the much needed urban accommodation (Tipple, 2000).

The urban dwellers lifestyle keeps changing with advancement in science and technology discoveries (Jiboye, 2014). This technological discovery through development of building materials has great impact on the lifestyle and most importantly the urban housing morphology. Housing is a product of culture of the people (Rapoport, 1969). The urban environment is therefore vulnerable to technological discovery and physical housing change reflects such changing urban environment.

The National Technical Working Group on Housing, (2009) report shows that Nigeria is experiencing rapid urbanization with about 50 per cent of the population living in urban areas. The housing deficit is estimated at 15-17 million housing units. This shows that there is the need for the provision of between 600,000 and 900,000 housing units per annum for the next 40 years. The deficit in housing supply creates pressure on the existing stocks especially among the urban poor groups. In the past several government interventions in addressing the housing deficit, especially as it affects the urban poor have been applied. These include site and services scheme, half completed project scheme, direct government intervention and in recent times public and private partnership (Olatubara, 2007). Apart from the fact that most of the schemes are located in the urban areas which attracted more immigrants to the urban centres in search of skill and unskilled labours, the success recorded in most cases end up in the hands of few high income civil servants (Morenikeji, 1991). Public housing sector is meant to complement the private sector urban housing and all these combine efforts have not address the quantitative and qualitative housing needs of the urban populace which is evident in the spontaneous changes on the existing houses.

However, some studies have been directed toward the public housing transformations in the south west Nigeria (Aduwo, 2011 & Adegbehingbe, 2011). The finding shows that the major reason for urban public housing transformation has been lack of satisfaction due to the absence of inputs from the part of the end-users. Studies by Peil (1991) and Ikejiofor, (2006) show that Housing provided by the individuals in the urban centers' are far and above the quantities provided by the governments. It has also been established that Private sector contributes over 80% of the existing housing stock in Nigeria (Olatubara, 2007). The private sector housing has gain little attention especially in the area of physical transformation in the south west Nigeria. The study aims at examining the reason for spontaneous physical housing changes in the area despite the fact that the houses were conceived and built by their respective owners. The house-types that are mostly affected by this change among the urban housing of the south west Nigeria were also identified. The study achieved this by examined the discrepancy between the original and transformed patterns of the housing structures in the area and determine the reasons for the spontaneous physical housing change that characterised the housing stock of the south west Nigeria. The study hypothesised that there is no statistical significance between the spontaneous physical housing change and the reason for such changes. The outcome of the study is expected to provide a policy framework for carrying out spontaneous changes that will not impede on the satisfactory primary function of the housing in south west, Nigeria.

1.1 THEORETICAL APPROACH TO THE STUDY.

The theory considered for this study due to the complexity of the housing problem is Sustainable Livelihood Framework (SLF). The sustainable Livelihood Framework, SLF considers a livelihood to be sustainable when people are able to maintain and improve their standard of living while reducing their vulnerability (Carney, 1998). In the SLF concept urban dwellers are viewed to operate in a context of vulnerability utilising their housing transformation to confront the threats of the urban changing environment.

Assets are the building blocks of a sustainable livelihood. By building assets, individuals and households develop their capacity to cope with the challenges they encounter and to meet their needs on a sustained basis. Figure 1 shows the relationship between the descriptive (urban dwellers) and the study variables (spontaneous Physical housing change) and the asset to be transformed for livelihood sustainability. The approach shows the level of vulnerability perceived by the urban dwellers in terms of the influence of threats to their livelihood due to challenges of changing environment and how changing their houses spontaneously help in reducing the vulnerability.

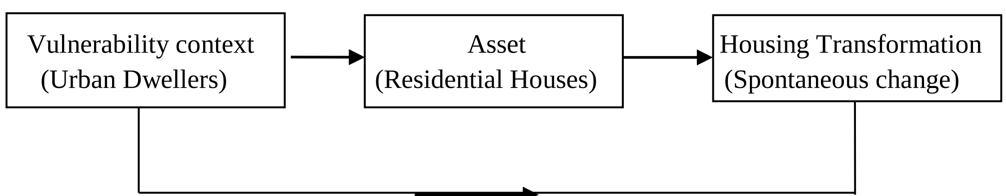


Figure 1: sustainable livelihood framework source: modified from Carney, 1998.

1.2 THE STUDY AREA

The study area is south west Nigeria. The region lies between Longitude 2^o and 6^o E and latitudes 6^o and 9^o N. The region is inhabited traditionally by the Yoruba speaking group of individuals that is made up of Oyo, Osun. Ondo, Ogun, Ekiti and Lagos States. The population of the six Yoruba speaking states put together by the 2006 Population census was 27,511,992 million, representing 21% of the country's population. Yoruba language in the region has many dialects (Bakare-Yusuf, 2011). The zone is classified according to the dialects into three sub-zones, namely North West, Central and South East sub-zones (Aremo, 2009). Accordingly, three most populated urban centres which also serve as administrative headquarters were selected from each of the sub-zones. Ibadan was selected to represent the North West (NWY) sub-zone. The North West Yoruba consists of Oyo, part Osun and part of Lagos. These are Oyo and Ibolo Yorubas (Johnson, 2001). The central Yoruba is made of Igbomina, Ekiti, Ijesa, Ife, Akoko in the present day of Osun, Ondo and Ekiti States. The South East Yoruba include part of Lagos and Ogun state (Fig 2.0). The morphology of

Ibadan, Abeokuta and Akure exhibits the common features of typical Yoruba traditional urban centres with three distinct spatial development patterns (Johnson, 2001); the core centre with concentrations of flocks of residential units with the traditional market square and Oba's palace at the centre; the intermediate zone with fairly concentrations of residential developments of both traditional and modern house-types. The outer part is the new and open up areas with modern buildings in a relatively defined layout with more ease of accessibility and concentrations of socio-economic structures capable of attracting economic activities to the area. The selected urban centres for the study are the administrative headquarters of their respective states and the most populated urban centres in each of the sub-zone they represent. Besides, each of the selected urban centres has diversified house-types and some apartment buildings. However most of the residential areas within the urban centres are characterised by interwoven of residential, social, commercial and administrative buildings.

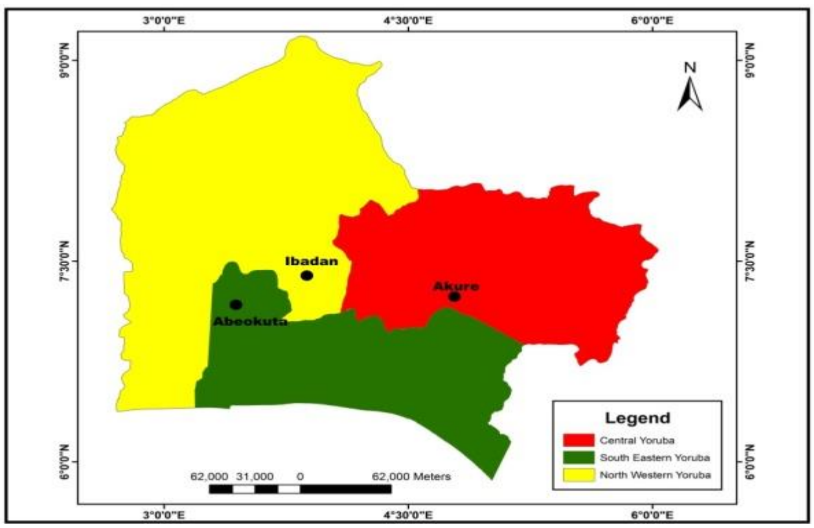


Figure2.0: The Three Yoruba Sub-Zones. Source: Aremo, 2009

2.0 METHODOLOGY

A triangulation of data was employed using observation, sketches and used of structured questionnaire to elicit information from the respondents in the study area. The sampling technique was non probability sampling which allows similar cases to be replicated in large study (Yin, 2009). The study took place in 2014. The projected population of the three selected urban centres based on 2006 census for the study was 1,878,830. This represents 313,136 households using a minimum of 6 persons per household (NPC, 2006). Due to constrained of non-availability of reliable data on housing population of south west, the study arrived at the sample size of 784 houses using the Zeist formula in equation (1) and population projection formula employed is represented in equation (2).

Sample Size, n is given by: $Z^2_{a/2}$ x P (1-p)/d^2 ....(1)

Where n = Sample Size; $Z^2_{a/2}$ = Critical Value = 1.96 ; P = Level of Significance (95%)

p = Estimated Rate expressed as decimal (50% = 0.5) i.e. 50% of the area covered.

d = Precision range expressed as decimal (+/-3.5 = 0.035)

Therefore Sample Size, n, = $Z^2_{a/2}$ x P (1-p)/d^2

= 1.96^2 x 0.5(1-0.5)/ (0.035) ^2 = 3.8416 x 0.25/0.001225 = 0.9604/0.001225 = **784 houses**

Population Projection, Pj is given by = Census (1+r/100) ^n................................ (2)

Where, r = growth rate = (3%); n, =year difference between census year & year under review (NPC,2006) i.e. (2014-2006=8yr)

Isreal (1992) states that 400 Sample size at 95% significance level of confidence is adequate for a social research where population of the study exceed 100,000. The sample size of 784 houses is therefore adequate for this study. Two local governments each were selected from Ibadan, Abeokuta and Akure. The sample size was distributed according to the population of the local government for proportional representations and to avoid dominance by the most populated urban centre within the three selected urban centres. This is shown in table 1.0

Table 1.0: Distribution of Questionnaire in the sampled Areas of south west, Nigeria

Urban centre	Local Govt	Ho Size household size	No. of Houses Covered	(%)
Ibadan	Ibadan North	68,909	173	2222.06
	Ibadan South East	59,756	150	1119.13
Abeokuta	Abeokuta North	45,220	113	11114.41
	Abeokuta South	56,214	140	2217.86
Akure	Akure North	43,138	108	2213.78
	Akure south	39,899	100	2212.76
Total		**313,136**	**784**	**11100%**

Source: Author Field work, 2014

A total of 557 questionnaires were retrieved representing 71% of 784 sampled houses. The sampled houses show five typologies of houses in the area. These are traditional compound houses, rooming (vernacular) houses, storey buildings, detached and semi-detached house type the distribution of the house types is shown in table 2.

Table 2: House Types in the Study Area

Building Typology	Frequency	% Respondents
Compound houses	17	3.0
Rooming Houses	284	51.0
Storey Building	129	23.2
Semi-Detached	96	17.2
Single Detached	31	5.6
Total Total	557	100

Author Field work, 2014

The study revealed that urban centre of south west Nigeria consisted of three distinct residential zones comprising of the inner core area, the intermediate zone and the peripheral zone as earlier established by Johnson (2001) and Jiboye, (2014). The study categorised the inner core area as the unplanned zone while the intermediate and periphery are planned zone of the urban centres investigated. The traditional compound houses is far diminishing in the area as most of the structures are in serious dilapidated situation and in some cases the compounds are inhabitable coupled with poor accessibility. A similar observation has been made by Jiboye, (2014).

Architectural plan of the existing houses where available were used to establish the spontaneous changes that exist in the selected houses. Sampled houses without building plan where directly measured to establish the discrepancies identified. Five houses in each of the house-types were directly selected and measured in each of the three urban centres covered and a total of 75 houses were directly measured on the field by this study. The data were analysed using descriptive statistics and Krustal Wallies H test was employed to test the hypothesis of the study in order to explore the reason for carrying out spontaneous physical housing changes by the house owners in the urban centres of south west.

3.0 RESULTS AND FINDINGS.

Table 3 presents the data on the locations where spontaneous physical changes are predominantly found on the sampled houses.

Table 3: Distributions of Spontaneous Physical Changes on the Buildings.

Location		Outside	Inside	Outside & Inside	Compound	Total
Southwest	Unplanned area	80	113	102	54	349
	Planned area	92	20	60	36	208
	% of Modification	30.9%	16.2%	29.1%	23.8%	557(100%)

Author Field work, 2014

The finding shows that 30.9% of spontaneous physical changes identified were located outside the buildings. This is closely followed by 29.1% of houses with spontaneous physical changes located outside and inside the houses. The spontaneous changes inside and within the compound of the houses survey were 16.2% and 23.8% respectively. The result shows that spontaneous changes cut across the house-types and spontaneous physical changes within the existing houses are not major physical housing changes in the study area. Alagbe et al, (2014) earlier observed that housing transformation cut across house typologies. The 16.2% recorded for inside houses modifications where due to mass urban renewal projects that characterised the study area as at the period of collecting the data. The houses affected where undergoing renovations and conversions. This suggests that probably spontaneous changes on the houses are not purposely for improving the houses. Houses located in planned and the unplanned zones also show high degree of spontaneous physical changes. It can be understood also that spontaneous housing changes also cut across planned and unplanned neighbourhoods of the urban centres of the study.

3.1 Assessment of Reasons for Carrying out Spontaneous Physical Change on the Houses.

Table 4.0 presents responses from the fieldwork. The four attributes why house-owners in the study area embark on spontaneous physical changes on the houses include comfort, revenue, provision for home based enterprises and security. These attributes were adopted with modification from previous studies of Alagbe et al (2014) and Adegbehingbe (2011). A five point scale rating from 1 to 5 was used. The scale varied from “very unimportant” to “very important”. As revealed in table 3.0, 50.0% of the respondents spontaneously changed their houses for economic reason. While 28.7% spontaneously transformed for security reason and 16.0% carried out spontaneous change to improve the comfort of the house. Spontaneous physical housing change as revealed by the findings is purposely for economic benefits and is not conceived for lack of satisfaction among the residential areas. This corroborates the earlier findings of Adegbehingbe, (2011) and Mai (2006) that housing transformation were purely for generating additional revenue by the house owners.

Table 4: Benefits derived from Spontaneous Physical Changes on the houses surveyed.

Benefits of Physical Changes **(Southwest)**	Trad.compd	Rooming House	‘Storey	Semi-Detached	Single Detached	Total	%Respondent
Comfort		19	32	38	0	89	16.0
More revenue	6	93	12	12	6	129	23.2
provision of shops		70	53	35	3	155	27.8
Security	11	88	25	11	19	160	28.7
All of the Above		14	7	0	3	24	4.3
Total Total	17	284	129	96	31	557	100.0

The finding suggests that the study area lack most of the socio-economic services for which the transformations are being used for. The table 3.0 also shows that rooming houses are the predominant house type in south west Nigeria. The table shows that 284, 129 and 96 of the houses were rooming, storey and semi-detached houses respectively. The finding also shows that traditional compound house type is gradually becoming obsolete and rooming houses is still popular due to mass urban transformation which the study area is also undergoing. This finding support the earlier findings of Jiboye, et al (2005) and Adegbehingbe (2011) that due to globalisation brought about by information technology the heterogeneous composition of urban centres is gradually affecting the lifestyle of the urbanites and by extension their houses. The need to evolve a more pro-active measure toward a policy that regulate activities of spontaneous physical housing changes in the residential areas of Nigeria urban centres is necessary. This requires participatory efforts by all the house-owners and professionals in the building industry including the environmentalist in areas of policy guidelines toward housing transformations within the residential neighbourhoods of the urban centres. This is because centralisation of much needed socio-economic facilities cannot be effective as the urban centres keep expanding with time.

3.2 Relationship between House-Owner and Reason for Spontaneous Physical Housing changes

Table 5 presents the data for testing the hypothesis of the study which is to verify the level of significance between house-owner reasons for carrying out spontaneous physical change. Krustal Wallies H statistical test was employed for this non-parametric data.

Table 5: Hypothesis Data

Spontaneous physical change characteristics	Users' characteristics.
1). House location	spontaneous physical housing change
2). No. of people in the house	Benefits derived from the physical change
3). Respondent status	

The table 5.0 shows the independent variables; house location and Number of people in the house and respondent status. The dependent variables are; location of the spontaneous change on the building and the benefit derived from the transformation. Table 6 present the results of the hypothesis test.

Table 6: Result of the Hypothesis Test

Users characteristics /Spontaneous Physical Housing changes	**Chi-square**	**P-value**	**Significant.**
House Location /Spontaneous Physical changes	40.630	0.000	Significant.*
House Location /Benefit of change	3.922	0.048	Not Significant.
No. of people /Spontaneous Physical changes	36.556	0.000	Significant*
No. of people /Benefit of change	83.826	0.000	Significant*
Respondent status / Spontaneous Physical changes	17.840	0.000	Significant*
Respondent status /Benefit of change	9.170	0.002	Significant

*significant at $p< 0.001$

Table 6 presents the result of the hypothesis test between the independent and dependent variables tested. Except the relationship between house location and the benefits derived by the house-owners which is not significant all other variables are statically significance at $p < 0.001$. The study hypothesis that there is no statistical significance between the spontaneous physical housing change and the reason for such changes is then rejected. The result shows that the users' characteristics influence the spontaneous physical housing changes in the study area. This corroborates Tipple (2012) that identified the benefits of housing transformation as (i) means of providing alternative accommodation for the urban dwellers; (ii) it increases housing space for low-income earners and (iii) make productive use of poorly maintained public space. The result findings also corroborates a similar assertion by Kalabamu and Bolaane, (2014**)** that Transforming structures and processes influence livelihood strategies that may be adopted by individuals, households, and communities in order to achieve envisaged livelihood outcomes. Therefore there is significance relationship between the reason why the urban dwellers transformed their houses and the transformation activities. The finding also shows that spontaneous physical housing changes among the urban residential neighbourhood are not because the users are not satisfy with their housing but transformations are purposely for economic benefits. The urban dwellers thereby use the proceeds from the transformed structure to confront the urban threat as it unfolds from time to time in the changing urban environment in order to improve and sustain their means of livelihood.

4.0 CONCLUSION.

The study assessed the significance of spontaneous physical housing changes on the urban dwellers of south west Nigeria. The main objectives were to examine the house-types that are mostly affected by this practice among the house-types in the urban centres of south west Nigeria. The study also established the relationship between the users and the spontaneously generated spaces. The study revealed that the rooming house-types predominate over the detached and semi-detached house-types. The traditional compound is the list house-type among the transformed houses. This further confirmed Jiboye, (2014) who also observed that traditional compound house-type has given way and the rooming house-type is more accepted in the area.

Besides, most of these traditional compound house-type are not fit for habitation as came across by the study in conduct of the fieldwork survey. The core parts of the urban centres studied have poor accessibility and other necessary infrastructures are conspicuously absent in most of these compound houses. Considering the house-types that are mostly affected by spontaneous physical change in the study area, the study revealed that rooming house-type is the most transformed house-type in south west Nigeria. Besides, the study revealed that housing transformation affects (i) all house-types (ii) spontaneous physical change can be located within the main building and around any available open space of the house. The quest for livelihood sustainability significantly influence spontaneous physical housing changes in south west Nigeria as revealed by the study

Besides, finding revealed that spontaneous physical housing change has consumed most of the urban public and parking spaces thereby making it difficult to have soft landscaping elements within the built environment and the transformed spaces have significantly reduced the domestic space around the houses and this is affecting the overall primary function of the housings for providing comfort to the occupants of the living area within the houses as ventilation and lighting of the living areas are seriously affected by the transformations activity. This is evident in the preponderance of spontaneous physical changes located outside the buildings as revealed by the study.

In view of these findings, it is recommended that policy guidelines for urban residential housing transformation should be provided for the house-owners and all the stakeholders in the building industry. There is no any policy framework for housing transformation in the south west Nigeria; the study suggests that a policy framework with specifications and details of the nature and extent of the modifications that is allowed. Such a framework will defined and monitor transformational activities in the study area, coordinate and reorder the built environment. The Public open and parking spaces within the residential areas of the urban neighbourhoods should be preserved for soft landscaping of these open spaces. The spontaneous physical housing changes should not be allowed to impede the primary function of the houses in the urban built environment.

REFERENCES

Adegbehingbe, V.O. (2011). Analysis of physical transformation of residential buildings in selected government estates in south western Nigeria. Unpublished PhD Thesis submitted to postgraduate studies, FU.T Akure.

Alagbe, A. & Aduwo, E.B. (2014). The impact of Housing Transformation on Residents Quality of Life: A Case Study of Low-Income Housing Estate, Ipaja, Lagos. *Covenant journal of research in the built environment, (CJRBE), 2(2), 134-147*

Amerigo, M. & Aragones, J.I. (1997). A Theoretical and Methodological Approach to the Study of Residential Satisfaction. *Journal of Environmental Psychology17, 45-57*

Aremo, B. (2009). How Yoruba and Igbo became different Languages. Ibadan: SCRIBE Publication Ltd.

Bakare-Yusuf, B. (2011). Yoruba's don't do Gender: A Critical Review of Oyeronke Oyewumi's the Invention of Women: Making an African Sense of WesternGenderDiscourses. www.codesria.org/IMG/pdf/BAKARE-YUSUF.pdf Accessed 11/05/12

Bello, M.O. (2003). A comparative analysis of the performance of residential property in Lagos metropolis. *Journal of Nigerian Institute of Estate Surveyors and Valuers (21)2.* Pp9-19

Carney, D. (ed.) (1998) *Sustainable Rural Livelihoods: What contribution can we make?* London: Department for International Development

Ikejiofor, C.U. (2006). Spatial Patterns of Housing in the Outskirts of Abuja, Nigeria.*Journal of Development Studies. 2(1). pp 244-266*

Israel, G.D. (1192). *Determining Sample Size.* University of Florida: Florida Cooperative Extension Service.

Jiboye, A.D., Ogunshakin, L. & Okewole, I.A. (2005). The Socio-Cultural Dimension of Housing Quality in Osogbo, Nigeria. International Journal of housing science & application of Coral Gables USA 29(2). 153-164

Jiboye, A.D (2014). Significance of house-type as a determinant of residential quality in Osogbo, Southwest Nigeria. *Frontier of architectural research. 3* .pp 20-27

Johnson, S. (2001). *The History of Yoruba.* Lagos: CSS (Nig) Ltd.

Jones, C. (1979). Housing: the element of choice. *Urban Studies. 1(2).* Pp 179-204

Kalabamu, F. & Bolaane, B (2014). Rapid urbanisation and housing transformations in Tlokweng, Boswana. Paper presented at the international conference on urban challenges, Bacelona between October 28th – 30th 2014.

Mai, M.M. (2006). Urbanisation and Globalisation of Gbagyi Housing Transformation. Unpublished PhD Desertification of Faculty of Built Environment, University of Teknologi, Malaysia

Mohammed, A.M & Mohammad, A. (2012). Assessment of residential satisfaction with public housing in Hulhumale', Maldives. *Procedia-social and behavioural sciences 50 pp 756-770.*

Morenikeji, O.O. (1991). Housing Problems in Nigerian Urban Centres: A case Study of Minna. *The Construction Journal 1(1) pp14-20*

National Technical Working Group on Housing (2009). Vision 2020. http:/www.npc.gov.ng./downloads/housing%20NTWG%20Report. pdf. 05th March, 2010.

NPC (2010). National Population Commission. http://www.citypopulation.de/Nigeria.html Retrieved 01/04/2010

Olatubara, C.O. (2007).Fundamentals of Housing in Agbola, T., Egunjobi, L. & Olatubara, C.O. (2007). Housing Development and Management: a book of reading. Ibadan: U.I Press

Onibokun, P. (1985). *Socio-Cultural Constraints on Urban Renewal Policies in Emerging Nations. The Ibadan Case. In Onibokun, P. (ed.), Housing in Nigeria*. Ibadan: NISER

Ozo, A.O. (1990). The private rented housing sector and public policies in developing countries: The example of Nigeria. *Third world planning review 12(3).pp 261-279*

Peil, M. (1991). *Cities and Suburbs: Urban life in West Africa*. New York: Holmes and Meier.

Sheuya, S.A. (2009). Urban Poverty and Housing Transformations in Informal Settlements: the case of Dar es salaam, Tanzania. *International development planning review 31(1).*

Tipple, G. (2012). Informal public housing expansion: transformation of existing multi-storey stock in Egypt. 6th world urban forum, Naples, September 1-7, 2012

Vision20: 2020(2009). National Technical Working Group on Housing. Report on the Nigeria Economic transformation. Retrieved from http:/www.npc.gov.ng./downloads/housing%20NTWG%20Report. pdf. on 05th march, 2010.

Yin, R.K. (2009). *Case Study Research: Design and Methods.* California: Sage Publications. 4th ed.

ROUTE RE-ALIGNMENT SURVEY FOR COST EFFECTIVE CONSTRUCTION OF A CONNECTING BRIDGE OVER SULEJA-DAM

Ibrahim, O.P., Mark, Z, Isau, A.I., Samaila-ija, H.A., Ajayi, O.G. & Nwadilor, I.J.
Department of Surveying and Geoinformatics, Federal University of Technology, Minna, Niger State, Nigeria.

Before the construction of Suleja dam in 1993, people and goods were conveyed / transported freely through the old road because the small river separating the adjoining communities (Ija, sabo bwari, ija kuchiko and ija koro) had a small bridge that accommodated vehicular and other means of transportation. However, because of the construction of the dam, the communities once connected are now separated in their economic and social interaction. In view of this; this research was carried out with the aim of realigning the old road to accommodate a shorter and cost effective bridge over the dam. Differential Global Positioning System (DGPS) receivers were used to set-out the new alignment while an Automatic level was used to transfer height from the Benchmark to the lake. Eco Map 50s was used to carry out the strip sounding over the proposed bridge route to determine the water depth. A total length of 2.919km was obtained from the proposed realignment as against a distance of 3.038km of the old alignment. As a result, a proposed bridge length of about 514m was achieved as against the 740m of the old alignment. AutoCAD 2010 and Carlson were used to plot the alignment, as well as the longitudinal profile and length calculation. In addition Layer stacking of the existing alignment and new alignment of the area on satellite imagery of the site was also carried-out in order to depict the differences between the existing road and the proposed realignment.

Keywords: *Communities, Bridge, Route Realignment ,Transportation*

piusibrahim.uk@gmail.com

Ibrahim et. al. (2016). **ROUTE RE-ALIGNMENT SURVEY FOR COST EFFECTIVE CONSTRUCTION OF A CONNECTING BRIDGE OVER SULEJA-DAM** Sustainable Built Environment and Climate change; The challe nges of Post 2015 Development Agenda. School of Environmental Technology Conference, SETIC, 2016

INTRODUCTION

Surveying is a complete system which involves data capture and storage on site either by direct or indirect means using instruments and techniques that are appropriate for executing the task at hand. There are several branches of surveying such as; Hydrographic Surveying, Engineering Surveying, Military Surveying, Geological Surveying etc. but this research combines Hydrographic and Route survey in order to have a design of a bridge. Route surveying is the measurement made which involves horizontal profile (along center line) and cross sections. This line contains both distance and bearing of the route. On the other hand, Hydrographic surveys are those made on a body of water such as bay, dam, harbor, lake or river. Hydrographic surveys are made for the purposes of determining channel depths for navigation, quantities of bottom excavation, location of rocks, sand bars, navigation aids, measurement of area subject to scour or silting, for offshore structure sitting and bridge construction amidst others (Raymond et al, 1981). Therefore *Bathymetric surveying* is the process of measuring the depth of water to obtain the topography of the bottom. All over the world roadways have had to be re-aligned for various reasons, ranging from traffic safety issues, major public infrastructural development, economic and cost considerations, growing population and city or metropolis growth, buffer from risk or potentially dangerous areas. Of all these factors mentioned above, man’s aim still remains to effectively convey goods, services and people from one place safely to another.

Rutland (2006), presented a detail report on his research which executed a route re-alignment between Cornish road and portions of Rutland road, old Vernon road. A newly constructed three-lane arterial roadway was used to tie an existing three-lane road between old Vernon and Rains road. However the Right of Way (ROW) was constructed to permit a four-lane roadway in case of future traffic. The existing Rutland road became a cul-de-sac south of old Vernon road. This provided further traffic allowance at the vicinity of highway Vernon road by removing closely spaced intersections. DGPS was used for carrying out the realignment survey.

However, whatever the need be for re-alignment, administrative considerations must be made. Feasibility study of such an area is carried-out in other to determine whether a road can be situated in such areas or not. Preliminary investigation such as subsoil investigation, vegetation and terrain, need for culvert and bridges are all carried-out. Maps and topographic relief charts of such areas are used for office reconnaissance to effectively determine where the alignment should pass through.

Transportation in every society is of major importance, as there is a need for movement of goods, services and people from one destination to another. Roads are one of major means by which such can be done. Roads have been constructed over time and can be traced to the creation of man, as man saw a necessity to travel from one point to another and in doing this he has come across obstacles such as water bodies, valleys etc. Man has over the years constructed bridges over such obstacles. In this light the communities of Ija, Tofa, which are separated by a dam; and because of the frequency of transportation and movement of goods by boats and ferries, need the construction of a bridge over this dam for more effective transportation. Route re-alignment is necessary for the construction of a new bridge over Suleja dam to connect the communities of Ija and Tofa, and also serving Kaduna, Bwari, etc. A map would be produced showing the profile of the road, to aid in proper design and planning of the road and bridge, as well as to show a suitable route that would save the cost of a bridge construction.

Bridges are part of road construction because the topographic of the earth is undulated, large water bodies sometimes separate towns and hence the need for a bridge to connect the towns.

However a bridge must be built when factors such as frequency of usage, volume of transported materials or goods, size of town's apart and economic as well as social factors are taken in to consideration. All over the world, bridges have been constructed but however routes with less cost implications have been used. It is necessary in every construction exercise to follow routes with the most minimal cost implication on the government. Therefore the proposed realignment for the construction of a bridge over Suleja dam will not only reduce the length of the bridge, but would also cut cost; most importantly for the Federal Government and also help connect communities such as Ija, Tofa, Bwari, the FCT as well as link the ongoing road project passing through Bwari into Kafanchan, and also link Plateau State.

Route Realignment Using GIS

Planning a new road or highway can be expensive and time consuming process. There are numerous environmental issues that need to be addressed. The problem is exacerbated where the alignment is influenced by the location of services, existing roads and buildings, and the financial, social and political costs of land resumption.

GIS, a powerful tool for the compilation, management and display data associated with geographic space, is used for the preparation of digital maps and analysis purposes. The conventional manual methods were difficult, time consuming and expensive. (Subramani e tal, 2012). The purpose of this study was to develop a tool to locate a suitable less route between two points. The GIS approach using ground parameters and spatial analysis provided to achieve this goal. Raster based map analysis provide a wealth of capabilities for incorporating terrain information surrounding linear infrastructure .Costs resulting from terrain, geomorphology, land use, drainage and elevation resulting the shortest routes for the study area. The existing road path was 90 km long from Erode to Palani (via Kangeyam, Dharapuram). Results indicate that the route which was designed applying GIS method is more environmentally effective and cheaper. This proposed shortest route provides traffic free, pollution free, risk free, operating for movement of vehicle passing from Erode to Palani. Time and consumption of fuel will also be reduced considerably. (Subramani & Kumar, 2012)

Study Area

Suleja dam is located between two communities in Tafa Local Government Area of Niger State. Latitude $09^0$14' 37'' and Longitude $07^0$17'15''. The Suleja dam over which the proposed bridge is to pass across was built in 1994, by the then Head of State Ibrahim Badamose Babangida as a Federal Government intervention program in Niger state, to help check water scarcity and shortage of clean and portable water for general consumption. The dam holds 36×10^6 cubic meters of water according to its initial design over an area of about

460 Hectares. Suleja dam is located in an area full of rocks of varying types, ranging from igneous, metamorphic and also sedimentary rocks. The dam is a zoned Earth filled water reservoir, constructed by dredging the sloppy side of the mountains. The area also has a good relief and a beautiful landscape towards its banks that support agriculture and grazing of cattle. However the hilly side of the dam is characterized by gully erosion, as water and other materials moving with high velocity during rainfall from the mountains, easily erode the Earth. This has made foot paths in the area difficult to navigate by motorist and motorcyclist.

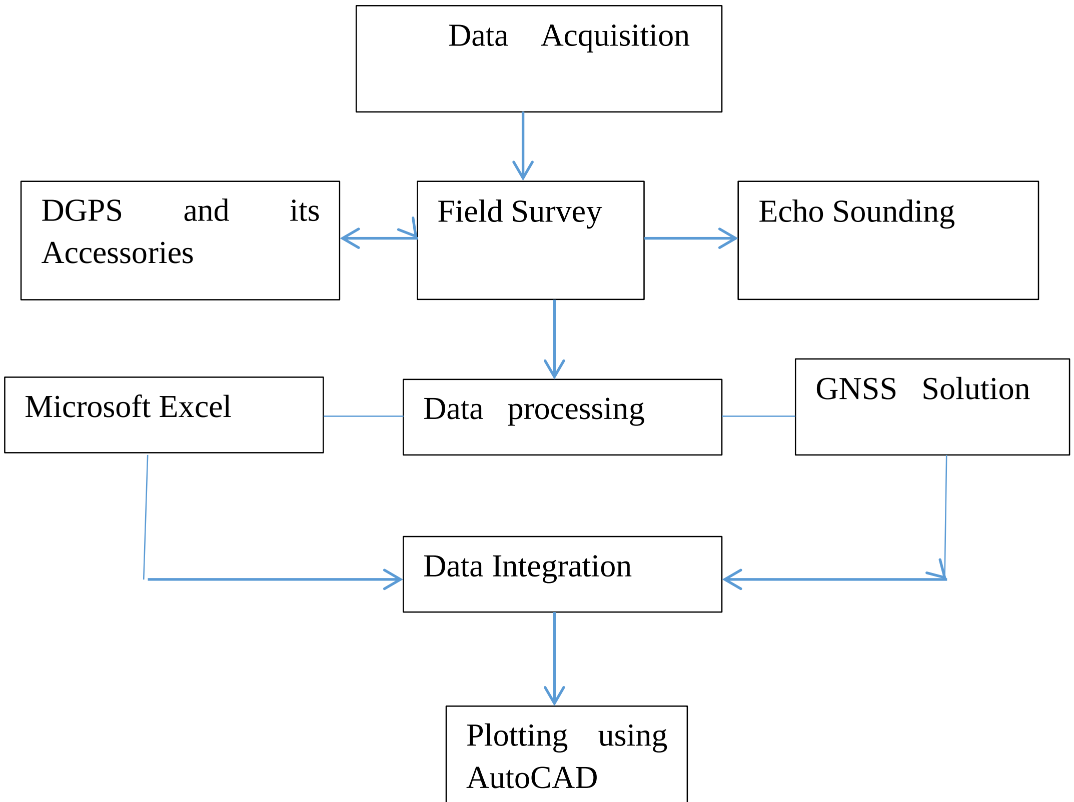
Climatic Conditions of the Area

Available geographic information indicates that the quantity of rainfall in the study area ranges from 50.2mm to 260.5mm during the month March to May when peak rainfall is recorded. The month of November to March and April are the hottest month of the year with temperatures ranging from 33^0c to 39^0c in April. The lowest temperature of 19^0 occurs in the month of December, while relative low temperature of 27^0c to 32^0c occurs during others months of the year. It is during these months of relatively low temperatures that evaporation values of 66 to 112 are recorded. The highest evaporation values of 220 to 245ml are recorded during December to April due to the high temperatures and low, rainfall prevailing during this period. It was further observed that the highest value of relative humidity (67% - 72%,) occurs between June and August while the lowest valves (14% to 22%) occur between December and march**.**

Materials and Method

This research employs the use of Differential Global Positioning System (Pro mark 3, Dual Frequency) receivers, Eco Sounder, handheld GPS, 100m steel tape, leveling instrument, a boat and all its accessories, Microsoft excel, and AutoCAD software packages. The method involves collecting 3 dimensional coordinates (X, Y, and Z) of observed selected points using direct field survey with the aid of DGPS receivers and its accessories. The DGPS base were set up on a control point (FCT 222p) and all necessary instrument set up and testing was carried out to ascertained the accuracy of the instrument (instrument calibration) i.e. bar check, after setting up. To densify the controls, the instrument was set up on static method of observation (for control extension). The occupation time spent on one control point to establish it was one hour fifteen minutes (1hr: 15m) and for the route alignment (edges and center line), the instrument was set on stop and go method of observation where 15-20 seconds was spent on each point at a chainage of 25 meters and the center line was six meters apart. Echo sounder was used to determine the depths at 10 seconds interval. Level instrument was used to reduce the water level for the day observation. GNSS Solution software was used to process the data and AutoCAD Land Dev. was used to process the data in order to produce profile map of the route realignment.

Fig 1: Flow Chart of Methodology



The following were done in order to achieve the research goal;

i. Determination of distances, area and angles
ii. Establishment of reference s ertical controls.
iii. Determination of profile on d is to pass(centerlines) to provide data for cuts and f
iv. Utility placements, as well as laying of structures, culverts and bridges
v. Depth determination of dam to enable bridge construction and support system.

Discussion of Results and Findings

Controls are established / reestablished in survey job in order to orient the job at hand or subsequent one where the existing controls have been destroyed or damaged and in some cases where they are far from the intending area of survey. The controls established in the course of this research were four with beacon numbers IJ02 to IJ05. The distance covered from IJ02 to IJ03 was 486.317m, IJ03 to IJ04 was 1092.33m and from IJ04 to IJ05 was 410.811m respectively.

Table 1.0: Second order controls established along the route

Pillar Number	Eastings(m)	Northings(m)	Height(m)
IJ05	306321.332	1021951.87	478.931
IJ04	306728.924	1022003.193	469.016
IJ03	307670.258	1022557.339	473.392
IJ02	308149.184	1022641.804	479.74

Table 2.0 shows the route realignment observed data. The Easting's, Northings and Heights in black, are the observed points on ground while the ones in blue are the points observed on the water body (reduced depth). The lowest point in the lake (through the profile) was 444.293m, the heights point on the profile map is 487.594m, total length of the realigned road was 2.919km while the total length of the old road is 3.038km. The length covered during strip sounding (profile sounding) was 493.03m and the length of proposed new bridge was 514.063m plus excess on land. The length of proposed old bridge was 731.430m plus excess on land and the difference in length between the proposed new bridge and the old one was 217.370m plus excess on land

Table 2.0: **Coordinates from route survey and strip bathymetry survey in blue**

s/no	Eastings(m)	Northings(m)	Height(m)	s/no	Eastings(m)	Northings(m)	Height(m)
1	308380.515	1022614.574	478.599	42	307411.7	1022348	464.85
2	308354.369	1022609.471	478.946	43	307392.1	1022331	465.295
3	308331.551	1022607.126	479.049	44	307373.4	1022315	463.868
4	308305.266	1022603.031	479.343	45	307354.1	1022299	463.162
5	308279.898	1022598.513	479.675	46	307330.5	1022288	463.262
6	308257.017	1022594.985	479.847	47	307311	1022280	458.793
7	308231.526	1022591.343	480.264	48	307292	1022273	459.393
8	308205.806	1022588.828	480.459	49	307274	1022260	458.893
9	308180.348	1022584.864	480.56	50	307236	1022253	458.493
10	308155.798	1022580.698	480.532	51	307217	1022246	457.893
11	308131.726	1022574.627	480.476	52	307198	1022239	456.893
12	308107.458	1022571.614	480.472	53	307180	1022232	455.693
13	308082.512	1022566.311	480.675	54	307161	1022219	453.693
14	308056.352	1022562.659	480.69	55	307142	1022219	452.793
15	308032.994	1022558.051	480.54	56	307123	1022212	452.093
16	308008.786	1022554.915	480.405	57	307104	1022205	446.493
17	307983.028	1022552.764	480.285	58	307086	1022198	444.293
18	307958.423	1022547.219	479.998	59	307067	1022191	449.163
19	307935.36	1022544.804	479.726	60	307048	1022184	452.893
20	307907.783	1022540.129	479.038	61	307029	1022178	453.693
21	307883.725	1022535.291	478.748	62	307010	1022171	454.093
22	307858.551	1022531.734	478.26	63	306992	1022164	455.893
23	307836.248	1022527.27	477.765	64	306973	1022157	458.493
24	307811.713	1022524.903	476.836	65	306916	1022137	459.293

25	307785.475	1022520.252	476.098	66	306898	1022130	459.793
26	307763.236	1022517.25	475.418	67	306879	1022123	460.193
27	307737.011	1022513.2	474.741	68	306871.9	1022121	464.242
28	307711.85	1022511.647	473.639	69	306850.6	1022111	465.03
29	307687.469	1022508.42	473.111	70	306829.4	1022097	465.737
30	307661.313	1022505.249	472.106	71	306807.8	1022085	466.433
31	307637.009	1022500.799	471.448	72	306786.7	1022072	466.965
32	307611.718	1022496.06	470.563	73	306766.5	1022058	468.01
33	307591.054	1022483.655	469.89	74	306743.1	1022046	468.855
34	307568.669	1022470.955	469.134	75	306721	1022034	469.711
35	307546.051	1022460.43	468.228	76	306699.9	1022021	470.102
36	307526.376	1022445.447	467.598	77	306677.4	1022008	470.687
37	307508.625	1022428.108	467.223	78	306658	1021998	470.789
38	307488.652	1022413.297	467.376	79	306635.5	1021986	470.789
39	307468.379	1022396.761	466.386	80	306612.6	1021973	469.183
40	307448.796	1022381.46	466.052	81	306587.5	1021969	465.824
41	307430.011	1022364.515	465.37	82	306563	1021964	470.237

s/no	Eastings(m)	Northings(m)	Height(m)	s/no	Eastings(m)	Northings(m)	Height(m)
83	306537.383	1021960.017	473.073	103	306048	1021874	482.995
84	306513.828	1021953.981	474.203	104	306023.5	1021870	483.317
85	306490.418	1021948.601	474.617	105	305998.6	1021866	484.103
86	306465.074	1021945.406	475.656	106	305971.9	1021862	485.284
87	306440.015	1021940.602	476.509	107	305948.8	1021858	484.392
88	306414.886	1021936.037	477.19	108	305924	1021854	484.1
89	306391.839	1021930.614	478.093	109	305899	1021851	483.921
90	306366.376	1021926.755	478.904	110	305875.5	1021846	483.865
91	306342.551	1021920.75	479.368	111	305851.3	1021843	484.404
92	306317.768	1021914.978	477.689	112	305826	1021841	485.151
93	306291.666	1021910.642	478.467	113	305800.3	1021836	485.042
94	306271.516	1021905.596	477.183	114	305776.8	1021830	485.222
95	306246.375	1021903.747	479.509	115	305752.1	1021827	485.371
96	306216.372	1021896.944	480.081	116	305727.5	1021824	485.83
97	306196.334	1021898.636	480.238	117	305703	1021819	485.707
98	306170.289	1021893.551	480.718	118	305676.7	1021815	486.307
99	306146.148	1021886.502	484.206	119	305651.8	1021811	486.665
100	306121.048	1021882.753	484.001	120	305625.8	1021816	487.594
101	306096.309	1021879.087	482.192	102	306072	1021877	482.555

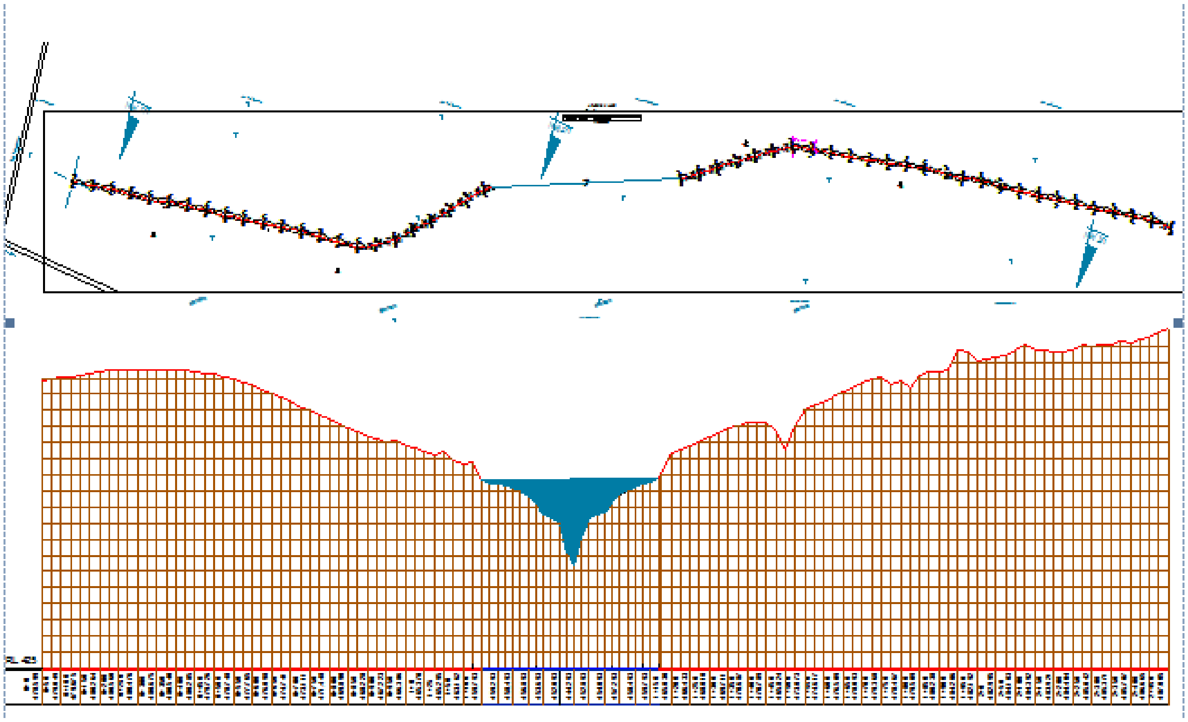


Fig.2 A profile view of the realigned road.

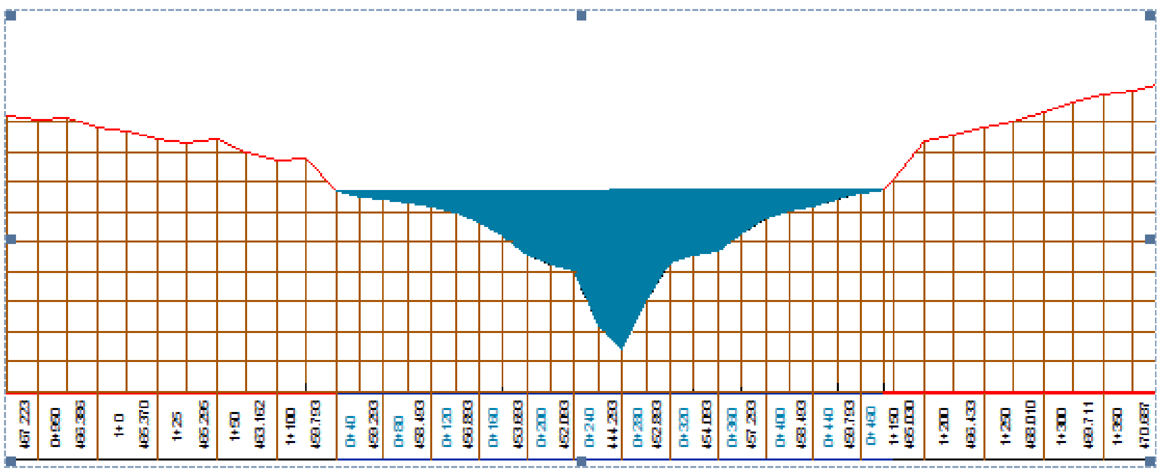


Fig 3: Profile along the Dam.

Fig4: The realigned road superimpose on the satellite imagery

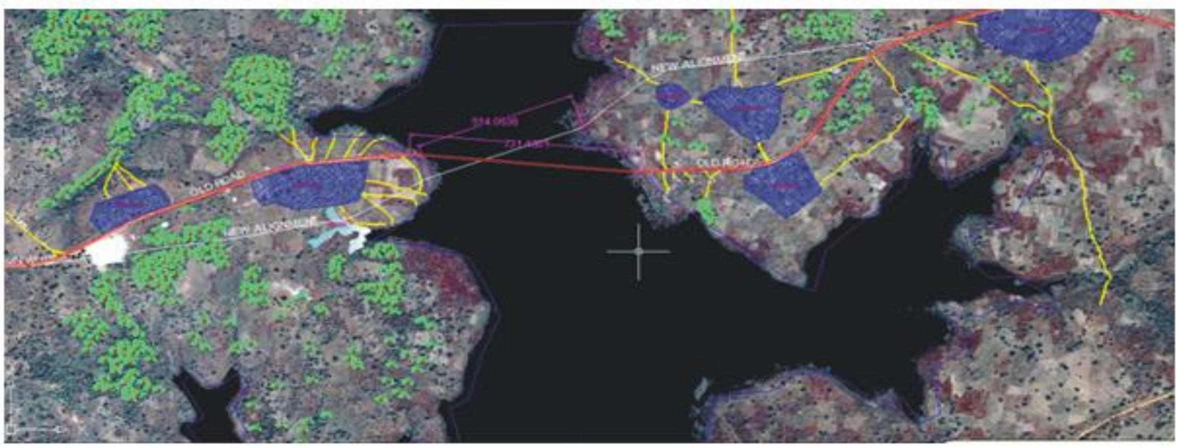


Fig5.: A plane view of the realigned road in white.

In Fig.5, the road in red shows the existing road that needs a bridge to be constructed over to link Ija, Bwari and the entire FCT, to KOFA, Sabon Wuse and Kaduna road. According to the old road design, it was observed that a bridge of about 750m or more will be required to be constructed over the dam to link the above communities. However, with the new realignment carried out, a bridge of only about 500m or more but not exceeding 525m will be required to connect the above communities. This will further save cost as the new alignment provides a shorter and less expensive route. Furthermore, the new alignment has been designed to allow free flow of traffic and to accommodate vehicular design speed, due to the fact that the new alignment is to be constructed in the out_skirt of the communities highlighted in order not to disturb activity going on in the settlement and also to reduce the cost of compensations. Since houses are being constructed close to the roadway recently. The route is an economically important road to the communities, as it helps in the transportation of goods and services, such as farm produce. Finally the major benefit of this project to the Federal Government of Nigeria is the reduction of cost of construction; because since the old road is about 750m and above, it will cost the government more to construct the bridge. It was also discovered that the new alignment of the road will cost the government less than the initial cost of constructing the bridge, and the aim of the project would have been meant.

CONCLUSION AND RECOMMENDATION

In conclusion, it is safe to say that using the new alignment a significant length would be reduced thereby saving cost of bridge construction. The Governments of Niger state and the Federal Capital Territory should come together and join forces to make sure that this project is realized because of the economic and social benefits the project has to offer to both states. Because of the good nature of the environment, a Survey resort should be constructed there to aid the development and practice of surveying in the country. This message is targeted at NIS, NGOs and investors.

REFERENCES

Ackerman, (2009); Communication, n.d.; Hakim & Ahmed, 2006; “Massachusetts Strategic Highway Safety Plan,” 2013; National, Highway, Academies, Toole, & Investigator, 2010)

Ackerman, F. (2009). Financing the Climate Mitigation and Adaptation Measures in Developing Countries, (57).

Communication, F. N. (n.d.). No Title.

Hakim, B. S., & Ahmed, Z. (2006). RULES FOR THE BUILT ENVIRONMENT IN 19TH CENTURY NORTHERN NIGERIA, *1*, 1–26.

Massachusetts Strategic Highway Safety Plan. (2013), (September).

National, T., Highway, C., Academies, T. N., Toole, J., & Investigator, P. (2010). Update of the AASHTO Guide for the Planning , Design , and Operation of Pedestrian Facilities.

Subramani, T., & Kumar, S. N. (2012). National Highway Alignment Using Gis, *2*(4), 427–436.

GPS Positioning Guide (1995), Published by authority of Natural resource Canada.

Roy S. K (2006), *Fundamentals of Surveying*. Prentice-Hall of India Private Limited. New Delhi.

Schofield W., Breach M. (2007), *Engineering Surveying*. Butterworth-Heinemann. Jordan Hill, oxford. UK.

The Ministry of Transport ‘MoT’ (1998),*Alignment Comparison Report*.

Washington State Department of Transportation (2005), *Highway Surveying Manual*. Washington. USA.

Document of Mass Highway (2006).

City of Beckley (1998), *SR 165 and Ryan Road Realignment*.

Ayuba S. A.(2010). *Longitudinal Profile from Western bye-pass through Shanu village to Maikunkele*. Minna. Nigeria.

Nwocha U. H (2010), *Route Profile and Cross Section of student hostel(B) to Garatu village*. Minna. Nigeria.

BUILDING A MODERN LAND ADMINISTRATION SYSTEM IN NIGERIA

Kemiki O. A., Ayoola, A. B., Kuma, S. S., Ojetunde, I. and Fabunmi, F. O.

Department of Estate Management and Valuation, Federal University of Technology, Minna, Nigeria

Land administration is a significant framework for the management of any nation's pool of resources and has remained one of the most chatted discourses among urban issues in many developing countries. This paper examines the issues in land administration in Nigeria and other developing countries, looking at the various administrative and legal frameworks in place for an efficient land delivery system. The land administration system in Nigeria is plaque by challenges spanning from policy, institutional and legal frameworks to technical and operational issues which have direct impact on implementation. These challenges emanated from some of the import ideologies that adjustments could not be made upon. The study recommends the reform of policies and the creation of a local integrated land administration system model (LAS) that will accommodate our country peculiarities. Also the development and sustenance of an ICT based professionals and infrastructure that will enhance efficiency in the land information system.

Keywords: Land Administration, Institutional Framework, efficiency, Policy,

kemiki@futminna.edu.ng

Kemiki et. al. (2016). **BUILDING A MODERN LAND ADMINISTRATION SYSTEM IN NIGERIA** Sustain able Built Environment and Climate change; The challenges of Post 2015 Development Agenda. School of Environme ntal Technology Conference, SETIC, 2016

1.0 INTRODUCTION

Land remains critical to any significant development of man and his society. The continued existence of man and his growth depend on the availability of land for the much needed development. This important resource of the earth which cannot be reproduced, destroyed nor depleted can however be mismanaged and once this done, the economy of such urban areas maybe distorted and will also impact on the socio-political fabric of the state. The consequences of which will be detriment of man.

It has been discovered that land accounts for between half and three-quarters of national wealth and a focused attention on land utilization have been an important step in achieving economic development and social stability in many countries around the world (Ukaejiofo, 2009). Ukaejiofo (2009) further added that the level of economic and social development of any society or nation is substantially tied to the level of rights exercisable by the citizens over their land resources. This is because land is considered as the ultimate resources for socio-economic development and the effective management of this resource is of utmost important to that nation for its development (United Nations Economic Commission for Africa *UN-ECA,* 2003).

Land administration is the tool for implementing a nation's land policy and is seen by United Nations Economic Commission for Europe, *UN-ECE* (1996) as the processes of recording and disseminating information about the ownership, value and use of land and its associated resources (United Nations Economic Commission for Europe *UN-ECE,* 1996). The processes of Land administration consist of land registration, cadastral surveying and mapping, fiscal, legal and multi-purpose cadastres and land information systems (Steudler, Rajabitfard and Williamson, 2003). Burns *et al* (2007) pointed out that various projects to improve land administration systems have been carried out by developing countries around the world over the past half century primarily to provide formal recognition of rights in land and to facilitate the trading of these rights. Typical project objectives include one or more of the followings: reforming and strengthening policy, legal and institutional frameworks; introducing formal land-titling systems or other forms of secure tenure; improving registration practices; upgrading survey and record keeping technologies; capacity building — all in an attempt to develop more efficient and effective land administration services (Burns *et al*, 2007).

In most developing, urban land administration system is usually dual in nature resulting to a plural characteristic. This has given rise to the concept of legal pluralism where the formal land administration laws exists side-by-side with normative rules. The understanding here is that, the formal land administration laws are perceived as alien and not in tandem with the customary norms and practices. This scenario has made the successful implementation of most urban land policies very challenging without adjustment to them (Kuma, 2013). According to Burns *et al*, (2007), over the last few decades, most developing countries commenced agitations for new urban land policies and in some cases some countries have successfully adopted new and reformed land laws. Though some still lack administrative machineries to for the proper implementation, also looking at the environmental limitations and funding which have remain standout problems hence, limited results have been recorded so far.

Atilola (2010) mentioned that the main objective of the modern land administration system will be to create an open market economy in which land is transformed into an economic commodity. This implying brings in economic concept and approach into land administration system rather than the general conventional approach which is becoming popular. The UN-ECA (2003) described these conventional approaches as operating majorly on deeds and title registrations and also declared that, no developing country has a land tenure system which satisfies fully any of its objectives or objectives worthy of a modern land administration system rather most of them have what is termed "Urban Cadastre" for the economically stronger households in the society.

Finally, in spite of the huge resources invested by various governments and the donor agencies towards the improvement of land administration infrastructure in developing countries, there has been little or no systematic and sustainable approach effective development.

2.0 THE URBAN LAND ADMINISTRATION

A land administration system may include processes to manage public land, which includes records and registration private interests in land, assess land value and determine tax, define land use, and support the process of development application and approval (UN-ECE, 1996; Enemark *et al,* 2005, Ukaejiofo, 2009). It is also seen as the processes of regulating land and property development and the use and conservation of land, the gathering of revenues from the land through sales, leasing and taxation, and the resolution of conflicts relating to the ownership and use of land (Dale and McLaughlin, 1999). A land administration system may include the following major aspects:

a) Management of public land
b) Recording and registration of private rights in land;
c) Recording, registration and publicizing of the grants or transfers of those rights in land through sale, gift, encumbrance, subdivision, consolidation,
d) Management of the fiscal aspects relating to rights in land, including land tax, historical sales data, valuation for a range of purposes, including the assessment of fees and taxes, and compensation for state acquisition of private rights in land,
e) Control of the use of land, including land-use zoning and support for the development application/approval process.

The land administration functions are relied on and are facilitated by suitable land information infrastructure that include cadastral and topographic datasets and provides access to entire and up-to-date information about the built and natural environment (Enemark *et al* 2005).

Land administration system is therefore a vital framework in the implementation of urban land policies in both developed and developing countries. It also supports the efficiency of land markets and also concerned with the management of land as a natural resource towards ensuring a sustainable development see figure 1 below.

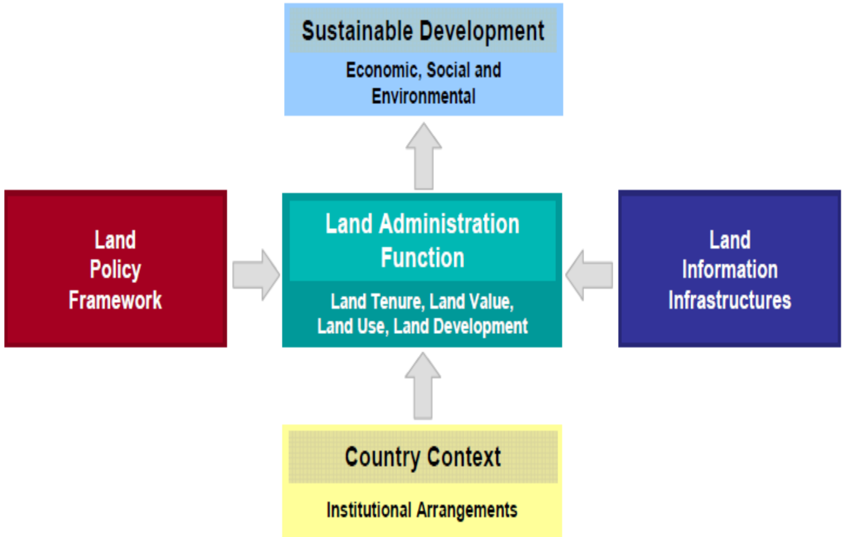


Figure 1: Land Administration System Web

Source: Enemark *et al (*2005)

The major consideration of any land administration system especially in the urban areas is to ensure equity in the distribution and access to land resources for both social and economic uses. This will evolve certain processes that determine adjudication of rights and attributes of land such as surveys, description, documentation and making available this information for ease of management (Dale, 2000). Thus the main functions of land administration as enumerated as Steudler, Rajabitfard and Wiiliamson (2004) are;

1. Juridical function which deals with land ownership and property rights (land tenure)
2. Regulatory function which controls land use planning and development.
3. The fiscal function relates to land values which also include land taxation and
4. Finally**,** information management includes information on the other three components which is very critical for effective land management.

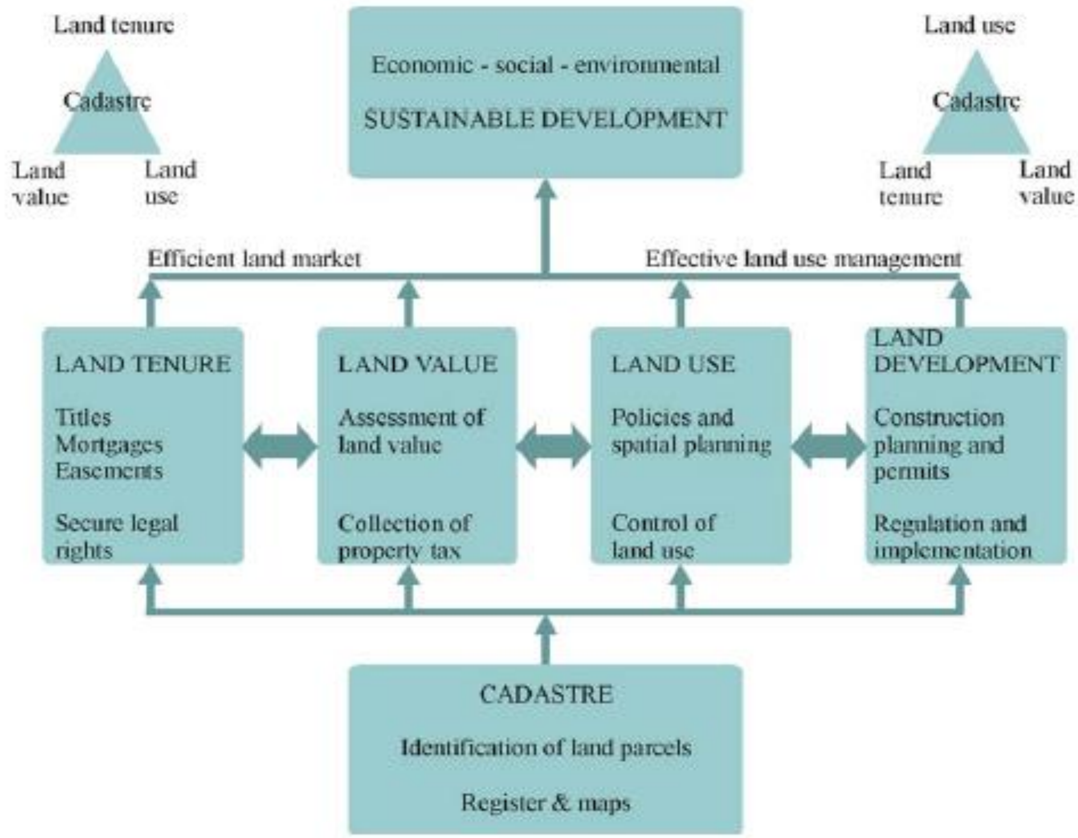


Figure 2: Global approach To Land Administration Systems

Source: Enemark and Sevatdal (1999)

Enemark (2001) further explains the various ranges of subsystems that comprise land administration system as illustrated in Figure 2 above:

1. **Land Tenure System:** this is the securing, allocation and security of rights in lands. This is a legal surveys meant to determine parcel boundaries; the transfer of property or use from one party to another through sale or lease; use of land as security; and the management and adjudication of doubts and disputes regarding rights and parcel boundaries.
2. **Land Value System:** The land value system is the assessment of the value of land and properties; the gathering of revenues through taxation; and the management and adjudication of land valuation and taxation disputes.
3. **Land Use System:** this system is principally anchored on the regulatory function of land administration. It relates to the control of land use through adoption of planning policies and land use regulations at the local, national and regional levels. The land use system also executed through the enforcement of land use regulations; and the management and adjudication of conflicts emanating from the various land use types.

4. **Land Development System:** this involves the building of new physical infrastructure; the implementation of construction planning and change of land use through planning permission and granting of permits; and management of complaints and disputes.

All these land administration subsystems are interwoven following that the actual economic and physical use of land and properties influences the land uses, also the adequacy in the management of land tenure, land value and land development subsystems will lead to effective land market. The connection together of efficient and effective land market and land use administration will lead to the establishment of a sustainable approach to economic, environmental and social development. Enemark (2004) further mentioned that this system should include land registration, cadastral surveying and mapping, comprehensive natural and built environment datasets, valuation and taxation systems, land use control systems, and land development processes of regulating land and property development measures.

Enemark *et al* (2005) further explained that a modern Land Administration Systems operates within the jurisdiction of adopted land policies that fulfil political objectives with regard to land issues. It also works within an institutional framework that imposes mandates and responsibilities on the various agencies and organisations and also concerned with providing comprehensive information at the individual land parcel level and it should service the needs of both the individual and the community at large.

3.0 NIGERIA'S CURRENT LAND ADMINISTRATION SYSTEM

Nigeria's land administration system is fashioned towards a uniform decentralized approach to land use management which places the decision making on governors of each state within the territory of Nigeria. However, the efficiency in the administration of land in Nigeria is lacking due to the shortcoming of the existing land policy. The policy has been cruised for lack of socio-cultural considerations as well as its rigidity in terms of practical implementation.

Nigeria presently has up to 38 land registries at both State and Federal levels with different standards (Ukaejiofo, 2009). In addition, some local government areas also have registries within their domain with land information system that is differing from that of the state. Some states have also embarked on computerization of their land administration system some with also reforms that majorly focus on re-certification programme without taking into consideration social context of land holding system. States like Lagos, FCT Abuja, Kano and Niger have embarked on the establishment of Geographical Information System units for their land records and administration however, this is limited to mainly urban areas.

Apart from the above, the cadastral system in Nigeria is still mostly analogue with files stored and retrieved manually for cadastre related activities (Vaibhav, 2015). The cadastral survey methods employ instrumentation such as T2 and EDM/steel band for cadastral survey (Akpoyoware, 2003). Most of the part of the country are poorly mapped and have outdated base maps. Some maps are based on local origin due to absence of control points and contradicting maps of the same area can emerged (Vaibhav, 2015).

4.0 IDENTIFICATION OF CHALLENGES

The following are the major challenges of land administration system in Nigeria as a developing country:

a. ***Policy Level* -** According to Atilola (2010), the Land Use Act was revolutionary because it unifies and nationalizes the land tenure system all over the country. The Act leads to the creation of statutory title to land covered by Certificate of Occupancy which is issued to all leaseholders. However, the Land Use Act did not fulfil all its potential to transform the land administration system in the country due to technical, institutional, social reasons and lack of sincerity and political on the part of various governments to implement and review the Act.

b. ***Institutional Framework*** – this is one of the prominent challenges to the successful land administration in the Nigeria and other developing countries. Majority of all these countries face the existence of multiple organizations all empowered by different legislations to participate in the delivery of some part of land administration cycle. Their powers often overlap and add to bureaucratic red-tape, which allows agencies to remain self-serving without regard to community needs and demands. This confusion on these processes and power play lead to the emergence of various form of forms of corrupt practices such as informal fees, cronyism among others that rule out the least able from participating in the formal land market and gaining security of tenure.

c. ***Legal framework* -** characterized by a multiplicity of overlapping land-related laws, compiled over decades with little attempt to rationalize the ambiguity resulting from successive legislation. Possible conflicts between customary and/or informal systems of land tenure and state-supported formal systems of land registration are an issue in all developing countries.

d. ***Technical Issues* -** Low skill levels and severe shortage of resources are technical issues common to all developing countries especially Nigeria. Also the absence of prerequisite base maps for determining the ownership of land, the non-explicit demarcation of urban and rural land and obsolete national cadastre and geospatial data infrastructure are some of the barriers to modern land administration system in a developing country like Nigeria.

e. ***Operation of Land Use and Land Titling*** - the "Trustees of Land Use Act" (Governors and Local Government Chairmen) have seen the act as a political weapon leading to lack of transparency and selective administration of its provisions. The operation of obtaining title to land is also expensive and cumbersome and it is limited to urban areas.

5.0 THE WAY FORWARD:

5.1 The Development of Indigenous Integrated Land Administration System Model

The ingredients of the global integrated land administration system model (Fig 2) is the model which policy makers and government of developing countries can use to measure their existing system and serve as a tool for change. The major focal point of this model is Integration and standardization and this will enable the developing countries to look inward in modifying the existing land administration system model to suit both local socio-cultural and economic needs. The evolution of modern land information through the embracement of Information Communication Technology (ICT) and Geographical Information System (GIS) have offer essential infrastructure which serve as a gateway for quick and effective access to information and development of standard for land titling and registration processes (Ukaejiofo, 2009).

Land Information System (LIS) is a branch of Geographical Information System (GIS) which is a computer based spatial land administration system designed basically for recording and managing land ownerships, tenure and all other rights therein (Ukaejiofo, 2009). Therefore, all developing countries should adopt a standardized one in managing land spatial information because of its significant to economic development and environmental management. The world is now a global village, the government and people of developing countries need to move with global changes. This is because transaction in land and landed properties is now possible online through the internet as long as it is validated.

Table I: the ingredients of an integrated Land Administration System (LAS(Model

INGREDIENTS OF THE INTEGRATED LAS MODEL		
	INGREDIENT	**DESCRIPTION**
1.	**Integrated vision to drive sustainable development**	Economically, environmentally and socially sustainable development (EESSD) is the policy driver for the integration of functions in Land Administration Systems (LAS)
2.	**Servicing e-democracy and e-governance**	These are not scientific terms but refer to citizen participation and government capacity being developed in land administration through web and spatial enablement of systems. Integration for purposes of e-democracy and e-government remains the major potential deliverable of the LAS model.
3.	**Built on country capacity**	Unique historical and cultural circumstances are incorporated.
4.	**Delivered through web environment**	ICT enabled and spatially enabled systems.
5.	**Covering essential areas of land administration**	Land registration, land valuation, land use planning and land development aimed at sustainable land management.
6.	**Universalisable**	In recognition of the regional and global dimensions of land administration, the model is attractive to national governments and potentially delivers seamless regional and global information and policy support.

Source: Enemark *et al (*2005)

5.2 The Need for Re-Invention of Estate Management Profession as a Key Player in building modern Land Administration System in Nigeria

Estate Surveyors and valuers in Nigeria have always been a major player in land administration and land market operations. However, there is need to change focus from being seen very much in traditional context of operation to contemporary one that embrace ICT as a tool of professional development. It becomes imperative for real estate profession through Nigerian Institution of Estate Surveyors and Valuers (NIESV) and Estate Surveyors and Valuers Registration Board of Nigeria (ESVARBON) to encourage the members to seek knowledge in the area of ICT and GIS. The estate surveyors and valuers should also prompt to be a frontrunner in the development of modern Land information system through the development of integrated land administration system model that will move Nigeria's system from been a "provider" driven to "user" driven. To support such a process there is needs for a valid valuation and property rating system which are core of services provided by the profession.

6.0 CONCLUSION

Mabogunje (2007) argued that government should take a firm responsible with respect to development of good and vibrant modern land administration. The inadequacies of the current land administration system in the developing countries like Nigeria still make land to remain a dead capital which locks away the economic value of land. A modern land administration system should been seen as tool that facilitate smooth operations of the land market and unlock the value.

Developing countries around the world should also re-engineer the land registration and cadastral system to meet the increasing demand placed on them by embracing new information technology as well as computerization of existing records. This is through the conversion of old analogue form to digital form so as to be in position to analyze data and monitor trends in land market. Therefore, modern integrated land administration system should be built based on the existing modified structure on ground but it must be back up with major integrated land administration system model which focus on information as a commodity to provide a modern framework that will meet demand of sustainable development.

REFERENCES

Akpoyoware, A.O. (2003*). Towards Improved Cadastral Services from Federal Ministry of Works and Housing, Nigeria. (A Scenario for Change).* M. Sc Thesis submitted to International Institute for Geo-information Science and Earth Observation, Enschede, The Netherlands.

Atilola, O. (2010). *Land Administration Reform Nigerian: Issues and Prospects*. Paper presented at FIG Congress on Facing the Challenges – Building the Capacity, Sydney, Australia.

Burns, T., Grant, C., Nettle, K., Brits, A. and Dalrymple, K. (2007). *Land Administration Reform: Indicators of Success, Future Challenges*. Land Administration Final Draft. May 2007. World Bank Report.

Constitution of the Federal Republic of Nigeria, 1999 – Land Use Act Cap L.5, 2004.

Cotula, L., Camilla Toulmin, L. & Hesse, C.(2004). *Land Tenure and Administration in Africa: Lessons of Experience and Emerging Issues.* International Institute for Environment and Development, London.

Dale, P. (2000).*The Importance Of Land Administration In The Development of Land Markets - a Global Perspective*. Department of Geomatic Engineering, University College, London, England.

Dale, P. and McLaughlin, J. (1999). *Land Administration.* Oxford University Press

Enemark, S. (2004). *Lecture note on Land Administration Systems 2*. Aalborg University, Denmark

Enemark, S.(2001). Land Administration Systems-A Major Challenge For The Surveying Profession. *Surveying and Land Information Systems*, 61(4):267-276.

Enemark, S. & Sevatdal, H. (1999): *Cadastres, Land Information Systems and Planning – is decentralisation a significant key to sustainable development ?* Technical Papers of UN/FIG Conference on Land Tenure and Cadastral Infrastructures for Sustainable Development, Melbourne, Australia.

Enemark, S., Williamson, I.P. & Wallace, J., (2005). Building Modern Land Administration Systems in Developed Economies. *Spatial Science* 50 (2): 51–68.

Mabogunje, A.L. (2007). *Development as Societal Transformation and Empowerment*. Lecture Delivered at the Retreat of the People's Democratic Party, Abuja, January 8.

Steudler, D., Williamson, I. P. & Rajabifard, A. (2003). The Development of a Cadastral Template. *Journal of Geospatial Engineering.* 5 (1): 39–47.

Ukaejiofo, A. N. (2009). *Land Titling and Registration as Necessary Factors in the national Land Reform Programme*. Paper presented at 39th Annual Conference of the Nigerian Institution of Estate Surveyors and Valuers, Awka, Anambra State.

United Nations Economic Commission For Africa (ECA) (2003). *Land Tenure Systems and Sustainable Development in Southern Africa*. ECA/SA/EGM.Land/2003/2. Lusaka, Zambia.

United Nations Economic Commission for Europe UNECE (1996). *Land Administration Guideline with Special Reference to Countries in Transition*, United Nation, Geneva.

Vaibhav, A. (2015*). Cadastre in Africa: A Leap towards Modernization*. http://www.geospatialworld.net/Regions/ArticleView.aspx?aid=2514

EVALUATION OF SITE PROGRESS RECORDS FOR EFFECTIVE PROJECT MANAGEMENT IN ABUJA, NIGERIA

Bajere, Paul Abayomi and Mohammed, Nasiru Abubakar
Department of Building, Federal University of Technology, Minna, Nigeria

Progress records such as monthly progress report, or site diaries are important tools for tracking construction progress and ensuring full compliance of the building contractors to statutory standards. Accuracy of these records is also important for quality assurance avoidance of delay in the construction process, finance, preparation, analyzing and resolution of claims in the event of failure or breach of contract. Literature reviewed identified a range of problems with respect to the quality, accessibility, legibility, continuity and consistency of these records. The objectives of this study was to identify the uses of site progress records, the importance of site progress records in building construction, and the problems encountered when compiling he records. Research methodology involved the use of structured questionnaire and site visitation to the various building construction site within the study area. Analysis of data involved the use of description statistics. Findings indicated that among all the parameters surveyed in the application of site progress records for effective project management, the most outstanding ones are 'effective site management and supervision', 'proper project planning and scheduling' and use up to date technology utilization. A possible explanation for this is that the quality of the construction work carried out will turn out to be good and it will also aide quick time delivery of the construction process. It was concluded that the necessity in keeping site progress records for effective project management are considered to be useful for construction project execution. It was recommended that resources should be provided for making and keeping of back-up of all records generated in the course of project management and the use of statutorily registered professionals for public projects should be advocated.

***Keywords**: Construction Process, Effective Construction Project management; Site Progress Records*

paulbajere@aol.com

Bajere, Paul Abayomi and Mohammed, Nasiru Abubakar (2016). **EVALUATION OF SITE PROGRESS RECORDS FOR EFFECTIVE PROJECT MANAGEMENT IN ABUJA, NIGERIA** Sustainable Built Environment and Climate change; The challenges of Post 2015 Development Agenda. School of Environmental Technology Conference, SETIC, 2016

Introduction

Progress monitoring and controlling is one of the most important tasks of construction project management and every team member needs to know in a timely and accurate manner, how the project is progressing (Memon *et al.,* 2006). Progress records include monthly progress report, day work sheets, photographs, weekly progress report, site diaries and daily report (Scott *et al.*, 1997; Scott *et al.*, 1999; Oribuyaku, 2008). These records are useful for quality assurance, finance, tracking progress, preparing, analyzing and resolving claims, and placing of responsibilities in the event of failure (Scott and Assadi 1997; Kartarm, 1999). The supervisor may be an individual or a team efforts, to act on behalf of the procuring agency to ensure compliance with acceptable building production standards as specified in the contract documents.

One main task of the supervising team on a building construction project is that of keeping good records of what actually takes place during the construction process on a daily basis.

Site reports and problems communicated between the contractor and the supervisor are recorded in the site diary (Oribuyaku, 2008). Summarizing the daily site report produces the foundation upon which the as-built scheduled will be developed (Kartam, 1999). Despite its importance, there are problems in respect to the quality of these records (Scott *et al.,* 1997, 1999; Summerville et *al.,* 2004). The range of identified problems deals with; accessibility, legibility, continuity and consistency (Nesiama, 2009; Sommerville, Craig and Carmey, 2004; Scott and Assadi 1999; Scott *et al.,* 1999; Summerville et *al.,* 2004). Poor record keeping has been identified as one of the most influential factors in limiting contractors' abilities for good claims preparation and presentation (Mbamali, 1996; Kartam, 1999; Kululanga *et al.,* 2001). Most importantly, records are kept to document claims or to guard against claims or extra costs caused by the wide spectrum of delays or changes during the construction process (Rubin *et al.,* 1999).

Site progress record keeping is needed for a range of purposes which include control of the on-going work, estimation of future work, preserving the contractor's right under the contract and ensuring progress of work in accordance with designed specification (Wildman, 1990).

Accurate information on the building process is required to trigger early counter-measures and to avoid costly delays in the construction process. Nowadays, the documentation of the construction process usually takes the form of written records which are filed in folders on the construction site or at the companies. In addition, work that are carried out on building construction site and are not properly recorded on a regular basis and can result in a financial risk for small and medium-sized companies in particular, but even big companies lose money too.

The aim of the study is to evaluate the application of site progress records for effective project management. The objectives are: 1.) To identify the use of progress records kept by construction managers, 2.) To evaluate the importance and level of satisfaction of progress records kept by site managers, 3.) To evaluate record keeping standard in terms of accessibility, legibility, continuity and consistency.

Four research questions for the study are: 1.) What are the uses of site progress records? 2.) problems are encountered in compiling the records? 3.) What is the importance of site progress records in building construction management? 4.) How can record keeping be improved, for effective project management?

Timely and accurate communication of project's progress is very important for every team member needs to know, in a timely and accurate manner, how is the project progressing, where they are currently in comparison to the initially set plans, whether deadlines are met, budgets are safely measured and followed. It is mainly the responsibility of the general contractor to update the architect or engineer, who in turn updates the owner. (Memom, Majid and Mustaffer, 2006).

Limited literature is available on project progress monitoring and control. Previous research efforts on project control focus on the development of cost control models (Hastak, Halpin and Vanegas, 1996). Most construction project employ scheduling methods to monitor and control the progress of work and develop progress reports, which involve the recording of construction achievements for detection of deviations from actual plan and for forecasting project performance. The primary control system used by project managers to mitigate time-based claims in construction industry is construction schedule (Conlin, J. and Retik, 1997). The execution phase of any construction project has been adjudged to be the most demanding and difficult position of the project for the construction team (Olusola *et al.,* 2002).

The current practice of project control is entirely dependent on cost, schedule, quality reports and personnel performance reviews (Sanvido and Paulson 1992). On most construction sites, a considerable volume of records would be amassed by the main parties, and records kept, cover a variety of aspects of the construction work these constitute the site record (Scott *et al.* 1997). The records relate to progress, finance and quality of the work. These records are maintained throughout the contract period for different purposes, ranging from providing a means of monitoring and controlling the construction process, to performing a fundamental role in resolving construction conflicts and disputes (Scott *et al.,* 1998).

Construction sites are information intensive environments (Chen and Kamara, 2008). Various construction personnel in the field need large amounts of information ranging from project design drawings to personal diaries to support their ongoing work (Chen and Kamara, 2008). The prudent contractor anxious to stay solvent, always require records for estimating future work, and for protecting his contractual right. There may be an argument that reliable data cannot be extracted from records after the fact that hand written records serve to provide the solid reminder (Wildman, 1990). These records are kept to document claims or to guard against claims or extra costs caused by the wide spectrum of delays or changes (Rubin *et al.,* 1999).

Chikara, (2008) classified the set of records into six categories. These include the following;

(1) Pre-bid Documents: invitation to bid, site visit notes, photographs, minutes of pre-bid meetings, proposed schedules and project log.

(2) Bid Documents: all supporting bid calculations, quantity take offs, subcontractors and suppliers quotations, estimated productivity of labor and equipments, proposed project schedule details; written memoranda of each quotation together with date and names of all parties involved; consultants reports; the names of other bidders and their bid amounts.

(3) Pre-contract documents:- minutes of negotiation meetings minutes of qualification hearings (where applicable); job schedules; and any other new photographs or addenda

(4) Contract Documents: original contract tender documents and all subsequent revisions, instructions to contractor; contemplated change notices issued by the owner; and sub-contractor quotations, purchase orders and correspondence.

(5) Construction Documents: these include documents used and generated in the construction process. These include duplicate copy of contract tender documents, shop drawings, daily time and equipment records, daily diary, progress photographs.

(6) Post construction documents: as built drawings; building operation and maintenance manual, maintenance schedules and records of maintenance work effected on the building Nesiama, (2009).

The performance of the construction industry in Nigeria has consistently been a source of concern to both public and private sector clients; the industry is characterized by repeated delays, cost overruns and collapse of buildings (Oyedele *et al.*, 2005).The popular saying 'if you fail to plan, you plan to fail' is equally true in the building production process (Ayo, 2004). The contractor is encouraged to monitor, regulate and accurately report progress and events, without bias (Emiowele, 2002). The main objective of monitoring is to achieve efficient and reliable project performance and at the same time provide feed-back to the management on the position of the project so that changes could be made when there is need for such, thus avoiding any short comings and constraints (Odusami, 2002).

Control refers to the process of comparing actual performance with planned performance, analyzing variances, evaluating possible alternatives, and taking appropriate corrective action as needed (PMBOK, 2000); it therefore includes monitoring and some level of evaluation. According to the NIOB (2006), through monitoring and evaluation you can; review progress records on site, identify problems in planning or implementation and make adjustments so that you are more likely to make a difference.

There is a strong relation between project management and project performance. Cheung et al., (2004) studied the project performance related to project managers. It is remarked that development of a Web-based construction Project Performance Monitoring System (PPMS) can assist project managers in exercising construction project performance indicators and can help senior project management, project directors, project managers, etc., in monitoring and assessing project performance.

Pheng and Chuan (2006) stated that while project management is only one of the many criteria upon which project performance is contingent, it is also arguably the most significant as people formulating the processes and systems who deliver the projects. Ugwu and Haupt (2007) stated that an adequate understanding and knowledge of performance are desirable for archiving managerial goals such as improvement of institutional transformations, and efficient decision making in design, specification and construction, at various project-level interfaces, using appropriate decision-support tools. Ling et al (2007) investigated project management (PM) practices adopted by Singaporean construction firms. It was determined the performance level of their projects in China; identifies PM practices that led to better performance; and recommended key PM practices that could be adopted by foreign construction firms in China to improve project performance.

Success of construction projects depends mainly on success of performance. Many previous researches had been studied performance of construction projects. Dissanayaka and Kumaraswamy (1999) remarked that one of the principle reasons for the construction industry's poor performance has been attributed to the inappropriateness of the chosen procurement system. Reichelt and Lyneis (1999) remarked three important structures underlying the dynamic of a project performance which are: the work accomplishment structure, feedback effects on productivity and work quality and effects from upstream phases to downstream phases. Thomas (2002) identified the main performance criteria of construction projects as financial stability, progress of work, standard of quality, health and safety, resources, relationship with clients, relationship with consultants, management capabilities, claim and contractual disputes, relationship with subcontractors, reputation and amount of subcontracting. Chan and Kumaraswamy (2002) stated that construction time is increasingly important because it often serves as a crucial benchmarking for assessing the performance of a project and the efficiency of the project organization.

Cheung et al., (2004) identified project performance categories such as people, cost, time, quality, safety and health, environment, client satisfaction, and communication. It was obtained by Navon (2005) that a control system is an important element to identify factors affecting construction project effort. For each of the project goals, one or more Project Performance Indicators (PPI) is needed. Pheng and Chuan (2006) obtained that human factors played an important role in determining the performance of a project. Ugwu and Haupt (2007) remarked that both early contractor involvement (ECI) and early supplier involvement (ESI) would minimize constructability-related performance problems including costs associated with delays, claims, wastages and rework, etc. Ling et al (2007) obtained that the most important of practices relating to scope management are controlling the quality of the contract document, quality of response to perceived variations and extent of changes to the contract. Tangen (2004) remarked the choice of a suitable measurement technique depends on a number of factors, including the purpose of the measurement; the level of detail required; the time available for the measurement; the existence of available predetermined data; and the cost of measurement.

Navon (2005) defined performance measurement as a comparison between the desired and the actual performances. For example, when a deviation is detected, the construction management analyzes the reasons for it. The reasons for deviation can be schematically divided into two groups: (a) unrealistic target setting (i.e., planning) or (b) causes originating from the actual construction (in many cases the causes for deviation originate from both sources). Navon (2005) stated that performance measurement is needed not only to control current projects but also to update the historic database. Such updates enable better planning of future projects in terms of costs, schedules, labor allocation, etc. Pheng and Chuan (2006) stated that the measurement of project performance can no longer be restricted to the traditional criteria, which consist of time, cost and quality. There are other measurement criteria such as project management and products.

It is widely accepted view that, at a minimum, performance measures of a project are based on time cost and quality (Barkley and Saylor, 1994). Atkinson (1999) noted that these three components of project performance as the ‘iron triangle’. However, Kumaraswamy and Thorpe (1999) considered variety criteria in measuring a project. This includes meeting budget, schedule, and the quality of workmanship, stakeholder's satisfaction, transfer of technology, and health and safety. Similarly, Chan and Tam (2000) noted that various other key components also used in measuring project performance such as health and safety, environmental performance, user expectation/satisfaction, actor's satisfaction and commercial value.

Methodology

The population of the study is construction managers on building construction projects site in Abuja and they consist of Architects, Builders, Engineers, consultants and contractors involved in project supervision. The sample criteria used for the research was based on the age of the organization, the staff strength, the years of experience of the staff working in the organization and the professionals working in the organization: 1.) 1.00 – 1.49 (Strongly Disagree); 2.) 1.50 – 2.49(Disagree); 3.) 2.50 – 3.49 (Undecided); 4.) 3.50 – 4.49 (Sometimes); 5.) 4.50 – 5.00 (Strongly Agree). The following instrument was used in collecting data for the purpose of the research work: i.) Field survey, ii.) Interview, and i.) Use of questionnaire

A total number of 100 (one hundred) copies of structured questionnaires was administered out of which seventy-one (71) was received representing a response rate of 71 %. At least, a copy of the questionnaire got to every major professional in the construction industry. Oral interview was also conducted to get more facts on the subject matter. Out of all the questionnaires distributed to respondent, only 71 was properly filled and returned which represent 71% of the total population of the study area

Data Presentation, Analysis and Discussion

This chapter will present the data obtained from the field survey and will be analyze by using statistical tools like frequency tables. The last part of this chapter will contain an interpretation of the data.

Table 1: Respondents by the Professionals.

Professionals	Frequency	Percentage
Architects	20	28
Builders	17	24
Engineers	28	39
Quantity Surveyors	2	3
Property Managers	4	6
Total	71	100

Source: Field Survey (2015)

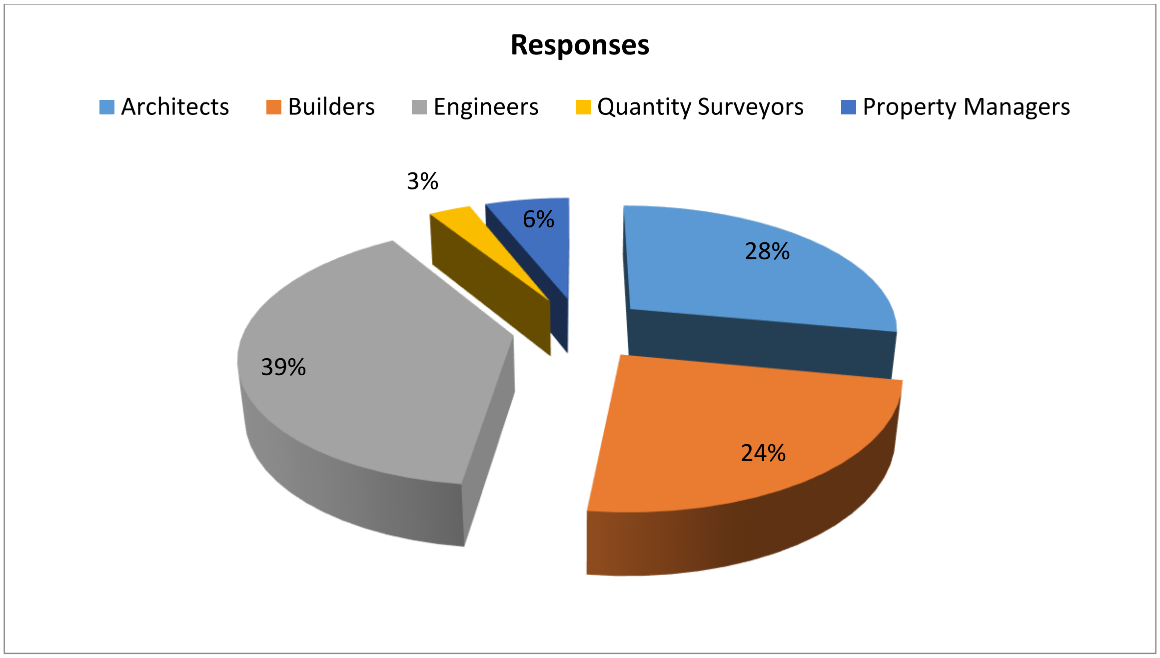


Figure 1: Proportion of respondents' by the professionals.
Source: Author Field survey 2015

Figure 1 showns the ranking by profession. As shown, out of the 71 responses obtained, the analysis shows the respondents consisted of Builders having 24%, Architects 28%, Engineers 39%, 3% consisting of Quantity Surveyors and 6% consisting of Property Managers.

Table 2: Years of Working Experience by Respondent.

Years of Experience	Frequency (No)	Percentage (%)
0 – 5 years	13	18
6 – 10 years	17	24
11 – 15 years	24	34
16 – 20 years	8	11
Above 20 years	9	13
Total	71	100

Source: Field Survey (2015)

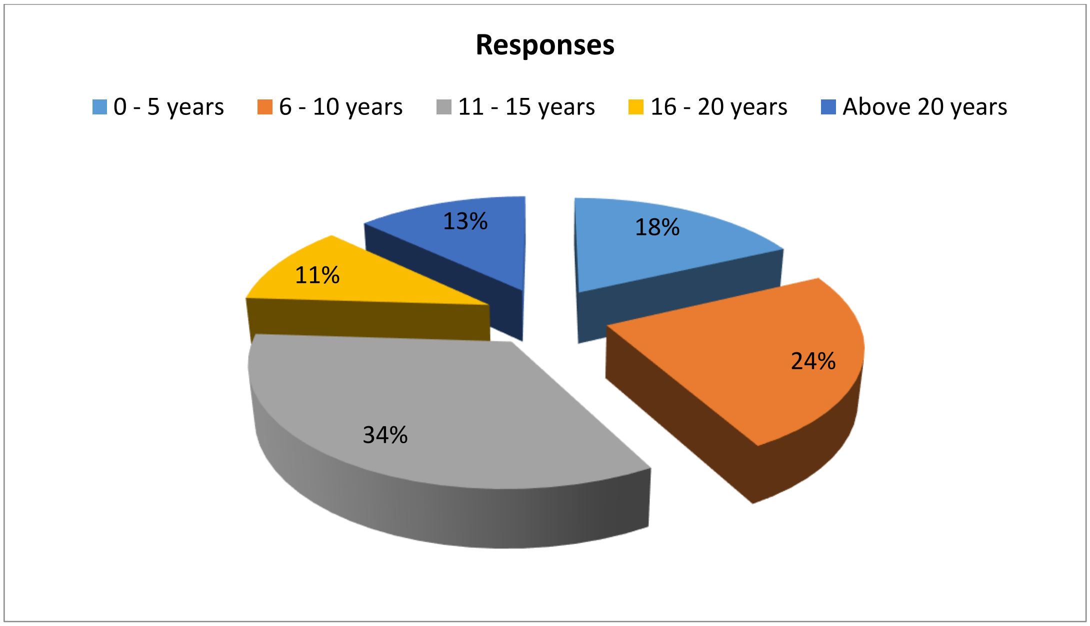


Figure 2: **Respondents Working Experience**
Source: Author Field survey 2015

The figure above shows that the respondents working experience' vary from five years to more than twenty years, with a mean working experience of eleven 11 years which also show that majority of the respondent working experience ranges between 11 to 15 years which represents 34% out of the total response.

Table 3: Category of Firms by Respondents

Responses	Frequency (No)	Percentage (%)
Small	3	4
Medium	8	11
Large	60	85
Total	71	100

Source: Field Survey (2015)

Table 4: Parameters of site progress records for effective project management

ITEMS	1		2		3		4		5		Mean
Parameters	FQ	%	FQ	%	FQ	%	FQ	%	FQ	%	
Effective strategic planning	5	7%	9	13%	11	15%	19	27%	27	38%	3.8
Proper project planning and scheduling	2	3%	6	9%	10	14%	18	25%	35	49%	4.1
Effective site management and supervision	2	3%	5	7%	3	4%	15	21%	46	65%	4.4
Frequent progress meeting	3	4%	7	10%	13	18%	23	33%	25	35%	3.8
Proper emphasis on past experience	2	3%	5	7%	12	17%	30	42%	22	31%	3.9
Use of experienced subcontractors and suppliers	3	4%	7	10%	15	21%	19	27%	27	38%	3.8
Use of appropriate construction methods	6	8%	9	13%	13	18%	19	27%	24	34%	3.6
Use up to date technology utilization	2	3%	5	7%	11	15%	24	34%	29	41%	4.0
Frequent coordination between the parties	2	3%	4	6%	5	7%	32	45%	28	39%	4.1
Perform a preconstruction planning of project tasks and resources needs	6	8%	9	13%	12	17%	25	35%	19	27%	3.6
Comprehensive contract administration	5	7%	9	13%	12	17%	21	29%	24	34%	3.7
Improving contract award procedure by giving less weight to prices and more weight to the capabilities and past performance of contractors	6	8%	9	13%	8	11%	27	38%	21	30%	3.7

Source: Author Field survey 2015

5= Strongly Agree, 4= Agree, 3= Undecided, 2= Disagree, 1= Strongly Disagree

FQ =Frequency, % = Percentage

Table 4.4 shows that majority of the respondents Agree that Effective site management and supervision, Proper project planning and scheduling, Frequent coordination between the parties, Use up to date technology utilization and Effective strategic planning having a high percentage rating of 65%, 49%, 41% and 38% with a mean of 4.4, 4.1 and 3.8 respectively can be implemented for effective site progress records.

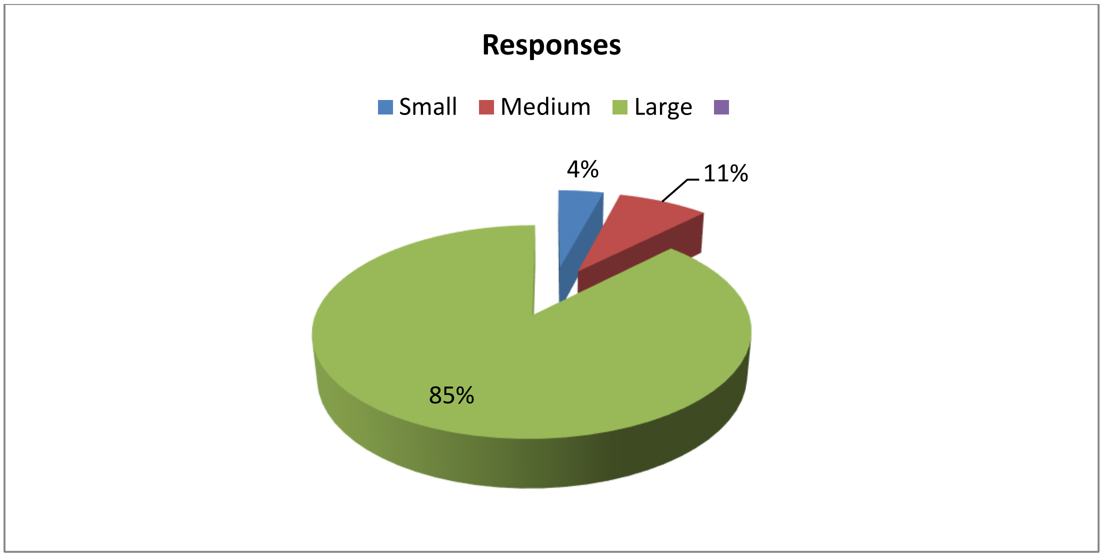


Figure 3: Profile of the Organizations
Source: Author Field survey 2015

The categorization of firms where the respondents work is based on The Federal Ministries of Works categorization. Large firms make up the vast majority (85%), medium and small firms make up the remaining 11% and 4% respectively.

Conclusion

Among all the parameters surveyed in the application of site progress records for effective project management, the most outstanding ones are 'Effective site management and supervision', 'Proper project planning and scheduling' and Use up to date technology utilization. For example, majority of the respondents ranging from 65%, 49% and 41% with a mean of 4.4, 4.1 and 3.8 respectively "Agree" that such parameters can be used in improving the site progress records effective project management couple with the fact that the quality of the construction work carried out will turn out to be good and it will also aide quick time delivery of the construction process.

The necessity in keeping site progress records for effective project management is considered to be useful for construction project execution. Based on the research findings, and in other to improve project management effectiveness, the following recommendations are suggested: a.) the use of statutorily registered professionals for public projects. b.) It was also advocated that resources should be provided for making and keeping of back-up of all records generated in the course of project execution, c.) use of computer for accurate record keeping was also suggested.

REFERENCES

Ayo, B. (2004). Building production management. Foresight Press Limited, Lagos, Nigeria.

Chen. Ya., and Kamara, J. (2006). The mechanism of information communication on construction sites. FORUM E journal. 8 pp 1- .

Chitkama, M. (2004). Successful construction: Code of Practice for Clients of Construction I Industry. CIB Netherland.

Kartam, S. (1999), Generic methodology for analyzing delay claims. *Journal of Construction Engineering and Management. 125 (6): 409 – 419.*

Kululanga, G.K, Kuotcha, W., McCaffer, R., and Edum-Fotwe, F. (2001) Construction contractors' claim process framework. Journal of Construction Engineering and Management 124 (4): pp 309 – 314.

Mbamali, I. (1996) Contractors' Problems in Construction Claims Preparation and Presentation. Spectrum, Kaduna Polytechnic vol. 3: pp 105 – 113.

Memom, Z.A., Majid, M.A., and Mustaffer, M. (2006). Digitalizing construction monitoring (DCM): An overview of Malaysian construction industry ad proposing prototype software. Asia – Percific Structural Engineering and Construction conference. Pp D – 15 – 27 .

Orinbuyaku, J.T. (2008a). Duties of the contractor's site representative on construction and World Bank projects. Association of consulting Engineers Nigeria.

Orinbuyaku, J.T. (2008b). Legal issues in supervision of construction projects Association of consulting Engineers Nigeria.

Orinbuyaku, J.T. (2008c). Overview of duties of resident Engineer on construction projects. Association of consulting Engineers Nigeria.

Oyedele, O.L., and Tham, W.K. (2005). Examining Architects' performance in Nigerian private and public sector building projects Engineering, Construction and Architectural management. 12: pp 52 – 68.

Rubin A.R., Fairweather, V., Sammie, D.G. (1999). Construction Claims. John Wiley and Sons Inc. New – York.

Sanvido, V.E. and Paulson B. Site level Construction Information System. *Journal of Construction Engineering and ManagementASCE (1992). 118: 701-715.*

Scott, S. and Assadi, S. (1997). Toward an electronic Site Diary. Construction information digital library, 78; - pp 349 – 358.

Sommerville, J., Craig, N., and McCarney, M. (2004). Document transfer and communication between district construction professionals. The construction and building research conference of the Royal Institute of Chartered Surveyors. Pp 1 – 10.

Wildman, R.M. (1990). Construction claims identification, communication and record keeping. TUNS/Revay Seminar.

CHALLENGES OF PROPERTY RATING ASSESSMENT IN KARU LOCAL GOVERNMENT AREA OF NASARAWA STATE

Celina, A., Kolo, M.Z and Ajayi, M.T.A
Department of Estate Management and Valuation, Federal University of Technology, Minna.

The Local Government Reform of 1975 strengthens the fact that Local Government as the third tier of Government, which directly impacts the people should have a concrete source of generating revenue independent of the central allocation by exploring property rating which is a good source of generating income for the Local Government. This form of tax is known to generate revenue to the government for the provision of the necessary infrastructures. The non-passing of "the Karu Local Government Tenement Rate Law" into Law by the State House of Assembly has limited the power of the rating authority to prosecute defaulters, lack of political will and inadequate records on properties just to mention a few. The research explored both primary and secondary which were synthesised for the purpose of underpinning the challenges of property rating assessment in Karu area of Nassarawa State. Findings have revealed that lack of accessibility resulting from bad road networking in the area, non-participation of professionals in carrying out the assessment exercise has been identified to be part of the problems working against a successful property assessment. This paper aims at investigating other challenges associated with assessment of properties for rating purpose within the Karu Local Government area by the use of questionnaires which would be administered within the subject area with the aim of identifying the problems of rating assessment and making suggestions on how to improve the income of the local government through rating assessment.

Key words: *Tenement, Property, Government, Law, Authority*

celinaadecks@yahoo.com

aminamzkolo@gmail.com

Celina, A., Kolo, M.Z and Ajayi, M.T.A (2016). **CHALLENGES OF PROPERTY RATING ASSESSMENT IN KAR U LOCAL GOVERNMENT AREA OF NASARAWA STATE** Sustainable Built Environment and Climate change; The challenges of Post 2015 Development Agenda. School of Environmental Technology Conference, SETIC, 2016

1.0 INTRODUCTION

The quality of our living environment depends largely on the ability of the State and Local Government to render services. This also includes their ability to maintain and manage these services on a regular basis. The provision and maintenance of basic infrastructural facilities and the execution of various development projects are limited by lack of funds. But such services can and should readily be provided if the local administration is able to organize and motivate the citizens to its civic responsibilities. This is by making regular and proper contributions through appropriate payment of taxes, levies and property rates. This can in turn be judiciously used by the administration to provide infrastructure and facilities for the common use of the community members.

Property rating as a source of revenue for the Local Government in Nigeria has for a long time not been fully and effectively exploited. State and Local government depend largely on federal grants and revenues allocated from Federation account. Not until now, other sources of revenue remain largely untapped and unexploited. This has subsequently contributed to the inability of the various governments to provide facilities and social amenities to its citizens.

i. **Assessment:** process of setting the value of real or personal property, usually for the purpose of taxation.

ii. **Property:** from a legal sense, according to ETON *et. al.* (1980) in the book titled "Modern Methods of valuation" property can be defined as the interest which can be acquired in external object or thing, but they constituted its foundation and material and aimless of property spring out of the connection or control or interest which according to law may be acquired in them or over them.

iii. **Rating:** this is an assessment of a property according to certain indices. This is in order to show much or how little of a quality it possesses.

iv. **Property Rating**: According to Oyegbile (1996) "property rating" is a form of tax levied on real property and it is normally charged at the local government level for raising the required revenue to carry out specific development project" it is always in the execution of certain project of the government.

The history of property rating in Nigeria dates back to our traditional system of local tax contribution, which was administered by Emirs, Chiefs and Kings in various communities before the advent of British rule in Nigeria. During that period, tenement rate was not known, what existed were traditional method of tax collection, which was referred to as "sweat tax" people believe that, this system of tax is the same with tenement rate. In those days members of communities in Nigeria individually or collectively contribute to carry out development projects. It was a relief and help to the members of the community. The contribution made towards projects such as real property development could either come in kind or cash, some contribute their farm products to raise money to carry out projects while others contribute their labour.

The rating system in its modern form started in Nigeria in the early years of the 19th century by the British colonial masters. The first of the statue to that effect is found in chapter 15 of the laws of the federation of Nigeria, the assessment ordinance of May 1915. It prescribed the method of assessment.

In the former northern region, the assessment law CAP 8 of the 1963, provided for the assessment of property for rating purpose, the Kano township rate was conducted under this law excluding Sabon Gari Area of Kano town. Kano was the first and only town where rating was carried out in Northern region during that period. This was followed by Kaduna and Plateau States much later when additional states were created. Furthermore, the federal government Guideline for local government Reform of 1976 gave a great boost to its development in Nigeria. The reforms emphasized the importance of property rating as a means of financing local government in Nigeria, the various states were empowered to enact local government edict that provided for property rating in their localities.

As a first step in property rating process, every rateable property must be identified, listed and appraised for taxation purpose. This procedure can be comparatively simple in some assessment district while it is often very complex in others. Care must be taken to ensure proper assessment of each hereditament. The procedure of assessment is subject to enabling law of property rating in each state. In order to achieve the aim and objectives for which rating was established, the rating authority should be constituted to carry out the assessment and collection rate. The rating authority is guided by certain statutory provisions and principles. The assessment of all rateable hereditaments for rating purpose has to be made in accordance with statutory provisions as contained in the Edict of various states enabling property law. The success of the assessment depends largely on the skill, experience, exposure and professionalism of the rating authority. The following functions are carried out by the rating authority before the commencement of the assessment.

Letter of instruction or authority:

The authority prepares and issues letter of authority to the Valuer or Assessor to serve as an introduction to the property occupier or property owner in case of any disagreement.

Enabling edict: the authority enlightens the general public about the existence and the importance of the edict and the commencement date of assessment.

The assessment exercise involves the following major steps which can be carried out within the framework of the law. This includes:

Identification of property:

The assessment of property for rating purpose is preceded by a hasty and not thorough survey of the rating area to identify the streets and locate the hereditaments within the area. The exercise includes drafting, mapping, numbering of a parcel and formation of a plan for updating both the area and ownership where streets are unnamed and buildings are unnumbered, the rating authority is then advised to effect naming and numbering of streets and buildings respectively.

Classification of each property

Each hereditament within the rating area must be classified in accordance with an agreed set of characteristics relating to such matters as its uses size, types of construction and improvements. The classification of each property enables the Valuer to give an accurate judgment of value to the property.

Identification of the person responsible for paying taxes

This is to identify the person responsible to pay rate. The person who is in occupation of property during the rate period shall be liable to be charged for that period. It is important to identify the legal owner in case of any default, the Valuer should establish who is the owner; list the owner's name and legal description of his property on the assessment roll. The principle of assessment is the same with the method adopted in valuation of properties for rating purpose. The purpose of any method adopted in rating valuation is to determine the annual value from which ratable value is arrived at. The annual value can be gross or net value depending on the figures obtained from the field. The Valuer must take and record the proper information to avoid any mistake during the valuation. In assessing a property for rating purpose, principles of assessment to be taken into consideration are:

Hereditament must be a value “Rebus sic stantibus” meaning as it is actually standing or existing physical state. The property to be assessed must be valued in its existing condition as at the time of assessment; in determining the value of similar properties, rent passing on comparable properties should be the basis of evidence. Assessment on comparable properties may be considered in the absence of better evidence.

The analysis intends to look at the problems recorded since the introduction of the first ever general assessment of property rates in Karu. As earlier stated, property rating is one of the sources of revenue for Local Government. However, there are problems militating against the effective assessment of properties for rating purpose in the Karu Local Government Area such as lack of basic social amenities, accessibility, lack of proper street naming. The aim of this analysis is to assess the problems of assessing properties for rating purpose in the Karu Local Government Area. The objectives of the study are to identify the problems and proffer solutions to the problems militating against assessment and implementation of property rating and its collection Karu Local Government Area. The scope of this study covers Karu Local government Rating Area. The study looked at the general rating procedures in the Karu Local Government Area and identifies the problems associated with the assessment of property for rating purpose. In this study, the limitation of the study is on the problems of assessment of property for rating purpose within the Karu Local Government Rating Area.

Karu Local Government is in Nasarawa State, Central Nigeria. It was created in 1991 out of the defunct Keffi Local Government Area with its headquarters in New-Karu town with a Land mass of about 2,640 square kilometers. It has about four chiefdoms and each of the chiefdom is headed by a paramount ruler. Karu town chiefdom is headed by the Esu Karu in the person of HRH Pharm. Luka Baba Panya, Karshi chiefdom is headed by the Emir of Karshi HRH Alh. Mohammed Bako II, the Nyenkpa (Panda) chiefdom is headed by HRH Barr. Joel S. Aninge, and the Koro chiefdom is headed by HRH Christopher Jatau. We also have the Nyenkpa, Gbagyi, Koro, Gwandara and Gade as the indigenous tribes. According to the 2006 census, the population of New-Karu town was 205,477 and a total population of two million in its urban towns. The urban areas of the Karu Local Government Area include Koroduma, New-Nyanya, Nyanya Gwandara, New-Karu town, Ado, Panda, Karshi, Masaka, Mararaba Gurku, Kodape etc.

The Local Government Area shares boundaries with FCT (Federal Capital Territory), Kaduna State, Keffi Local Government and Nasarawa Local Government respectively. All major tribes in Nigeria found their way to settle in the Local Government because of its proximity to the Federal Capital Territory (FCT). Though the indigenes are predominantly farmers who farm in large quantities for domestic consumption and commercial purposes, they also engage in economic activities such as mining and trading. They also have a very rich heritage which they still uphold despite the influence of western development

2.0 MATERIALS AND METHODS

The methodology of any research work is the various steps and techniques employed by the researcher. These also include all the information required to form an opinion thus, methodology forms the basic framework in which the research work is based on. This section, therefore, contains steps and procedures use in carrying out the study. The Population according to Osuala (1982), in his book titled “An introduction to research methodology” means identifying characteristic which members of the universe have in common and which will identify each unit as being a member of a particular group. In this case, the essence of this study focuses on the assessment of property for rating purpose with particular attention on Karu local government. The population of this study is restricted to the Karu local government of Nasarawa State. Owing to the nature of the study, the researcher concentrated on real estate-property owners, Estate Valuers and selected staff of the local government. Sample Size is the part of statistical practice concerned with the selection of individual observation intended to yield some knowledge about a population of interest especially for the purpose of statistical inference. Research data are facts and figure originating from a study. They may not be true in themselves, but are evidence of a given situation. The two main sources of data collection are primary and secondary. These are data which are expressly collected for a special purpose. Under this the questionnaire and interview methods are used. These sets of questions relating to the aim and objectives of the study to which the respondents are expected to answer. This is also used to enable the respondents to provide answers to the questions at their own convenience. This is a face to face interaction between the interviewer and the interviewee. This provides oral responses to questions asked. Apart from providing additional information, they also provide substitute answers to questionnaires not returned. This method is the extraction of information from existing records like journals, textbooks, gazettes, report and other research works which the researcher used to get additional information. In analysing, the data collected is analyzed through simple statistical method.

4.0 DISCUSSIONS AND DATA ANALYSIS

For the purpose of arriving at a meaningful conclusion of the analysis, the researcher chooses to analyze all relevant data relating to problems of rating assessment in Karu local government, which were experienced and collected mainly by the use of questionnaires and personal interview.

4.1 RATING AREA (KARU LOCAL GOVERNMENT)

The right and duty of Karu local government to carry out the assessment and collection of rates is backed by the Karu Local Government Tenement Rate Law 2012. The edict empowers the Karu Local Government to conduct and collect property rate within its Area of jurisdiction.

4.2 RATING ASSESSMENT IN KARU LOCAL GOVERNMENT AREA

Assessment for rating of a property in the Karu Local Government area started in 2012. All the tenements in the Local Government were assessed by reference to Net value. According to Karu Local Government Tenement Rate Law 2012, “Net value”. Means the rent at which the tenement might reasonably be expected to let from year to year if the Tenant undertakes to bear the cost of repairs and insurance and other expenses”. The assessment of property rating in the Karu Local Government Area is carried out within the Ratable Area such properties are commercial, residential, industrial and institutional properties.

4.3 EXEMPTED PROPERTIES

During the assessment of properties for rating purpose in Karu Local Government Rating Area, some properties were exempted. Such exempted properties include Government owned schools and hospitals, religious properties like churches, mosques, etc.

4.4 RATEABLE VALUE

In 2012, the rateable value of assessed properties in the Karu Local Government Area was 500 million.

Table 1: RATEABLE VALUE OF ASSESSED PROPERTIES (2012)

YR	RESIDENTIAL (₦)	COMMERCIAL (₦)	INSTITU-TIONAL (₦)	INDUST-RIAL (₦)	TOTAL (₦)
2012	200,000,000.00	200,000,000.00	50,000,000.00	50,000,000.00	500,000,000.00

Source: Field survey September 2012.

The above Table showed the professional fees payable for carrying out rating assessment in the Karu Local Government Area for 2012 assessment year.

Table 2: FEES PAYABLE FOR ASSESSMENT OF PROPERTIES FOR RATING PURPOSE IN KARU LOCAL GOVERNMENT (2012)

AGGREGATE (₦)	FEES (%)	PAYABLE AMOUNT (₦)
5, 000, 000.00	10.00	500, 000.00
5, 000, 000.00	8.00	400, 000.00
10, 000, 000.00	6.00	600, 000.00
30, 000, 000.00	5.00	1, 500, 000.00
50, 000, 000.00	3.00	1, 500, 000.00
100, 000, 000.00	2.50	2, 500, 000.00
300, 000, 000.00	2.00	6, 000, 000.00
TOTAL		**13, 000, 000.00**

Source: Field survey September 2012.

4.5 PROBLEMS OF ASSESSMENT OF PROPERTIES FOR RATING PURPOSE IN KARU LOCAL GOVERNMENT AREA

a. Lack of basic social amenities: These basic amenities include a good source of water supply and electricity, hospitals, schools and roads which are not in place has proved to be a major setback in Karu tenement rate exercise.

b. Accessibility: as a result of bad road network in the area, field workers assessing the tenements finds it difficult to access some properties in the area.

c. Low class houses: some of the houses in this area are dilapidated and awaiting re-development but in occupation by the owners. Such houses prove difficult to assign any rateable value to them and with no hope of them being able to pay any rate.

d. Lack of adequate sensitization of the civil responsibility and importance of payment of tenement rates by property owners.

e. The non-passing of ”the Karu Local Government Tenement Rate Law 2012” into a Law by the State House of Assembly has limited the power of the rating authority to enter and inspect the property for rating purpose.

f. Lack of awareness on property rating as a form of tax.

g. Lack of proper Street name and numbering.

From the findings made, it can be summarized that property rating has existed right from the time. Payment of the rates comes in different forms from one community to the other. With increasing population as a result of movements from rural to urban areas, and with effective and efficient assessment, property rates can be used to generate revenue for the government. Ignorance on the part of the citizens about its existence lies largely on the part of the Government to carry out effective mobilization and sensitization on property rating generally.

5.0 Conclusion and Recommendations

This research work sought to critically analyze the problems of assessment of properties for rating purpose in Karu Local Government. From the foregoing, it can be deduced that the problems are both institutional and individualistic in nature. Institutional in the sense that, the Government has helped to create the problems by not doing what it is supposed to do, i.e. the putting in place the necessary infrastructure for proper assessment. This is also strengthened by the failure of our system of revenue generating method. The individuals denied the assessment officers access to inspect and also refused them information. Property rates hold tremendous prospects for us both as a government and as individuals. What we need is the serious commitments on the part of both government and individuals to play our part conscientiously and transparently.

Streets should be properly named and numbered for effective enumeration and assessment. Government should involve professionals such as town planners, estate surveyors and

Valuers to carry out the process on its behalf, for efficiency. Therefore, registered professionals should carry out the assessment. This will produce effective and accurate valuation that is credibly assessed and also advise on the ideal way to deal with the issue of slum houses. The people should be educated on property rating and its importance to the community as a whole. The Karu Local Government Law on Rates of 2012 should be passed into a law to empower the rate authority to prosecute rate denial/defaulters in the area. It is also recommended that the assessment should be done on the Quin Quinial period in order to update the valuation list.

REFERENCES

Balowe, R. (1978) *Economic of Real Estate Land Resource*. The Estate Gazzete 3rd Edition London.

Frey, U.O (1996) *Property Rating in Nigeria* Dodrance Nigeria Ltd, Ikoyi, Lagos.

John, M.D (1988). *Land Information Management.* Calavendor press, Oxford U.S.A.

Karu Local Government (2006) *Edict No. 6 Karu Local Government Tenement Rating Law.*

Olusegun, K. (2002). *Principles And Practice Of Property Rating.* Lagos: Tony Terry Prints.

Osuala E.C. (1982) *Introduction to Research Methodology* African Feb Publishers Ltd, Onitsha.

Oyegbila, S.O. (1996). *The Principle and Practice of* Property *Rating And Taxation* Minna: Jameson Araphic publishers.

DISTRIBUTION PATTERNS OF FEDERAL AND STATE ROAD NETWORK IN IMO STATE (2000 – 2014)

IDIKE John Ebhohimen[1], SHITTU Abdullateef Adewale[1], ADAJI Edna Eleojo[1] & AKANMU William P[2]

[1]Department of Quantity Surveying, Federal University of Technology, Minna, Nigeria
[2]Department of Building, Federal University of Technology, Minna, Nigeria

The important nature of road transportation to economic, social and political development of Imo State has brought about the need for this study. Also, the fact that lack of logical distribution of road network coupled with the poor conditions and maintenance is a major setback in the socio-political and economic development in Imo State over the years. This study was aimed at establishing the relationship between the size of roads and demographic variables of the Geographical/Local Government areas of Imo State with a view to offering advice to policy makers in the government to be aware of physical aspect of road network planning like geographical area, population and population density in the allocation of Federal and State roads. Data were collected from the secondary source. The use of regression analysis was employed to determine the relationship between the variables for which data were collected. The results of the analyses revealed that there is partly strong and significant relationship and mostly weak and not significant/significant relationship between Federal/State roads and the geographical area, population and population density with R^2 value of 42.13% on the average. On the overall, the relationships between the total length of road and two of the parameters tested (population and population density) were also weak. It was concluded that the government was not giving total attention to population and population density during policy formulation. It was therefore recommended that the government of Imo State should take cognisance of these factors during policy formulation. Other States of the Federation having similar problem were suggested to be studied in future researches. Further studies were also suggested to be carried out on the development and distribution of feeder roads in Imo State.

Keywords: *Distribution Pattern, Geographical Area, Population, Population Density, Road Network.*

idiakeje@futminna.edu.ng

INTRODUCTION

The important nature of road transportation to economic, social and political development of Imo State has brought about the need for this study. Also, the fact that lack of logical distribution of road network coupled with the poor conditions and maintenance is a major setback in the socio-political and economic development in Imo State over the years.

Since BC 8000 until recent times population growth rate was 0.1%. Now it is over 2%. Two thousand years ago the population of the world was 250million. It took until 1800AD to reach I billion, an additional million was added after 130 years, 30 years and 17 years, to clock 4 billion in 1977, population for the year 2000 will be 6.5 billion estimated (World Bank, 1995).

As population grows, so the strain on the road transportation resources of the world increases. Puts the figure of persons living in area without adequate and good transport network at 60 million, no solution has been found to provide the people with adequate road. The population of the urban centres of the world's developing countries deserve special mention – world urban population increased from 737 million (29.2% total population) in 1950 to 2603 million (45.2% of the total population) in 1995, by the year 2025, 61.2% of the total population will live in the cities. This translates to 518.7 million people; 86% of global population growth will occurred in the urban areas of developing countries (Clark, 1989). By the 2000 in Nigeria, 18 cities in the country will have a population of over a million; Lagos State has a high population compared to its geographical area. It can also be noted that since independence in 1960, there has not been any systematic motor road development policy in Nigeria. The general scene is the intermittent release of packets of uncoordinated road contracts to reinvigorate the motor road system in Nigeria may be beyond the scope of the government. Foreign assistance is needed in the way of advice, planning and execution (NPE).

The main drawback to construction development in Nigeria from 1960 to 1999 is principally due to the lack of political, social and economic stability. The military which preoccupied the government of the country for decades was not equipped to provide populist planning which is a condition precedent to the development of a vibrant and internationally assisted development (Mogbo, 1998).

In order to address the identified problems from this study, the study was set out to establish the relationship between the size of roads and demographic variables of the Geographical/Local Government areas of Imo State with a view to offering advice to policy makers in the government to be aware of physical aspect of road network planning like geographical area, population and population density in the allocation of Federal and State roads. In order to achieve this aim, the following objectives were set out for the study.

i) To establish the relationship between total length of roads and geographical area.

ii) To determine the relationship between total length of roads and population.

iii) To examine the relationship between total length of roads and population density.

Historical Background of Nigerian Road Transportation

Roads can be described as strips of land that has been cleared and usually further improved for the movement of people and goods. Roads tend to have two fundamental purposes of mobility and accessibility. Transportation plays a major role in the political, social and economic development of a country. At every stage of national and regional development planning transportation is considered. The need to provide rapid economic growth makes transportation all important. It is based on this context that Munby (1968) said that there is no escape from transportation. Transportation in one form or another is a basic and essential part of the daily rhythm of life throughout the world Ratclife (1981) says it plays a document role in determining, the scale, nature and form of our towns and cities. Its efficiency contributes largely to the level of productivity, economic growth and standard of living.

When transportation is considered in terms of national development, it would be discovered that the nature of transportation and the crucial role it plays in the social and economic development of any nation makes it a pre-requisite to the development of all sectors of the national economy. (Carapetis *et al.*, 1993). The need for road transportation networks in a state extends to all aspects of political, economic and social development of a state and the nation as a whole. The presence good transportation network is essential, because an effective, efficient and extensive road transport system serves as a channel for the collection and exchange of goods and services, movement of people and information dissemination.

Ratclife (1981) reported that there is no escape from the transport needs because everybody is concerned and to an extent, everybody is affected in one-way or the other. Transportation plays a major role in determining the scale, nature and form of towns and cities. Nne-Ngene (1998) explained that transportation is the most important feature of human society because the history of civilization is the history of transportation. For long time, transportation of people and goods has been carried out by use of land, waterways as well as railway.

In Nigeria today road transportation has become an important and most vibrant sector of the national economy accounting for the daily movement of close to a million people. This thereby makes transportation play a major role in the development of a nation and its cities. Road transportation is one of the oldest means used in Nigeria. In Imo State, road transportation is most popular and the most widely used mode of transportation. There is however the need through planning and distribution of road networks. It is against this background that the study is carried out to find out if the distribution of the road network in the State is based on quantifiable and related factors such as, population, geographical area and population density across the various Local Government Areas in the State.

Road transportation is regarded by experts as a catalyst for engineering and rejuvenating economic, socio-political and strategic developments of any nation. The economic development of any nation can rightly be assured in terms of the level and sophistication of its road transportation system apart from modes of transportation. The importance and relevance of good road network cannot be underestimated. Thus when roads are bad apparently, economic and business activities becomes stalled and paralyzed (Nwoji, 1995).

The necessity of national development becomes apparent when the cynical role of transport in socio-economic development of any nation is considered. Kuhn (1995) reported that the national and individual welfare of a society is intimately and linked to the availability of road transportation system. In general the growth of towns and the opening up of rural areas is directly linked to the effectiveness of the transport system available. The accessibility of a town by road transport encourages investment and movement of people to and fro.

Transportation and Economic Development

Transportation plays a crucial role in the political, economic and social development of a country. Munby (1989), that there is no escape from transport. New strategies of economic planning require the modification and renewal of inherited transport system. The economic development of any country depends to a large extent on its transport system. A well planned adequately maintained, efficiently managed and properly operated transport system is a prerequisite to the development of all sectors of national economy. Also our national and individual welfare is intimately linked to the availability of welfare transport. The various modes of transport each have very distinctive physical and economic characteristics, which helps to accelerate development in any area.

Transportation Network Planning

Planning according to Thomson (1983) is not an occasioned task, it is a continuing activity, calling for regular data collection, monitoring of programs and predictions, updating and modification of plans and implementation. The first two components are organizational adequate planning capacity and means of implementation of the plans. Also there must be two plans, a long range directional plan and a short range design plan.

Transport network planning comes in various stages and various processes are involves. Planning of road networks have been largely confined to the process of evaluating costs and benefits of individuals' routes or groups of routes as a means of putting together a program of work. The need to establish a co-ordinated approach for national resource allocation at the national state and local levels in road planning is only recognized by a few countries and states. The economic importance and relevance of good network of roads in any nation cannot be underestimated. A glance at the conditions of the roads depicts the level of socio-economic and political development so far attained. Thus, when road are adequate, economic and basic activities becomes stalled and paralyzed. Transportation plays a major role in opening towns and villages. Transportation importance is strikingly clear in the contrast between a village that has already access to markets and one that is without an all whether road connection or perhaps any road whatever. In the latter case there is no knowledge of the outside world no scientific method of agriculture, no cash coming into the village, no health service which is not the case of the former (Oluyemi and Eniola, 1978).

As far as 1967, a United Nations study regarded transport as the formative power of economic growth. This at a given stage of development, a country requires a certain level of transportation facilities in order to maximize its resource potentialities. Any unsatisfied demand for transport, if allowed to persist, may in the long run have serious adverse effect on the country's economy. The indispensable nature of transportation and its importance makes experts regard it as a catalyst for engineering and rejuvenating economic, socio-political and strategic development of a nation. The economic development of any nation can rightly be assured in terms of its level and sophistication of its road transport system. Without transportation it would be apparent that there would be a dislocation in the nation's economic transactions (Nwoji, 1995). Economic growth will enhance level transport cost for industry through reduced times; improve access to ports and manufacturing facilitated and higher productivity through increase vehicle and dimensioned units. The tourism industry is enhanced by the improved access and travel condition through the provision of adequate road network (Mc. Quillen, 1996).

Factors That Affect the Routine Transportation Networks

The transportation makes it possible for a community to survive for its supplies the population with food and other necessities of life, it moves needed materials to factory, farms and workshops and it delivers the products of the community to buyers elsewhere in the country (Owen, 1978). The major factors that contribute to the efficiency and effectiveness of transportation distribution are population factors, geographical area factors and population density factors.

The Population Factor

The population factor plays a very important role in many government policies and actions such as revenue allocations among states, in the distribution of infrastructure facilities, in the subdivision of the country into administrative units and so on. People have come to realize the decisive role of the population factor plays in the development plans of government and they have become highly sensitive to anything relating to population, such as census and the collection of vital statistics. The population factor constitutes a vital component of the resource base and development potential of any country.

The most relevant element of the population in their regard is its of growth, spatial distribution, population concentration centres, shift in population (rural urban drift) and causes. Olayemi (1977) explained that the population factor, especially the degree of urbanization in the different parts of the country influences the demand for the distribution of road transport networks. Hoyle (1988) stated that roads and railways like new crops, schools, hospitals etc are some of the main tools of development for raising people standard of living and they have a bearing on many aspects of life. Population which constitutes a vital component of the resource base and the development potential of any country should be important not only as an indication of the level of development efforts in a given country or state particularly Nigeria.

The Geographical Area Factor

Geographical area (size) is a fundamental element in the political geography of states. Other things being equal the larger a state is in area, the greater the chances of its supporting a large population and a diversified natural resource base the two most important elements in the political and economic development of any state (Dikshit, 1983). The geographical area factor is an important factor to be considered for the efficiency of public services. The inequalities of public welfare provision which form principal subject of this research study exists partly as a result of the agencies of resource use. Geographical criteria of efficiency include catchment areas and population size. A hierarchy of public goods can be envisaged according to the scale of area over which services can be efficiently provided (Curtis, 1989).

The Population Density Factor

Onokhoraye (1984) defines population density as an expression of the ration between population and a given unit of size. Mathematically, population density is expressed as the number of objects or people in a certain population within a certain area, divided by the numerical value of the area. Thus population density of Imo State would be expressed as:

$$\text{Population density} = \frac{\text{Number of people in Imo State}}{\text{Total landmass of Imo State}}$$

Population density is a useful tool in the measurement of the density of the population in a given area. Unfortunately it ignores that fact that some parts of the given area may not be inhabited, the regulation density is thus stated in absolute terms. Even with this shortcoming, measures of population density still offer an invaluable tool for comparing different areas in relative terms. To overcome this shortcoming, population densities are expressed in a variety of ways. These includes as a ratio of the population to the available mass, total area under cultivation.

In line with the findings of review of literature and research gap identified from the study’s background, the study makes use of geographical area, population and population density in relation with the length of road networks in Imo State. This was done to address the identified problem of the study.

RESEARCH METHOD

The study adopted the quantitative research approach. Data collection was from the secondary source. Archival data were collected from the records compiled by Federal and State Ministries in Imo State. That is, the study used relevant data collected from the Imo State Ministry of Works and Housing, Federal Ministry of Works and Housing Imo State, Imo State Ministry of Urban Planning, and Imo State National Population Commission. Data collected covered the total length of road network comprising of Federal (Trunk A) and State (Trunk B) roads in the 21 Local Government areas of Imo State within period of fifteen years (2000-2014). Data for the study was collected on the length of road network, population, population density and geographical area.

The use of simple liner regression analysis was adopted to determine the relationship between the parameters. This was further confirmed by the degree of correlation between the variables (that is the R value). The one-way ANOVA using Duncan's test of significance to determine the degree of association between the sectional districts was also employed. In all analyses carried out, measures of goodness of fit using the co-efficient of determination (R-sq) were established. Linear regressions and transformations were used to prove or disprove the formulated hypothesis for the purpose of achieving the aim of this study. The analyses carried out from the study were done to test the following null hypotheses which were formulated for the study:

i) There is no significant relationship between total length of roads and geographical area.

ii) There is no significant relationship between total length of roads and population.

iii) There is no significant relationship between total length of roads and population density.

FINDINGS AND DISCUSSION OF RESULTS

The study carried out nine regression analyses in order to determine the relationship between the research variables for which data was collected. The results of these analyses were used to achieve the objectives and also test the hypotheses formulated for the study.

Analysis 1: Relationship between Federal Road (Km) and Geographical Area

From the first analysis, the regression equation shows positive linear relationship. The coefficient of determination R-sq, suggest a weak significant relationship between the variables tested of 32.10%. This shows that although there exists a positive relationship between the variables but the strength of the relationship is weak.

Hence it confirms that geographical area is not a strong factor used in determining the Federal roads network distribution in Imo State. The test for the overall significance of the relationship reveals an F-calculated value of 8.99 which is greater than F tabulated value of 4.38. Thus the relationship is statistically significant. The null hypothesis is there rejected. Table 1 gives a summary of this result.

Table 1: Relationship between Length of Federal Road and Geographical Area

NO	X AXIS	Y AXIS	MODEL	REGRESSION EQUATION	R^2 %	F TAB	F CAL	STRENGTH	REMARK
1	Geo Area	Fed. Road	Linear	Fed Road = 10.6+0.551 G/AREA	32.10	4.38	8.99	Weak	Significant
			Logarithm	Y = -78.17+19.59 Inx	41.67	4.38	13.57	Weak	Significant
			Quadratic	Fed Road = 7.75 + 0.198 G/Area –0.000 156 G/Area^2	48.64	3.55	8.52	Fairly Strong	Significant
			Cubic	Fed Road = - 13.404+0.26 30 G/Area – 0.000325 G/Area + 1.1479E-07	49.08	3.20	5.46	Fairly strong	Significant

Analysis 2: Relationship between State Road (Km) and Geographical Area

From the second analysis, the regression equation shows a positive linear relationship. The coefficient of determination R-sq is 72.50% suggesting that the relationship is strong and also there exists a significant relationship between the variables tested. This implies that approximately 73% of variation in State roads network is attributable to variation in geographical area sizes of the Local Government Areas. The test for overall significance of the relationship reveals an F-calculated value of 50.0 which is greater than F-tabulated value of 4.38. The null hypothesis was therefore rejected. The result of this analysis is summarised in Table 2.

Table 2: Relationship between Length of State Road and Geographical Area

NO	X AXIS	Y AXIS	MODEL	REGRESSION EQUATION	R^2 %	F TAB	F CAL	STRENGTH	REMARK
2	Geo Area	State Road	Linear	Total Road = 0.66 + 0.140 G/AREA	70.50	4.38	50.00	Strong	Significant
			Logarithm	Y = 180.49 + 41.04 INX	63.96	4.38	33.72	Strong	Significant
			Quadratic	State Roads = 10.0 + 0.127 G/Area + 1.42 E-05 G/Area^2	72.51	3.55	23.74	Strong	Significant
			Cubic	State Roads = - 11.92 + 0.274 G/Area – 0.0004 G/Area Q + 2.624 E-07 G/Area Cubic	73.31	3.20	15.56	Strong	Significant

Analysis 3: Relationship between Combination of Federal & State Road (Km) and Geographical Area

From the result of the third analysis, the regression equation shows a positive linear relationship. The coefficient of determination is R-sq of 70.40% showing that the relationship is very strong and suggests a significant relationship between the variables tested. This shows that approximately 70% of variation in total road network is attributable to variation in geographical area sizes of the Local Government Areas. The test for the overall significance shows an F-calculated value of 45.29 which is greater than F-tabulated value of 4.38. Thus the relationship is statistically significant and the null hypothesis is therefore rejected. Table 3 gives a summary of this result.

Table 3: Relationship between Length of Federal & State Roads and Geographical Area

NO	X AXIS	Y AXIS	MODEL	REGRESSION EQUATION	R^2 %	F TAB	F CAL	STRENGTH	REMARK
3	Geo Area	Total Road	Linear	Total Road = 9.93+0.195 G/AREA	70.40	4.38	45.29	Strong	Significant
			Logarithm	Y = -258.67 + 60.63 Inx	69.87	4.38	44.06	Strong	Significant
			Quadratic	Total Road = 6.74 + 0.325 G/Area –0.000	72.83	3.55	24.13	Strong	Significant
			Cubic	Total Roads = -25.33+0.538 G/Area – 0.0007 G/Area SQ + 3.771E-07 G/AREA CUBIC	73.66	3.20	15.84	Strong	Significant

Analysis 4: Relationship between Federal Roads Network (Km) and Population

From the fourth analysis, the regression equation shows a positive linear relationship. The coefficient or R-sq of 50.60% shows that the relationship is relatively strong between the variables tested. This shows that approximately 51% of variation in Federal roads network is attributable to variation in the population sizes of the Local Government Areas. The test for overall significance of the relationship reveals an F-calculated value of 19.44 which is greater than F-table value of 4.38, which shows that there is a significant relationship. The null hypothesis is therefore rejected. A summary of the result is given in Table 4.

Table 4: Relationship between Length of Federal Roads and Population

NO	X AXIS	Y AXIS	MODEL	REGRESSION EQUATION	R^2 %	F TAB	F CAL	STRENGTH	REMARK
4	POP	Fed Road	Linear	Fed Road = 15.9+0.0000314 POP	50.60	4.38	19.44	Strong	Significant
			Logarithm	Y = -512 + 46.22 Inx	44.98	4.38	15.53	Fairly strong	Significant
			Quadratic	Fed Road = 10.73 + 0.0029 POP + 2.09e-10 POP^2	50.69	3.55	9.25	Strong	Significant
			Cubic	Fed Roads = -1.43+4.99E-05 POP + 1.75 E – 09 POP^2 – 3.1E – 15 POP^3	50.72	3.20	5.83	Strong	Significant

Analysis 5: Relationship between State Roads Network (Km) and Population

From the fifth analysis, the regression equation shows a positive linear equation. The coefficient of determination R-sq was 25.60% showing that the relationship is relatively weak between the variable tested. It was also revealed that there is a significant relationship between the variables tested. The test for overall significance of the relationship reveals an F calculated value of 6.54 which is greater than F tabulated value of 4.38. The null hypothesis was therefore rejected. Table 5 gives a summary of the result.

Table 5: Relationship between Length of State Roads and Population

NO	X AXIS	Y AXIS	MODEL	REGRESSION EQUATION	R^2 %	F TAB	F CAL	STRENGTH	REMARK
5	POP	State Road	Linear	State Road = -14.0+0.0000410 POP	25.60	4.38	6.54	Weak	Significant
			Logarithm	Y = -167.36 + 56.07 Inx	23.14	4.38	5.72	Weak	Significant
			Quadratic	State Road = -7.012 + 0.00313 POP + 2.816E-10 POP^2	25.67	3.55	3.10	Weak	Significant
			Cubic	State Road = -91.14+0.023 POP - 1.36E – 08 $POPSQ^2$ + 2.80E - 14 POP^3 CUBIC	26.37	3.20	2.03	Weak	Significant

Analysis 6: Relationship between Combination of Federal & State Road Network (Km) and Population

From the result of the sixth analysis, there exists a positive linear relationship from the regression equation. The coefficient of determination R-sq is 43.00% which is relatively weak between the variables tested. Also there exists a significant relationship between the variables tested. The test for the overall significance of the relationship reveals F calculated value of 14.31 which is greater than the F tabulated value. The relationship was therefore statistically significant and the null hypothesis was rejected. Table 6 summarises the result.

Table 6: Relationship between Length of Federal & State Roads and Population

NO	X AXIS	Y AXIS	MODEL	REGRESSION EQUATION	R^2 %	F TAB	F CAL	STRENGTH	REMARK
6	POP	State Road	Linear	Total Road = -29.9+0.000752 POP	43.00	4.38	14.13	Weak	Significant
			Logarithm	Y = -1330.28 + 102.29. Inx	42.08	4.38	13.80	Weak	Significant
			Quadratic	Total Road = -17.746 + 0.00058 POP + 4.90E-10 POP^2	43.07	3.55	6.81	Weak	Significant
			Cubic	Total Road = -0.0023 POP – 1.186E – 08 POP^2 + 2.477E - 14 POP^3	43.35	3.20	4.33	Weak	Significant

Analysis 7: Relationship between Federal Roads Network (Km) and Population Density

From the seventh analysis, the regression equation shows a negative linear relationship. The coefficient of determination R-sq is 15.90, suggesting a weak relationship between the variables tested. This implies that there exists a negative relationship between the variables tested. The test for the overall significance of the relationship reveals a non significant relationship between the variables. This is because the F- calculated value of 3.59 observed was less than the F-tabulated value of 4.38. The null hypothesis was therefore accepted. Table 7 gives a summary of this result.

Table 7: Relationship between Length of Federal Roads and Population Density

NO	X AXIS	Y AXIS	MODEL	REGRESSION EQUATION	R^2 %	F TAB	F CAL	STRENGTH	REMARK
7	POP DENT	FED Road	Linear	FED Road = -42.2-0.0256 P.DENSITY	15.90	4.38	3.59	Weak	Not Significant
			Logarithm	Y = -114.65 – 14.12 Inx	16.32	4.38	3.70	Weak	Not Significant
			Quadratic	Fed Road = 51.47 – 0.0548 P.DENSITY + 1.85E -05 P.DENSITY	18.14	3.55	1.99	Weak	Not Significant
			Cubic	Fed Road = 43.34 – 0.002P. DENSITY – 6.23E – 05 + 3.29E – 08 DENSITY CUBIC	18.79	3.20	1.32	Weak	Not Significant

Analysis 8: Relationship between State Roads Network (Km) and Population Density

From the result of Analysis 8, the regression equation shows a negative relationship. The coefficient of determination of 34.90% suggests a weak relationship between the variables tested. This shows that there exists a negative relationship between variables tested. The test for overall significance of the relationship reveals an F- calculated value of 10.19 which is greater than F- tabulated value of 4.38, showing that there is a significant relationship. The null hypothesis was therefore rejected. This result is summarised in Table 8.

Table 8: Relationship between Length of State Roads and Population Density

NO	X AXIS	Y AXIS	MODEL	REGRESSION EQUATION	R^2 %	F TAB	F CAL	STRENGTH	REMARK
8	POP DENT	State Road	Linear	State Road = 79.1 -0.0641 P. DENSITY	34.90	4.38	10.19	Weak	Significant
			Logarithm	Y = -290.61 - 40.8 Inx	45.97	4.38	16.16	Weak	Significant
			Quadratic	State Road = 109.67 - 0.110 POP DENSITY + 6.104 POP DENSITY^2	43.54	3.55	6.94	Weak	Significant
			Cubic	State Road = 122.78 – 0.25P. DENSITY + 0.0079 P.DENSITY^2 – 5.313E – 08P. DENSITY	44.29	3.20	4.50	Weak	Significant

Analysis 9: Relationship between Combination of Federal & State Road Network (Km) and Population Density

From the ninth analysis, the regression equation shows a negative linear relationship. The coefficient of determination R-sq of 34.20% suggests a weak relationship between the variables tested. This shows that there exists a negative relationship between the variables tested. The test for overall significance of the relationship reveals an F- calculated value of 9.88 which is greater than F- tabulated value of 4.38, showing a significant relationship. This led to the rejection of the null hypothesis. Table 9 gives a summary of the result of the ninth analysis.

Table 9: Relationship between Length of Federal & State Roads and Population Density

NO	X AXIS	Y AXIS	MODEL	REGRESSION EQUATION	R^2 %	F TAB	F CAL	STRENGTH	REMARK
	POP DENT.	Total Road	Linear	Total Road = -121-0.0897 P.DENSITY	34.20	4.38	9.88	Weak	Significant
			Logarithm	Y = 405.26 – 54.21 Inx	42.08	4.38	13.80	Weak	Significant
			Quadratic	Total Road = 161.15-0.215 POP DENSITY + 7.75E -05 P. DENSITY^2	41.52	3.55	6.39	Weak	Significant
			Cubic	Total Road = 166.12 – 0.248P. DENSITY + 0.00013P. DENSITY SQ – 2.019E-08P DENSITY CUBIC	41.57	3.20	4.03	Weak	Significant

CONCLUSION

The study revealed a significant relationship between length of roads and all the demographic parameters except for the relationship between the length of Federal roads and population density which was not significant. Only Geographical Area shows a strong relationship with the length of Federal and State roads. It can therefore be concluded that Geographical Area is a very important factor to be considered in the construction of roads and road network design in Imo State.

In addition, it was revealed that out of the nine analyses carried out, eight (8) turned out to be statistically significant, thereby rejecting the null hypothesis, but with low R^2 values in most of the analyses. The highest R^2 value is 72.5%. Based on this result, it can be seen that the Federal and State Governments give little attention to population and population density during road network distribution, but needs to increase the attention given to these factors. This will ensure logical distribution and enhance economic and socio-political development of the State.

Other States of the Federation having similar problem should also be studied in future researches. Further studies are also suggested to be carried out on the development and distribution of feeder roads in Imo State.

REFERENCES

Carapetis T. Levy, H and Wolden, T. (1993). Sub-Saharan transport program, the road maintenance initiative building capacity for policy seminars series Washington D.C. World Bank

Clark J.I. (1989). Population Geography, 2nd Edition, New York pergamon.

Curtis, S. (1989). The geography of public welfare provisions.London Routtedge Publishers, P.56.
Diskshit R.O, (1983). Political geography, New Delhi, Tata Magraw Hill Pub Co. Ltd P.42
Hoyle B. (1988). Transport and development in the tropical Africa London: John Murray publishers Ltd pp.44-45.
Kuhn, T.E. (1995). Transport and communication systems planning reconstruction and development. In A.A. Ayida and H.M.A. Onitan (eds) Reconstruction and development in Nigeria: proceedings of a National Conference Ibadan NISER and Oxford University Press pp.489.520.
McQuillen R. (1996): Reform of road sector management and financing, federal ministry of works and housing road vision 2000 Workshop paper pp3.
Mogbo, T.C. (1998). The development and management of motor road in Nigeria.The quantity surveyor vol. 25, Nov/Dec pp.29-34.
Munby, O.ed (1989). Transport Penguim, the trainer, Zaria Vol. No. 4, p.118
Nne-Ngene T., (1988). Transport: A decade of road safety, administration in Nigeria.
Nwoji, C. (1995). Deplorable state of roads, Daily Champion Friday Sept. 22, P.9.
Olayemi, O.A., (1977). Land transportation: its problems and effects on Nigeria's economic development in S.O. Onakhomaiya and N.F. Ekanem (eds) Op. Cit p.99
Oluyemi J. and Eniola, O. (eds 1978). A development catalyst.A collection of professional papers of experts at various fields, Apapa-OshodiUniversity Press Ltd Pp. 149-151.
Onokhoraye A.G. (1984). The transportation system and distribution of public services in Nigeria. In S.O. Onakhomaiya and N.F. Ekanem (eds) op. citpp 200
Owen, Q, (1978). Aspects of human settlement planning (eds). Habibat conference secretariat, New York Pergamon Press pp 259-261.
Ratcliffe J., (1981). An introduction to town and country planning London: HutcChinson& Co. Publishers, pp 63-89.
Thompson, J.M., (1983). Towards better urban transport planning in developing countries World Bank staff working papers.No. 600 Washington D.C. World Bank.
World Bank (1995).Towards sustained development in Sub-Saharan Africa, Washington D.C. IBRD and World Bank pp 15-17.

SUSTAINABLE PRACTICE THEORIES

ADAPTATION AND FLEXIBILITY OF SPACE IN SUSTAINABLE HOSPITAL DESIGN IN NIGER STATE

AKERELE Adesola Olaronke & ADEDAYO Olatunde Folaranmi
Department of Architecture, Federal University of Technology Minna, Niger State, Nigeria

The ability to improve the total quality of life now and for the future, in a manner that shaping the environment in relation to its users ensures sustainability. Hence sustainable buildings are to provide a comfortable environment that enriches nature and human activities. To adapt a building, the floor shape and room volume should have the capacity to accommodate the activities of its initial design while allowing multi-anticipated user requirement. The capacity of a building to absorb future functional change, displacement and increase in size, enables a smooth operation of activities. Hospital buildings are a hub of treatment and care synonymous with unpredictable changes arising from demographic displacements or improvements in technology. A major problem with spaces in hospitals in Niger state is their functional rigidity which most times limit their capacity to meet the changing demands of biomedical care. The flexibility of spaces is the ability of such spaces to adapt to multiple use and multiple functions. Therefore, the paper examines the levels to which spaces in hospital buildings in Niger state can meet the functional requirements of multiple changes to meet the changing dynamics of biomedical care. The method of research is descriptive survey. Thus, this will involve direct observation and structured interview guide for the sample population. This paper will recommend the use of movable partitions, floor, and ceiling types to increase the level to which spaces can adapt to changing demands and yet meet the functional requirements of its intended use.

Keywords: adaptation, change, flexibility, hospital, space, sustainability.

akereleadesola05@gmail.com

AKERELE, et. al., (2016). **ADAPTATION AND FLEXIBILITY OF SPACE IN SUSTAINABLE HOSPITAL DESIGN IN NIGER STATE**Sustainable Built Environment and Climate change; The challenges of Post 2015 Development Agenda. School of Environmental Technology Conference, SETIC, 2016

INTRODUCTION

One of the most discussed topics in contemporary architecture is the ability of buildings to fit to the demands of changing uses without altering its structural nomenclature or increasing its embodied energy or its operational energy requirement over its life cycle. The need for flexibility of spaces has thus been a recurrent consideration in the thought process of architecture (Sarkis, H., Allard, P., & Hyde, T., 2001). Walter Gropius in 1954 commended the need for creating flexibility of spaces in response to the constantly evolving social and technological landscape to accommodate the dynamics of changing lifestyle. Flexibility of spaces in a facility provides the users with the option of changing the use of a building with no obligation to changes in its structural composition (Richard de N., Yun S.L., Stefan S., 2008). The ability to change or adapt a space to a need that provides solution for the users is beneficial to users and the environment (Peter O.A, Ezekiel A.C. and Paul O.O, 2012). Sustainable buildings ensure resource conservation, energy and cost efficiency, and improve human adaptation (Peter O.et al, 2012). A health care facility is a focal point for three categories of people, the patient, their families and the care givers. It is a facility that accommodates a changing population of either the care seekers or care givers. However, hospital buildings do not usually put into consideration the satisfaction of the users in terms of their flexibility to spaces. This reduces the strength of their essential therapeutic effect on users and consequently, service delivery. A common problem with most hospitals in Niger state is their inability to provide spaces to accommodate patients during emergencies and peak periods. For instance, the emergency unit of the hospital is always flooded with patients without adequate space, leaving patients in critical conditions on stretchers along the corridors and walkway. Hence, it is necessary to have spaces that can be flex or adapt to accommodate patients and allow for a good flow of operations by the caregivers. The rigidity of spaces in most hospitals makes it impossible to meet the demand that comes with emergency peak periods. The use of flexible partitions thus enables the spaces to suit changing demands of every hospital operation. This paper aims to assess hospital buildings in Niger state to determine the degree to which functional unit spaces are flexible and can adapt to required adjustments fitting multiple uses.

Sustainability and Hospital Building Adaptation

Healthcare facility design is a complex project with an inexhaustible range of functions from medical applications to functional programs. With modern medicine's reliance on technology and the attendant demanding building programs, modern hospital architecture may be viewed as incompatible with the principles of sustainable design (Bensalem, S.,2015). However, sustainability is not only a moral obligation for healthcare, it is beneficial to both the patient and care-giver, and accentuates the potency of a healing environment. To this extent, sustainability is not about sacrificing comfort or lifestyle for environmental benefit, but to find design solutions that increase quality of life today without sacrificing tomorrow. Therefore, this concept is mutually beneficial to both users and nature (Peter et al, 2012).

The ability of changing a constructed space to satisfy new needs and uses ensures that the physical environment is not further damaged in order to attain spatial reinforcement Hospital building functionality should be contingent upon operational efficiency, and the rapidly unanticipated changes in the demands of biomedicine (Tayebeh, N. 2015). The capacity of a building to absorb future functions should be studied at the outset in anticipation for the event of an expansion or extension, and to reduce the attendant additional material needs and cost of building waste. Also, maintenance considerations, and durability of construction components and their interaction with the natural environment is as essential. (Peter et al, 2012).

In considering of layouts and adjacencies, space planning, especially in inpatient units, can also respond to needs for future adaptation to space, for example, centralized staff spaces can be expanded or contracted as needed, to support transitioning clinical areas. The most successful design solutions plan soft spaces, like having offices adjacent to intensive operational areas such as surgery or procedure rooms, imaging rooms, laboratories and pharmacy (Robert J. F., Amaya C. L., and Joshua D. C, 2012). Locating clinical areas on the perimeter supports easier expansion and allows clinical spaces to expand easily as part of a multi-storey horizontal expansion, without displacing or impacting existing functional services.

Need For Flexibility in Hospitals

Flexibility is the capacity of changing a space to achieve new needs of the users. (Pati D. & Harvey .T.Jr 2008) In other words, it is a right but not an obligation to a specific future action. A good flexible system will typically have several switches to allow a reaction to different circumstances (Richard de N. et al, 2008). In the aspect of hospital design, flexibility of spaces is essential because of its ever changing patterns of service administration, technology and procedures, service lines, changing patient demography, and medical emergencies. Also, the emergent rise in outbreaks of infectious disease, automated information management eliminating the need for physical proximity, limited access to capital requiring more efficient utilization of all resources including staff and equipment, and space are crucial (Cynthia H., 2008). Contingency planning should be made to accommodate future needs of flexibility for easy and timely adaptations as this either eases or impedes the implementation of changes in the physical design over the life of a hospital. Designs that limit changes can lead to expensive renovation work during the life of a facility or its untimely degeneration or even the development of care-giving plan that is designed around the constraints of the facility and below par, and limiting operational efficiency (Berry, Parker, Coile, Hamilton, O'Neill, & Sadler, 2004).

Flexibility in Hospital Buildings

Although, there is no one way in which a hospital facility will evolve, which is dependent on the drivers of change and degree of performance. There are some basic assumptions that can help a design team prepare a hospital that will accommodate the changing demands of future growth and expansion. In the article, *Road to flexibility* (Robert, Amaya, & Joshua, 2012), architectural flexibility strategies are distinguished at the micro and macro levels. The micro level strategies operate within circulation approaches, zoning and programming, while at a macro level, the strategies affect site placement, building shape and orientation, and vertical and horizontal expansion considerations. (Pati D., et al 2008) defined flexibility in health care within three typologies: adaptability, convertibility, transformability or expandability. Each type of flexibility not only refers to the amount of change which occurs in the built environment, but addresses the degree of permanence of that change as well.

The capacity of the built environment to support multiple functions without altering the architecture is called adaptability. Here, different processes are accommodated through movable partitions, repositionable furniture and other aspects of the environment that are able to change to accommodate the user or occupant needs. The changes do not result in a permanent alteration to the space, and therefore the space can flex between the start-state and end-state with ease (Robert et al, 2012). The function changes, but the container doesn't. In expandability, the interior or exterior space can be altered permanently or temporarily without construction in response to external or internal stimulations. Although this type seems to be the most common in architecture, it is the least utilized in healthcare environments. The ability to go back and forth between a defined start-state and end-state is permanent, but the states themselves are not. This type of flexibility does not require construction, although some user interaction may be required. Within transformability, two subsets exist: moveable and responsive. This flexibility type addresses a much broader scope than any other type and, as such, is becoming increasingly applied in the healthcare sector. Convertibility accommodates changing functions through a certain amount of construction. It reduces construction cost and time by anticipating potential future needs. Therefore, convertibility respond to time and spatial scales, and more often than not, require permanent change (Robert et al, 2012).

Micro approaches

The identification of "hard" and "soft" spaces and their strategic placement within a healthcare facility's layout is a simple method to provide flexibility. "Hard" spaces are difficult to move and expensive to build; "soft" spaces can be relocated with relatively ease and are comparatively low in cost. This method of zoning adequately accommodates future growth needs while maintaining critical adjacencies (Robert et al, 2012). In addition, investments for relocation and renovation projects are lower than costs for new construction. However, the spaces that are relocated can lose critical connections to other areas and functions, and its operations are severely disrupted while relocating. Other design elements that need to be considered for this strategy to be effective are mechanical systems, walls and structure. The inclusion of soft boundaries also can help a facility in terms of flexibility. Locating like-type programs near each other provides the opportunity for shared spaces, especially if hard boundaries are eliminated. For example, locating clinics with similar programmatic requirements in an adjacent manner allows them to share spaces, and enables the clinics to grow or shrink as patient volume changes (Barbara, H. B., 2014). Potential challenges with this strategy include code and regulation limitations that might prevent sharing support spaces.

Providing space that can accommodate a variety of programs is also a valuable strategy when thinking about flexibility. Multi-use spaces include classrooms and conference rooms, consultation rooms that can be used for non-clinical patient visits and universal rooms. Universal rooms combine the requirements of regular inpatient rooms and intensive care rooms, allowing a facility to increase occupancy rates while reducing space requirements. They also reduce patient transfers, saving manpower time and costs (Cynthia H., 2008). However, there are hurdles to overcome when incorporating universal rooms; among them, the increased training needed for nursing staff, as well as a change in organizational culture.

MACRO APPROACHES

Site placement

Site situation should put into consideration additional land or purchase of adjacent properties to allow for potential future expansion options (Ellen T., Anjali J., Amy K., and Xiaobo Q.,2011). The *empty chair* strategy embraces a cycle of building obsolescence with the assumption of future demolition. The original structure is constructed on no more than half of the site, leaving room for future building projects. Once the new construction occurs on the vacant portion of site without interruption to the existing hospital operations, the old building is demolished, leaving half of the site available once again for future construction. This strategy is restricted to sites large enough to accommodate two buildings; it is not feasible in small sites. Additionally, it writes off facilities that could be remodelled to suit current needs. (Robert et al, 2012)

Infrastructure

In terms of structure, a regular grid or modular grid system allows plug and play development of rooms and spaces (Ellen T., et al 2011). Regular grids are more cost-effective and introduce standardization into the facility planning. Vertical expansion of structural systems also plays a role in macro-level strategies of flexibility for hospitals on a constrained site. In this case, appropriate steps would be to design additional capacity into the structural system and prepare the roof for incoming column connections, as well as avoiding locating mechanical equipment on the roof. (Robert et al, 2012)

Interstitial Floor

The inclusion of interstitial floors provides a location for wiring, ducts and other mechanical and electrical services, the floors it services are better able to be reconfigured without the restrictions of mechanical services. (Robert et al, 2012) In addition, routine and emergency maintenance can be performed without interrupting regular operations.

RESEARCH METHODOLOGY

The primary method of data collection for this research was the descriptive survey method, which involves a direct observation and a structured interview guide for the sample population. The total sample population comprises of twenty one (21) secondary health care (SHC) spread across the state. A sample size of six (6) secondary health care facilities was selected, two (2) of which are drawn from each of the three senatorial district of Niger state. The survey was conducted by directly observing major variables which were the types of walls, the use of space and identifying flexible unit. Other methods of data collection were the secondary data method of obtaining data. These were from reviews of literature relating to the principles of flexibility as it relates to hospital designs. These comprised of information gotten from books, journals, seminar papers, magazines and internet sources with adequate citations and references. The date gotten were analysed with the statistical software SPSS and Microsoft excel, which will be used to present the data in charts and tables.

Table 1.0: Secondary Health Care Facilities Studied

Secondary health care(SHC)	LGA	Number	Name of hospital
	BIDA	1	BIDA GENERAL HOSPITAL
	CHANCHAGA	2	MINNA GENERAL HOSPITAL
			IBB SPEACIALIST HOSPITAL
	KOTANGORA	1	KOTANGORA GENERAL HOSPITAL
	LAPAI	1	LAPAI GENERAL HOSPITAL
	SULEJA	1	SULEJA GENRAL HOSPITAL
Total	5	6	

Source: authors' fieldwork, 2015

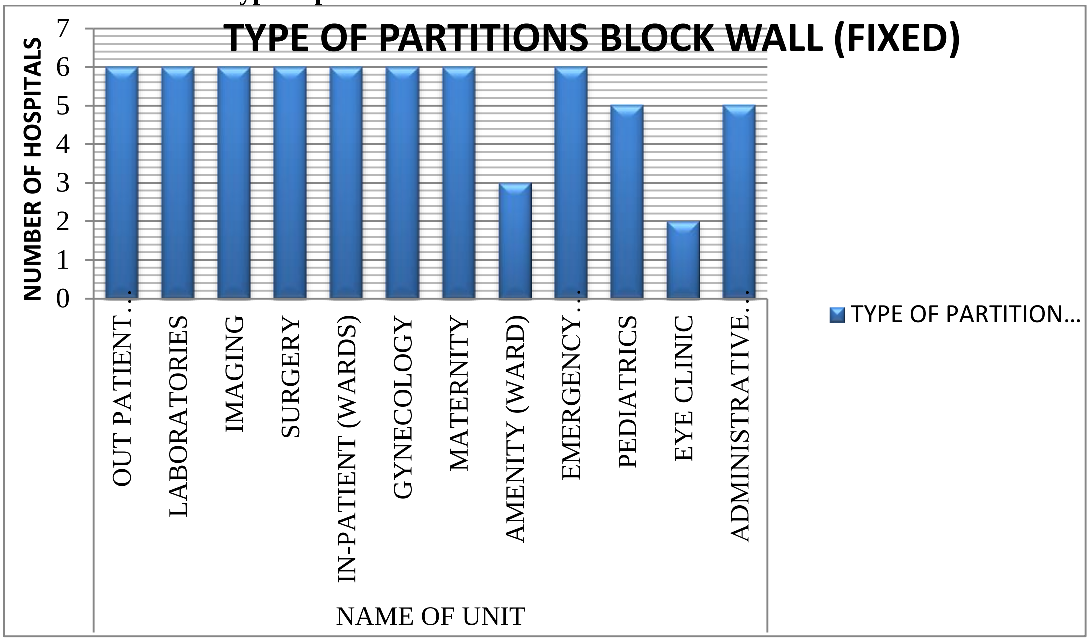
FINDINGS AND DISCUSSION OF RESULTS

The data gotten from the interview guide and observation schedule was analysed using Statistical Product and Service Solutions (SPSS) as an assessment tool and presented in tables. The survey was conducted by directly observing major variables which were the types of walls, the use of space and identifying flexible unit. The discussion of results covers the type of walling material used in construction, the use of spaces and identifying flexible unit in the hospitals building to determine the level of space adaptation and sustainability. Also the need and adequacy of spaces are also discussed to determine the efficiency of spaces. Which is dependent on three factors: The quantity of space, generally calculated in terms of floor area though occasionally volume may also be relevant, the number of users, potential and actual. And the amount of time the space is used (Space Management Group, 2006).

Type of wall for easy reconfiguration

The type of material used for the internal spaces in the hospitals as shown in Plate 1.0 shows, the type of walling materials adopted in different unit of the hospitals, unit such as the amenity unit, eye clinic, and paediatrics unit were found absent in some of the hospitals studied. It was discovered that most spaces were partitioned with fixed walling materials (sandcrete blocks), and thus. Reduces the level of which spaces can adapt or reconfigured. Also the cost of reconfiguring spaces will be cost intensive. This implies that the spaces in the hospital buildings can be considered as not sustainable.

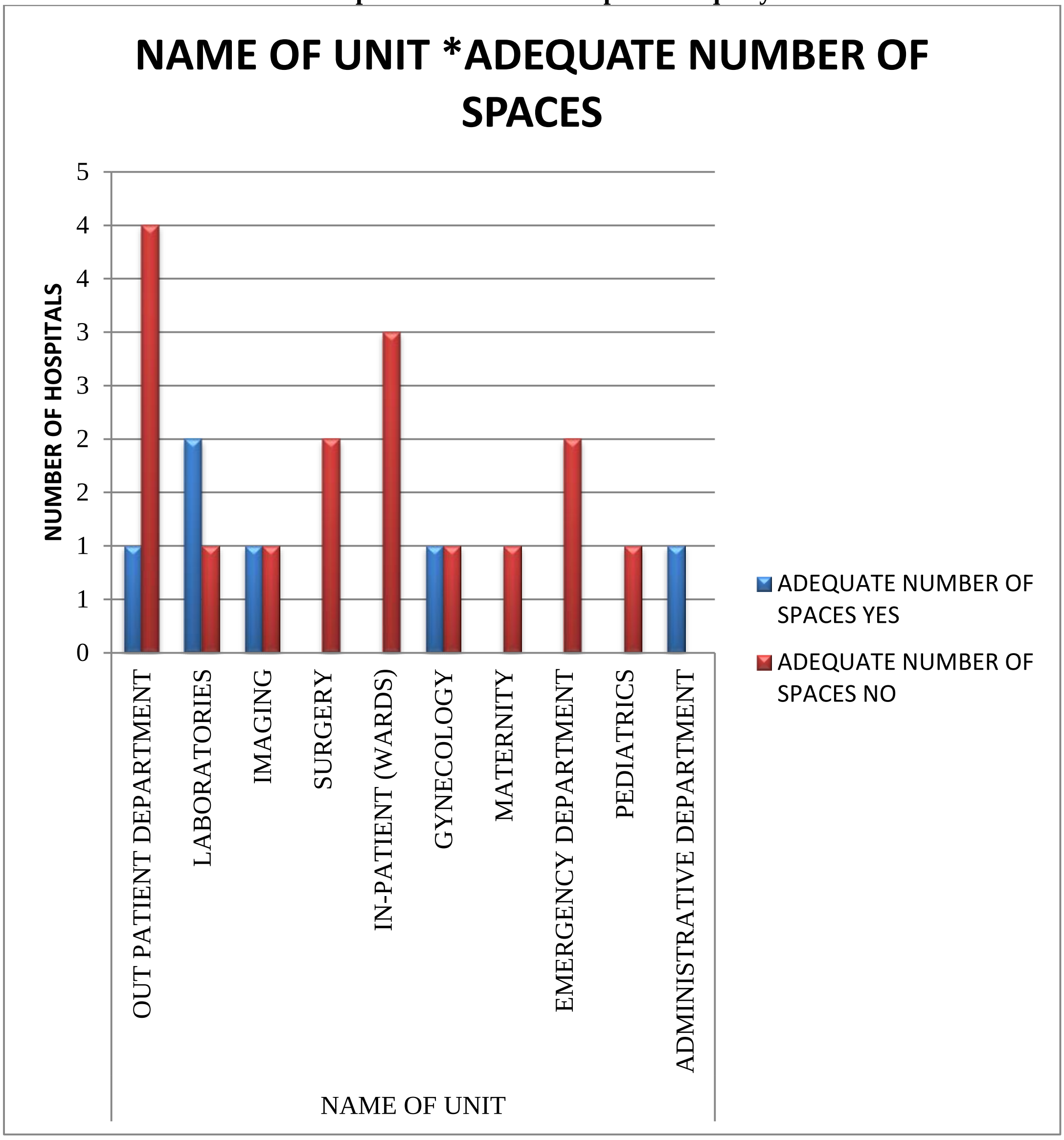
Plate 1.0: shows the type of partitions



Source: authors' fieldwork, 2015

Plate 2.0 shows a cross tabulation of units and adequacy in the number of spaces that have been provided which is dependent on the number of users, potential and actual and the amount of time the space is used. From the deductions gotten from the field, shows that some units require more spaces than the other due to the high influx of patient and service provision at varying times. In some unit most especially the emergency unit patient were seen in critical conditions sitting/laying on the floor waiting for attendance. In that case, these units will require being more adaptable to change to accommodate the pressing needs. It also shows that the out-patient unit requires a high number of spaces to accommodate the everyday visit of patients, also the surgery unit, inpatient unit, and emergency unit require more, this units could be made sustainable to needs, if a degree of flexibility was incorporated into the design of spaces.

Plate 2.0: Shows the Relationship between Units and Space Adequacy

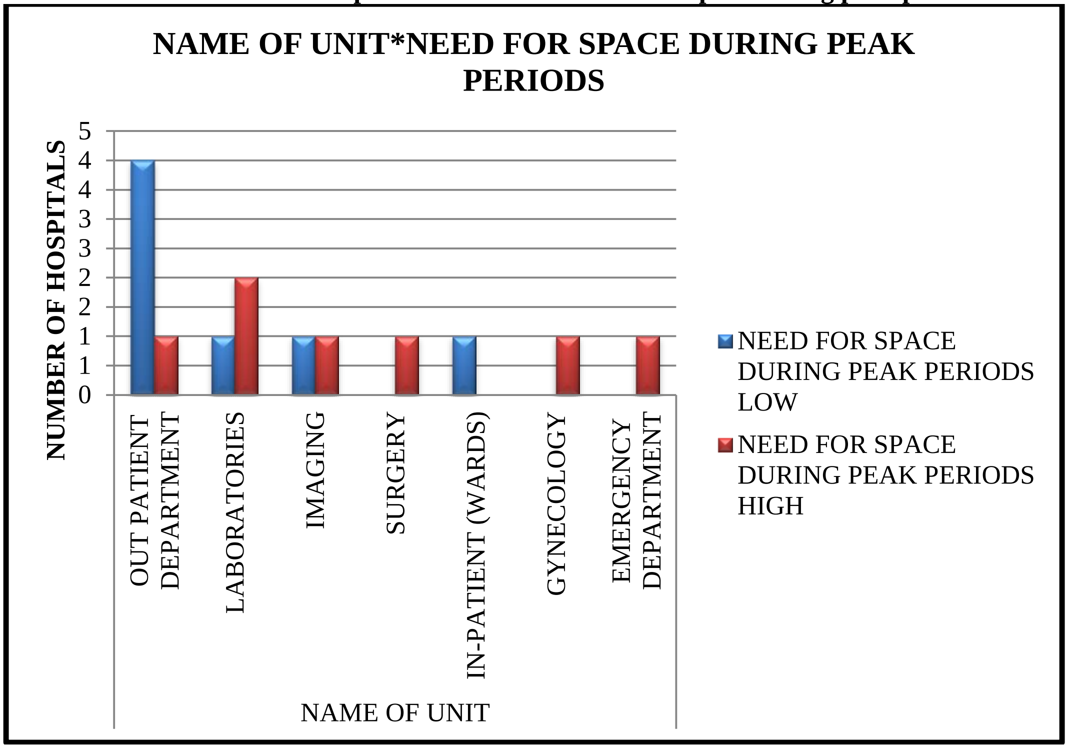


Source: authors' fieldwork, 2015

Need for spaces

The need for spaces during the peaks is been shown in plate 3.0 where, units that are constantly populated are shown. These periods are times when units or departments have a high influx of patient due to ever changing patient demography, and medical emergencies, the emergent rise in outbreaks of infectious disease, efficient utilization of resources including staff and equipment. The surgery unit, emergency unit, and gynaecology indicated a high demand for space during peaks. This implies that these unit experience over flow of patient at certain periods with no room to contain. It could be considered that the unit are not flexible to provide efficient services during the highs thus not sustainable.

Plate 3.0: shows the relationship between units and need for space during peak periods.



Source: authors' fieldwork, 2015

CONCLUSION

The need for unit spaces in many hospitals in Niger state is quite high and in most cases government cannot meet these needs because of the financial burden. However, the consideration for incorporating each type of flexibility into a building's conception and design should be an integral aspect in the early planning phase of a project. Sustainable practices for flexible spaces should be adopted for future constructions and renovations projects of healthcare facilities. These practices will not only save money during the lifespan of the healthcare facilities, but will also make hospital spaces more effective for healing. Additionally, it is pertinent to note that as a project evolves it becomes increasingly difficult to incorporate these strategies to curb the challenges of imminent changes. Hence, the design of hospitals should be a primary collaborative function of architects and experts in the field of biomedicine. This will ensure that right and timely decisions are made in providing spaces that can be adapted to in the future to enhance a smooth delivery of services. This submission is occasioned by the resentment towards the hospital environment observed on the care-seekers. Rather than adjust to fit their needs, the given hospital environments require them to fit into spaces, thus reducing the level of efficacy of its healing qualities and the effectiveness of the caregivers work as they do not have adequate monitoring of their patients. Therefore, Architects and professionals in the building and design industry(s) should consider the increased application of the principles of flexibility into the designs of hospital spaces to meet the needs of the users as it changes over time. In addition, it is also important to integrate the use of flexible wall types such as demountable partitions, moveable and transparent partitions to allow easy reconfiguration of spaces in the hospital.

REFERENCE

Barbara, H. B. (October, 2014). How to Design Flexible Healthcare Spaces. *Healthcare design magazine*.Retrieved from: https://www.healthcaredesignmagazine.com/article/how-design-flexible-healthcare-spaces on January 19th, 2016.

Bensalem, S. (2015). Sustainable Healthcare Architecture: Designing a Healing Environment. The University of Texas at Austin School of Architecture. Retrieved from:https://soa.utexas.edu/sites/default/disk/munpaper1/munpaper1/10_02_su_bensalem_s ara .pdf on September 17, 2015.

Berry, L.L., Parker, D., Coile, R.C Jr., Hamilton, D.K., O'Neill, D.D., Sadler, B.L. (2004). Can better buildings improve care and increase your financial returns? *Frontiers of Health Services Management 21*(3-24).

Cynthia, H. (2008). Planning Flexible Healthcare Facilities Is No Longer Optional. *Spacemed.com*. Retrieved from: https://www.spacemed.com/newsletter/trend-14-flexibility.pdf, on October 15th, 2015.

Ellen T., Anjali .J, Keller. A.M, Quan. X, (2011) Designing safety net clinics for flexibility: *California healthcare foundation: the centre for health design*.

Walter, G. (1954). *Eight Steps towards a Solid Architecture*. Architectural Forum, Feb 1954, Pp 157.

Peter, O. A., Chinyio, E., & Paul, O. O. (2012). Design of A Sustainable Building: A Conceptual Framework for Implementing Sustainability in the Building Sector. *Buildings 2*, 126-152. Doi:10.3390/buildings2020126.

Pati, D., & Harvey .T .E. (2008). *Inpatient Unit Flexibility: Design characteristics of a successful flexible unit.* Retrieved from www.worldhealthdesign.com/Inpatient-Unit Flexibility-Design-characteristics-of-a-successful-flexible-unit.aspx on September 2, 2015.

Richard de N.,Yun S. L., & Stefan S. (March, 2008). *Using Flexibility to Improve Value-for- Money in Hospital: Infrastructure* Investment. 1

Robert, J. F., Amaya C. L., & Joshua, D. C. (2012). *The Road to Flexibility*. Retrieved from: http://www.hksinc.com/insight/the-road-to-flexibility/ on September 17, 2015.

Sarkis, H., Allard, P., & Hyde, T. (2001). *Lecorbusier's Venice Hospital and the Mat Building Revival* (Edited). Munich: Prestel Verlag.

Space Management Group (2006). UK Higher Education Space Management Project Promoting space efficiency in building design.

Tayebeh, N. (2015). The Common Language of Sustainable Architecture in Creating New Architectural Spaces. *International Journal of Science, Technology and Society Special Issue: Research and Practice in Architecture and Urban Studies in Developing Countries.3* (2-1), 47-51. doi: 10.11648/j.ijsts.s.2015030201.20

COMPARATIVE ANALYSIS OF LOW-TECH SUSTAINABLE HOUSING PROJECTS IN ABUJA AND ENVIRONS

OLUIGBO Stephen Nwabunwanne [1] & DANJUMA Golesh Abel [2]

[1] Department of Architecture, Ahmadu Bello University, Zaria, Nigeria
[2] Nigerian Building and Road Research Institute, Abuja, Nigeria

Housing, which is a major index of sustainable development, remains a major challeng e in many developing countries. Sustainable housing delivery in Nigeria demands addre ssing the global challenge of housing production within the carrying capacity of suppor ting ecosystems, and the local challenge of low-cost or affordability. The solution lies p erhaps in the innovative use of low-tech solutions using sustainable building materials a nd technology. This is because materials are responsible for about 70 percent of the cos t of buildings. These materials and technologies must however meet the requirements o f sustainability. It is in this light that case studies of three housing projects in Abuja, Ni geria and environs were conducted using visual survey and descriptive analysis. The ev aluation was based on established requirements for sustainable building materials. The r esult shows that one of the projects largely met the requirements for sustainable buildin g materials and technology, while the other two could be rated as partially sustainable. Though all the case were classified as low-tech, materials such as steel and reinforced c oncrete which do not fall into this class were used in varying degrees thereby reducing t heir sustainability. Based on this, it is recommended that efforts at achieving low-tech s olutions for sustainable housing in Nigeria should focus innovative use of local and rea dily available material and avoid or minimise the temptation to augment with high-tech materials and methods.

Keywords: *Building materials, embodied energy, low-tech, sustainability, sustainable housing*

snoluigbo@abu.edu.ng,
danjumagolesh@gmail.com

OLUIGBO S. N[1] and DANJUMA G. A. (2016). **COMPARATIVE ANALYSIS OF LOW-TECH SUSTAINABLE HOUSING PROJECTS IN ABUJA AND ENVIRONS** Sustainable Built Environment and Climate change; The challenges of Post 2015 Development Agenda. School of Environmental Technology Conference, SETIC, 2016

INTRODUCTION

Housing represents one of the basic human necessities; it is as fundamental as the need for food and clothing. Nigeria's National Housing Policy defines housing as the process of providing safe, comfortable, attractive, functional, affordable and identifiable shelter in a proper setting within a neighbourhood, supported by continuous maintenance of the built environment for the daily living activities of individuals/families within the community while reflecting their socio-economic, cultural aspirations and preferences. The reality for Nigerians however is an acute deficit of housing currently estimated at 17million units (Federal Ministry of Land Housing and Urban Development, FMLHUD, 2012). This is against a background of dwindling natural and financial resources, hence the need for the adoption of sustainable housing strategies to bridge the Nigerian housing gap.

Sustainability is defined as the ability to meet the needs of the present while not compromising the ability of the future generation to meet theirs (World Commission on Environment and Development, 1987; Queensland Department of Public Works, 2008). It is relevant to state that the practical application of sustainability stands on three pillars which are; social concerns, economy and environment (Monteyne, 2013). Sustainable housing however is defined as housing that meets the diverse needs of existing and future residents, is sensitive to their environment and contributes to a high quality of life (National Institute of Consumer Research, 2011). For the purpose of this study, sustainable housing is defined as safe, comfortable, attractive, functional, affordable and identifiable shelter in a proper setting within a neighbourhood which fulfils the tripartite social, economic and environmental sustainability prerequisites.

Delivery of sustainable housing, especially in developing countries such as Nigeria, is hinged on the parley of building materials and technology. Jorchel (2013) categorizes sustainable building materials as either low-tech or high-tech. It is in this light that this study examines the application of low-tech building materials in selected sustainable housing projects in Abuja and environs, with a view to exposing the benefits of this approach to reducing Nigeria's housing deficit within the global requirement for sustainability. The objectives of the study are to:

i. Examine the concept of sustainable housing;
ii. Discuss the requirements of sustainable building materials; and,
iii. Evaluate low-tech sustainable building materials applied in selected sustainable housing projects in Abuja and environs.

Attributes of Sustainable Housing

The Geneva United Nations Charter on Sustainable Housing outlined the requirements of sustainable housing as:

i. Environmental protection;
ii. Economic effectiveness;
iii. Social inclusion and participation; and
iv. Cultural adequacy **(**United Nations Economic Commission for Europe Committee on Housing and Land Management UNECECHLM, 2014).

Environmental Protection

Environmental protection demands that housing be planned and used in a way that minimizes environmental impact and promotes environmental sustainability (Queensland Department of Public Works, 2008; UNECECHLM, 2014). This is achievable by incorporating features such as rainwater tanks, energy efficient hot water systems and passive solar design for the local climate. The passive solar design features to be incorporated are to ensure higher energy efficiency and help the environment by reducing household carbon emissions. The design and construction of houses should considers efficient use of building materials, minimize waste and use recycled materials where possible. Sustainable housing should consider reduced carbon footprint of the building from throughout its life cycle – from design, material supply, manufacturing and construction, to use, maintenance, refurbishment and demolition.

Economic Effectiveness

The Geneva UN Charter on Sustainable Housing stipulates that in achieving economic effectiveness in housing, the production of housing stock should be based, as much as possible, on local solutions, labour and local materials for their design, construction, and maintenance, thus contributing to local employment (UNECECHLM, 2014). The UN Habitat (2012) adds that sustainable housing should be affordable through the utilization of alternative/ecological local building materials and labour. The document, further adds that affordable housing activities contribute to economic development through its capacities to:

i. Stimulate economic growth through housing markets and homebuilding activities;
ii. Strengthen local building industry and enterprise and promote local and traditional building materials and techniques; and,
iii. Support regional and urban regeneration, development and growth.

Social Inclusion, Participation and Cultural Adequacy

While the Geneva UN Charter on Sustainable Housing tries to distinguish between social and cultural criteria for sustainable housing (UNECECHLM, 2014), the UN-Habitat (2012) discussed social and cultural sustainability of housing as an inclusive concept taking into consideration the diversity of lifestyles, values, norms and traditions of occupants thus amalgamating the ideals of social inclusion and participation and cultural adequacy. This study therefore enumerates the components of social/cultural inclusion and participation as follows:

i. Affordability, dignity and resilience of housing;
ii. Social infrastructure and facilities; and,
iii. Adaptable housing for present and future needs.

At the centre of effective housing policies lies the provision of affordable and adequate shelter for all, irrespective of wealth and social status. The inability of governments to provide socially and culturally sustainable housing leads to a variety of negative social and health implications such as slum developments, with attendant prevalence of diseases and antisocial activities. The UN-Habitat (2012) report stresses that affordability of housing is the requirement on which the social, economic, environmental dimensions of sustainability most clearly converge.

Adequate housing transcends beyond just the erection of buildings. It is also about descent infrastructure and dignity of communal life through opportunities for inclusive urban environment and decent and supportive social and cultural milieu (UN-Habitat, 2012). Furthermore, public facilities must ensure that people do not have to travel long distances via cars or otherwise, but have easy access to places where jobs and urban services are located.

Adaptable housing for present and future needs should inform housing policies and schemes by governments especially in developing economies. The designs of such houses should be flexible and responsive to various and changing needs of residents including those associated with elder groups, people with limited mobility as well as with children and women (UN-Habitat, 2012). Other applicable strategies include core housing options such that the housing designs allow for expansion as the needs and resources of the occupants permit (Golesh, Abdullahi & Danjuma, 2014).

Low-Tech Building Materials and Sustainable Housing Delivery

Low-tech sustainable buildings are those that focus on the simplest solutions and a choice of readily available and minimally processed natural materials. Kulesza (2010) noted that one of the epitomes of low-technology is satisfaction of ecological requirement for minimal damage to the earth during construction. This approach contributes to meeting the four requirements of sustainable housing as outlined by UNECECHLM (2014). The first requirement - environmental protection, is enhanced since the materials are largely renewable, recyclable, reusable, and bio-degradable. They are also usually available on-site or nearby. This results in energy savings in mining, production, storage and transportation, and little or no environmental pollution. The transportation and energy savings from such materials contribute to the second requirement - economic effectiveness, and reduces cost thereby making the houses more affordable and contribute to social inclusion and participation. Social inclusion and participation is also enhanced since the low-tech processing of materials and construction techniques are easily transferable to the local populace. This also contributes to local economy. Cultural adequacy is enhanced since low-tech is based on innovative use or adaptation of simple regionally available indigenous, traditional, vernacular or modern materials and methods. Most of the applied materials are obtained locally and easily conform to the practices already existing in the societies. They support the cultural practices in housing provision in the locations in which they are applied.

The alternative to low-tech solutions to housing is high-tech. Hi-tech sustainable building solution involves the application of latest technological advances (Cody, 2014). Studies by Jorchel (2013) suggest that though hi-tech sustainable solutions have high embodied energy they may have high recyclability potential such as materials like glass and steel. Table 1.0 below contains a list of building materials and their embodied energy. From this it can be seen that low tech materials such as air-dried sawn hardwood and stabilised earth have the lowest embodied energies (0.5 and 0.7 respectively). Consequently, such materials have less negative impact on the environment.

Table 1.0: Embodied Energy of Building Materials

Material	Embodied Energy (MJ/Kg)
Kiln dried sawn hardwood	*2.0*
Air dried sawn hardwood	*0.5*
Plastics- general	*90*
PVC	*80*
Stabilized earth	*0.7*
Gypsum plaster	*2.9*
Cement	*5.6*
Insitu concrete	*1.9*
Precast steam cured concrete	*2.0*
Clay bricks	*2.5*
Concrete blocks	*1.5*
Glass	*12.7*
Aluminium	*170*
Copper	*100*
Galvanized steel	*38*

(Source: www.victoria.ac.nz)

It is important to note that the more processing a material undergoes, the higher the embodied energy of that material. However, it is noteworthy to mention that re-use of building materials saves about 95% of embodied energy that will otherwise put into processing or production of new ones (www.victoria.ac.nz). The greatest amount of embodied energy in a building can be either from the extensive application of low embodied energy materials such as concrete or high embodied energy materials such as steel and glass.

Pierre and Alex (2013) listed the requirements for sustainable building materials. It is based on this that the housing projects below were evaluated. The requirements are:

i. Reduced impact of building material transportation;
ii. reduced embodied energy;
iii. Thermal performance of materials;
iv. Financial viability;
v. Recyclability of building materials;
vi. Minimal waste and pollution in manufacturing process; and,
vii. Construction technology.

RESEARCH METHOD

Three cases were studied using visual survey and descriptive account. The case were selected purposively in order to compare and illustrate the applications of low-tech sustainable housing solutions. The projects were descriptively analysed based on the following: Reduced impact of building material transportation, reduced embodied energy, thermal performance of materials; financial viability; recyclability of building materials; minimal waste and pollution in manufacturing process; and, construction technology. The materials used in the projects were scored based on a rating scale ranging from Low (L), Moderate (M), and High (H).

The studied housing projects are: Luvu Madaki Affordable Housing estate Masaka, Karu Local Government Area Nasarawa state (LMAH), Fuller Foundation Affordable Housing Estate Masaka, Karu Local Government Area Nasarawa state (FFAH), and a two storey residential building at Kubwa (Kubwa housing), Bwari Area Council, Abuja. These cases were selected to compare low-tech solutions based on the popular Compressed Stabilized Earth Bricks (CSEB) as used in LMAH, with a different alternative – gypsum boards as used in FFAH, while the third case is a combination of CSEB and concrete as used in Kubwa housing, which places it somewhat in the middle. LMAH is situated on a 1.2 hectare land in Masaka, a suburb 20km from the Abuja city centre. LMAH estate was planned as an affordable housing scheme of 6 units of two bedroom and is a product of the effort of a number of collaborating Non-Governmental Organisations (NGOs). FFAH is situated on a two hectare land in Masaka, a suburb 20km from the Abuja city centre. The estate was planned as an affordable housing scheme of 24 units. The two storey residential building at Kubwa (Kubwa housing), Bwari Area Council Abuja is a five bedroom single family storey building. The technology used for this building is the mortarless dry stacked interlocking compressed stabilized earth brick (CSEB).

FINDINGS AND DISCUSSION OF RESULTS

Reduced Impact of Building Material Transportation

LMAH estate was constructed largely with stabilized earth bricks though not dry stacked (Plate 1.0). This was produced on site thereby averting the negative environmental impact (Green House Gas Emission and environmental pollution) attributable to building material transportation. The only transportation of the bricks was from the point of manufacture to the plots, and the impact of this is minimal.

Plate 1.0: Housing units at LMAH.

FFAH estate was constructed using dry construction technology. The buildings are studio flats expandable to one bedroom flats. The dry construction technologies used for the FFAH is that of gypsum boards in steel frames (Plate 2.0). The impact of transportation was more in this project due to the fact that gypsum boards and steel frames were industrially produced, and needed to be transported. However, this is still minimal considering the fact that the gypsum cladded boards were manufactured within Abuja.

Plate 2: Housing units at FFAH.

For the Storey building at Kubwa, the major material was earth, which was readily available on site. The technology used for this building is the mortarless dry stacked interlocking CSEB. However, concrete was used for structural elements such as beams and columns (Plate 3.0). This brings the transportation of cement, sand, aggregate and reinforcing rods into play.

Plate 3: Two storey building at Kubwa, Bwari Area Council Abuja

Reduced Embodied Energy

The production of earth-based materials consumes much less energy and pollutes much less than other alternatives such as concrete blocks and fired bricks. The CSEBs used at LMAH and Kubwa were not burnt or fired. This reduces the embodied energy of the major building material for the housing estates. CSEBs are compressed to achieve the required strength after the process of curing was effectively carried out. The FFAH is made of industrially processed materials hence its higher embodied energy, however it has the advantage of speedy assemblage onsite and little or no need for water for assembly. The Storey building at Kubwa exhibit an increase in embodied energy due to the use of concrete for structural elements such as beams and columns. Cement alone has an embodied energy of 5.6 MJ/Kg (See table 1).

Thermal Performance of Materials

Thermal performance of building materials is critical to achieving thermal comfort in buildings. As a building material, CSEBs have high thermal capacity, thereby making it a good material for building in hot dry climates. This is of great benefit in Abuja, where LMAH and Kubwa storey building are located. For FFAH, though gypsum boards and steel frames were used, the cavity between the gypsum boards enhance thermal insulation.

Financial Viability

The fact that the CSEBs were produced locally, with readily available resource and semi-skilled labour, and little transportation, makes them cost effective. This is in comparison to the cost of energy needed for production of other building materials such as fired brick and concrete blocks. These materials are cheaper than fired bricks due to the fact that a lot of energy is needed to power a furnace for fired bricks. Compared to concrete block, they are also cheaper when considering the cost of cement and sharp sand used. However, in the case of the FFAH the financial viability of the gypsum boards and steel frame construction is greater than concrete blocks but less than CSEBs.

Recyclability and Reuse of Building Materials

CSEBs are not fired and do not undergo any change of state during their production. This makes them easily biodegradable. Also, interlocking CSEBs can be reused after demolition. For gypsum clad steel frames as in the case of FFAH estate it is easy to dismantle and re assemble after use.

Minimal Waste and Pollution in Manufacturing Process

Little or no waste was generated in the manufacturing process of the CSEBs. This is because the production was done at the same spot where the laterite was sourced, and any surplus or spilled laterite was returned to the earth. Also, the CSEB making is a non-toxic process, as compared to materials such as concrete. However, the same cannot be stated for the FFAH housing technology.

Construction Technology

The use of CSEBs at LMAH estate and Kubwa meant that the construction process required less-skilled or semi-skilled, and the skill required can be easily transferred within shorter periods as compared with concrete block laying. The process of block laying used in Kubwa also requires less time and energy as the CSEBs only required interlocking and no placement of mortar for binding. At LMAH estate mortar was used but was primarily a mixture of cement and laterite. At FFAH, the use of gypsum cladded steel frame required more skill though not very advanced.

Assessment of Sustainable Building materials used in the Projects

Based on the visual survey result, the housing projects were assessed against requirements for sustainable building materials as stated by Pierre and Alex (2013). The result is contained in tables 2.0 to 4.0 below.

Table 2.0 Assessment of Sustainability of Materials used at Luvu Madaki Affordable Housing (LMAH),

Requirements for Sustainable Building Materials	Level of Reflection			Comment
	L	***M***	***H***	
Reduced impact of building material transportation			*X*	*CSEB was sourced and processed on-site*
Reduced embodied energy			*X*	*Stabilized earth has an embodied energy of 0.7MJ/Kg (see Table 1.0)*
Thermal performance of materials			*X*	*CSEB has high thermal capacity, thereby making it good for building in hot dry climates*
Financial viability			*X*	*CSEB is cheaper that concrete. Cost of an Earth Block wall system is about 40% cheaper than conventional systems*
Recyclability of building materials			*X*	*CSEB is not fired and does not undergo any change of state during their production*
Minimal waste and pollution in manufacturing process			*X*	*Little or no waste in CSEB manufacturing since production was done at the same spot and surplus or spilled laterite was returned to the earth*
Simplicity of construction technology			*X*	*Construction process requires less skill*

L = Low; M = Moderate; H = High.

Table 3.0 Assessment of Sustainability of Materials used at Fuller Foundation Affordable Housing (FFAH)

Requirements for Sustainable Building Materials	Level of Reflection			Comment
	L	***M***	***H***	
Reduced impact of building material transportation		*X*		*The gypsum board and steel frames were produced off-site*
Reduced embodied energy	*X*			*Gypsum plaster has an embodied energy of 2.9MJ/Kg while steel has 38MJ/Kg (see Table 1.0)*
Thermal performance of materials		*X*		*Cavity between the gypsum boards enhance thermal insulation*
Financial viability		*X*		*Construction with gypsum board is cheaper that concrete locks*
Recyclability of building materials		*X*		*Gypsum boards and steel frames can be dismantle and reused*

Minimal waste and pollution in manufacturing process	*X*			*There is wastage in gypsum board and steel cut offs*
Simplicity of construction technology		*X*		*More advanced skill but still easily acquired*

L = Low; M = Moderate; H = High.

Table 4.0 Assessment of Sustainability of Materials used at Kubwa Housing

Requirements for Sustainable Building Materials	Level of Reflection			Comment
	L	***M***	***H***	
Reduced impact of building material transportation		*X*		*Stabilized earth was produced on-site while materials used for concrete components were produced off-site*
Reduced embodied energy		*X*		*Stabilized earth has an embodied energy of 0.7MJ/Kg but concrete has 1.9MJ/Kg (see Table 1.0)*
Thermal performance of materials			*X*	*Stabilized earth brick and concrete have high thermal capacities thereby making them good for building in hot dry climates*
Financial viability		*X*		*Stabilized earth bricks are cheap while concrete is not*
Recyclability of building materials		*X*		*Stabilized earth brick can easily be recycled but in-situ concrete is not easy to recycle*
Minimal waste and pollution in manufacturing process		*X*		*Little waste in CSEB manufacturing but there is waste in concrete and reinforcement*
Simplicity of construction technology		*X*		*Less kill for the CSEB but more for the concrete and associated formwork*

L = Low; M = Moderate; H = High.

CONCLUSION

Low-tech solutions presents a viable opportunity for sustainably clearing the housing deficits of developing countries such as Nigeria. Both non-complex dry and wet construction technologies can be explored. This should however be based on skills which are locally available or those can be easily transferred in order to speedily reduce the housing deficit, especially at the low-income level.

Though all the case studied were classified as low-tech, it could be seen that materials such as steel and reinforced concrete were applied to varying degrees. The first LMAH was largely of stabilized earth bricks. The second - FFAH was of gypsum cladded boards in steel frames which required both higher level technology for manufacturing and construction. The third - the two storey residential building at Kubwa combined CSEB and concrete, thereby reducing its categorization as low-tech. Based on this, it is recommended that efforts at achieving low-tech solutions for sustainable housing in Nigeria should focus totally on locally and readily available material and avoid or minimise the temptation to augment with high-tech materials and methods.

REFERENCES

Cody, A., (2014). The Role of Technology in Sustainable Architecture. In: *Wolkenkuckucksheim, Internationale Zeitschrift zur Theorie der Architektur. Jg.* 19, Heft 33, 2014, [Seiten], cloud cuckoo.net/fileadmin/hefte_de/heft_33/artikel_cody.pdf [Abfragedatum].

Federal Ministry of Land Housing and Urban Development (FMLHUD) (2012). *National Housing Policy*. Abuja: Federal Ministry of Land Housing and Urban Development.

Golesh, A. D., Abdullahi, A. & Danjuma, F. T. (2014). Core housing as a tool for affordable housing delivery in Nigeria. *West African journal of Road and Building Research, vol.1 (2).*

Jorchel, S., (2013). From High-Tech to High-Quality and Low-Tech: The Sustainable Potential of Earth as a Building Material. *Central Europe towards Sustainable Building 2013.*

Kulesza, M., (2010). Low-tech Systems in Modern Ecological Construction. *Published Bachelor of Constructing Architect, VIA University College, Horsens, Denmark.*

Monteyne, H., (2013). Letter from an Engineer: Nigeria through the Eyes of a Belgian Engineer. *ArchiAfrika magazine. Vol. 3 August 2013.* 81-91.

National Institute of Consumer Research, (2011). Issues in Sustainable Housing. *1st "Policy meets research" Workshop Helsinki, 24th November 2011 Pal Strandbakken.*

Pierre, R., and Alex, A. (2013). Sustainable building materials. Retrieved July 10, 2015 from www.sustainabledevelopmentnetwork.com/manual1/Chapter%203.pdf

Queensland Department of Public Works, (2008). *Smart and Sustainable Home Design Objectives.* ISBN 978-0-9804690-2-8.

UN-Habitat, (2012). *Sustainable Housing for Sustainable Cities: A policy framework for developing countries*. Nairobi, Kenya. ISBN: 978-92-1-132488-4.

United Nations Economic Commission for Europe Committee on Housing and Land Management (UNECECHLM) (2014). *Geneva UN Charter on Sustainable Housing.* Retrieved from http://www.iut.nu/UN/UN_ECE/GenevaCharter2014.pdf, retrieved 3/1/2016.

World Commission on Environment and Development (WCED) (1987). *Our Common Future. World Commission on Environment and Development.* Oxford, New York: Oxford University Press.

DESIGN CONSIDERATION FOR ECOLOGICAL AND GREEN DESIGN IN SHOPPING CENTRES IN MINNA NIGER STATE, NIGERIA

M.I. BALA & METU John

Department of Architecture, Federal University of Technology Minna

Growing census in human population has it that the infrastructure and cities ecology are both at risk as a result of the impacts of climate change experienced globally. Buildings are found to be both, one of the biggest consumer of energy and producer of greenhouse gases. According to the National Institute of Building Sciences (USA), buildings generate 35 percent of the carbon dioxide (the primary greenhouse gas associated with climate change), 49 percent of the sulphur dioxide, and 25 percent of the nitrogen oxide found in the air. These activities in the long run affect the environment in terms of urban ventilation and cooling, urban drainage and flood risk and water resources and conservation. The aim of this study is to identify and discuss the ecological and green design considerations to be implemented when designing shopping facilities to achieve more environmental friendly buildings. This research collated data from a sampled population of existing shopping complexes in Minna (the study area) based on zoning and volume of commercial activities in these buildings. This was done by using observation schedule to assess the effects of energy emission and conservation, ventilation and cooling, water conservation, power source, building orientation, outdoor finishing material and spaces (including air quality and biodiversity) and how all these parameters affects the environment. This is with the view to create structures that are environmentally responsible and resource efficient to reduce the impact on human health and the natural environment. This proffered solution is not short termed but rather one which provides built environment that is self-sustaining and efficient.

KEYWORD: *Ecological design, Sustainability, Water conservation, Cooling and Ventilation, Building Orientation, Power source, finishing material, Roof type*

Joncreekfieldenergy@yahoo.co.uk

M.I. Bala & Metu John (2016). **DESIGN CONSIDERATION FOR ECOLOGICAL AND GREEN DESIGN IN SHOPPING CENTRES IN MINNA NIGER STATE, NIGERIA** Sustainable Built Environment and Climate change; The challenges of Post 2015 Development Agenda. School of Environmental Technology Conference, SETIC, 2016

INTRODUCTION

Buildings account for more than 35% of all global carbon dioxide emission, one of the main culprits implicated in the phenomenon of global warming. Green building is the practice of constructing or modifying structures to be environmentally responsible, sustainable and resource-efficient throughout their life cycle. This includes efficiently using energy, water and other natural resources, protecting occupant health, improving employee productivity and reducing waste, pollution and environmental degradation. Green buildings accounts for improving environmental footprint by reducing energy use by 30-5-%, CO2 emissions by 35%, waste output by 70% and water usage by 40%.

From the environmental viewpoint, buildings also account for nearly half of all energy consumption and raw material use around the globe. The 2008 Building Energy Data book (USDE 2008) says that commercial and residential buildings are held responsible for 39.7 percent of the energy consumed (residential 21.5 percent and commercial 18.2 percent) globally and 76 percent of the electricity used and 15 percent of the total water consumed (Architecture 2030 2009). Building and Construction sector takes up the lion share of resources for land use and material extraction, 50 percent of the world's raw material wealth – many of which are non-renewable resources – and are responsible for 36 percent of all waste generated worldwide. Some of the non-recyclable materials such as lead-based paints, asbestos, mould, wastes containing mercury, fluorescent bulbs, batteries pose serious environmental and health problems. Hazardous waste must be disposed of in a separate landfill at a very high cost.

This aim of this study is to assess the ecological and green design variables of shopping complexes within Minna Niger State. This assessment has been carried out by the collation of data using observation schedule and the objectives will be, (1) to identify shopping complexes in Minna Niger State, (2) to assess the eco design variables of a selected sample population of shopping complexes based on zoning, making recommendations of possible solution on eco design implementation. Ecological and green design approaches in both exterior and interior spaces will be discussed. Energy and emissions in interior spaces with lighting, ventilation, and air conditioning thermal comfort, insulation, Cooling systems, Number and sizes of windows, Building Orientation, finishing materials and the surface treatment systems and their contributions to the concept of ecological and green will be overviewed.

CONCEPT OF ECOLOGIC AND GREEN DESIGN

The concept of ecological design in the sector of construction is defined as; "the creation and responsible management of a healthy built environment, based on the efficient use of resources and on ecological principles" by Scott in 1999. Ecological and Green design in the construction industry works for the present and future improvement in the life quality.

This requires the characterization of materials from an ecological point of view, a complex operation under the conditions in which the environmental impact of building materials is difficult to assess, mainly due to the numerous different problems to be taken into consideration and to the fact that the data available are frequently inadequate for an accurate evaluation.

Basic principles that underlie ecological and green design in construction industry can be listed as:

1. Saving of existing material resources;
2. Maintenance of a clean and healthy environment both in terms of topographic changes and the degree of air, water and soil pollution;
3. Reduction of the embodied energy in buildings;
4. Measures regarding the diminution of heat losses;
5. Provides an optimal ratio between the surface of the envelope and the building volume;
6. Contributes the thermal insulation of the closing elements of a building (exterior walls, floors, roofs);
7. Ensuring of adequate thermal inertia;
8. Contributes the creation of insulating spaces between environments with different temperatures (buffer spaces in attics, basements, staircases, etc.);
9. Requires more efficient installations and equipments;
10. Provides hierarchy of spaces requiring different temperatures and their orientation in relation to the cardinal points;
11. Requires use of renewable energy sources (solar, geothermal energy);
12. Provides optimization of natural ventilation;
13. Encouragement of investments for the conservation of energy;
14. Provides and increased awareness of users, adoption of more rational building operation conditions

NEEDS AND ISSUES

The ecological crisis today is very serious and till date much of the debate still focuses on the symptoms rather than the causes. As a result there is an urgent need to emphasize and workout the best possible approach towards environmental protection thereby minimizing further degradation. Architecture presents a unique challenge in the field of sustainability. Construction projects typically consume large amounts of materials, produce tons of waste, and often involve weighing the preservation of buildings that have historical significance against the desire for the development of newer, more modern designs. Sustainable development is one such measure, which presents an approach that can largely contribute to environmental protection. A striking balance between Environmental protection and Sustainable development is a difficult and delicate task. Sustainable design is the thoughtful integration of architecture with electrical, mechanical, and structural engineering. In addition to concern for the traditional aesthetics of massing, proportion, scale, texture, shadow, and light, the facility design team needs to be concerned with long term costs: environmental, economic, and human.

Potential climate change Impacts of built environment in Nigeria

Flooding:

- More frequent and intense rainfalls leading to flooding and overwhelming of urban drainage systems.

Water Resources:

- Heightened water demand in hot, dry times
- Reduced soil moisture and groundwater replenishment.

Health:

- Poorer air quality affects asthmatics and causes damage to plants and buildings.
- Higher mortality rates in Nov. – June due to heat stress.

Biodiversity:

- Increased competition from exotic species, spread of disease and pests, affecting both fauna and flora.
- Increased ground movement in affecting underground pipes and cables.
- Reduced comfort and productivity of workers.

Transport:

- Increased disruption to transport systems by extreme weather.
- Reduction in cold weather-related disruption.

RESEARCH METHODOLOGY

The methodology of this survey consists of practical field observation and field based data. The study was carried out using both primary and secondary data sources. The method of primary data collection was used to familiarize the researchers with the study area and also identifying shopping complexes based on zoning and the frequency of commercial activities. Observation schedule was used to collect data on the following: Ventilation system and Cooling system, Water Conservation, Power Source, Landscape, Building Orientation. This is done by checking the window sizes, Numbers of window in a space, Types of windows, orientation of the windows and opening/fenestrations of the shopping complex and availability of courtyard with its sizes. These data are now compared with some international case study of building that are eco friendly and then compared with the standards rating system (LEED) to ascertain how efficiently Eco design parameters have been considered in the implementation.

STUDY AREA

The study area is Minna the capital city and the commercial nerve centre of Niger State. The commercial activities or volume of trade in this town is moderate compared to other state capital in the northern part of Nigeria. Therefore, there are just a handful of shopping complexes spread across the length and breadth of this city. Minna is divided into two zones namely Chanchaga and Bosso and the total number of shopping complexes put together is forty eight (48). So based on observation over a period of time, a sample population have been taken from each zone depending on the daily traffic or shopping activities that takes place in those shopping complexes. Basically this research have studied a total of 15 shopping complexes taking 8 from Chanchaga LGA and 7 from Bosso LGA respectively.

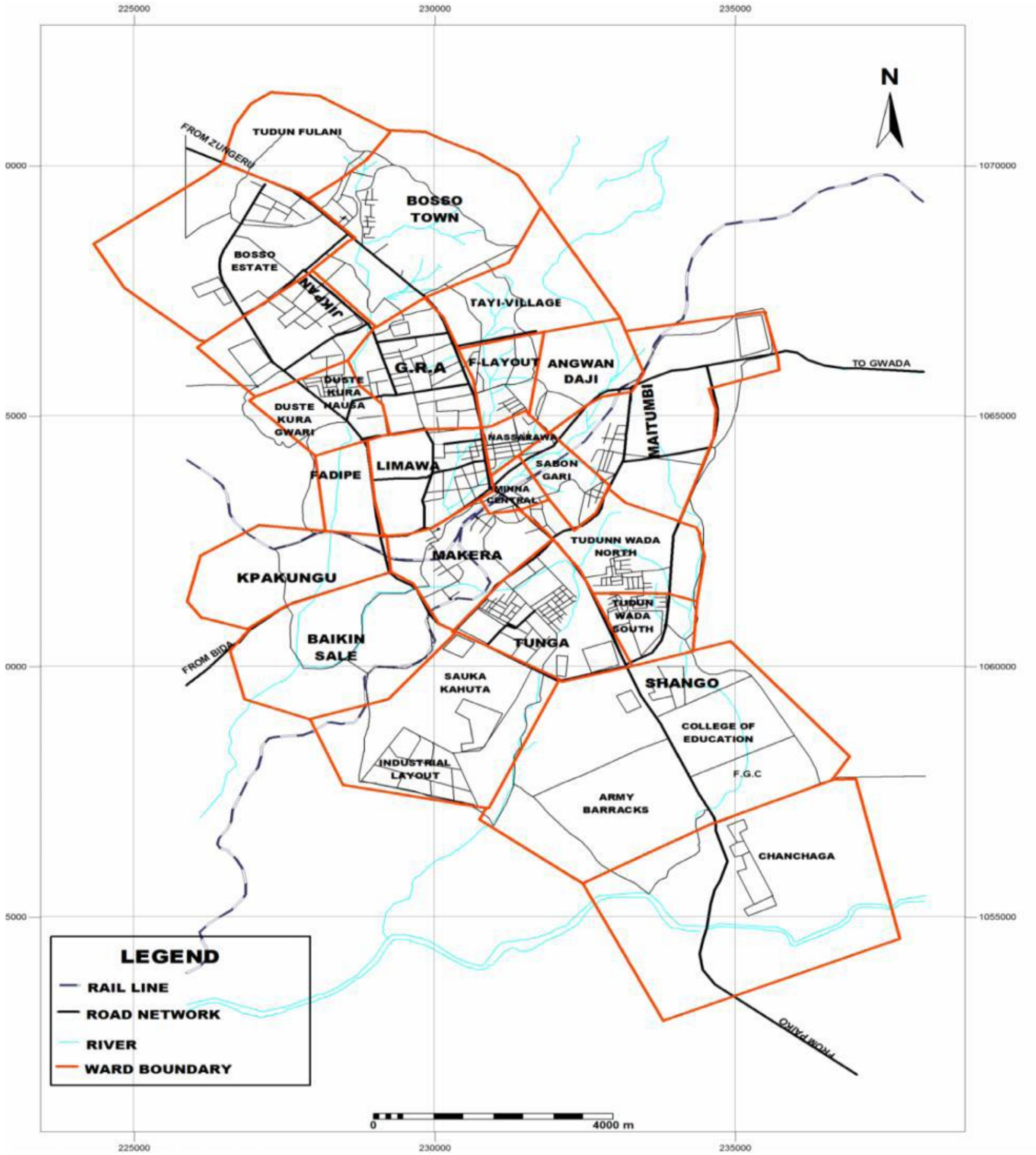


FIG 2: **MAP OF MINNA**
Source: *Urban and Regional Planning Department, FUT, Minna2012*

ENERGY AND EMISSION AND CONSERVATION IN BUILDING

Buildings use great amount of energies in interior spaces for lighting, heating, cooling ventilating air conditioning and so on. Energy consumptions of the buildings for those activities should be controlled by the designers. Greenhouse gas emissions in interior spaces are directly related to energy consumption. Integrated Energy Approach Greenhouse reductions are achieved in a staged approach. Reduction in overall energy consumption through demand reduction and energy efficiency should be considered.

Reduction in electricity and gas utility consumption by utilizing waste products and renewable energy technologies should be aware of. Lighting, heating, ventilating, air conditionings and insulation are important design parameters in the ecological and green interiors.

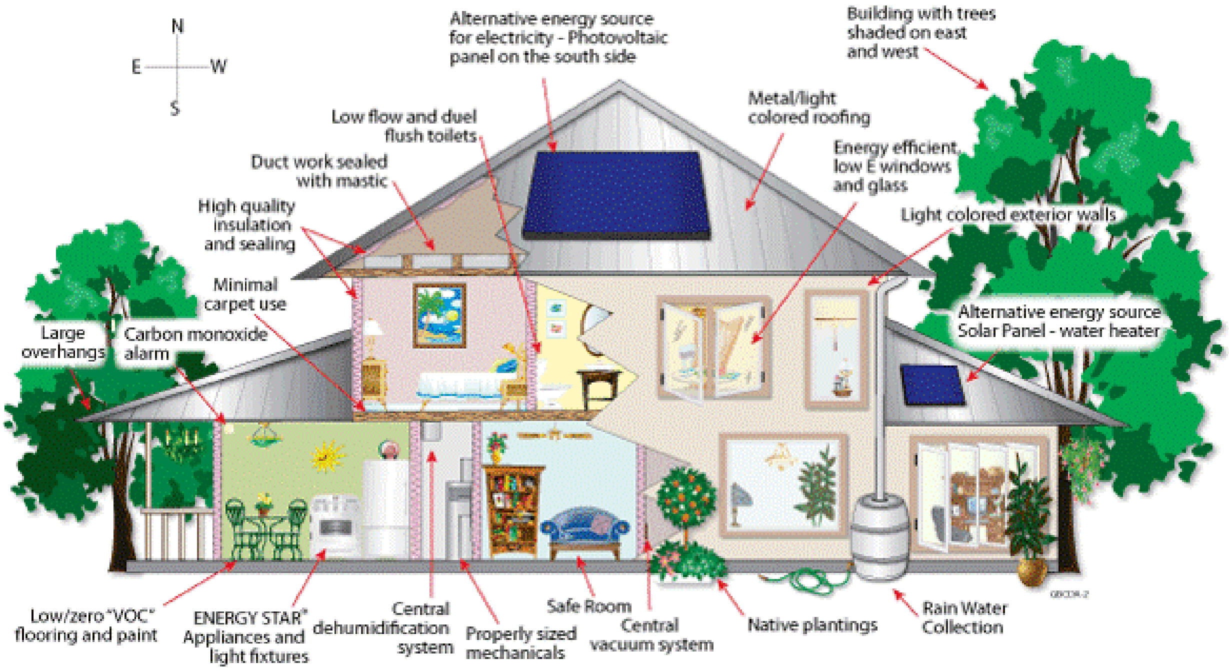


FIG 3: Energy Resources of a building
Source: GOZEN GUNER AKTAS - Interior Architecture and Environmental Design

COOLING SYSTEM, HEATING, VENTILATION & AIR-CONDITIONING

Heating, ventilation and air conditioning in interior spaces are another important energy consumption parameter. Natural ventilation and air change effectiveness is an important concept in the interior architecture. The cross ventilation system proposed relies on cooled filtered air being provided by surrounding vegetation and landscaping. This cooled and filtered area is then drawn through the apartments via convection. The facade openings would be small, top-hung and set low in sets of two or three to draw in the low lying cooler air. Purpose designed vents, high level louvers, or ventilating skylights can be used to exhaust warm air at the top of the spaces, creating outlets for the thermal flues that are formed by the stairwells, thermal chimneys or centralized ducts. Surrounding vegetation would improve the effect of natural ventilation especially during summer time

Natural Ventilation should be considered a priority over wind energy. Natural ventilation systems rely on pressure differences to move fresh air through buildings. The pressure differences can be caused by the buoyancy effect created by temperature differences, by wind, or by differences in humidity. Natural ventilation systems are circuits, equal importance must be given to both air supply and exhaust

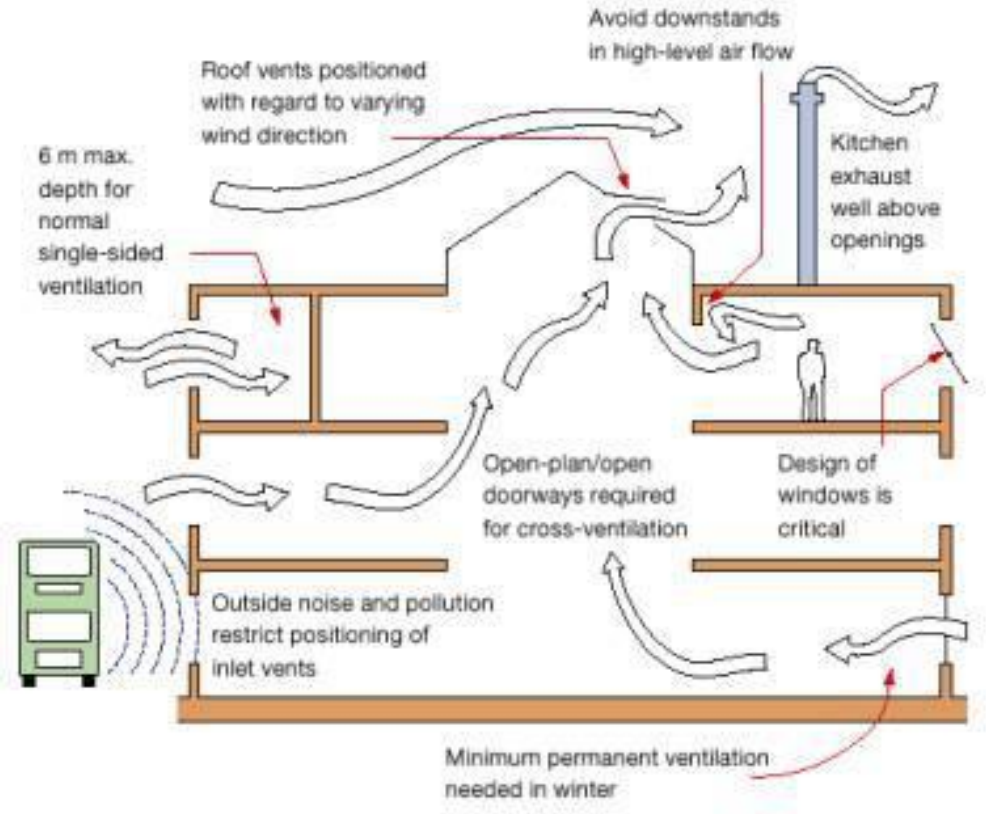
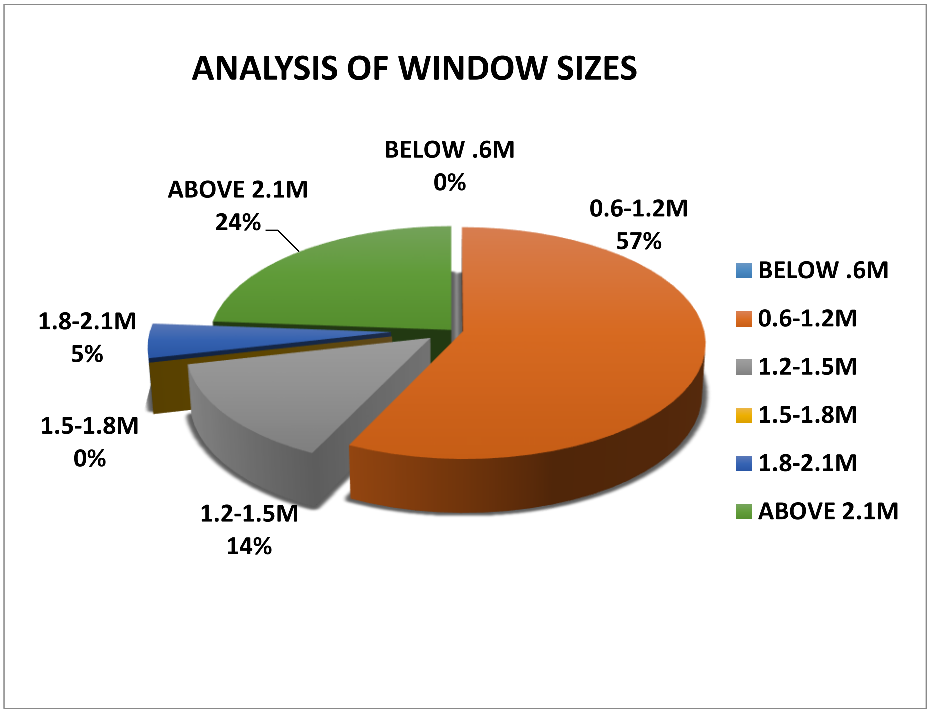
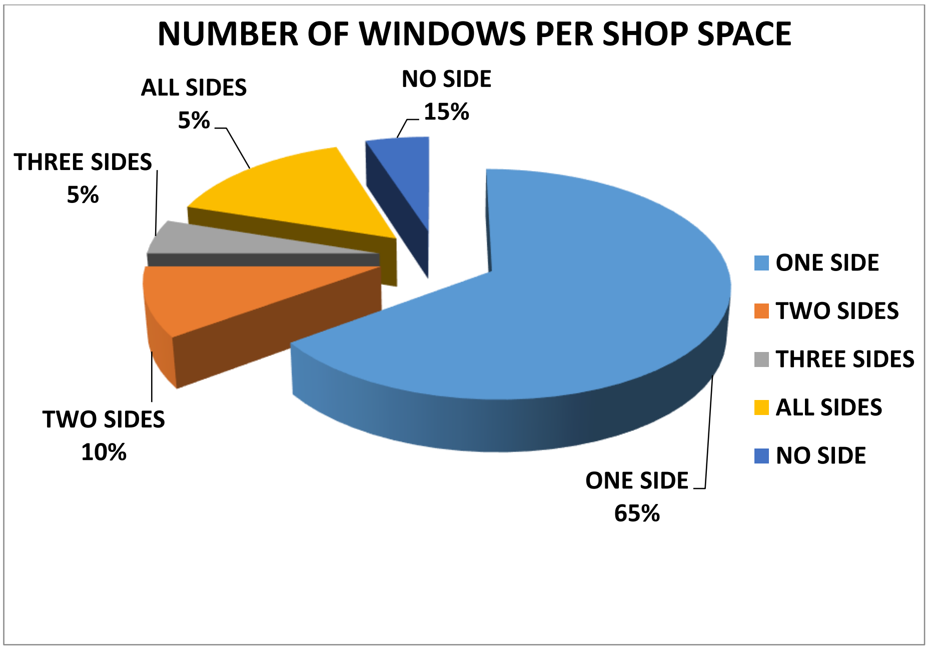


Fig5: *showing Natural Cooling system or Ventilation*
Source: GOZEN GUNER AKTAS - Interior Architecture and Environmental Design

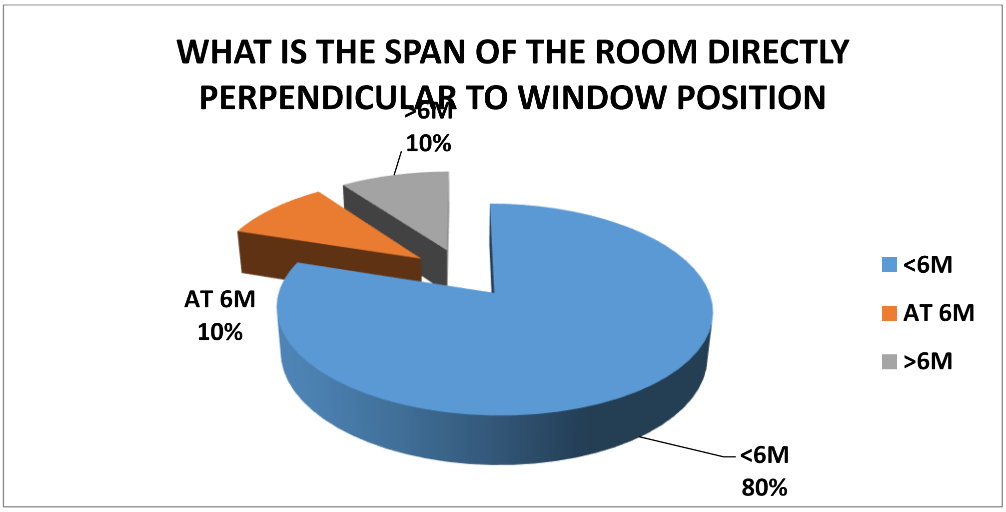
Heating and cooling of the building will make up a large proportion of the building's energy use throughout the year. Several options for the HVAC systems will be investigated. The layout and type of the development will allows either a localized package or split unit design, or a centralized energy plant design where the thermal energy is generated centrally and then distributed around the development. The efficiency of the system, capabilities of the system as well as expected installation and operation cost should be considered.



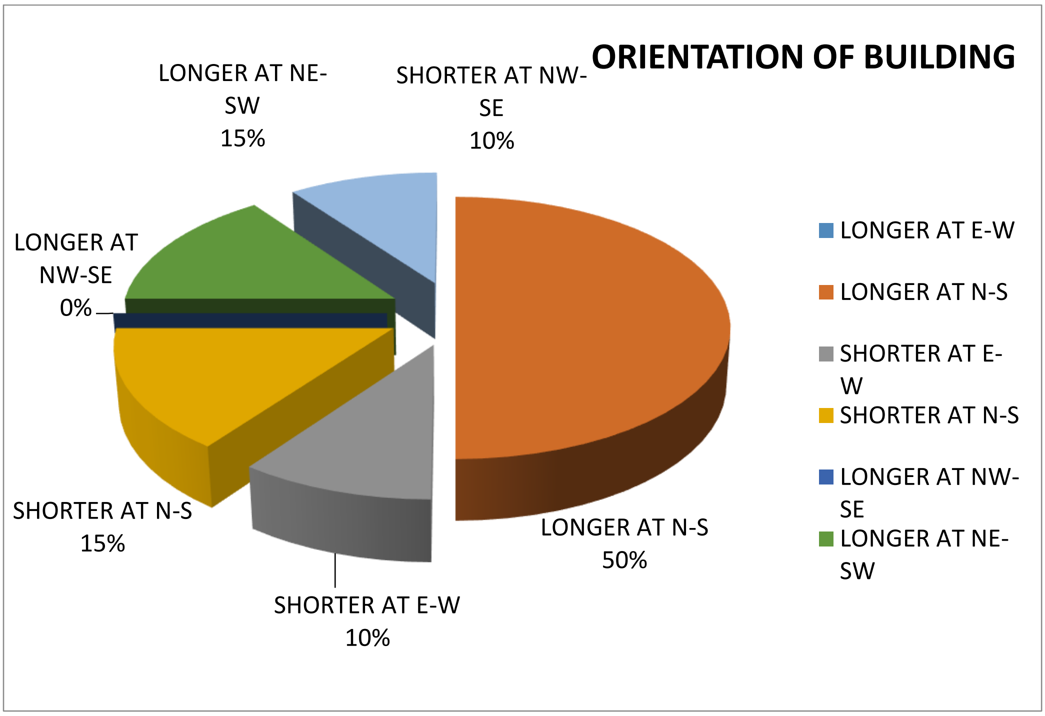
The analysis of the windows sizes has shown that the relationship of window sizes to the depth of the shops where they are placed is inadequate. Which means that the spaces are not properly cross ventilated thereby an artificial cooling system is employed to cool those spaces. For window sizes of 0.6-1.2m have the highest number of windows at 57%. Those of 1.2-1.5m are at 14%. This has shown that windows of 1.8-2.1m are at 5%, and finally those of above 2.1m are at 24%.



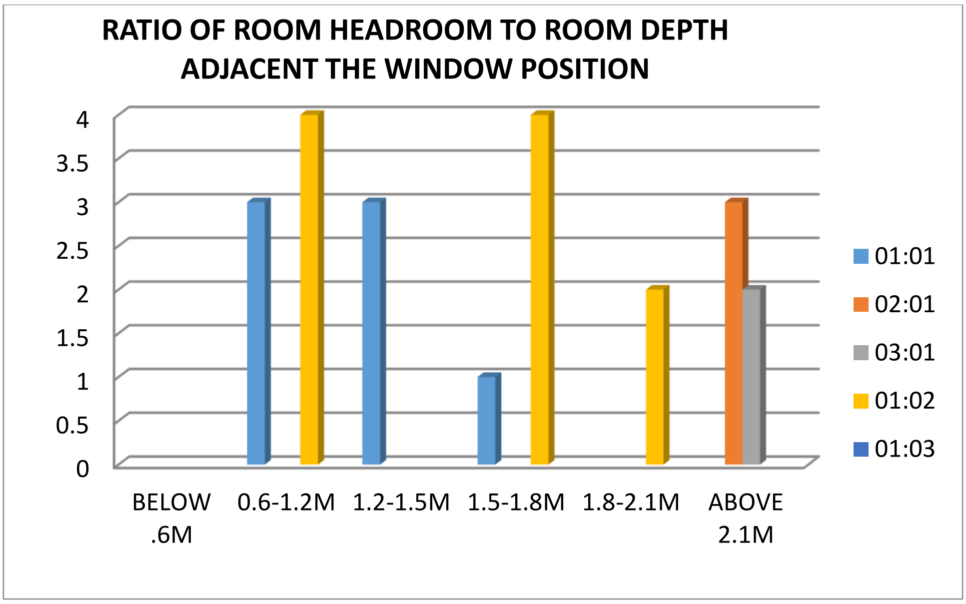
The analysis of windows per shop room shows the number of sides, carrying windows. Shops where only one side have windows, is at 65%, no side is at 15%. 2 sides is at 10%, 3 sides is at 5% , all 4 sides is at 5%. This means that the shops are not adequately ventilated, Natural lighting is also in adequate and the natural cooling systems.



Span of the room is determinant to the depth light is able to travel. At 6m span, 10%. While for rooms greater than 6m, it is at 10%. While rooms less than 6m, it is 80%.



For orientation of building, buildings that have proper orientation is at 20% while poor orientation is at 80%. This analysis shows that these buildings have not adequately made use of the North-East Trade wind, South-West Trade wind and the Sunrise/Sunset to enhance the lighting and cooling systems of the internal spaces.



This will determine the depth light and air are able to travel. For headroom height, there is a degree of 50% where there is an equal ratio of room height to room span, it is at 50%. Where there is a ratio of headroom to at least twice the space of the room width, it is at 10%.

FINISHING MATERIAL

Materials and design are always being very ecological and green interior spaces. The selection of material for certain product is of vital importance, while the material determines the use of our natural resources as well as the amount of energy used for the production and the use of the product.

Selection of material is traditionally made by technical demands like price, strength of material, temperature stability, density and hardness. The selection of material for certain product is of vital importance, while the material determines the use of our natural resources as well as the amount of energy used for the production and the use of the product. Selection of material is traditionally made by technical demands like price, strength of material, temperature stability, density and hardness

GREEN SURFACE SYSTEM

This system is considered as the most versatile interior system. By using industry standard pots, it is easily maintained and can have plants easily changed out for different seasons and special occasions. It can be installed on virtually any indoor surface. The system contains patent-pending recycled polypropylene trays that can fit any wall dimension and its waterproof. It has a tongue and groove waterproof backing along the entire back surface of the surface. Remote irrigation system is computerized vertical flow irrigation system that allows for remote control, when installed with standard recirculation tanks. Recirculation tanks are stored below or behind the wall, these tanks can be topped up automatically when a water supply is available, or filled by hand.

CONCLUSION

Ecological green and sustainable designs are the important concepts in the changing and developing world considering the world resources and the world population. Interior architecture and interior design in the field of construction sector mainly should be developing some ecological green and sustainable approaches in their design field. In the concept of ecological and green design in built environments, interior spaces have a great significance as they are the main shelters of the individuals. Using the basic concepts of ecological and green design requirements interiors will have a great contribution the concept of sustainability. Interior finishing material selections and the interior surface applications like green walls can make a great contribution to the interiors, occupants and the sustainability as well.

With this study the ecological and green design concepts within the built environment discipline was evaluated. Ecological and green design approaches in interior spaces were discussed. The main contributions of the area with energy and emissions in interior spaces with lighting, ventilation, air conditioning thermal comfort and insulation in interiors and their contributions to the concept were determined. In addition, interior finishing materials and the surface treatment systems were overviewed in order to make a contribution to the interior design field from ecological and green design point.

REFERENCES:

[1] Aciu,C., Cobirzan, N.at all “Selection of Sustainable Building Materials” *International Sustainable Building Symposium,* 185-190, 26-28 May 2010.

[2] Aktas, G, “Contribution of Natural Lighting to the Concept of Interior Sustainability in the Food Court Areas of Shopping Centers” *International Sustainable Building Symposium,* 601-605, 26-28 May 2010.

[3] Aktas, G., “Sustainable Approaches in Shopping Center Public Interiors: Lighting and Finishing Materials” *2nd International Conference on Urban Sustainability and Cultural Sustainability, Green Development, Green Structures and Clean Cars,* (USCUDAR,11) September 26-28 2011 pp:1832-187, Praque Chez Republic, 2011.

[4] Aktas, G, “Social and Cultural Changes that Prepare contemporary Shopping Centers in Turkey *” 2nd International Conference on Art and Culture* (ICAC’11) December 29-31,2011. pp 28-32 Montreux, Switzerland, 2011.

[5] Aktas, G, "Ecological and Green Design Significances in Interior Spaces" *7th WSEAS Conference on Energy and Environment* (EE'12) July 13-17,2012. pp 244-249, Kos island, Grece,2012.
[6] Ayalp,N. "Environmental Sustainabilti in Interior Design Elments" *7th WSEAS Conference on Energy and Environment* (EE'12) July 13-17,2012. pp 163-167, Kos island, Grece, 2012.
[7] Fan Shu-Yang, F., Freedman, B. and Cote, R. "Principles and Practice of Ecological Design" *Environmental Review* Vol: 12 p: 97–112, 2004.
[8] Ferreira, A, Mendes, S. "The Relation Between the Traditional Construction and the Sustainable Development" *The 21st Conference on Passive and Low Energy Architecture*. Eindhoven, The Netherlands, 19 – 22, September:1-5, 2004.
[9] Gissen, *David, Big and Green Towards Sustainable Architecture in the 21st Century*, Princeton Architectural Press, 2003.
[10] Kanbul, B., Bozkurt, E. "Essesment of Construction Materials used in Interior of Past and Present Efes Hotel Considering Sustainable Issues" *International Sustainable Building Symposium*, 601-605, 26-28 May 2010.
[11] Kang, M., Guerin, D. "The Characteristics of Interior Designers Who Practice Environmentally Sustainable Interior Design" *Environment and Behavior* Vol:41 No:2 p:170-184, 2009.
[12] Ozkaynak,G., Ust, S. "Sustainable Design Solutions to Humanitarian Crises" International ustainable Building Symposium, 270-275, 26-28 May 2010.
[13] Scott, F.A . " Ecological Design handbook: Sustainable Strategies for Architecture, Landscape Architecture, Interior Design, and Planning" Donnelley & Sons Co., New York, N.Y.,1999.
[14] Todd, J., Brown, E., and Wells, E. "Ecological design Applied" Ecological Engineering Vol:20 p:421-440, 2003.
[15] Working Group for Sustainable Construction, ''Working Group For Sustainable Construction Methods and Techniques Final Report'' Brussels, Belgium, 2004
[16] Yang F., Freedman B., Cote R., "Principles and Practice of Ecological Design" *Environmental Review*, 12, pp: 97–112, 2004
[17] Yeang, K., ''The Green Skyscraper: The Basis for Designing Sustainable Intensive Buildings'' ISBN-13: 9783791319933, Prestal Verlang, London 1999.

GREEN ARCHITECTURE: THE PERCEPTION OF NIGERIAN ARCHITECTS

ELIMISIEMON Monday Chris[1], DAMEN Moeduutman Raymond[2] & GARBA Hyeladzira Msheila[3]

1 Department of Architecture, Kaduna State University, Kafanchan, Kaduna State, Nigeria.
2 Department of Architecture, Kaduna Polytechnic, Kaduna State, Nigeria.
3 Department of Architecture, Ramat Polytechnic, Maiduguri, Borno State,Nigeria.

Human needs in the 21st century are ever increasing with limited resources to meet them. The challenges of insufficient energy, shortage of water, poor health and health facilities, pollution, climate change and human inability to sustain built environment are becoming enormous. Developed countries are adopting new architectural practices such as green design or sustainable design to combat such challenges. Green design or sustainable design imply developing more environmentally benign products and processes that would lead to energy efficiency, water efficiency, waste reduction, building operation, construction, maintenance, occupant healthy and productivity, stormwater and flood management, climate and sustainable built environment. Therefore, the purpose of this paper is to examine the perception of Nigerian architects on green design. Other specific objective of the study will be to examine the level of awareness and practice of green architecture in Nigeria. The survey research will be adopted for the study. Primary data will be collected through the use of structured questionnaires. The questionnaire will be distributed to architects in Kaduna state. Descriptive statistics and t-test will be used to present and analyze collected data using SPSS v16. The study will conclude by making recommendations based on the findings of the study.

Key words: Built environment, climate change, green design, sustainable design

chrisdesign2000@yahoo.com
arcdamen@yahoo.co.uk
mshelia3000@yahoo.com

ELIMISIEMON et al. (2016). **GREEN ARCHITECTURE: THE PERCEPTION OF NIGERIAN ARCHITECTS** Sustainable Built Environment and Climate change; The challenges of Post 2015 Development Agenda. School of Environmental Technology Conference, SETIC, 2016

INTRODUCTION

The term sustainable architecture is interchangeably used with sustainable design, green architecture or green design, a philosophy of designing buildings to comply with the principles of social, economic and ecological sustainability. The idea of sustainability, or ecological design, is to ensure that our actions and decisions today do not inhibit the opportunities of future generations (DeKay & Brown, 2014).

Today, architects are facing increasingly tougher regulation about how energy efficient buildings must be environmentally informed and demanding clients, and effort on their part to improve professional practice. According to Royal Institute of British Architects, RIBA (2012), current focus in architecture is providing member-focused guidance on the principles, tools and techniques necessary to design and build low carbon buildings, and adaptive, flood resilient design, and to advise clients on what is possible.

Green architecture uses a conscious approach to energy and ecological conservation in the design of the built environment. The main goals of sustainable design are to reduce depletion of resources including energy, water, and raw materials; minimize negative environmental impacts caused by buildings and facilities throughout their life; and create better building environments. The key features of sustainable architecture is the need to minimize material and resource consumption and some strategies for achieving this and consequently sustainable construction through efficient use of renewable energy resources and materials; selection of materials and products that minimize life cycle environmental impacts for example, the use of local, natural and renewable/recycled materials; employing construction techniques that enhance energy savings, water and waste minimization; use design that works in harmony with climate, prevailing air movement path and other natural features to achieve comfort.

The building industry is a major sector in the economy of any country. It influences the environmental, economic and social sectors. It plays an important role in the realization of a sustainable environment. Therefore it is important to inculcate sustainable development into construction of infrastructure as it consists of both buildings as well as the services it renders. It is the backbone of a nation’s economy, to achieve sustainable infrastructure development, there must be a change in attitude and manner in which material and resources are made use of, from the construction to the disposal stage as the achievement of sustainable construction and building will subsequently result to a safe, healthy and comfortable environment (Nwafor, 2006 and Aluko, 2011).

For many years now, Nigeria has been facing challenges in extreme energy crisis, inadequate supply of water, gas and negative effect of urbanization. This deficiency is multi-faceted, with causes that are environmental, economical, structural, and sociopolitical, none of which are mutually exclusive. It is estimated that the population connected to the grid system is short of power supply over 60% of the time and less than 40% of the population is not even connected to the grid (Lukman, 2003 and Okoye, 2007). Water shortages are common. To supplement the government’s supply of water during times of deficiency, private sources provided water to people’s houses at high prices leaving many people to drinking unclean water from streams.

In addition, Osuide and Dimuna (2005) noted that the urbanization process in many developing countries particularly Nigeria, has not been accompanied with a corresponding supply of adequate houses, basic amenities and infrastructures. These have created demand on housing stocks leading to high rents, overcrowding and development of slums, ghetto, shanty settlements (Onibokun, 1972; Olotuah, 2005) and also have serious impact on the built environment and serious consequences on health of city residents. In the light of the above, this study was carried out to examine the perception of Nigerian architects on green design. Other specific objective of the study will be to examine the level of awareness and practice of green architecture in Nigeria aimed at reducing energy, operation and maintenance cost, reduced building related illness, increase the productivity and comfort of building occupants; reduce waste and pollution and increase building and component durability and flexibility.

Attributes of sustainability in green architecture

This study examines five attributes of sustainability, environmental, economic, biophysical, social and technical.

Social Attributes and Principles

According to Hill and Bowen (1997), the social attributes of green construction calls specifically for addressing poverty and inequality. The basic principle of social sustainability is to improve the quality of human life by ensuring secure and adequate consumption of basic needs, which are food, clothing, shelter, health, and beyond that by ensuring comfort, identity and choice. The first step towards achieving this goal is poverty alleviation.

Social sustainability attributes include: Improve quality of human life, including poverty alleviation, make provision for social determination and cultural diversity in development planning, protect and promote health through a healthy and safe working environment, implement skills training and capacity enhancement of disadvantaged workforce, seek fair distribution of the social costs of construction, seek equitable distribution of the social benefits of distribution, and seek intergenerational equity.

Economic Attributes and Principles

According to Sultan (2005), economic sustainability attributes include: Labour – intensive construction policies (promotion of employment by mandating minimum crew size and supervisors and use of less machinery in construction projects associated with import reduction of machines, spares and foreign exchange savings); Energy efficiency policies in Design and Construction (Mandating the use of low embodied energy materials such as granite, minimizing high energy materials such as cement and steel, energy reduction in buildings via insulation, day lighting, optimize material use and minimize site waste); Credit and Policies to select projects, strategies for sustaining the continuity of affordable infrastructure projects (infrastructure projects can help enhance the process of industrialization by raising productivity and reducing production cost);

Strengthening the law and regulations in construction and land affairs; Pricing policies (maintain the monetary and fiscal discipline required to promote price control); improve administration effectiveness and reduce bureaucratic procedures. Choose environmentally responsible suppliers and contractors. Ensure financial affordability for intended beneficiaries, and maintain sustained and efficient use of resources and materials, sustained employment opportunities through formal construction, material production and distribution, maintenance during the economic life span of buildings.

Bio-physical Attributes and Principles:

This is founded on the second part of the definition of sustainability proposed by IUCN (1991). The IUCN stated that sustainability requires the improvement of the quality of human life within the carrying capacity of supporting ecosystems. Bio-physical sustainable attributes include: Project design facilities that reflect consciousness of the fragility of the ecology in which it is situated and the awareness of its impact upon it; The use of renewable building materials from sustainable sources and designs that take into consideration existing cultural patterns and behaviours, materials and techniques; Prevention of pollution from construction activity and preserving sites in their natural state and water use reduction and conservation and rainwater collection and; Reduction of energy use and on-site renewable energy and encourage construction waste management (Wolley,2000)

Technical Attributes and Principles:

The technical attribute of sustainability has been used in this paper to group a number of concepts, including concepts that relate to the performance, quality and service of a building. The emphasis on the application of these principles should be on implementing a process which seeks to achieve consensus among interested parties on which principles are more and which are less important. Sustainable technical attributes include: Design for flexibility, adaptability and durability of exposed building parts. Pursue quality in creating the built environment and use serviceability to promote sustainable construction as well as revitalize existing urban infrastructure. (Hill and Bowen, 1997; Sultan, 2005; Wolley, 2000)

Process-oriented principles of sustainable construction

In this paper, the essence of process oriented principles is to articulate ways of achieving - social, economic, biophysical and technical indicators of sustainable construction. The concept is to emphasize that the following stages are essential in sustainable construction. That is, undertake prior assessments of proposed activities and involve all stakeholders on the project in due time; Promote interdisciplinary collaborations and recognize the complexity and multiplicity of objectives inherent in the concept of sustainability; Utilize a life cycle framework, which recognizes the need to consider all of the principles of sustainable construction at each and every stage in planning, assessment, design, construction, operation and decommissioning of projects. Comply with relevant legislation and regulations and manage activities through the setting of targets, monitoring, evaluation, feedback and self-regulation of progress (Gardner, 1989), in a process that is iterative and adaptive in nature.

RESEARCH METHODOLOGY

The survey research was used in this study to survey one hundred and fifty architects in Kaduna, Bauchi and Maiduguri. The study took place in the study areas above simply because Kaduna is metropolis consists of many Federal institutions, commercial centre for most banks and other business head offices; Bauchi and Maiduguri states are among the fasting developing states in northern in terms of infrastructure development. Respondents were randomly selected by random sampling technique. The closed –ended questionnaire in which three sections was designed. The first section was concerned with the characteristics of the respondents. In the second section, features of green architecture were highlighted and respondents were asked to rate their significance based on a five-point Likert scale. In the final section, respondents were asked to identify potential drivers of green architecture. This method is considered appropriate having being used in closely related studies (Ali and Al Nsairat, 2009; Adegbile, 2013; Ahn, et al. 2013 cited in David and Adegboyega, 2014).). Two hundred (200) questionnaires were distributed in all out of which 150 were duly completed and returned. This represents 75% return rate. All analyses were carried out with the aid of SPSS.16.

FINDINGS AND DISCUSSION OF RESULT

The data analysis was done based on three sections and presented in table 1, 2 and 3. In the first section is the analysis of the data on the characteristics of the respondents which were presented in table 1.0. The second is the analysis of the features of green architecture and presented in table 2.0. The third section is the analysis of the potential drivers of green architecture which is presented in table 3.0. All analyses were presented using descriptive statistics.

Table 1.0: Characteristics of respondents

ITEM		FREQUENCY	PERCENTAGE (%)
GENDER	Male	90	60
	Female	60	40
TYPE OF BUSINESS	Architectural Consultancy firm	70	46.67
	Contractor	-	-
	Developer	10	6.67
	Government ministry/parastatal/institution	-	-
	Civil Servants	60	40
	Project managers	10	6.67
	Engineering firm	-	-
DESIGNATION	Architects	150	100
	Construction managers	20	13.33
	Lecturers	65	43.33
	Consultants	40	26.67
	Contractor	25	16.67
ACADEMIC QUALIFICATION	OND	10	6.67
	HND/B.sc	30	20
	PGD	20	13.33
	M.Sc	85	56.67
	Ph.D	5	3.37
YEARS OF EXPERIENCE	Below 5	40	26.67
	0-5	20	13.33
	6-10	20	13.33
	11-15	20	13.33
	16-20	10	6.67
	20 and above	40	26.67
PROFESSIONAL AFFILIATION	Nigerian Institute of Architects	150	100
	Nigerian Society of Engineers	-	-
	Nigerian Institute of Quantity Surveyors	-	-
	Nigerian Institute of Estate Surveyors and Valuers	-	-

Source: Authors' Fieldwork (2015)

Table 1.0 reveals the characteristics of respondents surveyed. 60% of the 150 respondents were male. All the respondents were architects with majority being lecturers (23.33%) and consultants (20%), 46.67% of them working in consulting firms and 40% being civil servants. Majority of the respondents (56.67%) were graduates M.Sc holders. On experience, it is a heterogeneous population as 26.67% had below 5 years, 26.67% has 20 and above years' while the 13.33% have 6-10, 11-15 and 16-20 years' experience respectively. The respondents are associate, full and fellow members of the Nigerian Institute of Architects.

Table 2.0: Potential features of green architecture

	Items	Mean	Interpretation
Environment factors	Evidence of alternative energy supplies from renewable sources such as solar panels	*3.9*	*Significant*
	Absence of indoor air pollutants net	*4.5*	*Significant*
	Use of ODP or GWP refrigerants	*4.46*	*Significant*
	Water consumption (potable, hygiene and cooling towers)	*4.54*	*Significant*
	Fossil fuel energy use	*4.62*	*Significant*
	Recycling and water capture measures	*4.39*	*Significant*
	Indoor quality measured by ventilation, natural lighting, individual thermal/cooling control, noise abatement	*4.47*	*Significant*
	Wastewater reduction	*4.51*	*Significant*
	Disclosure and transparency of environmental data, regulation compliance, awards, and environmental expenditure of any type	*4.43*	*Significant*
	Hazardous and non-hazardous waste and effluents recycling or removal strategies	*4.47*	*Significant*
Economic factors	Strengthening the law and regulations in construction	*4.59*	*Significant*
	Strategies for sustaining the continuity of affordable infrastructure projects	*4.48*	*Significant*
	Sustained and efficient use of resources and materials	*4.45*	*Significant*
	Choose environmentally responsible suppliers and contractors	*4.41*	*Significant*
	Local material protection policy	*4.51*	*Significant*
	Energy – Efficiency policies in Design and Construction	*4.4*	*Significant*
	Pricing policies	*4.53*	*Significant*
	Improve administration effectiveness and reduce bureaucratic procedures	*4.49*	*Significant*
	Ensure financial affordability for intended beneficiaries	*4.55*	*Significant*
	Sustained employment opportunities	*4.44*	*Significant*
Biophysical factors	Encourage construction waste management	*4.36*	*Significant*
	Renewable building materials	*4.68*	*Significant*
	Project design facilities	*4.5*	*Significant*
	Promote the use of rapidly – renewable materials	*4.38*	*Significant*
	Prevention of pollution from construction activity	*4.64*	*Significant*
	Designs that takes into consideration existing cultural patterns and behaviours	*4.56*	*Significant*
	Reduction of energy use	*4.41*	*Significant*
	Water use reduction and conservation and rainwater collection	*4.52*	*Significant*
Technical factors	Design for flexibility and adaptability	*4.63*	*Significant*
	Design for durability of exposed building parts	*4.55*	*Significant*
	Pursue quality in creating the built environment	*4.59*	*Significant*
	Use serviceability to promote sustainable construction	*4.60*	*Significant*
	Construct durability of exposed building parts	*4.7*	*Significant*
	Revitalize existing urban infrastructure.	*4.74*	*Significant*
Social factors	Quality of working conditions	*4.59*	*Significant*
	Education and training	*4.51*	*Significant*
	Knowledge management	*4.65*	*Significant*
	Impact on employment	*4.68*	*Significant*
	Health and safety	*4.69*	*Significant*
	Innovative potential	*4.51*	*Significant*
	Social characteristics and cultural diversity in development planning	*4.55*	*Significant*
	Societal product benefit	*4.57*	*Significant*

Source: Authors' Fieldwork (2015)

Note:

A total of 150 architects were surveyed, 121 males, 29 females. The significance of the respondents' responses to potential features of green architecture was determined along the following logic to determine a cut-off mean of 3. The sum of the weight of 5,4,3,2 and 1 is 15, which is divided by 5 (number of response category: Strongly Agree, SA=5; Agree, A=4; Undecided, U=3; Disagree, D=2 and Strongly Disagree, SD=1) yields 3. It follows from this that a response can be considered as significant when the mean score is equal or greater than 3 (≥3). A response is considered insignificant if the mean score is equal or less 3 (≤3).

The analysis in Table 2 above shows that architects consider all the environmental, economic, biophysical, technical and social potential features of green architecture as significant for the built environment in Nigeria.

Table 3.0 Potential drivers of green architecture in Nigeria

Item	Frequency	Percentage (%)
Government	49	32.67
Investors	22	14.67
Property owners	23	15.33
Estate surveyors and valuers	18	12
Architects	38	25.33
Property occupiers	-	-
Total	**150**	**100**

Source: Authors' Fieldwork (2015)

In order to ascertain whether respondents were aware of the role they could play in in the promotion and integration of green architectural practices in Nigeria, they were asked to identify potential drivers of green architecture. Table 3.0 above shows the respondents' opinion on the potential drivers of green architecture in Nigeria. Majority of the respondents shows that government (32.67%) and architects (25.33) are the major drivers of green architectural practices in Nigeria. Others include property owners, investors and estate surveyors and valuers.

Table 4: Level of awareness of green architecture in Nigeria

Level of awareness	**Very High**	**High**	**Low**	**Very Low**	**Total**	**Interpretation**
	Mean					**Insignificant**
	22/88	17/51	77/144	38	321	
	2.14					

Source: Authors' Fieldwork (2015)

A total of 150 architects were surveyed, 121 males, 29 females. The significance of the respondents' responses to potential features of green architecture was determined along the following logic to determine a cut-off mean. The sum of the weight of 4,3,2 and 1 is 10, which is divided by 4 (number of response category: Very High=4; High=3; Low=2 and Very low=1) yields 2.5. It follows from this that a response can be considered as significant when the mean score is equal or greater than 2.5 (≥2.5). A response is considered insignificant if the mean score is equal or less 2.5 (≤2.5).

From the result in Table 4 shows that the level of awareness of the concept of green architecture is low/very low.

The implication of these findings is that architects in Nigeria are aware of the green architectural practices and its environmental, economic, bio-physical, technical and social potentials for environmental sustainability. Also, government and other stake holders in the construction industry make policy that will promote the adoption of green architectural practices in the country. The concept of green architecture is at its infant stage, hence, the low level of awareness.

CONCLUSION

Architects are aware of green architectural practices applicable to construction projects in Nigeria. Government, architects, investors and property owners are the major drivers of green architecture. The study recommends that government should make policy and establish green/sustainable construction council that will provide guidelines for green building design, planning and construction that will encourage sustainable built environment.

REFERENCES

Adegbile, M.B. (2013). assessment and adaptation of an appropriate green building rating system for Nigeria. *Journal of Environment and Earth Science,* 3, 2224-3216. In David, O.N. and Adegboyega, S.S. (2014). Stakeholders perception on the awareness of green building rating systems and accruable benefits in construction projects in Nigeria**.** *Journal of Sustainable Development in Africa* (Volume 16, No.7). Clarion University of Pennsylvania, Clarion, Pennsylvania

Ahn, Y.H., Pearce, A.R., Wang, Y. & Wang, G. (2013). Drivers and barriers of sustainable design and construction: The percecption of green building experience. *International Journal of Sustainable Building Technology*, 4 (1): 35-45 in David, O.N. and Adegboyega, S.S. (2014). Stakeholders perception on the awareness of green building rating systems and accruable benefits in construction projects in Nigeria**.** *Journal of Sustainable Development in Africa* (Volume 16, No.7). Clarion University of Pennsylvania, Clarion, Pennsylvania

Ali, H.H. & Al Nsairat, S.F. (2009). Developing a green building assessment tool for developing countries- Case of Jordan. *Building and Environment* 44, 1053-1064

Hill, R.C and Bowen, P.A. (1997). Sustainable construction, principles and framework for attainment, *Construction Management and Economics,* 15, 223-239

International Union for the Conservation of Nature and Natural Resources (IUCN) (1991). *World Conservation Strategy.* Gland, Switzerland.

Okoye, J.K. (2007). *Background study on water and energy issues in Nigeria* to inform the National Consultative Conference on Dams and Development.

Olotuah AO (2005). Urbanization, Urban Poverty, and Housing Inadequacy; Proceedings of Africa Union of Architects Congress, 23-28 May, Abuja, Nigeria pp.185-199.

Onibokun, A.G. (1972). Nigeria: Strategies for urban redevelopment. In*: Journal of the Royal Town Planning Institute* 58(2). In Lanrewaju, A.F. (2012). Urbanization, housing quality and environmental degeneration in Nigeria. *Journal of Geography and Regional Planning* Vol. 5(16), pp. 422-429, Available online at http://www.academicjournals.org/JGRP.

Osuide, S.O. & Dimuna, K.O. (2005). *Effects of population growth on urbanization and the environment in Nigeria*. pp. 27-33. In: Proceeding of year 2000 National

Seminar on Population, Growth, Architecture and the Environment. Osuide SO (Ed.). Rasjel Publishers.

RIBA (2012). *Sustainability and climate change*. Royal Institute of British Architects. Retrieved March 18, 2012 from www.architecture.com.

Sultan, M K. (2005). *The construction industry in Yemen: Towards economic sustainability.* A Thesis Submitted in Partial fulfilment of the requirement for Doctor of Philosophy.

Woolley, T. (Ed). (2000). *Green building: Establishing principles*. Ethics and the Built Environment. Warwick Fox. Rutledge, London: 44-56.

Gardner, J.E. (1989). Decision Making For Sustainable Development: Selected Approaches to Environmental Assessment and Management. *Environmental Impact Assessment Review*, 9(4), 337- 66.

Nwafor, J.C. (2006). *Environmental Impact Assessment for Sustainable Development*. Enugu: Eldermark Publishers.

M. DeKay & G.Z. Brown, 2014 Sun Wind & Light, architectural design strategies, 3rd ed. *Wiley*.

Aluko (2011) in David and Adegboyega (2014). Stakeholders' perception on the awareness of green building rating systems and accruable benefits in construction projects in Nigeria. *Journal of Sustainable Development in Africa* (Volume 16, No.7, 2014) ISSN: 1520-5509 Clarion University of Pennsylvania, Clarion, Pennsylvania.

Lukman, R. (2003). Energy Commision of Nigeria "*National Energy Policy*" Federal Republic of Nigeria.

INTEGRATION OF KEY DESIGN ELEMENTS FOR PLAY-LEARNING ENVIRONMENT IN ELEMENTARY SCHOOLS IN MINNA, NIGERIA.

AKPAMA, Daniel Sokowam & AYUBA, Philip
Department of Architecture, Federal University of Technology, Minna Niger State, Nigeria.

In an era of climate change and a time when pupils especially those in elementary schools are confined indoor to learning. Attempt to entice and encourage children and their teachers to spend more time in a well-structured, child-centred green designed school grounds is timely and cannot be overemphasized. Creating an Outdoor learning and play environment is an initiative that would incorporate green design principles targeted at meeting children's developmental needs. Children's developmental needs are cognitive, physical, social and emotional. This paper assessed the physical outdoor spaces and natural elements in elementary schools with a view to integrating these elements in elementary schools in Minna, Niger state. The research was carried out by the use of a structured observation schedule and questionnaires. Data collected were analyzed using descriptive statistical tools such as mean, percentages and averages. The findings revealed that only 25% of the playgrounds of primary schools in Minna have above average fixed components. It also showed that no provisions were made for experimental, individual, gathering and ecological spaces. The results generated were shown in tables. The paper recommended that play-learning environment be integrated in elementary schools in Minna.

Keywords: Climate change, Developmental needs, Elementary schools, Green designed, Space.

sadaniel4real@gmail.com

AKPAMA, D. S & AYUBA, P (2016). **INTEGRATION OF KEY DESIGN ELEMENTS FOR PLAY-LEARNING ENVIRONMENT IN ELEMENTARY SCHOOLS IN MINNA, NIGERIA.** Sustainable Built Environment and Climate change; The challenges of Post 2015 Development Agenda. School of Environmental Technology Conference, SETIC, 2016

INTRODUCTION

In the world over, every child plays. The drive to play in children is profound that children will make effort to do so in the midst of any circumstance. Young children considers pretending, running and building as fun (Whitebread, 2012). It is a well known fact to researchers and educators that these playful activities are of immense benefit to the development of the whole child across social, cognitive, physical and emotional domains. Play is indeed such instrumental to a healthy child's development, it is no wonder that the American Academy of Pediatrics (Ginsburg, 2007) issued a white paper on the topic. The National Association for the Education of Young Children((2009) named play as a central component in developmentally appropriate educational practices, and the United Nations High Commission on Human Rights(1989) recognized play as fundamental right for every child.

Play has a wide range of definitions ranging from discrete descriptions of various types of play such as physical, construction play, language play, or symbolic play (Miller & Almon, 2009), to a list of broad criteria, based on observations and attitudes that are meant to capture the essence of all play behaviors(Rubin, Fein, & Vandenberg, 1983).

Contemporary definitions of play focuses on a number of key criteria. The founder of the National Institute for Play, Stuart Brown in his words define play as "anything that spontaneously is done for its own sake." More specifically, he says it "appears purposeless, produces pleasure and Joy,[and] leads one to the next stage of mastery (as quoted in Tippett, 2008)." Similarly, Krasnor & Pepler, 1980; Rubin, Fein, & Vandenberg, (1983) say play is defined along a continuum as more or less playful using a set of behavioral and dispositional criteria. Play includes "activities that are freely chosen and directed by children and arise from intrinsic motivation". (Miller and Almon 2009). Today under the pressure of rising academic standards in our elementary schools, play has been given trivial consideration. In our society today, a pseudo dichotomy has been created between play and learning.

This paper seeks to discourage the strict relegation of learning to the four walls of the classroom by assessing the physical outdoor spaces and natural elements in elementary schools with a view to integrating these elements in elementary schools in Minna, Niger state. This research will encourage outdoor learning through play thereby reducing the time spent by pupils in the classroom and also limiting the effect of climate change.

The Importance of Play

Play builds the foundation for a lifetime of learning. Play is pleasurable, intrinsically motivated, freely chosen and is process oriented. Play is also non-literal and is actively engaged. According to this view, children playful behaviours can range from 0-100% playful. It is through play that children at a very early age engage and interact in the world around them. The American Academy of Pediatrics titled "The Importance of Play in Promoting Healthy Child Development and Maintaining Strong Parent-Child Bonds" elucidates on the importance of play to the healthy development of children. Among other things, the report says the" play allows children to use their Imagination, dexterity, and physical, cognitive and emotional strength". Play is important to the development of healthy brain. Children stands the chance to learn how to work in groups, to negotiate, to share and to resolve differences, and to learn self-advocacy skill. (Landscape and Child Development, 2013) These aforementioned benefits of play would be impossible without a well structured and conducive environment that can foster and instigate children and their teachers to spend appreciable time outdoor to play and learn.

It is alarming that as experts are arguing and yet to come to terms with the importance of play in the lives of children, the actual time children spend daily in playing continues to decrease. Today, children play eight hours less each week than their counterparts did two decades ago (Elkind, 2008).

Play as a Pedagogy

Moyles, Adams and Musgrave (2002) examined that although adults endorsed the educational benefits of play, they were uncertain of their role in play and how to assess the prospects of play. Professional knowledge and expertise is critical in planning and engaging in playing, learning and teaching. Siraj-Blatchford, Sylva, Muttock, Gilden, and Bell (2002) studied effective pedagogy and distinguished between pedagogical framing (planning for play, providing resources and a routine) on behalf of adults and pedagogical interactions (specific behaviors in face to face encounters), and established that both are required. In conclusion they emphasized that the most effective settings had a balance between adult-initiated and child-initiated activities.

Play is a natural medium through which learning and development is holistically enhanced. As suggested by Hayes(2003), "Play is a pedagogical tool for the teacher as well as a pathway for learning for a child". It is obvious that young children learn through play in a composite system.

Components of a Supportive Environment

Outdoor and indoor learning environments should be motivating and inviting to all children, so that they are encouraged and helped to explore and to use all the possibilities offered for fun, adventure, challenge and creativity (NCCA, 2004).The physical environment, both indoors and outdoors, encourages positive growth and development for children through opportunities to explore and learn. Safe, clean, spacious, bright, welcoming, warm, and accessible environments for children and adults, including those with additional needs, should afford opportunities to rest and play. Babies, toddlers and young children need fresh air and outdoor play space is essential if children are to have a balanced, healthy day. Learning is constrained and may be damaged if young children are required to sit still indoors, where adults do most of the talking and require children to follow their lead (Bruce, 2004). The environment should offer children opportunities to: actively explore, make decisions and follow through with their ideas; engage in co-operative, symbolic, dramatic or pretend play; move, dance and increase control over their bodies (Hohmann and Weikart, 1995).

Socio-cultural theory is concerned with children's learning in context. Children respond to the reality they see around them and what they learn reflects that reality (Penn, 2005). Environments can reflect the lives and activities of the children/families in the service to establish positive identities. In addition, environments can have resources to counteract stereotypical and discriminatory attitudes (French, 2003).

The same principles apply whether organizing indoor or outdoor areas. In fact many of the activities babies, toddlers and young children enjoy indoors can be achieved outdoors and with greater freedom. If in group care, careful consideration of the organizing of rooms for different age groups is necessary. Babies and toddlers need a room or home base where they can relate for part of the day with a small group of children and adults, where they can feel secure and build relationships. Older children need more space (French, 2003).

A supportive environment is one structured to meet the developmental needs of children. The developmental needs includes emotional development, physical development, social development and cognitive development needs. It is paramount to note that any distinct space on the playground is likely to have both fixed and movable components and serving a range of developmental needs.(Landscape child development,2013)

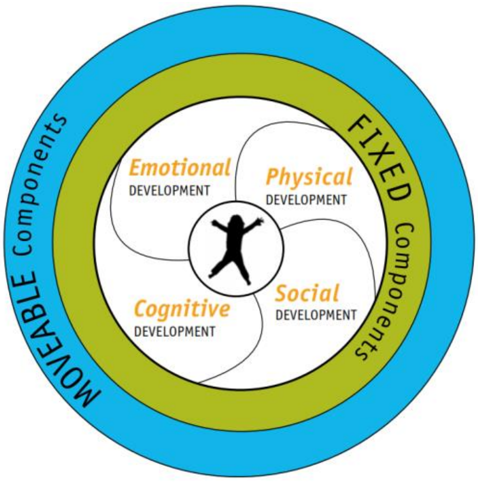


Plate I. Fixed and moveable components serving developmental needs
Source: (Landscape child development,2013)

Fixed landscape components are the anchor points of a landscape- for example, trails, groves of trees, hills, and rock circles. These components must be thoughtfully arranged, to prioritize connectivity, maintain flexibility and create a kind of "loose fit" that allows educators and children to play an active part in adding moveable components to customize their play-learning environment (Landscape child development, 2013).

A menu for moveable components was suggested by (Heidi, C. 2013). to serve as objects that enhances play and can be incorporated into the play space.

They include but not limited to:

- Containers: milk crates, buckets
- Gardening equipment: wheelbarrows, gloves, watering cans
- Chalk boxes and tubes
- Dirt, mud, cob, sand and water e.t.c

Creating a Supportive Environment

Montessori (cited in Smith, Cowie and Blades, 2005) advocated that the learning environment should be carefully planned to meet childrens' needs by providing them with the optimum opportunities to work independently, to make choices, decisions and solve problems, to engage in real experiences, and to experience success. The High/Scope Educational Research Foundation (2001) suggested the space should be inviting for children and organized into well-defined areas of interest to encourage distinctive types of play. Hohmann and Weikart (1995) noted that the interest areas are arranged to promote visibility and easy movement between areas and are flexible to accommodate … children's changing interests. Steiner promoted a variety of easily accessible, open-ended, natural, found, real life materials which can be used in creative and purposeful ways and reflect children's family lives (Curtis and O'Hagan, 2004). Materials are stored so that children can find, use and return materials they need. The most effective learning comes from simple but versatile materials and environments which extend the child's imagination and can be adapted by children to suit their learning needs and level of understanding. Dowling (2000) referred to this as an informational environment which supports childrens' ability to make and learn from mistakes, discover the best way of doing things and learn how to make decisions.

Integrating Key Spaces into Play-Learning Environments

Developing a conceptual design for a play-learning environment will require the bringing together of all the piece together- the fixed and moveable landscape components, children's developmental needs and the desired spatial qualities of the site. It was advocated that priority be placed on five key spaces that should work in concert to create a diversity of play and learning opportunities. (Landscape Child development, 2013)

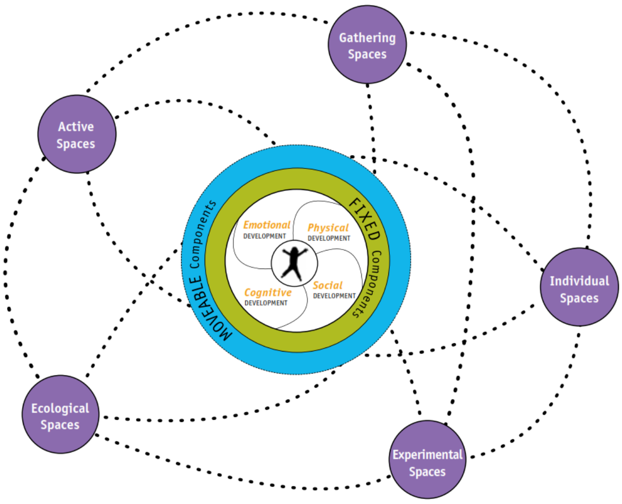


Plate II. Key spaces in play-learning environments
Source: (Landscape child development, 2013)

The key spaces as described by (Landscape child development, 2013)are Active spaces, Experimental spaces, Individual Spaces , Gathering Spaces and Ecological spaces.

a. Active Spaces

Spaces that encourage active play vary in topography, incorporate changes in height, challenge the mind to assess competencies and go beyond perceived limits. These spaces feel energetic; they promote fitness and health.

Plate III. Active Space
Source: Landscape Child development (2013)

b. Experimental Spaces

These are spaces for discovery, exploration, hypothesizing. They are temporary in nature. They are also flexible, alive, messy and emergent. They should feel more like a lab, a space that supports creativity, constructing, building, testing and idea generating. These spaces are often very social, offering opportunities for the development of communication/language skills. They are filled with materials, and have child sized furnishings and storage. Mud, sand, water, wood, buckets, tools and other types of loose parts are essential. Educational materials such as hand lenses, clipboards, pencils and cameras should be used.

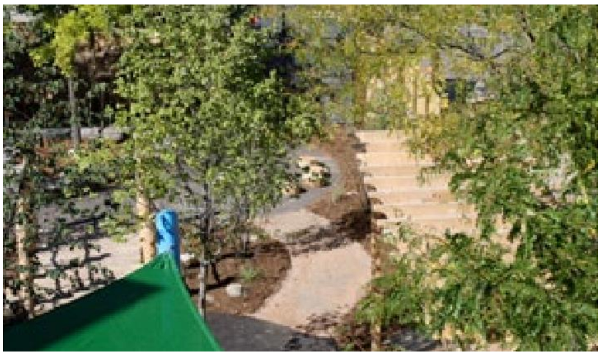


Plate III. Experimental Space
Source: Landscape Child development (2013)

c. Individual Spaces

Individual spaces support quiet reflective moments, observation and listening. They feature small enclaves that are protected, cozy and enclosed. This type of space would accommodate one or two children and could be on the edge of another play zone, most likely away from an active play area. This is a space for private time. Some children are sensitive to noise and have need for a quiet space in the playground.

Plate IV. Individual Space
Source: Landscape Child development (2013)

d. Gathering Spaces

Gathering spaces can be for a large or small group. These are typically welcoming, fostering of social interaction, and focused on communication, negotiation, and sharing. They offer seating, shade, and should have a balance of soft and hard features. They should be flexible and accommodate multiple use and users (staff, children, parents).

Plate V. Gathering Space
Source: Landscape Child development (2013)

e. Ecological Spaces

Trees, shrubs, and vegetation are strong elements of these spaces. They are alive, containing ecosystems that attract birds, butterflies, insects, and worms. They offer children access to water, soil, and plants. They create habitat on different scales and will attract a diversity of plant and insect species. They evoke an emotional response, nurture a sense of responsibility, and offer moments for reflection.

Plate VI. Ecological Space
Source: Landscape Child development (2013)

RESEARCH METHOD

The research method employed to carry out this study was the use of post-occupancy evaluation. An observation schedule was structured to evaluate the physical outdoor spaces and natural elements available in primary school play grounds. The assessment was conducted in Minna Niger state, Nigeria. Two local governments which lies within Minna are Bosso and Chanchaga Local governments. Ten primary schools were selected at random from each of these local governments by simple random technique of probability sampling method. The Data was collected and analyzed using descriptive statistical tools such as mean, percentages and averages in a tabular format.

FINDINGS AND DISCUSSION OF RESULTS

Table 1.0: Fixed components in playgrounds

S/ NO	List of schools	**Hard/soft sur.**	**Hills**	**Rock Circles**	**Groves Of trees**	**Trails**	Total
01	Baban dabo primary school	**1**	**0**	**0**	**1**	**0**	**40%**
02	Chanchaga primary school	**1**	**0**	**0**	**1**	**0**	**40%**
03	Dr. Yahaya bawa bosso pry sch.	**1**	**0**	**1**	**1**	**0**	**60%**
04	Gusase primary school	**1**	**0**	**0**	**0**	**0**	**20%**
05	Gurusu primary school	**1**	**0**	**0**	**1**	**0**	**40%**
06	Jikuchi ube primary school	**1**	**0**	**0**	**1**	**0**	**40%**
07	Kadna primary school	**1**	**0**	**1**	**1**	**0**	**60%**
08	Maitumbi primary school	**1**	**1**	**0**	**1**	**0**	**60%**
09	Shango primary school	**1**	**0**	**0**	**1**	**0**	**40%**
10	Tudun-fulani model school	**1**	**0**	**0**	**1**	**0**	**40%**
11	Aliyu mu'azu sarkin yakin mem. Sch.	**1**	**1**	**0**	**1**	**0**	**60%**
12	Anguwan zakka primary school	**1**	**0**	**0**	**1**	**0**	**40%**
13	Dr.umar farouk primary school	**1**	**0**	**0**	**1**	**0**	**40%**
14	Ibb primary school	**1**	**0**	**0**	**1**	**0**	**40%**
15	Kuyanbana primary school	**1**	**0**	**1**	**1**	**0**	**60%**
16	Kwarkwota primary school	**1**	**0**	**0**	**0**	**0**	**20%**
17	Limawa model primary school	**1**	**0**	**0**	**1**	**0**	**40%**
18	Tunga north primary school	**1**	**0**	**1**	**0**	**0**	**40%**
19	Umar audi memorial primary sch	**1**	**0**	**0**	**1**	**0**	**40%**
20	Usman nagogo primary school	**1**	**0**	**0**	**1**	**0**	**40%**
	Total	**100%**	**10%**	**20%**	**85%**	**0%**	

Source: Authors Fieldwork (2015)

The results obtained through observation schedules and questionnaire were recorded using following representations.

0 -not available

1 - available

The result in table 1.0 shows that all the playgrounds of the schools had both hard and soft surfaces required for physical development. It also85% of groves of trees which will enhance the emotional development of children. It furthermore shows that only 10% of the playgrounds have hills which supports cognitive learning, 20% of rock circles which supports social development but none had trails or pathways in the playgrounds.

Table 2.0: Moveable components in playgrounds

S/No	List of Schools	Containers	Garden Equip.	Chalk Boxes	Sand/ Mud	Play Tables	Total
01	Baban Dabo Primary School	0	0	1	1	0	40%
02	Chanchaga Primary School	1	1	1	1	0	80%
03	Dr. Yahaya Bawa Bosso Pry Sch.	1	0	1	1	0	60%
04	Gusase Primary School	0	0	1	1	0	40%
05	Gurusu Primary School	1	0	1	1	0	60%
06	Jikuchi Ube Primary School	0	0	1	1	0	40%
07	Kadna Primary School	1	0	1	1	0	60%
08	Maitumbi Primary School	1	0	1	1	0	60%
09	Shango Primary School	1	1	1	1	0	80%
10	Tudun-Fulani Model School	0	0	1	1	0	40%
11	Aliyu Mu'azu Sarkin Yakin Mem. Sch.	1	0	1	1	0	60%
12	Anguwan Zakka Primary School	0	0	1	1	0	40%
13	Dr.Umar Farouk Primary School	0	0	1	1	0	40%
14	Ibb Primary School	1	0	1	1	0	60%
15	Kuyanbana Primary School	1	1	1	1	0	80%
16	Kwarkwota Primary School	0	0	1	1	0	40%
17	Limawa Model Primary School	1	1	1	1	0	80%
18	Tunga North Primary School	0	0	1	1	0	40%
19	Umar Audi Memorial Primary Sch	1	1	1	1	0	80%
20	Usman Nagogo Primary School	0	0	1	1	0	40%
	Total	55%	25%	100%	100%	0%	

Source: Authors Fieldwork (2015)

Table 2.0 shows that all the playgrounds had either sand or mud or both and chalk boxes which supports emotional and cognitive developments in children during play. No playground had a play table which supports both cognitive and social development and only 25% had garden equipments which also supports cognitive developments in children.

Table 3.0: Types of spaces required for a play-learning environment.

S/ No	List of Schools	Active	Experi-Mental	Indivi-Dual	Gather -ing	Ecolo-Gical	Total
01	Baban Dabo Primary School	1	0	0	0	0	20%
02	Chanchaga Primary School	1	0	0	0	0	20%
03	Dr. Yahaya Bawa Bosso Pry Sch.	1	0	0	0	0	20%
04	Gusase Primary School	1	0	0	0	0	20%
05	Gurusu Primary School	1	0	0	0	0	20%
06	Jikuchi Ube Primary School	1	0	0	0	0	20%
07	Kadna Primary School	1	0	0	0	0	20%
08	Maitumbi Primary School	1	0	0	0	0	20%
09	Shango Primary School	1	0	0	0	0	20%

10	Tudun-Fulani Model School	1	0	0	0	0	20%
11	Aliyu Mu'azu Sarkin Yakin Mem. Sch.	1	0	0	0	0	20%
12	Anguwan Zakka Primary School	1	0	0	0	0	20%
13	Dr.Umar Farouk Primary School	1	0	0	0	0	20%
14	Ibb Primary School	1	0	0	0	0	20%
15	Kuyanbana Primary School	1	0	0	0	0	20%
16	Kwarkwota Primary School	1	0	0	0	0	20%
17	Limawa Model Primary School	1	0	0	0	0	20%
18	Tunga North Primary School	1	0	0	0	0	20%
19	Umar Audi Memorial Primary Sch	1	0	0	0	0	20%
20	Usman Nagogo Primary School	1	0	0	0	0	20%
	Total	100%	0%	0%	0%	0%	

Source: Authors Fieldwork (2015)

Table 3.0 shows that the only type of play space available in the playgrounds of the selected primary schools is the Active space. The ecological space, individual space, experimental and gathering space which supports play-learning environments are not available.

CONCLUSION

In conclusion, the study has revealed that a play-learning playground has not been given any considerable attention. It was observed that only 25% of the playgrounds of primary schools had above average fixed components and 55% had moveable components. It is alarming that no provisions were made for experimental, individual, gathering and ecological play-learning spaces. These would limit or deprive the children certain developmental needs which these spaces would have offered if they were present. This paper therefore recommends that stake holders, developers and professionals involved in the development of primary schools pay attention to these key design considerations which supports play-learning playgrounds thereby creating an enabling environment where childrens' developmental needs would thrive.

REFERENCES

Bruce, T. (2004). *Developing learning in early childhood.* London: Paul Chapman.

Cowie, B. and Carr, M. (2005). The consequences of socio-cultural assessment. In Anning, C. Cullen, J. and Fleer, M. (eds.) (2004). *Early childhood education: society and culture* (pp.95-106). Delhi, New York and London: Sage Publications.

Curtis, A and O'Hagan. M. (2004). *Care and education in early childhood: A student's guide to theory and practice.* London: Routledge Falmer.

Dowling, M. (2000). *Young children's personal social and emotional development.* London: Paul Chapman.

Elkind, D. (2008). The Power of Play: Learning What Comes Naturally.

French, G. (2003). *Supporting quality: Guidelines for best practice in early childhood services (2nd ed.).* Dublin: Barnardos.

Ginsburg KR. (2007), The importance of play in promoting healthy child development and maintaining strong parent-child bonds. American Academy of Pediatrics; 119(1):182-91.
Hayes, N. (2003). Play, care and learning: Creating an integrated curriculum for early childhood education in Ireland. *Researching Early Childhood,* Vol 5, pp. 69-81.
High/Scope Educational Research Foundation. (2001). *The physical learning environment: Participants guide.* Michigan: High/Scope Educational Research Foundation.
Hohmann, M. and Weikart, D. (1995). *Educating young children.* USA: The High/Scope Press.
Krasnor, l., & Pepler, D. (1980). The study of children's play: Some suggested future directions. *New Directions for Child Development, 9,* 85–94.
Miller, E., & Almon, J. (2009). Crisis in the kindergarten: Why children need to play in school. College Park: Alliance for Childhood.
Moyles, J., Adams, S., and Musgrave, A. (2002). *Study of pedagogical effectiveness in early learning.* Research Report No. 363. London: Department for Education and Skills.
National Association for the Education of Young Children (2009). Developmentally appropriate practice in early childhood programs serving children from birth through age 8. http://www.naeyc.org/files/naeyc/file/positions/PSDAP.pdf. [Accessed May 22, 2015].
National Council for Curriculum and Assessment. (2004). *Towards a Framework for Early Learning*. Dublin: National Council for Curriculum and Assessment.
Penn, H. (2005). *Understanding early childhood*. Glasgow: Open University Press.
Richard, L.(2013). Landscape and Child Development: A design guide for early years-kindergarten play-learning.
Rubin, K., Fein, G., & Vandenberg, B. (1983). Play. In P. Mussen (Ed.)*, Handbook of child psychology* (Vol. 4, pp. 693–774). New York: Wiley.
Siraj-Blatchford, I., Sylva, K., Muttock, S., Gilden, R. and Bell, D. (2002). *Researching effective pedagogy in the early years*. Research Report No. 356. London: Department for Education and Skills
Smith, P., Cowie, H. and Blades, M. (2003). *Understanding children's development (4th ed.).* UK: Blackwell Publishing.
Heidi, C. (2013). Landscape and Child Development: A Design Guide for Early Years-Kindergarten Play-Learning Environments.
Tippet, K. (2008). Play, spirit, and character. [interview]. Speaking of faith. [Radio broadcast]. St. Paul, Minnesota: American Public Media.
United Nations High Commissions on Human Rights 1989
Whitebread, D. (2012). The Importance of Play: A report on the value of children's play with a series of policy recommendations.

MITIGATING CLIMATE CHANGE THROUGH GREEN ARCHITECTURE

ELIMISIEMON, Monday Chris, RAYMOND, L. Damen & HYELADZIRA, Msheila Garba[3]

[1]Department of Architecture, Kaduna State University, Kafanchan, Kaduna State.
[2]Department of Architecture, Kaduna Polytechnic, Kaduna State.
[3]Department of Architecture, Ramat Polytechnic, Maiduguri, Borno State.

Climate change is real and felt globally. Climatic factors such as intense solar radiation, high humidity and condensation, dust and sandstorms and flood affects the comfort of man and safety of built environment. Most of the climatic changes are due to human activities in the environment, particularly the built environment. These suggest that human activities and physical constituents of built environment interact with other climate drivers. These prompt the need for response. And response to climate change falls into two phases- mitigating and adaptation. Therefore, this paper discusses how climate change can be mitigated through green architecture in Nigeria. In this light, the paper will be a conceptual paper. The library research method was used in this study to gather secondary data from textbooks, articles and journals to develop a conceptual framework how green architectural practices can be used to mitigate climate change in order to sustain built environment in Nigeria. This paper adopts the U.S. Green Building Council (USGBC) (2015) principles of green building and sustainable site design. It highlights climatic changes and their effect in Nigeria. It further discusses the concept and principles of green architecture. The study concludes that Nigerian built environment is vulnerable to the impact of climate change. Therefore, there is need for architects, building engineers and clients to promote and adopt green architectural practices in order to mitigate the effect of climate change for sustainable environment.

Key words: Built environment, climate change, climatic factors, green architecture

chrisdesign2000@yahoo.com
arcdamen@yahoo.co.uk
mshelia3000@yahoo.com

INTRODUCTION

Climate change has become a global threat. Climatic factors such as intense solar radiation, high humidity and condensation, dust and sandstorms and flood affects the comfort of man and safety of built environment. In Nigeria, cities for instance anticipate climatic changes such as periods of extreme cold, increase frequency of air and water pollution, increase in rainfall, increased thermal discomfort in buildings, water shortages and draught, rising and changes in timing, frequency and severity of urban flooding, building collapses and increase in cost of building construction and operation.

Studies have revealed that increase in research, technological advancement and economic growth, building construction has greatly increased and has been said to account for nearly half of all the greenhouse gas emissions and energy consumed owing largely to the energy used in the production and transportation of materials to building construction sites, and energy used to operate these buildings. The picture is not different about Nigeria who is now faced with the challenge of evolving performance standards, systems, codes and other regulatory means to mitigate and adapt to the built environment and climatic changes.

Researches have established that most of the climatic changes are due to human activities in the environment, particularly the built environment. These suggest that human activities and physical constituents of built environment interact with other climate drivers. The interaction between human activities and the built environment which prompt climatic changes raises the need for response. And response to climate change falls into two phases- mitigating and adaptation.

Consequently, the adoption of an environmentally responsible approach to building design and construction has become inevitable. Therefore, the aim of this paper is to discuss and promote green architectural practices as a means of mitigating climate change in Nigeria. Embracing sustainable architectures in Nigeria is aimed at reducing energy, operation and maintenance cost, reduced building related illness, increase the productivity and comfort of building occupants; reduce waste and pollution and increase building and component durability and flexibility.

METHODOLOGY

The paper is a conceptual paper. The library research method was used in this study to gather secondary data from textbooks, articles and journals to develop a conceptual framework on how green architectural practices can be used to mitigate climate change in order to sustain the built environment in Nigeria. This paper adopts the U.S. Green Building Council (USGBC) (2015) principles of green building and sustainable site design. The discussion was based on these five principles.

Climate Change and Its Effects in Nigeria

According to Federal Government of Nigeria (2009), the location and size of, and the characteristic relief in Nigeria give rise to a variety of micro climates ranging from tropical rainforest climate along the coasts to the Sahel climate in the northern parts of the country. Nigeria has a population of about 140 million impacting on the physical environment through their various activities within an area of about 923,000 square kilometres. This, coupled with variability in elements of climate such as rainfall and temperature among others, exposes several physical and socio-economic sectors in the country to the impacts of climate change. For instance, climate change will lead to a shift in the boundaries of major ecological zones, alter animal and plant composition, aggravate soil erosion and flooding in areas of higher rainfall, heighten drought and desertification in the marginal arid zones of the country and salt water intrusion along the coastal belt.

Climate change will also impact the agricultural sector. Agriculture remains a major source of food, industrial raw material and a means of earning foreign exchange. It employs close to 70 per cent of the Nigerian population. With respect to energy, it is a two-way vulnerability for Nigeria. First, Nigeria is vulnerable to the adverse impacts of climate change. In this regard, the most important significant impact of climate change on energy will include higher electricity demand for heating, cooling and pumping water; reduced availability of hydroelectricity and fuel wood; and extensive damage on petrochemical industrial installations presently concentrated in the coastal belt. Inadequate supply of power could force closures of many industries thereby rendering several Nigerians jobless. This, in turn, will aggravate the country's existing macroeconomic problem of unemployment. Products from such industries become unavailable and where available through importation, the prices are beyond what an average Nigerian can afford.

According to Komolafe (1988), Climatic change do not affect people's comfort alone; they can also impair the safety of buildings and lead to building damage and premature fatigue of building materials. In the tropics, for example, factors such as intense solar radiation, high humidity and condensation, dust and sandstorms and the salt content of the air affect building material**.** Walling materials for instance, the comfort implication of heat storage capacity, where they are needed, are secondary to those of privacy, stability, protection and security against house walling and thin mud walls, adobe or wattle and daub are commonly used in various climatic zones. The picture is not better with respect to roofing materials in common use. For example, galvanized iron sheet absorbs 65% of solar radiation which increases to 80% when it gets old roofing sheets absorb as high as 61% of heat, which increases to 83% when old and dirty (Komolafe, 1988). Generally, the problem is not what is thermally desirable and efficient, but what is readily available and economically affordable to the people.

Concept of Green Architecture

The term "sustainable architecture", is used to describe the movement associated with environmentally conscious architectural design (Boston Society of Architects, 1991 cited in Pragrad, n.d.). The term sustainable architecture is interchangeably used with sustainable design or green design, is a philosophy of designing buildings to comply with the principles of social, economic and ecological sustainability. Sustainable architecture uses a conscious approach to energy and ecological conservation in the design of the built environment. The main goals of sustainable design are to reduce depletion of resources including energy, water, and raw materials; minimize negative environmental impacts caused by buildings and facilities throughout their life; and create better building environments.

According to Nwafor, (2006) green architecture sustainable design is the systematic consideration of a project's life cycle impact on environmental and energy resources. Integrated Waste Management Board (2005) cited in Kadiri, (2006) defined green building (also known as sustainable building) as "a structure that is designed, built, renovated, operated or used in an ecological and resource-efficient manner.

According Giaccardo, (2004) defines green design as design and construction practices that significantly reduce or eliminate the negative impact of buildings on the environment and occupants in five broad areas: sustainable site planning, safeguarding water and water efficiency, energy efficiency and renewable energy, conservation of materials and resources and indoor environmental quality.

The key features of green architecture is the need to minimize material and resource consumption and some strategies for achieving this and consequently sustainable construction through efficient use of renewable energy resources and materials; selection of materials and products that minimize life cycle environmental impacts for example, the use of local, natural and renewable/recycled materials; employing construction techniques that enhance energy savings, water and waste minimization; use design that works in harmony with climate, prevailing air movement path and other natural features to achieve comfort (Nwafor, 2006).

The call and desire for sustainable construction is in realization of the construction industry's capacity to make a significant contribution to environmental sustainability because of the enormous demands it exerts on global resources. The construction industry accounts for one-sixth of global fresh water consumption, one-quarter of global wood consumption and two-fifths of global material and energy flows, and almost one-quarter of ozone depleting gases come from air-conditioning units in buildings. Apart from global resource consumption, the industry also generates waste on a scale that dwarfs most other industrial sectors. Given the conflicting scenario of the rapid depletion in global natural resources simultaneous to the acceleration in global population, it is imperative that the attendant demands on global natural resources are balanced with the 'carrying capacity' of the physical environment (Kadiri, 2006).

Green Design and Environmental Sustainability

Green architecture is about environmental interactions. It involves energy efficiency, water efficiency, waste reduction, building operation, construction, maintenance, occupant health and productivity, stormwater management, climate and environmental integration (Immaculata and Henry, 2011). According to Engel– Yan, Kennedy, Saiz and Pressnand (2005 cited in Immaculata and Henry, 2011), energy efficient buildings may both reduce storm water runoff and provide evaporative cooling.

According to Gottfried (1996), 50% of the energy used in a building is devoted to producing an artificial indoor climate through heating, cooling, ventilation and lighting.

A typical building energy's bill constitutes approximately 25 percent of building's total operating costs in the United States. However, estimates indicate that climate – sensitive design with the use of appropriate and available technologies could cut heating and cooling energy consumption by 60 percent. Federer in (Engel – Yan, Kennedy, Saiz and Pressnand, 2005 cited in Immaculata and Henry, 2011) describes the effect of trees in modifying the urban microclimate, which affects both comfort and building space conditioning energy use.

In a study conducted by Simpson and McPherson (2001) in the United States, it is recommended that urban trees be located in several regions to maximize energy saving. This is because the east and west orientation provides shades when sun angles are lower and conclude that larger trees should be used to maximize benefits. They did find that except for southerly orientated trees, energy savings are generally inversely proportional to tree – building distances. And factors such as climate conditions, electricity emissions factors, building construction and tree growth rates, must be considered in energy savings and carbon dioxide emission reduction calculation. Energy saving through natural ventilation and lighting could further be enhanced through wide windows and external doors and good material choice in window design like glazed windows of different brands (Fulleton 1978, Hachler, Holderen 2008; and Lippiatt and Norris 1996).

Poor stormwater management could lead to flooding in urban areas. This could adversely affect the sustainability of the urban environment. High levels of stormwater runoff in urban areas cause many environmental and economic problems including water pollution, flooding and erosion. Different measures are taken by planners to enhance environmental sustainability through stormwater management. The principle of stormwater source control is to manage rainwater at its source, instead of discharging it into conventional, combined or separated sewer systems. The urban forest helps to mitigate the negative impact of stormwater through double fold process. The first is that trees intercept and store rainfall on leaves and branch surfaces which helps in alternating runoff volume and delays the onset of peak-flows. Secondly, root growth and decomposition enhances the capacity and rate of soil to absorb or infiltrate rainfall and minimize overland flow.

Other methods of stormwater management include; provision of infiltration basins, retention ponds, infiltration tranches, porous paving with reservoir structure e.t.c (Immaculata and Henry, 2011; Engel-Yan, Kennedy, Saiz and Pressnand, 2005, and Martin, Ruperd and Legret, 2007). Another important factor in green architecture is materials used. Materials flow and cycle is a technique for tracing material use and location over time. For example, steel is routinely recovered from demolished buildings and other products such as automobiles, melted and re-used in close recycle loop. Some materials are disposed into landfills. These materials can equally be recovered and reused (Hedrickson et-al undated cited in Immaculata and Henry, 2011).

Application of green buildings and concepts can yield savings during the construction process. Measures that are readily easy to implement can result in savings to the contractor or developer. Some of these include; lower energy by monitoring usage, and installing energy efficient lamps, lower water costs by monitoring consumption and using storm water, lower material costs with more careful purchase and re-use of resources and materials among others.(Gottfried,1996).

Designing and manufacturing green products require appropriate knowledge, tools, production methods and incentives. These design tools will help identify design changes that have lower costs while improving material use and recyclability (Hendrickson 2008 and Roberts 2007).

Principles of Green Architecture

To advance the understanding of green architecture, this study examines five fundamental principles of green building and sustainable site design: sustainable site design, water quality and conservation, energy and environment, indoor environmental quality and materials and resources identified by The U.S. Green Building Council (USGBC) (2015).

i. Sustainable site design

Minimize urban sprawl and needless destruction of valuable land, habitat and green space, which results from inefficient low-density development. Encourage higher density urban development, urban re-development and urban renewal, and brownfield development as a means to preserve valuable green space. Preserve key environmental assets through careful examination of each site. Engage in a design and construction process that minimizes site disturbance and which values, preserves and actually restores or regenerates valuable habitat, green space and associated eco-systems that are vital to sustaining life.

ii. Water Quality and Conservation

Preserve the existing natural water cycle and design site and building improvements such that they closely emulate the site's natural "pre-development" hydrological systems. Emphasis should be placed on retention of storm water and on-site infiltration and ground water recharge using methods that closely emulate natural systems. Minimize the unnecessary and inefficient use of potable water on the site while maximizing the recycling and reuse of water, including harvested rainwater, storm water, and gray water.

iii. Energy and Environment

Minimize adverse impacts on the environment (air, water, land, natural resources) through optimized building siting, optimized building design, material selection, and aggressive use of energy conservation measures. Resulting building performance should exceed minimum International Energy Code (IEC) compliance level by 30 to 40% or more. Maximize the use of renewable energy and other low impact energy sources.

iv. Indoor Environmental Quality

Provide a healthy, comfortable and productive indoor environment for building occupants and visitors. Provide a building design, which affords the best possible conditions in terms of indoor air quality, ventilation, thermal comfort, access to natural ventilation and day lighting, and effective control of the acoustical environment.

v. Materials and Resources

Minimize the use of non-renewable construction materials and other resources such as energy and water through efficient engineering, design, planning and construction and effective recycling of construction debris. Maximize the use of recycled content materials, modern resource efficient engineered materials, and resource efficient composite type structural systems wherever possible. Maximize the use of re-usable, renewable, sustainably managed, bio-based materials. Remember that human creativity and our abundant labor force is perhaps our most valuable renewable resource. The best solution is not necessarily the one that requires the least amount of physical work.

Mitigating Climate Change through Green Architectural Practices in Nigeria

Base on the above principles of green building and sustainable site design, climate change can be mitigated in Nigeria if Nigeria architect and building engineers adopt and promote the following green design strategies and technologies:

Sustainable site design

- ✓ Make more efficient use of space in existing occupied buildings, renovate and re-use existing vacant buildings, sites, and associated infrastructure and consider re-development of brownfield sites. Design buildings and renovations to maximize future flexibility and reuse thereby expanding useful life.
- ✓ When new development is unavoidable, steer clear of sites that play a key role in the local or regional ecosystem. Identify and protect valuable greenfield and wetland sites from development.
- ✓ Recognize that allowing higher density development in urban areas helps to preserve green space and reduce urban sprawl. Invest time and energy in seeking variances and regulatory reform where needed.
- ✓ Evaluate each site in terms of the location and orientation of buildings and improvements in order to optimize the use of passive solar energy, natural daylighting, and natural breezes and ventilation.
- ✓ Make best use of existing mass transit systems and make buildings and sites pedestrian and bike friendly, including provisions for safe storage of bicycles. Develop programs and incentives that promote car-pooling including preferred parking for commuters who carpool. Consider making provisions for re-fueling or recharging alternative fuel vehicles.

- ✓ Help reduce the urban heat island effect by reducing the building and site development footprint, maximizing the use of pervious surfaces, and using light green colored roofs, paving, and walkways. Provide natural shading of buildings and paved areas with trees and other landscape features.
- ✓ Reduce impervious areas by carefully evaluating parking and roadway design. Pursue variances or waivers where local ordinances may unintentionally result in the over-design of roadways or parking.
- ✓ Optimize the use of on-site storm water treatment and ground water recharge. Minimize the boundaries of the construction area, avoid needless compaction of existing topsoil, and provide effective sedimentation and silt control during all phases of site development and construction.
- ✓ Use landscape design to preserve and restore the region's natural habitat and heritage while emphasizing the use of indigenous, hardy, drought resistant trees, shrubs, plants and turf.
- ✓ Help reduce night-time light pollution by avoiding over-illumination of the site and use low cut-off exterior lighting fixtures which direct light downward, not upward and outward.

Water quality and conservation

- ✓ Recognize that the least costly, least time consuming and most environmentally preferable design for site and storm water management is often the one in which the design of buildings and site improvements respect the existing natural flows and features of the land, instead of designing the building and site improvements with total disregard for the site, which results in needless, extensive, disruptive, costly and time consuming excavation and earthmoving.
- ✓ Conduct a thorough site assessment and strategically locate buildings and site improvements so as to preserve key natural hydrological features. Special effort should be made to preserve areas of the site that serve as natural storm water retention and ground water infiltration and recharge systems. Preserve existing forest and mature vegetation that play a vital role in the natural water cycle by absorbing and disbursing up to 30% of a site's rainwater through evapo-transpiration.
- ✓ Minimize the building's footprint, site improvements and construction area, and minimize excavation, soil disturbance and compaction of existing topsoil as this soil in its natural uncompacted state serves a vital role in absorbing and storing up to 80% of natural rainfall until it can be absorbed by vegetation or enter the site's natural sub-surface ground water system.
- ✓ Design and locate buildings and site improvements to optimize use of low-impact storm water technologies such as bio-retention, rain gardens, open grassy swales, pervious bituminous paving, pervious concrete paving and walkways, constructed wetlands, living/vegetated roofs, and other technologies that support on-site retention and ground water recharge or evapo-transpiration. Storm water that leaves the site should be filtered and processed naturally or mechanically to remove trash and debris, oil, grit and suspended solids. Use "hold and release" technologies such as dry retention ponds only as a last resort as these technologies do not preserve the natural water cycle, have little or no benefit in terms of ground water recharge and result in needless additional site disturbance.

- ✓ Establish a water budget for the building and implement a design that minimizes the use of potable water by using low-flow plumbing fixtures and toilets and waterless urinals. Harvest, process and recycle rainwater, site storm water, and building gray water and identify appropriate uses within the building and site. Use on-site treatment systems that enable use of rain water for hand washing, graywater for toilet flushing, rain and storm water for site irrigation, cooling tower make-up and other uses.
- ✓ Conserve water and preserve site and ground water quality by using only indigenous, drought resistant and hardy trees, shrubs, plants and turf that require no irrigation, fertilizers, pesticides or herbicides.

Energy and environment

- ✓ Optimize passive solar orientation, building massing and use of external shading devices such that the design of the building minimizes undesirable solar gains during the summer months while maximizing desirable solar gains during winter months.
- ✓ Optimize building orientation, massing, shape, design, and interior colors and finishes in order to maximize the use of controlled natural day lighting which significantly reduces artificial lighting energy use thereby reducing the buildings internal cooling load and energy use. Consider the use of light shelf technology.
- ✓ Use high performance low-e glazing, which can result in significant year round energy savings. Consider insulated double glazing, triple glazing or double pane glazing with a suspended low-e film. Selective coatings offer optimal light transmittance while providing minimal solar gain and minimal heat transmission. Window frames, sashes and curtain wall systems should also be designed for optimum energy performance including the use of multiple thermal breaks to help reduce energy use.
- ✓ Optimize the value of exterior insulation and the overall thermal performance of the exterior envelope assembly. Consider advanced/high performance envelope building systems such as structural insulated panel systems (SIPS) and insulated concrete form systems (ICF's) that can be applied to light commercial and institutional buildings. SIPS and ICF's and other thermally "decoupled" envelope systems will offer the highest energy performance.
- ✓ Use energy efficient T-8 and T-5 bulbs, high efficiency electronic ballasts, and lighting controls. Consider using indirect ambient lighting with workstation based direct task lighting to improve light quality, reduce glare and improve overall energy performance in general office areas. Incorporate sensors and controls and design circuits so that lighting along perimeter zones and offices can be switched off independently from other interior lights when daylighting is sufficient in perimeter areas.
- ✓ Use state-of-the art, high efficiency, heating, ventilation and air conditioning (HVAC) and plumbing equipment, chillers, boilers, and water heaters, etc. Use variable speed drives on fan and pump motors. Use heat recovery ventilators and geothermal heat pump technology for up to 40% energy savings.
- ✓ Avoid the use of HCFC and Halon based refrigeration, cooling and fire suppression systems. Optimize the use of natural ventilation and where practical use evaporative

cooling, waste heat and/or solar regenerated desiccant dehumidification or absorption cooling. Identify and use sources of waste energy.

- ✓ Use Energy Star certified energy efficient appliances, office equipment, lighting and HVAC systems.
- ✓ Consider on-site small-scale wind, solar, and/or fuel cell based energy generation and co-generation. Purchase environmentally preferable “green” power from certified renewable and sustainable sources.

Indoor environmental quality

- ✓ Use building materials, adhesives, sealants, finishes and furnishings which do not contain, harbor, generate or release any particulate or gaseous contaminants including volatile organic compounds.
- ✓ Maximize the use of natural daylighting. Optimize solar orientation and design the building to maximize penetration of natural daylight into interior spaces. Provide shades or daylight controls where needed.
- ✓ Maximize the use of operable windows and natural ventilation. Provide dedicated engineered ventilation systems that operate independently of the buildings heating and cooling system. Ventilation systems should be capable of effectively removing or treating indoor contaminants while providing adequate amounts of fresh clean make-up air to all occupants and all regions of the building. Monitor indoor air conditions including temperature, humidity and carbon dioxide levels, so that building ventilation systems can respond when space conditions fall outside the optimum range.
- ✓ Provide a smoke free building. When smoking must be accommodated, provide completely dedicated smoking areas are physically isolated, have dedicated HVAC systems, and remain under negative pressure with respect to all adjoining spaces. Assure that air from smoking areas does not get distributed to other areas of the building does not re-enter the building through doors or vestibules, operable windows, or building fresh air intakes.. Locate outdoor smoking areas so that non-smokers do not have to pass through these areas when using primary building entrances or exits.
- ✓ Design building envelope and environmental systems that not only treat air temperature and provide adequate ventilation, but which respect all of the environmental conditions which affect human thermal comfort and health, including the mean radiant temperature of interior surfaces, indoor air humidity, indoor air velocity, and indoor air temperature. Following these principles and providing a building that is also responsive to seasonal variations in desirable indoor humidity levels, air velocity, and mean radiant temperatures can also result in significant energy savings as improved occupant comfort results in less energy intensive operation of the buildings air-side heating and cooling system.
- ✓ Maximize occupant health, comfort and performance by providing occupants with individual space/zone control of heat, ventilation, cooling, day-lighting and artificial lighting whenever possible.
- ✓ Prevent contamination of the building during construction. Take steps to minimize the creation and spreading of construction dust and dirt. Prevent contamination of the building and the buildings heating, cooling and ventilation systems during the

construction process. Protect construction materials from the elements so that they do not become damp, moldy or mildewed.

- ✓ Provide a clean and healthy building. Use biodegradable and environmentally friendly cleaning agents that do not release VOCs or other harmful agents and residue. Prior to occupancy install new air filters and clean any contaminated ductwork and ventilation equipment. Use fresh outdoor air to naturally or mechanically purge the building of any remaining airborne gaseous or particulate contaminants.

Materials and resources

- ✓ Optimize the use of engineered materials which make use of proven engineering principles such as engineered trusses, composite materials and structural systems (concrete/steel, other…), structural insulated panels (stress skin panels), insulated concrete forms, and frost protected shallow foundations which have been proven to provide high strength and durability with the least amount of material.
- ✓ Identify ways to reduce the amount of materials used and reduce the amount of waste generated through the implementation of a construction waste reduction plan. Adopt a policy of "waste equals food" whereby 75% or more of all construction waste is separated for recycling and used as feedstock for some future product rather than being landfilled. Implement an aggressive construction waste recycling program and provide separate, clearly labeled dumpsters for each recycled material. Train all crews and subcontractors on the policy and enforce compliance.
- ✓ Identify ways to use high-recycled content materials in the building structure and finishes. Consider everything from blended concrete using fly ash, slag, recycled concrete aggregate, or other admixtures to recycled content materials such as structural steel, ceiling and floor tiles, carpeting, carpet padding, sheathing, and gypsum wallboard. Consider remanufactured office furniture and office partition systems, chairs and furniture with recycled content or parts.
- ✓ Explore the use of bio-based materials and finishes such as various types of agriboard (sheathing and or insulation board made from agricultural waste and byproducts, including straw, wheat, barley, soy, sunflower shells, peanut shells, and other materials). Some structural insulated panels are now made from bio-based materials. Use lumber and wood products from certified forests where the forest is managed and lumber is harvested using sustainable practices. Use resource efficient engineered wood products in lieu of full dimension lumber which comes from older growth forests.
- ✓ Evaluate all products and systems used for their ability to be recycled when they reach the end of their useful life. Preference should be given to products and systems that facilitate easy, non-energy intensive separation and recycling with minimal contamination by foreign debris.
- ✓ Recognize that transportation becomes part of a product or building materials embodied energy. Where practical, specify and use locally harvested, mined and manufactured materials and products to support the regional economy and to reduce transportation, energy use and emissions.

CONCLUSION

The impacts of climate change are real and are felt globally. The Nigerian built environment is vulnerable to the impact of climate change. There is need for Nigeria architects, engineers and their clients to promote and adopt green architectural practices for the built environment. This would mitigate some of the effects of climate change and lead to environmental sustainability, economic and social sustainability. The implication of these is possible added value to the quality of life of individuals and built environment.

REFERENCES

Engel-Yan, J. Kennedy, C. Saiz, Bressnail, K. (2005). Towards sustainable Neighbourhoods: The need to consider infrastructure interactions. *Journal of Civil Engineering.* Vol 32. 2005, NRC Canada.

Federal Government of Nigeria (2009). *Nigeria and climate change: Road to COP15 'achieving the best outcome for Nigeri*a'. Federal Ministry of Environment. MRL Public Sector Consultants Limited.

Gottfried D.A. (1996). *The economics of green buildings* (1996) in Sustainable Technical Manual, Public Technology Inc. U.S.A.

Hackler J and Holden J.P. (2008). Design and Performance of an Award – *Winning Green Head quarters Journal of Green Building.* Vol.3 No 1, winter 2008.

Hendrickson, C, Schempt, N.C., Lave L, McMichael F. (undated). *Introduction to Green Design,* Green Design institute, Carnegie Mellon University, Pittsburgh P.A

Hill, R.C and Bowen, P.A. (1997). Sustainable construction, principles and framework for attainment, *Construction Management and Economics,* 15, 223-239

Immaculata, N. and Henry, O. (2011). Sustainable or green construction in Lagos, Nigeria: Principles, attributes and framework. *Journal of Sustainable Development* Vol. 4, No. 4. www.ccsenet.org/jsd

Kadiri, (2006); Planning sustainable and livable cities in Nigeria; *Research Journal of Social Sciences 1 (1) 40-50 2006, INSI net Publication*

Lippiatt B.C, and Morris G.A. (1996). *Selecting environmentally and economically balanced building materials in sustainable technical manual,* Public Technology Inc. U.S.A.

Martin C, Ruperd. Y, Legret, M. (2007). Urban stormwater management: The development of multi-criteria decision approach for best management practices, *European Journal of Operational Research,* No 181, pg 338-349, Elsevier

Nwafor, J.C. (2006). *Environmental impact assessment for sustainable development,* Eldermark Publishers, Enugu Nigeria.

Okoye, J.K. (2007). *Background study on water and energy issues in Nigeria* to inform the National Consultative Conference on Dams and Development.

Roberts T. (2007). Historic Preservation of Green Buildings: A Lasting Relationship, Environmental Building News, January 2002.

Simpson, J.R., and McPherson, E.G. (2001). tree planting to optimize energy and CO2 benefits, Proceedings of the 2001 Urban forest Conference, Washington D.C, 5 – 8 September 2001, American Forest Washington D.C; 81 – 84

US Green Building Council (USGBC). (2009d), "LEED 2009 for New Construction and Major Renovations", Washington, DC. 2009. [Online] Available: http:// www.usgbc.org. (August 6, 2012).

UNDERSTANDING THE ROLE THE ARCHITECT PLAYS IN ATTAINING SUSTAINABLE DESIGN AND CONSTRUCTION

AJUFOH MICHAEL ONYEMAECHI[1], **DAUDA ALI**[2] & **YAKTOR J. L.**[3]
1 & 2 Department of Architectural Technology Federal Polytechnic Bauchi
3 Department of Architecture, University of Jos

To comprehend the part of the architect in achieving sustainable design and construction, we must first realise that the architect is "the first developer" in the building and construction industry. Initially the Architect, as the originator controlled the outline purpose and regulated the work of the developers. As building projects turned out to be more complex, building experts in civil engineering and other related fields became secondary designers to the Architect. Today the Architect is the said to be the focal contact among other professionals in the building industry working towards the completion of a project. The paper starts by answering the question of what Architecture is. It discusses the job description of the architect and his role in a construction site. The paper also highlights sustainability factors and principles as it relates to architecture, while also discussing principles of sustainable building design. The paper highlights the various roles of the Architect in attaining sustainable design and construction in the built environment. In conclusion, the paper recommends the integration of the concept of sustainability at the training stage of Architects.

Keywords: Architect, Construction, Design, Environment, Sustainability

mikeajufoh@yahoo.com

Ajufoh et.al. (2016). **UNDERSTANDING THE ROLE THE ARCHITECT PLAYS IN ATTAINING SUSTAINABLE DESIGN AND CONSTRUCTION** Sustainable Built Environment and Climate change; The challenges of Post 2015 Development Agenda. School of Environmental Technology Conference, SETIC, 2016

INTRODUCTION

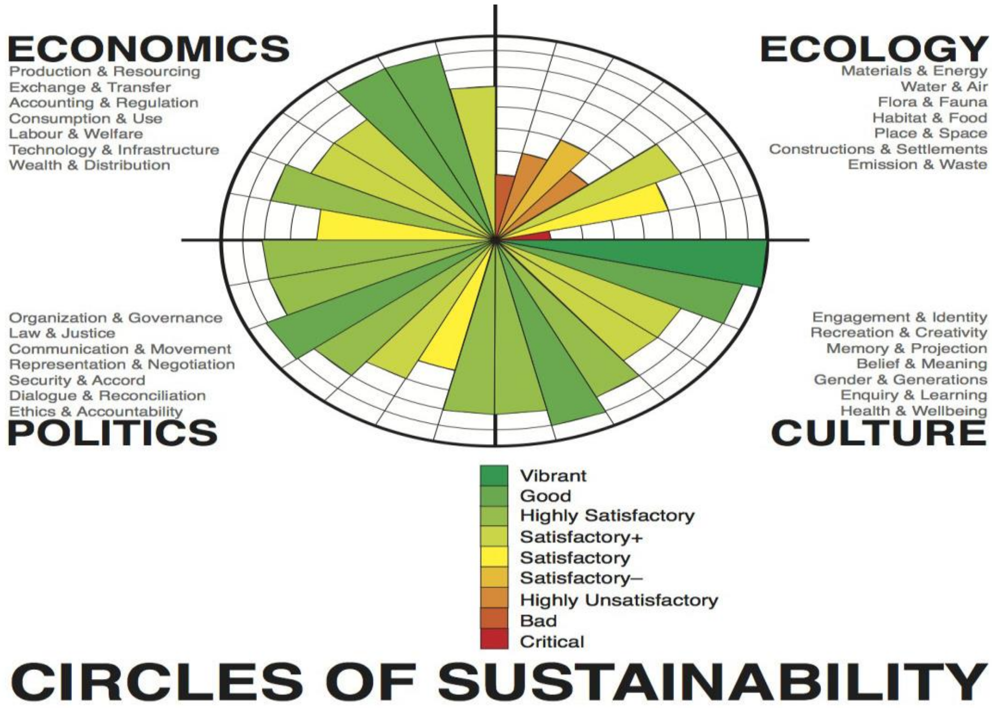
Architecture is the procedure and the result of arranging spaces, planning functions, designing and erecting building and other related structures. Architectural works can be related to symbols of culture and as art centerpieces. Ancient civilizations are usually distinguished by their surviving design accomplishments. Architecture encompasses arranging, outlining and developing form, space and structures to reflect utilitarian, specialized, social, natural and appealing considerations. It requires the imaginative control and coordination of materials and innovation, and of light and shadow. Frequently, clashing necessities must be determined. The act of Architecture likewise envelops practical aspects of erecting buildings and structures, including planning of various activities, estimation of cost of labour and materials and finally, project management. Architects are usually involved at the initial stage of a building undertaking, which starts with the client's brief, setting up budgets, surveying the necessities of the building and its occupants, and the environmental impact assessment. They also play vital roles in the site selection process and supervise works carried out by contractors to ensure that the building standards are met. Furthermore, Architects ensure that functionality, sustainability and aesthetics are achieved (Jones C. - 2014). Documentation created by Architects, usually drawings, layouts and specialized details, characterizes the structure and/or conduct of a building or other sort of framework that is to be or has been developed. As the focal figure, the Architect is responsible for the initial concept, the working drawings and details that transform that idea into a real building, the specialized arrangements and particulars that characterize the development for the temporary worker and by and large for oversight of the development task to safeguard that the development is assembled as composed. While some technical details might be produced by some building specialists, the Architect is in charge of the overall project as conveyed to the client.The Architect makes an interpretation of the clients' requirements into design solutions that satisfy the clients' needs, comply with building and statutory codes in order to achieve a building that is environmentally friendly, structurally sound, fire proof, thermally efficient and durable.

The paper identified the problem of inadequate contribution by the Architect in achieving sustainable design and construction and therefore seeks to ascertain the various roles the Architect plays in attaining sustainable design and construction. This was achieved by reviewing several literature on sustainability and highlighting specific roles of paramount importance to the Architect in order to achieve sustainability. Secondary data was obtained from reviews of literature relating to sustainable design and construction. This comprise information gotten from books, journals, seminar papers, magazines and internet sources using desk research.

THE ARCHITECT AND SUSTAINABILITY ISSUES

According to The World Commission on Environment and Development, "sustainbility" entails addressing the requirements of the present without trading off the capacity of future eras to address their own particular issues. — From Our Common Future (London: Oxford University Press, 1987.

Sustainable Architecture refers to the design and construction of buildings in order to reduce the overall negative impact on the environment by efficient use in the choice of materials, energy and technology used to modify a given space. Architecture that is sustainable tends to conserve energy and preserve the ecological balance in a built environment. The concept of sustainability, or eco-friendly design, is to guarantee that our activities and choices today don't hinder the chances of future eras (Reed B. 2010).



Source: Greenpedia (2012).

Sustainability in socio-economic or architectural context ought to be seen within the environmental point of view. The reason is that they are all related to the environment. The model portraying their interconnectivity lessens the compelling force of nature. All fields need to work together and operate with nature and the environment (Ijatuyi O, Arayela O.- 2013)

SUSTAINABLE CONSTRUCTION

Sustainability is a fundamental idea that emphasises various endeavours to guarantee decent life for future eras. The Bruntland Report (1987) characterizes sustainable development as "… addressing the requirements of the present without trading off the capacity of future eras to address their issues". This definition demonstrates that the environment and social issues are as important as economic issues, and proposes that human, natural, and economic frameworks are related. It additionally includes intergenerational equity, highlights the risk of the present era for the wellbeing of millions yet unborn, and includes the thought that present era are utilising the environment, its assets, and its natural capacity and quality from future eras (Kibert, 2005.

The term sustainable construction simply refers to the development of sustainable principles in the building and construction industry. In 1994, the Conseil International du Batiment (CIB) described sustainable construction as "… developing the built environment through efficient use of resources and environmentally friendly principles" (Kibert, 1995). Hill and Bowen (1997) defined it as four basic composition namely: social, economic, biophysical and technical. Du Plessis (2002) characterized it as "a comprehensive procedure intending to restore the relationship between nature and the built environment, and make settlements that assert human nobility and promote economic viability". The CIB hypothesized seven standards of sustainable construction which assist building professionals at every phase of the building process namely: minimizing the consumption of resources; recycling resources; utilizing recyclable resources; protecting the environment; eradicating toxic wastes; applying life-cycle costing; and underscoring quality (Kibert, 2005). To acquire ideal answers for present building and construction issues, it is important to consider all aspects such as the technical, political, social, economic and the relationships between them.

Sustainability along these lines communicates arrangements as to an entire framework, with a whole blend of results as communicated by an assortment of remarks and conclusions (Ferng and Price, 2005). A sustainable construction industry does not just mean to proceed with its business and development, additionally needs to meet the standards of sustainable development, which mean it might require, at times, to quit developing or develop in various ways (Du Plessis, 2002). According to the United States Green Building Council, Leadership in Energy and Environmental Design (USGBC), structures in the USA constitute 36% of total energy consumption and 65% of power utilization. 30% is ascribed to greenhouse gas emissions, 30% to waste generation while 12% is ascribed to portable water consumption (USGBC, 2003). The merits of implementing sustainable techniques at the initial stage are connected with three principle viewpoints namely: benefits to the environment such as better air and water quality, reduced water and energy consumption, minimal waste disposal, benefits to the economy such as cost reduction in operation and maintenance, higher revenues, and benefits to the health of the community such as comfort of the occupants and minimal liabilities. (Kats and Alevantis, 2003).

In addition, accomplishing sustainable design will create structures that have reduced emissions that are harmful to the environment and buildings that constructed with recyclable resources and are generally more energy efficient. Ashe (2003) argued that sustainable design tend to increase the demand of building professionals and also promote marketing chances. Hayles (2004) explained that the implementation of sustainable construction techniques gives greater value to building users and the built environment as a whole. Manoliadis and Tsolas (2006) stated various sustainable design principles which are: renewable resources, eco-friendly technologies, energy conservation, indoor air quality, minimal waste, urban planning policies, new cost metrics, incentives programmes, re-engineered design process, product innovation, sustainable urban planning policies and new partnerships among building stakeholders.

These techniques should be given due consideration at the initial and conception stage of a building project.

Sustainable Construction Barriers

The main barrier to the implementation of sustainable construction is perceived to be cost. In other words, sustainable buildings are perceived to cost more. Initially, sustainable construction projects may cost up to 2-7 percent extra when compared to ordinary projects and just a few ventures can recover general net expenses in a brief period. Building stakeholders hardly utilize entire life cycle expenses to assess diminished working costs (Castillo and Chung, 2005). These barriers can be eliminated by changing the reasoning of the building stakeholders from cost and short-term goals to value and long term goals.

SUSTAINABLE DESIGN

The aim of sustainable design is to minimize or eradicate negative impact of building on the environment. The concept of sustainability can be utilized in all design related fields such as building and product design. A sustainable design irrespective of the area of application seeks to conserve energy, reduce adverse effect on the environment, lower greenhouse gas emissions, reduce water consumption, utilize renewable resources, reduce or eliminate waste, apply bio- mimicry principles, ensure the health and well-being of building occupants, give priority to the use of non-toxic material and underscore quality and durability over cost. In order to achieve sustainable designs, the environment and the development process which are interconnected, must be integrated.

According to WBDG Sustainable Committee (2014), the reduction in the use of critical resources such as raw materials, water, energy and the elimination of environmental pollution as a result of building and construction activities in order to create a healthy, comfortable and habitable environment are the main objectives of sustainable design. More so, sustainability also translates to re-modelling existing buildings rather than erecting new structures due to the cost effectiveness that can be attributed to reduced operational costs, reduced environmental impact and increased flexibility.

PRINCIPLES OF SUSTAINABLE BUILDING DESIGN

Optimize Site Potential

Appropriate site selection and evaluation of existing buildings are the first steps required to create a sustainable building. The ecosystems, energy use and transportation method can be affected by the location, orientation and landscape of a building. It is critical to fuse sustainable design principles into the management of a project irrespective of the nature of the project. Siting for physical security is a basic issue in upgrading site plan, including passive security measures. Whether a new design or re-design of an existing building, the site plan must incorporate sustainable design principles. The site plan of a sustainable building should be designed in such a way as to reduce storm water run-off and incorporate the existing site features such as vegetation, topography and landscape.

Optimize Energy Use

The impact of the global climate change on the environment have become more apparent and the need to find alternative sources of energy due to the ever increasing demand on the worlds fossi fuel resources have led to great concerns for energy efficiency and use of renewable energy resources. Therefore, the public and private sector need to be increasingly committed in applying the principles of sustainable designs in order to reduce the dependence of fossil fuels and operate net-zero energy buildings.

Protect and Conserve Water

In numerous parts of the world, water shortages are common. A sustainable building is designed to conserve the use of water or possibly recycle used water for other purposes. The transportation of portable water to various households consume enormous amount of energy. Portable and drinkable house hold water is as a result of the treatment with often toxic chemicals that are hazardous to the environment. There are also huge financial and environmental costs of sewage treatment or pipe borne water, hence the need for sustainability in design.

Optimize Building Space and Material Use

As the world populace keeps on increasing (to more than 9 billion by 2050), the demand for natural resources, goods and services are also on the increase. It is of paramount importance to utilize materials and other resources that can be recycled, maximized and can reduce pollution. A sustainable building is designed and built with recyclable materials that can re-used over time. The materials utilized as a part of a sustainable approach are designed to minimize life-cycle ecological effects such as global warming, resource depletion, and human toxicity. Ecologically friendly materials have reduced effect on human well-being, the environment and add to enhanced building occupant well-being.

Enhance Indoor Environmental Quality (IEQ)

The indoor environmental quality (IEQ) of a building significantly affects users' wellbeing, solace, and efficiency. Among other varibles, a sustainable building boosts daylighting, has adequate ventilation and dampness control, streamlines acoustic execution, and evades the utilization of materials with high-VOC emissions. Standards of IEQ additionally stress inhabitant control over frameworks, for example, lighting and temperature.

Optimize Operational and Maintenance Practices

Optimizing the operational and maintenance practices such as improved working environments, reduced costs, energy utility and higher productivity are best considered at the preliminary design stage. In other words, building stakeholders are best encouraged to participate at the initial conceptual stage. Architects can specify sustainable building materials to be used throughout the construction process while a regular track of the success of the implementation of sustainability can be recorded using meters, charts and program schedules.

CONCLUSION

The paper gives an understanding of the unique roles the Architect plays in implementing the concept of sustainability in design and construction. Various building materials in the market today lay claims to be green and sustainable, however the Architect must be able to distinguish between genuine green materials and ordinary building materials. It is also the role of the Architect to determine if the merits of a building material outweighs the demerits for a particular building material that has been improved upon. There are standards for picking new materials, however the Architect must be cautious, keep all building stakeholders educated and record all interchanges in the event that an issue emerges that powers contradictions.

The Architects principle design goal must be to eliminate the exhaustion of basic natural resources such as energy, water, and crude materials; avoid environmental pollution brought about by negative impact of building and infrastructure on the environment for the duration of their life cycle; and transform the environment to places that are liveable, agreeable, safe, and beneficial.

The paper has also shown that the Architect drives the path in promoting sustainable development through adequate energy conservation, reduction in waste, water and material usage and adequate consideration given to indoor air quality, indoor environment quality and land use.

RECOMMENDATION

The concept of sustainability is rapidly gaining new grounds in advanced education. The syllabus of sustainability should not only incorporate data from numerous conventional scholastic fields, but also incorporate the technical know-how of the Architect. Numerous proficient Architects are experts in achieving sustainable design and construction in the built environment due to the fact this concept can be readily integrated in the design process and used to solve client's problems. In order for the Architect to achieve sustainable design and construction, the following recommendations are therefore necessary:

1. The Architect can contribute towards sustainability if adequate consideration is made between various factors affecting designs and construction such as design elements, site considerations, building functions and systems, energy and resource limitations.
2. Choices must be made on the type of embodied energy to be utilized, therefore, the Architect needs to have expertise knowledge on energy efficient systems of construction.
3. Renewable construction materials should be specified in the specification schedules by the Architects.
4. Sustainable construction techniques should be employed by the contractors under the supervision of the Architect.

5. Various professionals in the building industry should be educated on the principles of sustainability since they contribute one way or the other to the success of a building project.

REFERENCES

Afolabi A. D, Graeme D. L. and Runming Y. (2013). Sustainable Construction In Nigeria: Understanding Firm Level Perspectives. Sustainable Building Conference 2013, Coventry University.

Ashe, B et al. (2003) Sustainability and the building code of Australia.

Castillo, R. and Chung, N. (2005). Last update, the value of sustainability, [Online]. Available: http://www.stanford.edu/group/CIFE/online.publications/WP091.pdf [21 April 2005].

Du Plessis, C. (2002) Agenda 21 for Sustainable Construction in Developing Countries. Pretoria, South Africa: The CSIR Building and Construction Technology.

Ferng, J. and Price, A.D.F. (2005). An exploration of the synergies between Six Sigma, total quality management, lean construction and sustainable construction. International Journal of Six Sigma and Competitive Advantage, 1(2), 167-187.

Greenpedia, (2012). General concepts of sustainable development. Retrieved from http://www.greenpedia.ro/general concepts

Hayles, C. (2004) The Role of Value Management in the Construction of Sustainable Communities, The Value Manager, The Hong Kong Institute of Value Management 15-19.

Hill, R.C. and Bowen, P.A. (1997) Sustainable construction: principles and a framework for attainment. Construction Management and Economics, 15(3), 223-239.

Ijatuyi Olufunto O. ,Arayela Olatunde (2013). Sustainable Development through Architecture: A Reflection. International Journal of Engineering and Technology Volume 3 No. 6, June, 2013

Jones C. (2014). The Architect's Job description. Online Career guide written for *AGCAS & Graduate Prospects Ltd*, Nottingham Trent University.

Kats, G., Alevantis, L. et al. (2003) The cost and financial benefits of green buildings- A report to California's sustainable building task force.

Kibert, C. J. (2005) Sustainable construction: green building design and delivery. Hoboken, New Jersey: John Wiley and Sons, Inc.

Manoliadis, O., Tsolas, T. and Nakou, A. (2006) Sustainable construction and drivers of change in Greece: a Delphi study. Construction Management and Economics, 24, 113-120.

Quote from Henry Cameron in Alyn Rand's novel "The Fountainhead" (1943).

Reed, B. (2010). Boston Society of Architects Lecture, the Practice of Living System Design, Boston, January 20 2010.

USGBC (2003) United States Green Building Council, Why Build Green? [Online] Available at http://www.usgbc.org/AboutUs/whybuildgreen.asp [Cited 8 November 2004].

USE OF OPEN SPACES IN IMPROVING OFFICE BUILDING SUSTAINABILITY IN TERTIARY INSTITUTIONS

OQUA, Idowu Titilope & ADEDAYO, Olatunde Folaranmi
Department of Architecture, Federal University of Technology Minna, Niger State, Nigeria.

The increase in globalization of the marketplace, rising economic competition, population growth and environmental challenges ranging from climate change to air pollution and flooding to rising energy costs, sustainability has become a key requirement in the design of office buildings regardless of their location. The demand for office buildings is high in many tertiary institutions and the use of open spaces have not been fully utilised in the design of building in them. The challenges of climate change have made it evident that courtyards alone should not be seen as the only open space in office buildings for responding to climate issues. The growing demand for energy efficient buildings requires a greater responsibility of architects today and in the future to rise up to the call. The aim of the study is to examine the utilization of open spaces in office building of tertiary institutions with the view to determine how they can be used to improve the sustainability of office buildings. The research method adopted for the study was mixed method. Data was obtained using an observation schedule and a questionnaire. The data was cross tabulated with SPSS 17 and using descriptive statistic. The research was able to determine the relationship among variable and the frequency of occurrence of others. Result obtained presented in chats and plates. The study reveals that the traditional open space in tertiary institution buildings are courtyards and they are not designed to counter the effect of climate change. The paper concludes by recommending that smaller open spaces can be fused into office designs to improve utilization and cater for climate change problems.

Keywords: *Courtyard, Energy efficiency, Office building, Open spaces, Sustainability*

ideeyemi@yahoo.com

***OQUA, Idowu Titilope[1] & ADEDAYO, Olatunde Folaranmi[1]** (2016). **USE OF OPEN SPACES IN IMPROVING OFFICE BUILDING SUSTAINABILITY IN TERTIARY INSTITUTIONS** Sustainable Built Environment and Climate change; The challenges of Post 2015 Development Agenda. School of Environmental Technology Conference, SETIC, 2016

INTRODUCTION

The creation of time human activities have continuously revolved around environment whether considered scientifically or technologically, the practises and activities of man dwell with his devoted and continuous interaction with the environment. According to Obabori, Ekpu and Ojealaro (2009) The developing effort in all spheres which include industrialization, manufacturing, processing, construction, agriculture, rural and urban growth and development have subjected the environment to changes that are being witnessed today. The negative impact has brought problems due to lack of control and negligence on our part. In most developing countries, mainly those in tropical regions like Nigeria, the climate is considered with high temperature and humidity all year round. It has being observed that the interior temperature of buildings during the dry period in some part of the country varies beyond good temperature level that supports their occupant's comfort because of the extreme interior temperature. Cooling is required in order to achieve the required thermal comfort especially in large spaces such as the office buildings where they depend mostly on mechanical cooling system. This is even required more in faculty buildings offices which provide pedagogy services to students in order to acquire knowledge in various fields. Most establishments normally opt for mechanical cooling strategies that unavoidably use large amount of electricity. Currently, the rate of electricity consumption in Nigeria is increasing as the population continue to increase leading to an overpowering increase in the demand for energy and improved comfort levels. The challenge of energy consumption in buildings is worsened by extremely high temperature and intense solar radiation which drives the quest to use more energy within the buildings Akande, Fabiyi, Mark (2015). We have to minimize energy consumption and embrace sustainable approach for thermal comfort and interior air quality to moderate these problems.

The building design is one of the key factors determining the building's energy efficiency besides occupant behaviour Etisa (2010). A sustainable faculty office building can be achieved by optimising thermal comfort, especially through maximising natural airflow with the use of open spaces in the office building. With the high request for office buildings in many tertiary institutions in Nigeria as they are inadequate for their staff, the use of open spaces have not been fully utilised in the design of building in tertiary institutions. There is a growing demand for energy efficient buildings as a result of climate change which requires a greater responsibility of architects to rise up to the call. The aim of the study is to examine the utilization open spaces in office building in tertiary institutions with the view of determine how they can be used to improve the sustainability of office buildings.

CONCEPT OF SUSTAINABILITY IN NIGERIA TERTIARY INSTITUTIONS

The universal accepted definition of Sustainable development is development which meets the needs of the present without compromising the ability of future generation to meet their own needs (WCED, 1987). This definition tries to balance the needs of people today with the future needs of younger generations and the natural systems that sustain all life. These can be achieved through creating a balance between inter-dependant social, environmental and economic factors. According to Obabori, Ekpu and Ojealaro (2009) sustainability involves economic and development activities that meet the needs of the present generation without compromising, reducing or destroying the ability of the future generation to meet their needs. Sustainability rests on three pillars economic, social and environmental activities that promote the ability of the present and future generations to live within the earth's capacity to support it.

Tertiary institutions refers to a system which embraces much of the country's research capacity and reproduces majority of the skilled professionals that are required in the labour market. Adeyemi (2001). These institutions are expected to offer services that significantly contribute within the framework of a sound macro-economic and political environment to the growth of the society Bagoro (2015). The sustainability of institutions, organizations or any society depends basically on the creative capacity of the institution to be capable of effectively performing its functions by offering the required services for the sustenance of the system. According to Udida, Bassey, Udofia, & Egbona, (2009) Sustainability of tertiary institution may be said to be dependent on how the system performs in terms of management in the execution of Higher Education policy, through proper control, organization, budgeting and upholding the basic social beliefs. Many nations around the world have embraced the need for education to achieve sustainability, but lack of vision and awareness has hindered its progress in Nigeria due to lack of planning, proper supervision and execution of well-made policies. Omole, Ozoji (2014).

Every tertiary institution is meant to serve the institution with the physical assets and facilities. These physical assets and facilities are important element in our tertiary institution for us to achieve qualitative education. For effective teaching and learning to take place, there is need for adequate and qualitative facilities. When this is in place, learning process becomes much easier for both the students and lecturers. These Facilities include buildings, utilities, and equipment such as all types of buildings for academic and non-academic activities, equipment for academic and non- academic activities, sports and game areas, beautiful landscape, car parks, ICT, transportation, security, and facilities for the physically challenged persons etc. These facilities play vital role in the actualization of the educational purposes by satisfying the physical and emotional needs of students and staff.

SUSTANABLE OFFICE BUILDING DESIGN

A sustainable office building is an environmental sustainable building, designed, constructed and operated to reduce harmful effects on human health and the environmental impacts. A sustainable office buildings provide noticeable benefits such as materials, energy and water savings during use, other benefits includes improved productivity in workplaces, reduced operation and maintenance costs, and reduced demands on infrastructure, enhanced reputation of developers or owners and improved sales. An energy efficient office building reduces energy consumption, water conservation, recycling waste. A Well designed sustainable building will save money, increase comfort and create healthier environments for staff to work, using improved indoor air quality, natural daylight, and thermal comfort. The building design of a sustainable office building takes advantage of passive cooling and heating can reduce dependence on artificial cooling methods. This helps in improving the economic and ecological sustainability of the office building while optimising thermal comfort for the occupants. Open spaces in office building has the potential to provide opportunity for inspiration, increase socialization, environmental stimulation, informal interaction as well as increases exposure to sunlight (vitamin D absorptions).

INFORMAL INTERACTION IN FACULTY OFFICE

Human exist in a space and space influences him. A space which gives good influence to mankind is a sustainable space. Rather than being a distraction, informal interaction is seen as a way to build commitment, spread ideas about work and as a way to share knowledge and skills Rashid,Kampschroer,Wineman & Zimring (2006). When workers talk face to face with people who are in close proximity, Social relationships are built up. This is as a result of the physical proximity and accessibility of workstations and bumping into each other frequently. Open spaces in office buildings create an avenue for staff to have chance encounter Staff interaction in such spaces can enhance their sense of belonging to people and at same time increase attachment. As most of them either go there to relax during a long day at work or walk by. When staff interact informally in the office, they share idea and solutions with each other. Informal conversations in office area provide for teamwork as well as workers being aware of impromptu meetings. Open and beautifully designed greenspaces provide space for recreation, informal interaction and have positive influence on health. Outdoor leisure provides an opportunity to increase quality of life and enhance staff social interaction. It can also help staff gain basic and social skills, obtain qualifications, rebuild their lives, and maintain or improve quality of life. It provides something to talk about, a chance for enthusiasts to impart knowledge, provides motivation, and self-esteem.

PASSIVE MEASURES OF SUSTAINABILITY

Passive measure is a method that does not require energy input either by the building or through a mechanical device. This would provide a sustainable approach to reducing the impact of energy use on the built environment. To achieve an energy efficient office building, it would require modifying to the climate change the world is facing. Proper planning should be done and architects should be mindful of designing energy efficient buildings. These energy efficient buildings should provide a high level of comfort for the occupants to be able to execute their job. The use of passive design strategies aims at minimizing operational energy demand in buildings and therefore optimizing demand side efficiency whilst the use of low energy technologies aims at optimizing the increased use of renewable energies in the energy supply thereby reducing the circumstances for enhanced gas emissions and resource depletion. Passive design strategies are basic ways or techniques in which buildings make use of natural or ambient energy in the environment and its free running capability to control indoor climates of buildings for thermal comfort. The use of passive climate control can reduce energy use in building operation. The natural energy sources such as passive solar, ventilation and daylight are considered as high-grade energy sources. High- grade energy can be easily converted into useful work without conversion and waste Greenland (1991)

RESEARCH METHOD

The research method adopted for the study was descriptive method. There are fourteen (14) tertiary institutions in Niger state and six of it was purposely selected for the study. Data was obtained using an observation schedule and questionnaires. Questionnaires were administered to 108 academic and non-academic staff selected based on random sampling technique. For each institution, three most populated faculties was selected and the six questionnaires were administered to each of the faculties through random selection. Three building were observed in each institution bringing it to a total of 18 building studied. The data was cross tabulated using SPSS 17 and using descriptive statistic the research was able to determine the relationship among variable and the frequency of occurrence of others. The result obtained presented in chats and plates.

Table 1.0 The institutions studied

S/no	Name of institution	No. Of buildings with courtyard	No. Of buildings studied
1	Federal university of technology minna	5	3
2	Ibrahim babangida university, lapai	12	3
3	Federal polytechnic,bida	6	3
4	Niger state polytechnic, zungeru	0	3
5	College of education, minna	3	3
6	School of nursing, bida	0	3
	Total	26	18

DISCUSSION OF RESULT

Open Spaces in Office Building

It was observed that only 25% of the buildings as seen in fig1.0 have courtyard in them while 75% do not. It was also observed that most of the building with a courtyard didn't fully utilize it. Plate 1.0 shows an institution courtyard. The width of this courtyard is too small as compare to the height which has made it look hollow. There is minimal air flow inside the building due to the size of the courtyard and the closeness of the building. The size of the courtyard does not provide an opportunity for relaxation or refreshment for staff who want to just take few minutes off work stress or even socialize with colleagues.

Plate 2.0 shows a well landscaped courtyard. These plants will help to improve the air quality. However, there are no provisions for staff to sit. This would have given an opportunity for change encounter where social relationships can be built and in turn have great effects on their jobs as well as themselves. A well landscaped courtyard should go beyond aesthetics, it should be a place for informal interaction.

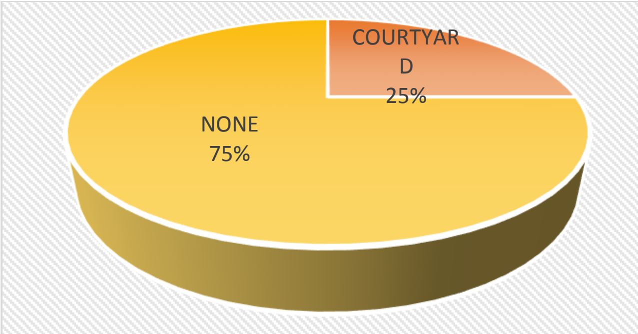


Figure 1.0: Availability of courtyard.
Source: Author's field work 2016

Plate 1.0: Courtyard of a faculty building at Federal polytechnic Bida.
Source: Author's field work 2016

Plate 1.0 Shows a courtyard not being utilized because of its size. The courtyard is hollow and small which does not provide enough lighting and ventilation for the offices around it. The Courtyards should have being wider to allow adequate air flow and lighting for the offices around it. Having a well landscaped courtyard will creates an informal interaction space when staff can sit and relax during and after work. This will also increase chances of encounter amongst staff and encourage research collaboration.

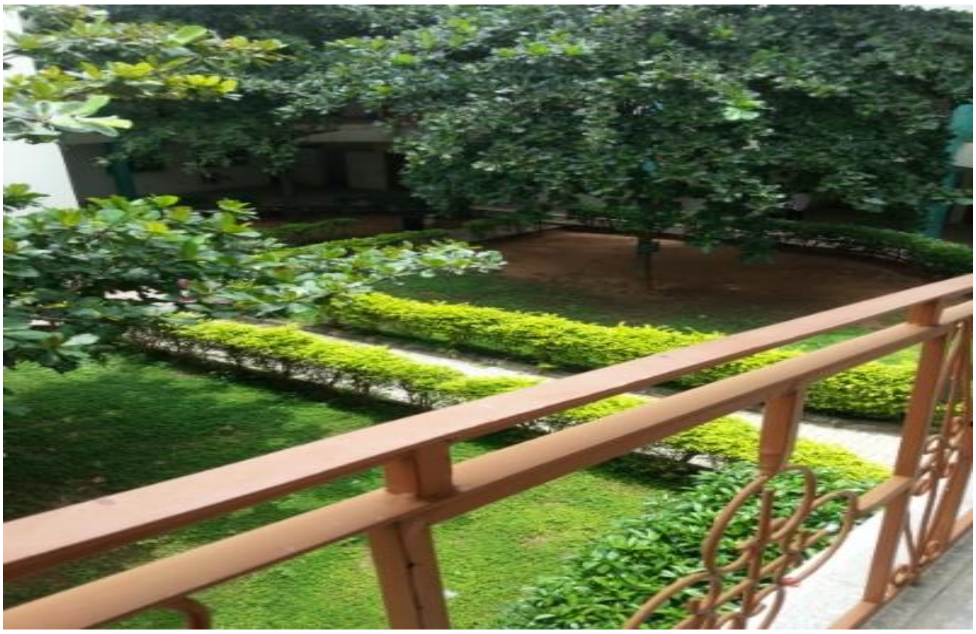


Plate 2.0 a well landscaped faculty office building courtyard. The plants helps to cool the offices.
Source: Author’s field work 2016

TYPES OF OPEN SPACES IN OFFICE BUILDING

Courtyards

Courtyards is an open space within a building that offers a substantial potential for utilizing passive strategies for indoor thermal comfort. The modest idea of introducing open spaces such as courtyard in a building is to provide natural lighting, cooling and ventilation. The incorporation of a courtyard into a building form offers a microclimatic barrier zone between the outdoor and indoor environments of the building. The open nature of the built volume creates natural flow of air within the building. From a climate design perspective, a courtyard building offers a greater flexibility in promoting larger areas of internal passive zones, which can benefit from natural ventilation as well as daylight. Courtyard in office building serves the main purpose of creating an air and light inlet to building. The effect of air movement on human thermal comfort is important. The courtyard can also be utilized for other purpose such as recreational, green areas and relaxation during and after work. One of the reasons courtyard has lasted for more than 5000years in hot, temperate and tropical regions is because it provides thermal comfort as well as being a source for light, heat and air flow. Courtyard helps to reduce peak temperature by channelling breeze to adjust the degree of humidity.

Roof garden

Roof garden improved aesthetic value of an office building. The design of the roof garden allows flow of the wind as well as the eaves. It Cools the building and also creates an avenue for staff to relax where chances of encounter which help them interact informally. Apart from being an informal interaction space, it could also be in the form of terrace garden, giving insulation to the building and reducing solar radiation. The design of a roof garden does not only address informal interaction and thermal comfort but also the visual appeal and environmental issues of the office building.

In a green roof system, much of the precipitation is captured in the vegetation and will eventually evaporate from the soil surface or will be released back into the atmosphere by transpiration. The plant material on rooftops provide numerous ecological and economic benefits, including storm water management, energy conservation, easing heat effect, increased longevity of roofing membranes, and providing a more aesthetically pleasing environment for people to work. Growing plant protects roofing membranes from solar exposure and ultraviolet radiation that can damage the traditional bituminous roof membrane. These materials also reduce day or night temperature fluctuations at the membrane, which reduces the stress of daily expansions and contractions. Roof garden helps with noise reduction on hard surfaces office building which is more likely to reflect sound. Green roofs absorb sound waves because of the nature of the substrate and vegetation

Garden

Gardens improve aesthetic value in office buildings. It helps to create familiar and non-institutional surrounding and has tremendous health benefits such as reducing stress, lowering blood pressure, releasing muscle tension, and increasing positive feelings. These benefits can in turn improve health and worker productivity. When staff are less stressed, they experience greater job satisfaction. From observation only one (1) of the office buildings has a garden in it.

Balcony

The balcony can be described as a horizontal shading device. It is a covered and hanging platform from a building that has access from any floor level. It is literally open to outer air by three sides. Beside the use of window and door opening, a balcony is an alternative architectural element that allows air into a building for better ventilation. Balcony could be used as transitional space to control and induce the outdoor air flow into indoor spaces of terrace house.

OFFICE BALCONY

Figure 2.0 shows that only 28.6% of the buildings balcony open to a courtyard while 71.4% of them do not. When offices are opened directly to courtyard, it gives them better chances of ventilation as there will be adequate level of air speed without obstruction Plate 3.0 shows an office balcony with little or no space for informal interaction along the balcony which is where staff are likely to meet the most. There will be obstruction of movement with this size of balcony.

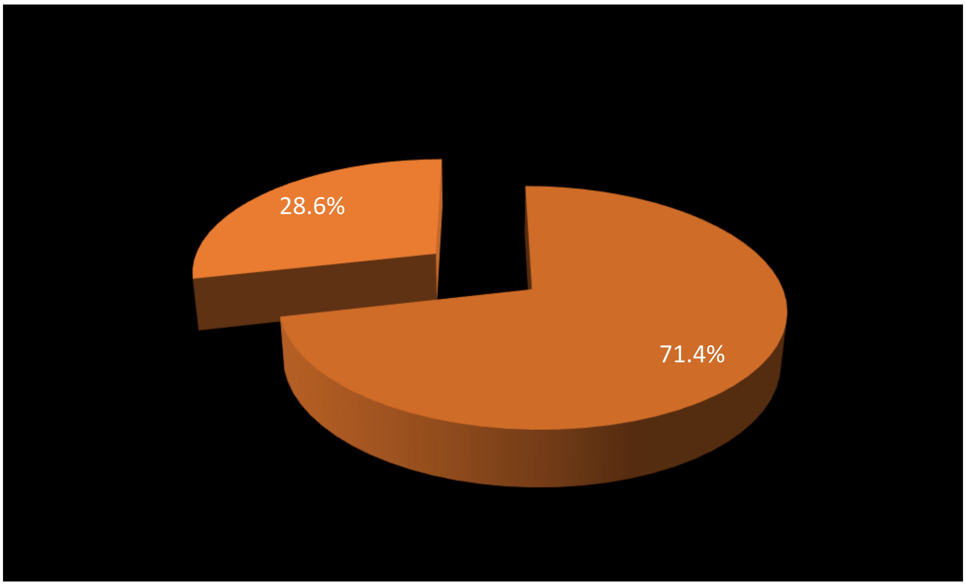


Figure 2.0: Buildings that their balcony open to the courtyard.
Source: Author's field work 2016

Plate 3.0 Faculty office balcony & Corridor with very little space for informal interaction
Source: Author's field work 2016

OPEN SPACES AND VENTILATION

Figure 3.0 shows that 8% of the staff are very comfortable in their offices in terms of thermal comfort and ventilation. 57% are not comfortable, 33% are comfortable, while only 2% are very comfortable in their offices. This data shows that more than half of the staff are not comfortable in their offices. This is quite alarming as it can affect their level of productivity. The temperature in Niger state is usually very hot and most office buildings depend on mechanical air conditioning but with the epileptic power supply it is being difficult to achieve good thermal comfort in the offices. Most of this offices are usually not cross ventilated having either only a window or windows on one side as most of them are double banked offices. Plate 4.0 shows an institution office building with long corridor and has little air coming into the corridor

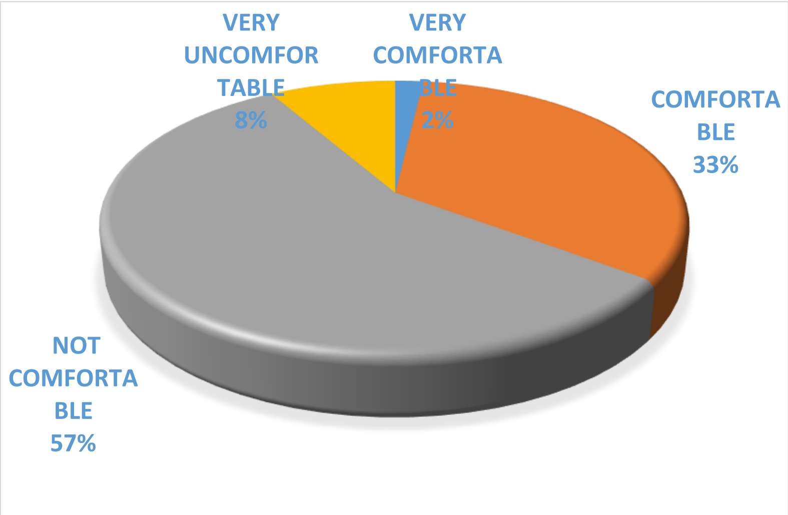


Figure 3.0: showing how comfortable staff are in their offices.
Source: Author's field work 2016

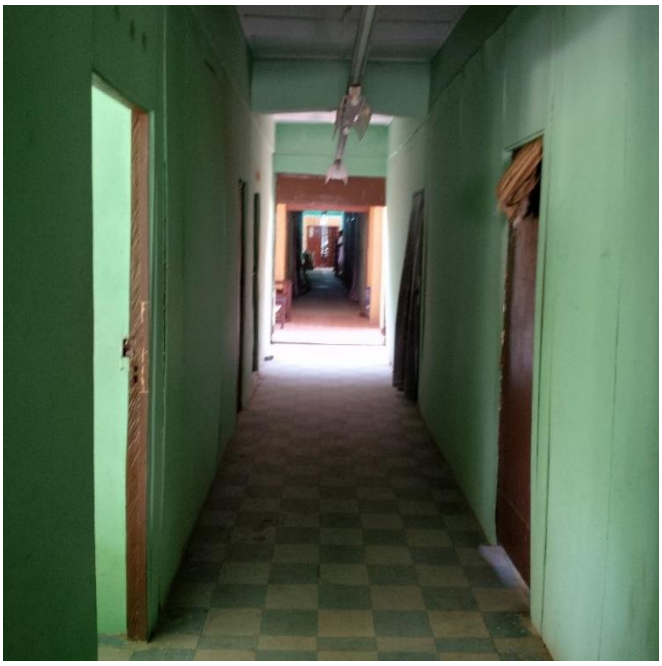


Plate 4.0 A long dark corridor of a staff office
Source: Author's field work 2016

OPEN SPACES AND INFORMAL INTERACTION

Figure 4.0 shows that only 19% of the institutions studied are has dedicated spaces for informal interaction while 81% does not. Informal interaction occurs mostly in open spaces around the office because people only visit their friends or those that need things for in their offices but there are high tendency of chances encountered in open spaces than in offices. It was observed that the institutions with dedicated informal interaction spaces are indoor as seen in plate 5.0 some of the staff find it difficult to go and relax there for some reasons but if there was provision for and outdoor informal interaction space, staff will want to take advantage of the fresh air and socialize. Plate 6.0 show an institution with some park benches in the courtyard where people can interact. Staff do not use it because they are inadequate and not well sheltered.

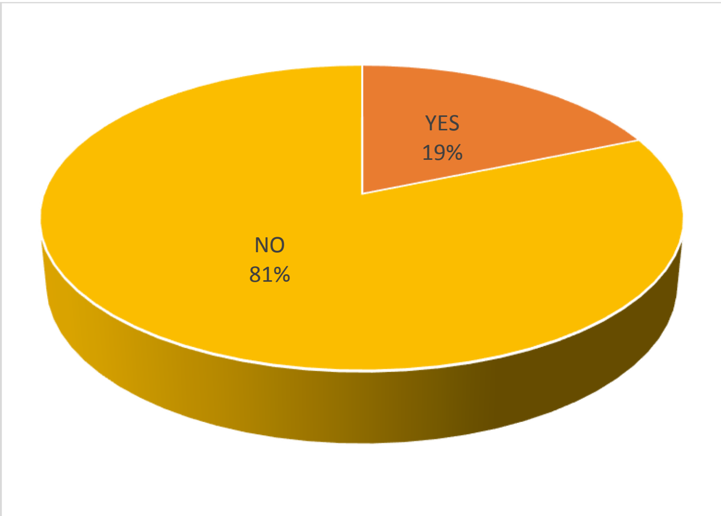


Figure 4.0: Showing if they have dedicated spaces for informal interaction.
Source: Author's field work 2016

Plate 5.0: faculty office lounge at Niger state polytechnic Zungeru.
Source: Author's field work 2016

Plate 6.0: courtyard of a faculty building with park benches used for informal interaction Source: Author's field work 2016

CONCLUSION

Improving the energy efficiency in office buildings is a systematic process and requires efforts regarding, design, construction, operation, and maintenance. With participation from architects to construction workers and even end users, the range of involved parties has to be wider than in the past. The practicable use of open spaces such as courtyard, balcony, roof garden and veranda in planning and design of tertiary institution office building would enhance the quality and efficiency of the building and its occupants

RECOMMENDATIONS

At the design stage of a sustainable office buildings, the incorporation of passive measures is an important consideration which may enhance the future operations for energy efficiency and lowering operational costs. Architects should adopt these measures in their designs in order to minimize energy use and at same time thermal comfort for the building occupants. These methods include

- Designing the office building in such a way that it will be solar protected. The Balcony roof design should help to shade the wall or window as a means of making adequate provision for natural ventilation to reduce the internal temperature of the building. A well shaded balcony will also serve as an informal interaction space as there will be unplanned meeting where staff can learn together

- Having appropriate type of large windows with a well projected overhang above it to provide shade from a sunny day. Heat gain into the building during periods of high temperature can be reduced by using large windows with sun shading devices. Materials and paints that would permit less penetration of the solar rays should also be used.

- Providing planters along the corridor will help control natural ventilation and natural vegetation as this helps to cool and filter the air.

- Well Landscaped courtyard with trees and flowers as they help improve the surrounding air and keeps the environment cool. This courtyard also creates an avenue for informal interaction as staffs can relax. This increases the chances of encounter amongst staff where they can share ideas with each other and this spontaneous meeting can give birth to research collaboration

- Open spaces can be used for interaction, social sustainability as well as response to climate change in terms of energy efficiency and therefore essential for every office building.

- Relevant focal points for sustainable development must be identified and addressed in our tertiary education sector through quality education which leads to acquisition of relevant skills and knowledge required for sustainable development.

REFERENCE

Abdullahi I, Yusoff W.Z (2015) State of Physical Facilities of Higher Education Institutions in Nigeria. *International Journal of Scientific and Research Publications, Volume 5, Issue4, April 2015 1 ISSN 2250-3153*

Adedeji D, Toyin A and Damilola A D (*2012)* Green architecture and sustainable development in Nigeria. *Journal of Sustainable Development and Environmental Protection 2(2),*95

Adeyemi JK, Igbineweka VO (2000). "Sitting Space Utilization in Nigerian Universities*: A case study of the University of Benin". J. Teach. Educ. Teach. 4(1): 12-23.*

Adeyemi, K. (2001). Equality of Access and Catchment Area; Factor in, University Admission in Nigeria, *Journal of Higher Education* 42:307 -322

Agwaranze, D.I. (1987). Resource Management in Higher Education in Nigeria. *Unpublished M.Ed Thesis University of Jos, Nigeria*

A.O. Obabori, A. O. O. Ekpu and B.P. Ojealaro. An Appraisal of the Concept of Sustainable Environment under Nigerian Law Kamla-Raj 2009 J Hum Ecol, 28(2): 135-142(2009)

Ar Aniza A, Yasmin M A. (2013) Incorporation of innovative passive architectural features in office building design towards achieving operational cost saving-the move to enhance sustainable development. *Centre for Urban & Regional Real Estate, Faculty of the Environment, University of Malaya, Kuala Lumpur*

Ayşin S, Görkem A (2014) Natural Ventilation for the Sustainable Tall Office Buildings of the Future. *International Journal of Civil, Environmental, Structural, Construction and Architectural Engineering* 8(8), 14

Bello M. (2007). The state of Nigeria public universities. *Article 6000/NEWS7632.htm2007, www.gamji.com.*

Bogoro S.E(2015) Sustainability of higher education institutions in Nigeria: challenges and prospects (Executive Secretary), TETFund, Abuja, Nigeria *paper presented as Guest Speaker at the 44th Air Force Institute of Technology Convocation Lecture on August 18, 2015*

ECN (Energy Commission of Nigeria). National Energy Policy. Federal Republic of Nigeria, Abuja. 2003.

Etiosa, (2009) U. A Guide for Developing Policy and Legislation. *International Rivers. Benin City, Community Research and Development Centre*. 2009.

Greden, L. (2005) Flexibility in Building Design: A Real Options Approach and evaluation Methodology. Massachusetts Institute of Technology: Cambridge, MA. pp. 5-16.20. 28.300.49. 62, 215, 216. 2005

Kristin L. Getter1 and D. Bradley Rowe (2006) The Role of Extensive Green Roofs in Sustainable Development HORTSCIENCE 41(5):1276–1285. 2006.

Levine M., Urge-Vorsatz, D., K. Blok, L.G., Harvey, D., Lang, S., Levermore, G., Mehlwana, A. M., Mirasgedis, S., Novikova, A., Rilling, J. and Yoshin, H.(2007) ‘Residential and commercial buildings, Climate Change 2007.*Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge, UK*

Nina M (2003) Health, Well-Being and Open Space Literature Review OPEN space*: the research centre for inclusive access to outdoor environments Edinburgh College of Art and Heriot-Watt University*

Oluwafemi K. A, Oluwayemi F, and Ikenna C. M, (2015)“Sustainable Approach to Developing Energy Efficient Buildings for Resilient Future of the Built Environment in Nigeria.” *American Journal of Civil Engineering and Architecture*, 3(4),15: 144-152. : 10.12691/ajcea-3-4-5.

Omole C. O, Ozoji B. E(2014) Science Education and Sustainable Development in Nigeria Science laboratory Technology Department. *Nigeria 2Science Education Department, University of Jos, Jos. Nigeria 2014*

Organisation of Ecnomic Coopeartion and development (OECD) (2003), Environmentally sustainable buildings: challenges and policies, Paris: OECD

Our Common Future, pp. 4, Oxford University Press, New York, 1987. World Commission on Environment and Development (WCED)

Upendra R, Richard H (2005) sustainable by passive architecture, using courtyards in non-domestic buildings in southeast Queensland *the 2005 World Sustainable Building Conference, Tokyo, 27-29 September 2005 (SB05Tokyo)*

Planning for sustainable future www.epa.gov/region2/sustainability/greencommunities November 2010

Rashid M,Kampschroer K.,Wineman & Zimring.C (2006), 'Spatial layout and face-to-face interaction in offices - a study of the mechanisms of spatial effects on face-to-face interaction', *Environment and Planning B: Planning and Design,* 33, 826-44.

Susan M (2011) Higher Education and Skills Group Improving Energy Efficient, Sustainable Building Design and Construction in Australia. *Learning from Europe*

Kleiven T (2003), Natural Ventilation in Buildings: Architectural Concepts, Consequences and Possibilities, Doctoral Dissertation, Norwegian University of Science and Technology, 2003. *World Academy of Science, Engineering and Technology*

Udida, L. A. Bassey, U. U. Udofia, I. U. Egbona, E. A. (2009) System performance and sustainability of higher education in Nigeria. *Paper presented at the 11th International Conference of Educational Management Association of South Africa (EMASA)*

ASSESSMENT OF THE IMPACT OF PARTITION MATERIALS ON FLEXIBILITY OF SPACES IN SELECTED COMMERCIAL OFFICES IN MINNA.

Muhammed, Bashir Ajala & Anthony I. Anunobi
Department of Architecture, Federal University of Technology, Minna, Niger State, Nigeria.

The new trend of knowledge-work for which commercial office spaces are meant, requires that staff must have ease for collaboration and integration. From research, this is because improvement in productivity is achieved when collaboration takes place. Space flexibility is amongst many factors that prompt collaboration. The effect of this means the choice of wall partition materials is also of concern toward achieving space flexibility for collaboration. The commercial offices of Minna may or may not have adopted the requirements for collaboration when compared to required standards for collaborative spaces. Therefore, this research seeks to examine how the commercial offices in Minna have fared when they are viewed from the perspective of that premise. This paper have examined selected commercial offices in Minna and how the choice of materials for partitioning the indoor spaces have impacted flexibility of spaces. Observation schedules were used to source data and later analysed. The results from the tables presented showed that five out of the six offices visited have open plan office type which the research showed as the best plan layout for flexibility of the office spaces. Timber, Glass, plastic, and aluminium were the commonly used partition materials. However out of the five offices, only four have internal wall partition materials that are flexible and allow for flexibility in the event of change of use. Recommendations are that, in NIPOST plaza, offices should be remodelled to have flexible interior partition materials for adaptability to occur. Also, collaborative spaces must be adopted in future commercial office as a proven means of improving productivity.

Keywords: *Knowledge Work, Collaboration, Integration, Productivity, Space Flexibility, Commercial Office, Wall Partition, Remodel, Adaptability*

bashirajalarc@gmail.com

Mohammed B.A and Anunobi A.I. (2016). **ASSESSMENT OF THE IMPACT OF PARTITION MATERIALS ON FLEXIBILITY OF SPACES IN SELECTED COMMERCIAL OFFICES IN MINNA** Sustainable Built Environment and Climate change; The challenges of Post 2015 Development Agenda. School of Environmental Technology Conference, SETIC, 2016

INTRODUCTION

Human wants and needs change. Majorly due to the gradual demands for better life and expansion for greater opportunities and growth. This notably occurs in all aspects of the human living. Commercial office spaces in the world over have often failed to keep a pace with the demand for rapid organisational change. Indeed, the ownership of real estate and the prevalence of long lease periods are often seen as impediments to organisational change (Harris, 2001; Latshaw; Harmonvaughan; Radford, 2001). Minna city, a developing and growing urban centre over the last two decades have seen a rapid rise in the number of commercial businesses. The rate of urbanisation in nearby Federal Capital territory is gradually growing into Minna causing the increase in commercial offices owned by both private individuals and government. However, there has been a failure for this to imbibe the culture of sustainable planning as many commercial office buildings fall to poor space planning. Highly notable is the NICON House which is the first commercial building in Minna constructed in 1979 (Mustapha, 2001). They lacked expansion possibilities, large floor areas not less than 1000sqm and internal structures to support flexibility (Ogbage, 1998). According to Amina and Shehla (2009), office design significance affects employees work output, workplace environment motivates employees and this ultimately leads to sustainable employee performance. El – Zeny (2013) further stated that office environment causes to enhance employees' productivity significantly. Interior design and environment management process positively affect employees' outcome and overall enterprise performance (Olalere, 2014). Another study explains that 90% of participants express that better office interior design positively affect employees' productivity (Gensler, 2006). This paper aims to assess the impact of various partition wall materials on flexibility of spaces in selected by commercial offices in Minna.

WORKPLACES TODAY

Knowledge-work is cognitive in the sense that employees have to invest their own individual memory, insight and analytical powers in order to develop and create ideas (Heerwagen, J.H., Kampschroer, K., Powell, K.M. & Loftness, V, 2004). However, besides having a cognitive side to it, the success of knowledge work also depends on the social side of work (e.g. interactions and collaboration of co- workers). According to Schon, D. (1991), this is caused by the complexity of the tasks which encourages employees to interact and collaborate together to maximise the quality of their work. For example, nowadays it's virtually impossible for a single employee to possess all the knowledge and skills needed to develop high-tech trains, airplanes. and super cars. It is much more effective to work together and combine the best knowledge and skills of several employees. Even in a situation where researchers are highly specialised, like those working in a university, the feedback from colleagues on one's work can greatly improve the quality and usability of the individual's work outcome. Furthermore, the sharing of knowledge ensures that everybody pursues the same goals. Together these examples warrant the conclusion that social interactions are an important ingredient of knowledge work that need to be stimulated. Interactions between employees are facilitated by the social networks employees participate in. These networks are maintained by formal and informal contact; moments that employees have during the day (Allen, T., 1977)

From observational research conducted by Brill, M., Weidemann, S. & BOSTI Associates (2001), it showed that employees in the office mainly communicate through brief but frequent face-to-face contact. Most of these conversations are not planned but happen spontaneously as people walk from their workspace to other places in the office, like the toilet or the coffee machine. The reason these kinds of face-to-face contacts are also preferred seems to lie in the richness of information they contain compared to, for instance, information conveyed via an email. It also fits nicely with the basic premise of social presence theory which explains why face-to-face contact is so powerful. Social presence theory states that non-verbal cues are essential for communication within a group. Non-verbal communication has the added bonus that it can transfer social-emotional information (Ramirez, A., Jr., & Zhang, S. 2007). When employees meet in person their non-verbal communication unconsciously strengthens their social cohesion, making it easier to understand each other on a personal level (Wolfeld, l. 2010).

RELATIONSHIP BETWEEN OFFICE DESIGN AND PRODUCTIVITY

The American Society of Interior Designers (ASID, 1999) carried out an independent study and revealed that the physical workplace design is one of the top three factors, which affect performance and job satisfaction.

The study results showed that 31% of people were satisfied with their jobs and had pleasing workplace environments. 50% of people were seeking jobs and said that they would prefer a job in a company where the physical environment is good.

Brill, M. Margulis S, Konar E, Bosti (1984) ranked factors which affect productivity according to their importance. The factors are sequenced based on the significance: Furniture, Noise, Flexibility, Comfort, Communication, Lighting, Temperature and the Air Quality.

There are various schools of thoughts on that suggest various definitions of the term “flexible working”. Experts in this area such as Arge, Steiner and Hassanain have researched the subject from different standpoints: flexibility in terms of flexible building design and physical office and flexibility in the sense of time flexibility and locational mobility. Thus, Arge (2005) defined flexibility as part of building adaptability, the function which enables to face changing user or owner needs by changing its property easily. Steiner’s (2005) explanation of flexibility is very close to the one of Arge (2005). He defined flexibility as ability of the building to easily accommodate reorganisation due to alterations and office renovations as well as business restructuring and introduction of new technology. The layout of the physical office is the main focus in the research of Steiner (2005). According to Hassanain (2006), flexible working reflects “the concept of the physical layout and functional opportunities of the workspace (and) the concept of organisational flexibility as it relates to where and when staff would work regardless of their employment contract”.

However as this research looks into office space, and its effect on workers collaboration toward productivity, Steiner (2005) definition will be adopted.

THE DEVELOPMENT OF OFFICE ENVIRONMENT (Need for flexible Partition Wall materials)

Fredrick Taylor's work on management practice (Taylor, 1911) had a significant impact on the development of office spaces over the twentieth century. Taylors' ideas regarding the importance of order, hierarchy, supervision and depersonalisation were integrated into the architecture of office buildings (Duffy, 1997). But while European countries shortly after Second World War begun to rethink the contribution of these ideas of Taylorism when it came to office work settings, in Northern America these ideas had established themselves more firmly. Northern Europe and Northern America steered in different directions. In Northern Europe, office environments were designed with the aim of enhancing interaction among staff, but office spaces in Northern America mainly emphasised corporate discipline (Duffy, 1997; Sundstrom, 1986).

Nevertheless, ideas about new ways of working have emerged during recent decades that challenge conventional office practices. While the North European office has focused on creating *effectiveness* by adding value, the Japanese office has focused on *efficiency* by driving down occupancy costs. However, the future office should strive to become both efficient and effective—that is, it should use space more efficiently and add value by creating a good physical work environment for employees (Duffy, 1997).

RESEARCH METHODOLOGY.

This research focused on government owned commercial offices. This is because they present the researcher with a wider range for sampling than the privately-owned commercial offices and they are the common types readily available in Minna.

The offices visited are:

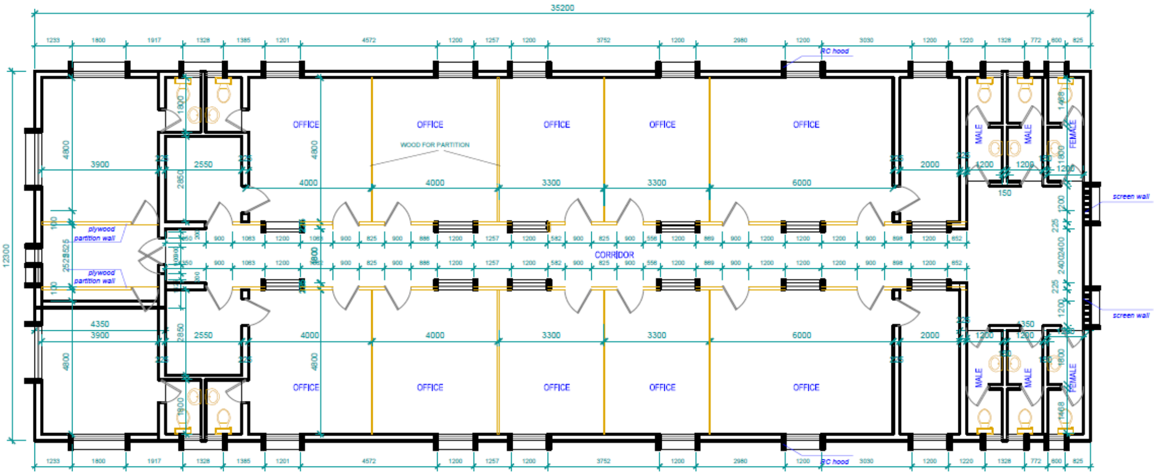
1. BANK OF AGRICULTURE PLAZA, BOA ---Old Airport Road, Minna
2. NIPOST PLAZA, ----NP Old Airport Road, Minna
3. NICON HOUSE, NH--- behind central bank, Bosso Road, Minna
4. NSDC HOUSE,NSDC Bosso Road, Minna
5. AMINU YUSUF PAIKO HOUSE, AYP ---Bosso Road, Minna
6. UNITY BANK PLAZA, UBP---Bosso Road, Minna

The paper discusses the research findings of the studies carried out. This research used observation schedules to check the type of wall materials used for the internal partitioning.

DATA COLLECTION AND ANALYSIS

1. BANK OF AGRICULTURE PLAZA, Old Airport Road, Minna

Plate I: Exterior views of BOA plaza
Source: Field Work, 2015



PROTOTYPE FLOOR PLAN

OFFICE FLOOR PLAN TYPE: OPEN PLAN OFFICE
USE OF FLEXIBLE INTERNAL WALLS: YES (timber)
POSSIBIILITY FOR FLEXIBILITY : YES

2. NIPOST PLAZA, Old Airport Road, Minna

Plate II: Exterior views of NIPOST plaza
Source: Field Work, 2015

OFFICE FLOOR PLAN TYPE: OPEN PLAN OFFICE
USE OF FLEXIBLE INTERNAL WALLS: NO (brick wall)

POSIBIBILITY FOR FLEXIBILITY: NO

3. NICON HOUSE, behind central bank, Bosso Road, Minna

Plate III: Exterior views of NICON house Source: Field Work, 2015

OFFICE FLOOR PLAN TYPE: OPEN PLAN OFFICE
USE OF FLEXIBLE INTERNAL WALLS: YES (Timber and aluminium)
POSIBIBILITY FOR FLEXIBILITY : YES BUT VERY EXPENSIVE

4. NSDC HOUSE, Bosso Road

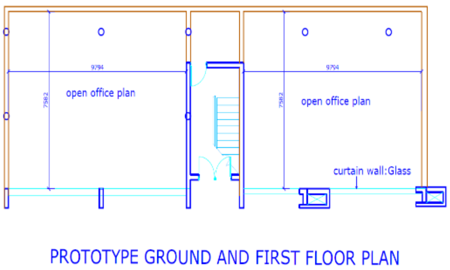
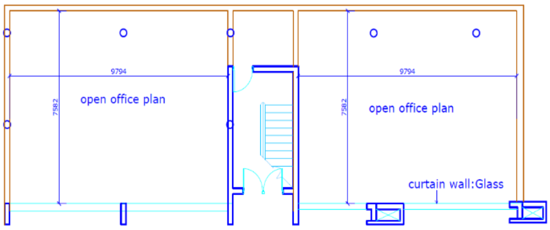


Figure: floor plan arrangements
Source: Field Work, 2015

OFFICE FLOOR PLAN TYPE: OPEN PLAN OFFICE
USE OF FLEXIBLE INTERNAL WALLS: NONE, FULL OPEN SPACE
POSSIBILITY FOR FLEXIBILITY: YES

5. AMINU YUSUF PAIKO HOUSE, BOSSO ROAD

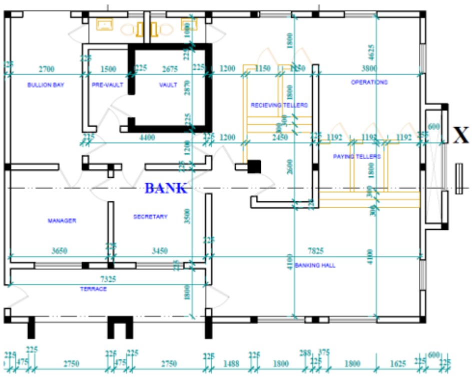


PROTOTYPE FLOOR PLAN

Figure: floor plan arrangements
Source: Field Work, 2015

OFFICE FLOOR PLAN TYPE: OPEN PLAN OFFICE
USE OF FLEXIBLE INTERNAL WALLS: NONE, FULL OPEN SPACE
POSSIBILITY FOR FLEXIBILITY: YES

6. UNITY BANK PLAZA, Bosso Road, Minna



GROUND FLOOR PLAN

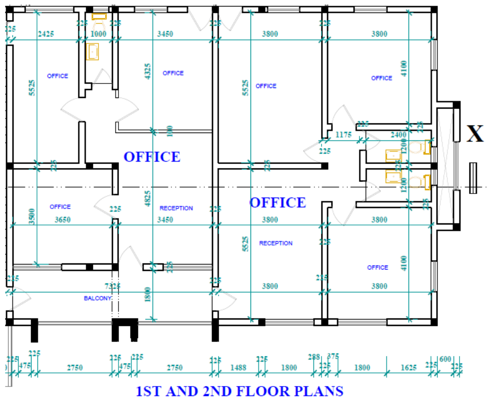


Figure: Ground floor plan
Source: Field Work, 2015

Figure: 1ST AND 2nd floor plans
Source: Field Work, 2015

OFFICE FLOOR PLAN TYPE: THE SHARED-ROOM OFFICE

USE OF FLEXIBLE INTERNAL WALLS: NO (brick wall)
POSSIBILITY FOR FLEXIBILITY: NO

DATA ANALYSIS AND DISCUSSION OF RESULTS.

Table showing the type of office floor plan types in each of the visited buildings.

PARTITION MATERIALS	BOA	NP	NH	NSDC	AYP	UBP
1. *BRICK PARTITIONS*		●				●
2. *PLASTIC FRAMES*						
3. *GLASS PARTITIONS*						
4. *CONCRETE PARTITIONS*						
5. *METAL LATH*						
6. *TIMBER*	●		○			
7. *ALUMINIUM*			○			

Source: Field Work, 2015
SYMBOLS ADOPTED ARE AS FOLLOWS:

● ONLY ONE MATERIAL IN USE
○ TWO DIFFERENT MATERIALS IN USE

CONCLUSION

Spaces in offices affect productivity, and comfort. Humans are constantly faced with change in one way or another other because human needs and want growth with time. Our offices for work are no different to this. With this, we need to ensure that our places of work do not suffer due to lack of an organised plan for containing such desires. Space flexibility must be considered in choice of materials and the style of planning of the interior spaces. The flexible nature of the floor plans can allow for adaptability (i.e. The possibility of a space being rearrange for other functions or carrying more functions), expansibility (i.e. The possibility of a space being expanded), and flexibility (i.e. The ability of a space to be rearranged for more functions). The studies in this research have shown that against the backdrop of the standard of office spaces, five out of the six research areas have used materials that are flexibility. 83% of the research areas have flexible spaces for adaptability. But expansibility of the offices will be impossible because material used for the exterior wall (sanctrete block).

RECOMMENDATIONS

The recommendations to bring the ease in flexibility of the interior spaces include:

- In the design of offices spaces, open plan spaces should be up to at least 500m^2 so that it easily allows for more functions in the event of increased staff.
- It is preferable to adopt the use of modular construction technique because it can allow for expansibility without high cost implications.
- Offices must adopt the use of grid design and construction so that spaces are not disorganised.

The results shed more light on the usability of space syntax analysis to predict how well an office is suited to promote face-to-face contact. This in turn can help us to design better offices for the future, where employees work in an environment better suited to sustain and develop collaboration. This can contribute to the success of organizations and companies who rely on knowledge work as their primary production asset.

REFERENCES

Allen, T.J. (1977). *Managing the flow of technology: technology transfer and the of technical information within r&d organizations,* Cambridge: MIT press, Brown, J.S. & Duguid, P. (2000). *The social life of information.* Boston: Harvard business school press.

American Society of Interior Designers (1999) “Recruiting and retaining qualified employees by design.” *White paper*

Amina, H., & Shehla, A. (2009). *Impact of office design on employee’s productivity.* A case study of banking Organizations of Abbottabad, Pakistan . *Journal of Public Affairs, Administration and Managemen*t, *3*(1), 1-3.

Arge, K. (2005). Adaptable office buildings: theory and practice. *Facilities , 23* (3/4), 119-127.

Brill, M. Margulis S, Konar E, BOSTI (1984) *Using Office Design to Increase Productivit*y, 1, 495-500. Buffalo, N.Y: Workplace Design and Productivity.Buildings/IAQ.

Brill, M., Weidemann, S. & BOSTI Associates (2001). *Disproving widespread myths about workplace design.* Jasper: Kimball International; In: Reder, S. & Schwab, R.G. (1990). *The temporal structure of cooperative activity, in CSCW' 90 proceedings*, 303–320. New York: ACM PRESS; Heerwagen, J.h., Kampschroer, K., Powell, K.M. & Loftness, V. (2004). *Collaborative knowledge work environments. Building Research & Information,* 32 (6), 510-528.

Duffy, F. (1997). *The new office.* 21-35. London: Conran Octopus.

EI-Zeiny, R. M. (2013). Interior Design of Workplace and Performance Relationship: Private Sector Corporations in Egypt. *Asian Journal of environment-Behaviour Studies*, 4(11), 49-63.

Gensler Design Performance Index, the U.S. Workplace Survey (2006). www.gensler.com. Retrieved from ISO: http://www.iso.org/iso. on 12th December, 2015 at 2:49 am.

Gutwin, C., & Greenberg, S. (2001). A *descriptive framework of workspace awareness for real time groupware.* CSCW*'01.* dordrecht: kluwer; Heerwagen, J.H., Kampschroer, K., Powell, K.M & Loftness, V. (2004). *Collaborative knowledge work environments.* Building research & information, 32 (6), 510-528 .

Harris, R. (2001) From Fiefdom to Service: the evolution of flexible occupation. *Journal of Corporate Real Estate*, 3(1) 7-16.

Hassanain, M. A. (2006). Factors affecting the development of flexible workplace facilities. *Journal of Corporate Real Estate , 8* (4), 213-220.

Heerwagen, J.H., Kampschroer, K., Powell, K.M. & Loftness, V. (2004) Collaborative Knowledge Work Environments. *Building Research & Information,* 32 (6), 510-528.

Latshaw, M.; Harmon-Vaughan, B.; Radford, B.(2001). How Companies can Deliver Flexible, Effective Corporate Real Estate Fast. *Journal of Corporate Real Estate*, 3(1) 46-55.

Mustapha (2001). The art of space management. Planning flexible workspaces for people. *Journal of Facilities Management , 4* (1), 6-22.

Ogbage, 1998. Impact of workplace connectivity on office productivity. *Journal of Corporate Real Estate , 10* (4), 286-302.

Olalere, B. P. (2014). Evaluation and re-designing of a file retrieving system in a village medical center. *The International Journal of Engineering And Science (IJES),* 3(6), 28-35.

Ramirez, A., Jr., & Zhang, S. (2007). When online meets offline: *the effect of modality Switching on relational communication. Communication Monographs,* 74 (3), 287-310.

Schon, D. A. (1991) *The Reflective Practitioner.* Alderschot: Ashgate Publishing.

Steiner, J. (2005). The art of space management. Planning flexible workspaces for people. *Journal of Facilities Management , 4* (1), 6-22.

Sundstrom, E. (1986). *Work places: The psychology of the physical environment in offices and factories.* New York: Cambridge University Press.

Taylor, F. W. (1911). *The principles of scientific management*. 93-112. New York: Harper & Brothers.

Wolfeld, L.R. (2010). Effects of office layout on job satisfaction, productivity and Organizational commitment as transmitted through face-to-face interactions. *Colonial Academic Alliance Undergraduate Research journal,* 1 (1), 8.

GREEN BUILDING CONSTRUCTION IN ABUJA: THE MATTERS ARISING

Rasheed Babatunde Isa, Paul Abayomi Bajere, Richard Ajayi Jimoh & Usman Shittu
Department of Building, Federal University of Technology, Minna

Recent trend in the international construction sector has witnessed the rise of green buildings in developing and developed countries. Although the concept and implementation of green buildings is on the rise worldwide, this is not the case in Nigeria hence, this paper assessed project stakeholders' level of awareness and extent of use of green concept in the Nigerian construction industry with specific reference to Abuja. The study adopted combination of physical observation and structured interview methods to elicit information; 3 active sites were visited and 13 interviews were conducted. Findings showed that awareness is not associated with implementation. The participants in the study recognised the benefits inherent in green buildings and affirmed moderate level of familiarity with the concept. To key into this, construction practices must be fully regulated and enforced in line with sustainability agenda in Abuja.

***Keywords**: Built Environment; Green Building; Nigeria; Stakeholders; Sustainability*

batunde@futminna.edu.ng

Isa et. al. (2016). **GREEN BUILDING CONSTRUCTION IN ABUJA: THE MATTERS ARISING** Sustainable Built Environment and Climate change; The challenges of Post 2015 Development Agenda. School of Environmental Technology Conference, SETIC, 2016

INTRODUCTION

Building construction and related activities consumes over 40% of the world's inert materials (U.S Green Building Council, 2014), and the built environment consume 32% of the global renewable and non-renewable resources during service life, produce 40% of CO_2 emissions, and used up to 12% of available water (GBCA – Green Building Council of Australia, 2013). These new discoveries have led to a paradigm shift in the thinking of the policy makers towards pursuing myriad of regulatory ideas to drive green building awareness and promote green building projects over the last decades. The recent Paris Agreement on Climate Change is a historic achievement for humanity particularly the built environment. In place is now a common legally binding agreement to hold global warming well below 2^oC with aspiration to achieve 1.5^oC integrated with frameworks for action on resilience and adaptation. And for the first time the Buildings and Construction sector, which is responsible for about 30% of global GHG emissions, 50% of global wealth, and provision of urban habitat for more than 60% of humanity, has been given a mandate and global framework for helping to achieve these goals (UN, 2015). While stakeholders view on the sustainability mantra has grown to becomes global issues, and recently assumes the stature of a global sustainability development goals (SDG's) with a strong commitment among political actors to its successful implementation, the rate of green building uptake has been less than expected (Mukherjee and Muga, 2010).

While much has been written about the associated benefits of sustainable practices and to some extent green construction that make it worth pursuing for developing nations. Some reported benefits of these practices are; competitive advantage, meeting legislative framework, company reputation, improve productivity, client value creation, meeting client demand, overall financial incentive, good community relation and ultimately a balanced ecosphere in the face of sustained development (Othman, 2011: Suresh, Bashir and Olomolaiye, 2012; Madu and Kuei, 2012). The lack of awareness and implementation challenges have overtime shape the views of built environment stakeholders and often time made these – benefits – elude most industry stakeholders, and this is even more pronounce within the developing economy. It is a common knowledge that most developing countries are socially challenged, politically troubled and technically lagging behind the developed markets that have hitherto taken serious steps towards sustainable construction (Mousa, 2015). These barriers, couples with the nature of construction industry that is fragmented, complex and project-based nature, have been a major hindrance to the adaptation and implementation of the sustainability concepts. The low awareness level and the lack of proper knowledge and understanding of the new concept has long been responsible for sustain associated benefits eluding the industry stakeholders in the developing markets, especially in Nigeria (Bygballe and Sward, 2014). As a result, the implementation has been below expectation and challenges continue to trail it practice within the region. For policy makers to be able to aptly respond to this problem, it must be able to first assess the industry posture towards sustainable development (green building) within the industry stakeholders so as to have a base for sustainable development within the built environment. The main question now is; *what is the stakeholders' level of awareness and extent of use of green building concept in the Nigerian construction industry?* In proffering solution to this question with specific reference to Abuja, the next section of the paper presents a succinct account of the state of green building and sustainability in the built environment. Thereafter the method used for obtaining the views on green building among the stakeholders is discussed before the findings are presented. The plausible answers to the questions and observations then form the concluding section of the paper.

LITERATURE REVIEW

The world is rapidly changing and the rising climate indicators are beginning to impact on every aspect of our environment. Regions hitherto known for moderate weather are now experiencing severe climatic conditions. In Nigeria, the temperature range now exceed 26ºC in the Northern parts of the country where draught, flood and heat waves, is now a common phenomenon (NIMET, 2012). Since, patterns of development in the past have been largely neglected the reality of natural resources and environmental issues with its effects on the socio-economic dimensions (Wackernagel and Rees, 1996). These affect the general cost of maintaining the climatic conditions within the 'comfort zone' and predictability of general operating environments that calls for awareness and knowledge based practices.The energy crisis, environmental pollution and the climate change in the 1970s alerted the world of the need for a balanced ecosystem (Ghosh *et al*., 2014). Response to this new environmental phenomenon later gave birth to the world congress, which cumulated in the Bruntland's report for the World Commission on Environment and Development (WCED, 1987) that defines sustainable development as "a development which meets the needs of the present without compromising the ability of future generation to meet their own needs". Therefore, in order to lessen or probably reverse the destructive impact of construction on the natural environment, OECD brought together experts to develop sustainable management and operational practices ranging from planning, design, development, construction, ownership, financing, management and utilization of built properties (OECD, 2003). As the needed change must be informed by rigorous and targeted research that can be readily and rapidly applied to counter emerging climate change in order to develop more sustainable built environments. During the aforesaid processes, various concepts were proposed and developed overtime, such concepts as, green building, sustainable design and construction, green business, green economy and so on. Therefore, the modern day trend within the built environment stakeholders is to be well equipped to go green and initiate operational efficiency towards environmental responsiveness in construction industry. The international construction sector has hence witnessed the rise in its advocacy and implementation of the green building concepts worldwide in an attempt to sustain the industry.

In Africa, though considered as a low risk area because of the availability of green building potentials in inert resources, materials such as sun dried bricks, compressed earth blocks, lime stabilized earth blocks, laterite stones and pozzolana are in abundance but their use is so limited to have significantly increase global warming (Manu *et al.*, 2009). Green building philosophy has mostly been championed by pressure groups, and to a lesser extent, public institutions and organizations. Bangdome-Dery and Kootin-Sanwu, (2013) report organizations such as Promoting Renewable Energy in Africa (PREA), South Africa Chapter of the Green Building Council (GBCSA), Holcim Foundation as well as Emerging Africa Infrastructure Fund (EAIF) are agencies in the forefront of sustainability in South Africa. In a related development, the South African Government, unlike the Nigerian Government, has made progress in establishing policy in favour of sustainable development through regulations guiding the built environment. At present, there are two South African National Standards which promote environmental sustainability and energy savings (Ashiboe-Mensah *et al*., 2011). To this end, efforts should be made towards change in policy direction, incentives and disincentives that encourage sustainable urban and rural development, environmental education and the use of renewable energy and green building materials to attain a balanced ecosystem in the region particularly in Nigeria.

Most studies (Jacobs, 2011and Wilreker 2011) have flag cost; lack of knowledge about sustainable practices; lack of knowledge about effects of non-sustainable practices in the environment; lack of training and education; availability / lack of availability of green resources; and attitude of professionals as barriers for sustainable design and construction in Sub-Saharan Africa. The absence of a legislative framework / polices on sustainable development and political consideration – especially in public projects - in most developing countries also remain a major barrier. Jacobs (2011) and Nilsson *et al*. (2009) assert that improvements in the knowledge base of various stakeholders, coupled with the right policy formulation regulating the green building practice will impacts positively on the sustainable design and construction in the industry.

RESEARCH METHODOLOGY

This study employed an interpretative paradigm to add to what is known about the issues. By adopting a combination of physical observation and structured interview methods to elicit information; 3 active sites were visited and 13 interviews were conducted among stakeholders. The participants were selected using purposive sampling, as this was vital to the success of the interviews. Purposive sampling means that participants are selected according to a defining characteristic that makes them a role players of the data needed for the study (Nieuwenhuis, 2007). Interviews were between 15 to 30 minutes in duration. Each participant was asked about his/ her experience and perception of the numerous themes related to the phenomenon. All interviews were recorded and transcribed. The physical evidence on green technology were collected concurrently on three active sites with interview sessions with projects managers.

As mentioned earlier, thirteen interviewees participated in the study. The findings were further supported with available secondary data on completed projects from the Ministries of Works and Environment. The interviewees consisted of 4 women and 9 men between the ages of 33 and 52. The educational levels of the participants ranged from Higher National Diploma (HND)/Degree to PhD level, and work experience ranged from 5 to 29 years (see Table 1).

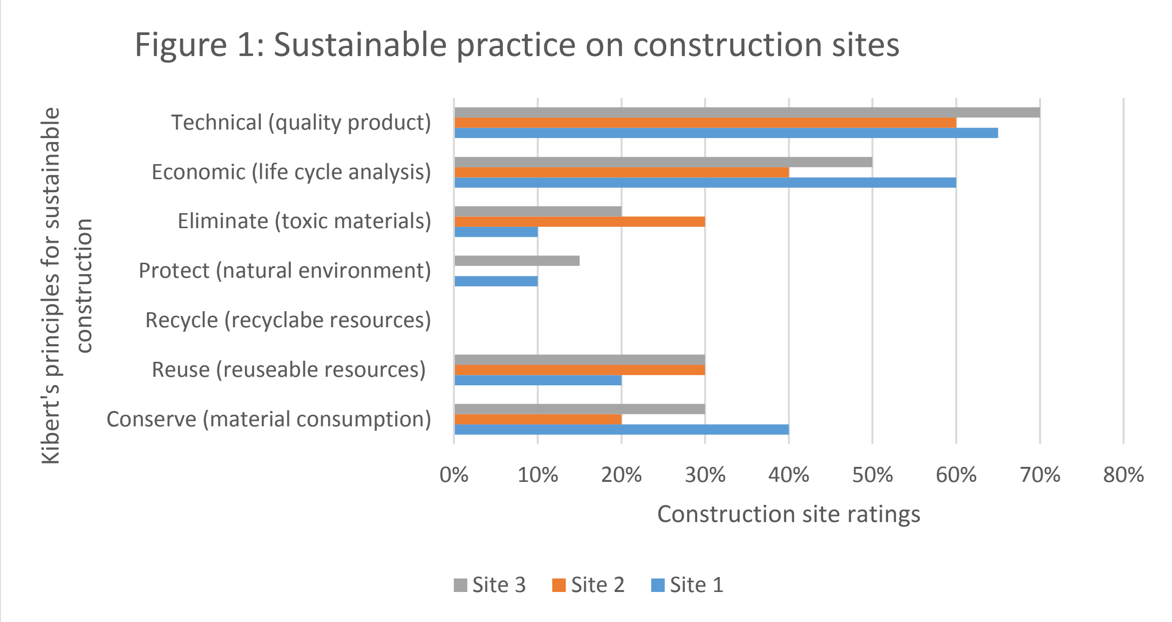
Table 1: The demographY of interviewees

S/N	Highest Level of Education	Organisation	Designations	Years in Industry
	BSc	Ministry of Works	Project Director	16
	BSc	Consultant	Project manager	9
	HND	Ministry of Works	Site agent	5
	MTech	Consultant	Architect	21
	MSc	Ministry of Envir.	Deputy Director	23
	PhD	Academia	Senior Lecturer	15
	HND	Ministry of Works	Project Manager	11
	BSc	Project developer	Director	29
	HND	Project Managers	Director	18
	B Tech.	Consultant	Quantity surveyor	14
	M Eng.	Consultant	Civil engineer	9
	PhD	Ministry of Envir.	Deputy Director	26
	MSc	Academia	Lecturer I	10

RESULTS AND DISCUSSION

The results are presented based on the methods adopted in eliciting information. The first part was the observation carried out on the 3 active sites while the second part arranged in themes was the interview sessions conducted.

The three active sites were accessed based on the proposed Kibert's 7 principles for sustainable construction practice (Kibert, 1994). These principles cover most aspects of the Triple bottom line (TBL) of economic, social and environmental dimensions of sustainability and the concept of "doing no further harm" to the built environment (Figure 1). Adopting these principles will ensure the reduction / elimination of adverse effects of construction activities on the built environment through efficient use of resources and its outcomes could be regarded as a vital ingredient of improved competitiveness in the construction industry (Opoku and Ahmed, 2015). As illustrated in Figure 1, most active sites visited perform below average when gauged against Kilbert's sustainable construction indicators.



Theme 1: Level of Stakeholder Awareness in Sustainable Design and Construction

The effectiveness of built environment infrastructure depends on meeting the demands of varying stakeholders, which is often, hinged on the level of their awareness of the activities and knowledge of the sector. The sector awareness serves as a driver for their demands and the ability to benchmark own determinant for sustainable infrastructure (Emuze, Ntoi and Isa, 2015). Most of the interviewees confirm the knowledge of green design and construction but however quick to deny any involvement in such project. About a quarter of mostly consultants agree to at a point green projects. The physical observation shows most projects are of conventional design and construction with little reference to sustainability considerations. The designers allude to lack of demand from client as a major factor to the seemingly low state of green uptake in the built environment.

Theme 2: National Building Code (NBC) and Green Construction

National building codes are common laws for the regulation of construction activities in any nation. The Nigerian NBC was approved in 2006 after incessant collapse of buildings in Nigeria. This is meant to regulate the construction stakeholders by guaranteeing safety, efficiency and quality of building infrastructure to include sustainability concerns (Ogunbiyi, 2014). One-third of the interviewees affirmed that the code to have recommends green building rating system. Though recommending is one thing, compliance is another ball game entirely; the Nigerian NBC was greeted with fun-fare when it approved for use in 2006 but ten years down the lane, except Kano, Lagos (Form C- variant of NBC) and Abuja where compliance level has been on the increase Most interviewees were neutral on the subject as they have not digest the whole documents. A glance at the thirteen sub-heads of the NBC does not confer any major privilege to sustainability.

Theme 3: Rating System and Nigeria Construction Industry

The absence of home grown rating system guiding Nigeria construction industry was noted. Most interviewees advocated the development of Nigerian rating system, adopting the LEED standards with modifications to reflect our own reality. This resonate with the practices of most developed countries that are desirous of sustainable development. Developed nations overtime have develop rating system for regulating environmental and energy related issues in infrastructure development in their region. The British's Leadership in Energy and Environmental Design (LEED) is the front-runner and forms the bases for the establishment of various rating system globally to reflect zonal peculiarities. In Africa, the South African Green Building Council (GBCSA) Green Star SA rating tool is the only known attempt at rating system in the region (Ashiboe-Mensah *et al*., 2011). Furthermore, the ability to develop, promote and implement such development within the industry stakeholders were argued for.

Theme 4: Feasibility of Green and Sustainable Construction in Nigeria

Most interviewees agreed with the feasibility and viability of green technology and sustainable practices in Nigeria, sitting the natural renewable resources endowment of the nation as a blessing to such development. Sustainable materials such as sun dried bricks, compressed earth blocks, lime stabilized earth blocks, laterite stones and pozzolana are in abundance, while their use is also so limited to have significantly increase global warming (Windapo and Omeife, 2013). When confronted with low uptake of sustainability practice in the industry despite the known benefits that include but not limited to low energy consumption, improved productivity, and low running and maintenance costs. The interviewees are of the opinion that the current state is down to lack of appropriate law regulating the industry and awareness level within the stakeholder. On further prompting by the researcher on why sustainable concept and renewable materials were not deployed on site, the project managers are of the few that some of generic barriers; awareness and demand, cost implications, education and experience, policy issues are hindering the feasibility of such concept.

CONCLUSION

Sustainability issues to include green technology in the built environment is becoming more imperative, moving from local considerations that are evident in an emerging ecosphere to international socio-economic concerns. While some works have been carried out about this phenomenon globally, the understanding and implementation level of the concept in Nigeria is still emerging. The findings of this study resonate with previous work. It highlights the industry lack of sufficient grasp which has continually challenged the uptake of green building ethos in the industry. It can be said that most stakeholders have a moderate fore knowledge of sustainability and green technology concepts by recognizing the inherent benefits in them. The implementation level is however does not correlate with this level of awareness. To key into this for maximum benefits, construction practices must be fully regulated and enforced in line with sustainability agenda in Nigeria. Change strategy that equips the stakeholders with the right knowledge and awareness needed to do things differently seem to be a major factor for the promotion of green building concept in the built environment. However, it can be said that this paper is limited to Abuja role players perspectives hence it affects its generalization, the dearth of data and knowledge of stakeholders regarding the scope and the context of this study also calls for a wider study within Nigeria.

REFERENCES

Ashiboe-Mensah, N.A., Akuffo, F. and Fugar, F. (2011). Investigating the perceptions of architects in the Ghanaian building Industry with regard to photovoltaic energy technology. In: Laryea, S., Leiringer, R. and Hughes, W. (Eds) *Procs West Africa Built Environment Research* (WABER) Conference, 19-21 July 2011, Accra, Ghana.

Bangdome-Dery, A. and Kootin-Sanwu, V. (2013). Analysis of barriers (factors) affecting architects in the use of sustainable strategies in building design in Ghana. *Research Journal in Engineering and Applied Sciences* (RJEAS), 2(6), 418-426.

Baygballe, L.E. and Sward, A. (2014). Implementing lean construction: a practice perspective. In: *Proceedings of the 22nd Conference of the International Group of Lean Construction* (IGLC), Oslo, Norway

Emuze, F., Ntoi, B.K. and Isa, R.B. (2015). Sustainability in the Built Environment: Exploring Barriers in South Africa. *Proceedings Smart and Sustainable Built Environment* (SASBE), Pretoria, South Africa.

Ghosh, S., Bhattacharjee, S., Pishdad-Bozorgi, P. and Ganapathy, R. (2014). A case study to *examine environmental benefits of lean construction. In: Proceedings of the 22nd Conference* of the International Group of Lean Construction (IGLC), Oslo, Norway.

Green Building Council of Australia (2013). Green star project directory. Available from Green Building Council Australia.

Jacobs, E. (2011). Sustainable Building awareness in the Free State Province, South Africa. *Proceedings of 6th Built Environment Conference*. July – August 2011, JHB, South Africa.

Kibert, C.J. (1994). Establishing principles and a model for sustainable construction. In *Proceedings of First International Conference of CIB TG 16 on Sustainable Construction*, 3-12, Tampa, Florida, USA.

Madu, C.N. and Kuei, C. (2012). Introduction to Sustainable Management. In: Madu, C. N. and Kuei, C. (eds), *Handbook of Sustainability Management. Singapore*. Singapore: World Scientific Publishing Co.

Manu, F.W., Baiden-Amissah P.D, Adobor, D.C.I. and Danquah, J.A. 2009. Mitigating Global Climatic Change through The Use Of Green Building Materials. *National Housing Conference Proceedings*: 7th-8th October, 2009 at STEPRI. C.S.I.R (Building and Road Research Institute).

Mousa, A. (2015). A business approach for transformation to sustainable construction: An implementation on a developing country. *Journal of Resources, Conservation and Recycling*. 101(1), 9-19.

Mukherjee, A. and Muga, H. (2010). An integrative framework for studying sustainable practices and its adoption in the AEC industry: A case study. *Journal of Engineering Technology Management*. 27(3), 197-214.

Nieuwenhuis, J. (2007). Qualitative research designs and data gathering techniques. First steps in research, 69-97. OECD, 2003. Environmentally Sustainable Buildings: Challenges and Policies. Organization of Economic Cooperation and Development (OECD), Paris.

Nielson, C., Wolfe, C.B. and Conine, D. (2009). Green Building Guide: Design techniques, Construction Practices and Materials for Affordable Housing. Published by Rural Community Assistance Corporation (RCAC). Available from www.rcac.org

NIMET (2012). Nigeria metrological agency annual climate review bulletin. Retrieved at www.nimet.gov.ng/content/nimet-weather-data-pack-1

OECD, (2003). Environmentally Sustainable Buildings: Challenges and Policies. Organization of Economic Cooperation and Development (OECD), Paris.

Ogunbiyi, M.A. (2014). The national building code and the construction industry professionals in Nigeria. *International Journal of Social Sciences and Entrepreneurship*, 1(12), 937 -948

Opoku, A. and Ahmed, V. (2015). Drivers and challenges to the adoption of sustainability construction practices. In: Opoku, A. and Ahmed, V. (ed), *Leadership and Sustainability in the Built Environment*. Oxon: Taylor and Francis

Othman, A.A.E. (2011). Lean principles as a strategic option for delivering innovative sustainable construction projects: a client value driven approach. In: *proceedings of 6th Built Environment Conference*, Johannesburg South Africa 31 July – 2 August.

Suresh, S., Bashir, A.M. and Olomolaiye, P.O. (2012). A protocol for lean construction in developing countries. In: Ofori, G. (ed.) *Contemporary Issues in Construction in Developing countries*. London: Spon Press.

UN Report, (2015). United Nation's conference on climate change: COP21/CMP11. Available from http://www.cop21.gouv.fr/en/follow/

U.S Green Building Council, (2014). LEED VA for building design and construction. US Green Building Council, Washington, DC.

Wackernagel, M. and Rees, W. (1996). *Our ecological footprint: reducing human impact on earth*. Gabriola Island: New Society Publishers

WCED, (1987). *Our Common Future*: Brundtland report of the world commission on environment and development (WCED), United Nations General Assembly, New York.

Wilreker, H. (2011). Green – an architect's perspective. *Urban Green File*. 15(6), 6-7.

Windapo, A. and Omeife, C. (2013). Towards environmental sustainability: Sourcing, assessment and selection of building materials in Nigeria. *The Professional Builder*. 3 (1), 1-16.

ASSESSMENT OF SUSTAINABLE REAL ESTATE DEVELOPMENT ISSUES IN NIGERIA.

Bajere, Paul A. [1] **and Shofoluwe, Musibau A.** [2]
[1] Department of Building, School of Environmental Technology, Federal University of Technology, Minna,
[2] Department of Built Environment, North Carolina A & T State University, Greensboro, N. C., USA

Sustainable development (green building design and construction) can be described as the utilization of environmentally responsible methods of optimizing the efficient use of resources such as energy and water, to maintain a healthy land, water and air quality throughout the building life cycle. Green construction practices have gained wide popularity in many developed countries in the construction of residential and commercial buildings. The story is the opposite in the developing countries. For instance, Nigeria as a country depends mostly on crude oil and electricity for its energy fulfilment. With epileptic supply of electricity, increasing in cost of energy, and the need to improve energy efficiency, there is a need to develop a sustainable and efficient energy system, to meet Nigeria's future energy needs. Study objectives are to: (1) identify constraints limiting involvement of built environment professionals and other built environment professionals in sustainable development practices in Nigeria; (2) determine the respondent's perception of the importance, affordability, and adoptability of sustainable development in Nigeria. (3) access respondent's perception of Nigerian regarding green building attributes, and (4) access respondents perception of Nigerian regarding green building practices. Literature review revealed that technical knowledge such as professional and scientific training on complexities of the construction and operation of intelligent buildings, lack of government support and incentives, and lack of relevant environmental laws and regulations are some of the critical barriers. The sample consisted of 74 respondents randomly selected built environment professionals in Niger State, Nigeria. The analysis involved the use of descriptive statistics. Findings revealed that majority of those surveyed identified, among others that lack of government support and incentives, and lack of funding from public and private housing finance institutions were identified as barriers to sustainable development in Nigeria. Inferences were made to improve awareness education through advocacy and enlightenment programmes and empowering regulatory agencies to enforce and strengthen existing regulations.

Keywords: Affordability, Green Building, Sustainable Development

paulbajere@aol.com
musibaus@ncat.edu

Bajere, Paul A. and Shofoluwe, Musibau A (2016) **ASSESSMENT OF SUSTAINABLE REAL ESTATE DEVELOPMENT ISSUES IN NIGERIA** Sustainable Built Environment and Climate change; The challenges of Post 2015 Development Agenda. School of Environmental Technology Conference, SETIC, 2016

1. Introduction

Sustainable development issue recently received world attention because of climate-change, energy crisis and increasing environmental pollution. In recent years, population increase, industrialization, migration, and other human activities such as forest burning and operation of power plants has led to environment pollution by emission of greenhouse gas (GHG) emissions such as carbon monoxide (CO) and carbon-dioxide (CO_2) into our environment. This has led to changes in climate and increased degradation of the built environment. The energy crises of the early seventies also revealed the escalating cost of fossil fuels, associated risk and the reality of environmental degradation (Kalogirou, 2004).

The concept of sustainability focuses on the utilization of environmentally responsible methods of optimizing the efficient use of resources such as energy and water, to maintain a healthy land, water and air quality throughout the building life cycle. According to Chambers (1993), sustainability is defined as "that which is capable of being sustained. In ecological terms, it is the amount or degree to which the earth's resources may be exploited without deleterious effects"; while sustainable development is described by the famous Brundtland report (WCED, 1987) as that "which meets the needs of the present without compromising the ability of the future generations to meet their-own needs". Plausibly, these definitions clearly underscore the desire to jealously protect and manage the earth's natural resource base for economic, social and environmental well-being of the society.

There is a global consensus and the desire to solve the environmental problems and build a humane, equitable, and caring global society, cognizant of the need for human dignity for all (Fisher, 1992). Consequently, sustainability studies continue to attract global attention among researchers. The efforts focus, on reducing consumption of natural resources by using 100% post-consumer renewable materials or materials from recyclable resources (which were harvested without harm to the environment and without depletion of the resource base), using 100% recyclable waste streams, using entirely renewable and non-polluting (solar thermal and electric, wind power, bio-mass, etc.), energy conservation and energy supplies, minimizing waste and pollution. These efforts will help to develop efficient use of renewable energy resources, maintain a healthy land, water and air quality throughout the building life cycle.
Sustainable development are efforts to provide efficient and effective solutions to our environmental problems, preserve natural resources for future generations, and also generate new jobs without causing negative environmental impacts (Dincer, et al., 1998). These efforts will help to develop efficient use of renewable energy resources, maintain a healthy land, water and air quality throughout the building life cycle. Sustainable construction, also called Green building, has made proven and phenomenal impact on saving energy, preserving resources, removing pollution, and enhancing the environment in the developed countries.

Sustainability, in form of green construction practices has gained wide popularity in many developed countries. Despite a significant increase in public awareness regarding environmental issues in Nigeria, there are no active and visible efforts promoting sustainable development (green building) issues in country. This is probably because there is a lack of institutional structure for promoting sustainability issues in the country.

The built-environment comprises of buildings, civil and heavy engineering works. According to Horvath (2004), the built-environment by virtue of its size is one of the largest users of energy, material resource, and it is a formidable polluter of air and water. It is estimated that at least three billion tonnes of materials are used in buildings every year, which is equal to about 40% of total global material flows. The International Energy Agency estimated that existing buildings are responsible for more than 40% of the world's total primary energy consumption and for 24% of global carbon dioxide emissions.

Over the past century, fossil fuels have increasingly provided most of our energy because these are much cheaper and more convenient to harness than energy from renewable energy sources such as solar radiation, wind, falling water, biomass, tides, and geothermal. However, it had been established that current oil and gas reserves would be adequate to meet our demands for another 40 to 100 years, given the current rates of consumption. The reserves for coal are in better situation as they would be adequate for at least the next 250 years. Considering the implications of these limited reserves, it is evident that the world will be faced with a situation in which the price of fuels will ever be increasing as the reserves are depleting. Since the occurrence of energy crises of the early seventies, serious concerns had been expressed about the escalating cost of fossil fuels as well as its associated risk and the reality of environmental degradation.

Green buildings are designed to reduce negative impacts on the environment caused by building construction, while increasing the occupant health, by addressing these five categories: 1.) sustainable site planning, 2.) safeguarding water and water efficiency, 3.) energy efficiency, renewable energy and lower greenhouse gas emisions, 4.) conservation and the reuse of materials and resources, and 5.) improved health and indoor environmental quality (Chau et al., 2010). The environmental impact of building is always underestimated while the perceived costs of green buildings are always overestimated. Kats et al. (2003) investigated the cost and benefits of green buildings in California, United States of America. Kats claimed that the average cost premium over just building to code is less than 2%. The Kats report finds that "minimal increases in upfront cost of about 2% to support green design would, on the average, result in life cycle savings of 20% in construction cost than ten times the initial investment" CEA (2011) added that the savings in the green building are in the maintenance and the utility cost.

In the execution of construction projects, challenges faced include completing the project within an owner's schedule and budget, and eliminating and minimizing harmful impacts on the environment. The current sustainability effort in construction is neither focused on developing renewable energy nor on eliminating potentially hazardous toxic materials. The efforts are focused on reducing energy intensity of buildings through the use of insulating materials, low energy lighting and natural ventilation.

The primary goal of sustainability is to reduce humanity's environmental or ecological footprint on the planet, (Journal of Sustainable Development, 2011. Mbamali (2005) bestowed the responsibility of attaining sustainable construction to the Nigerian construction industry. Despite the remarkable efforts made in the developed countries, sustainability issues and sustainable construction have not received sufficient attention and awareness in Nigeria (Dahiru, 2005; and Dania, 2007). This is probably because there is a lack of institutional structure for promoting sustainability issues in the country. The creation of awareness about the importance of green construction as a sustainability process for structures would probably increase the demand for sustainability developments.

A Green building is a structure designed to meet certain life cycle based objectives, so that the building can be designed, built, renovated, operated, or reused in an ecological and resource efficient manner. Most green building practices fall into seven basic categories: energy saving, land saving, storm water runoff-reducing, material conservation and pollution reduction (ECO Northwest, 2001). Material waste generated during construction is reduced or recycled. Energy efficiency also improved, perhaps, by relying on the use of natural light and ventilation or solar power. Less water is used, or rainwater harvesting system is installed to ensure wiser use.

The decision to build a sustainable building and establish firm environmental objectives for the project that will be compatible with the environment is made early in the design process. This is because opportunities for incorporating green technologies and design solutions become less and less available and increasingly costly to implement as the project design and construction process progresses. Ideally, the decision to build green should be made before the site is selected, as many of the sustainability criteria are affected by site characteristics and some sites are inappropriate for certain eco-friendly and energy sustainability projects. This early decision helps to maximize the overall success by incorporating the green potential, minimize redesign, and ensuring the economic viability of the green elements of the building project.

Nigeria as a country depends mostly on crude oil and electricity for its energy fulfilment. With epileptic supply of electricity, increasing in cost of energy, and the need to improve energy efficiency, there is a need to develop a sustainable and efficient energy system, to meet Nigeria’s future energy needs. While a lot of effort is being expended in the area of power generation and distribution, not much attention has been given to ensuring that the power generated is used efficiently. Approximately about 40% of power generated is wasted due to this end-use energy inefficiency.

It is feasible to apply Green construction principles in Nigeria. This will add a considerable solution to Nigeria’s energy challenges such as the challenge of connecting most rural areas to national grid for its energy use. Green construction is also considered essential in the practice of green architecture and environmental sustainability both in urban and rural societies in Nigeria. The current effort is focused on reducing the energy intensity of buildings through the use of insulating materials, low energy lighting and natural ventilation, and neither on non-renewable nor potentially hazardous toxic materials. In the western countries, such as the United States of America, the construction industry is growing sustainability ethic based on the principles of resources efficiency, health and productivity.

Samari, et al. (2013) investigated the barriers in developing green building in Malaysia. Lack of credit resources to cover upfront cost, risk of investment, lack of demand and higher final price were identified as main barriers. Zhang et al. (2011) investigated the barriers to Implement Green Strategy in the Process of Developing Real Estate Projects. The paper examined 10 typical barriers encountered in the process of real estate development and facilities management by employing questionnaire survey. Case study approach is adopted to investigate how and why the barriers can hinder the implementation of real estate development projects. It approaches the subject from the whole process of developing real estate project, including plan and design, construction and operation and management stages. Research results show that high cost for green appliance and lack of motivation from customers’ demand are identified as the two major barriers. The paper concludes by exploring the reasons that these barriers exist and suggesting some ways in which the barriers may be overcome.

Spires, Shackleton, and Cundill, (2014) investigated the barriers to implementing planned community-based adaptation in developing countries. Context-specific social, resource and physical barriers are significant, and these overlap and interact with one another. The investigators claimed that the most pervasive of these barriers relate to poor coordination within and between organizations responsible for planning and implementing adaptation actions, who adhere to discourses that are often technical and managerial and therefore not well suited to supporting CBA, and a lack of, or irrelevant knowledge/information on climate change as well as ineffectual communication between built environment professionals involved in CBA actions.

Public awareness of environmental issues has increased significantly in Nigeria. Presently, property owners and investors are seeking commercial buildings that meet acceptable environmental and health levels. Unfortunately, there is a lack of institutional structure promoting green buildings in terms of awareness on the part of clients, tenants, professionals in the built environment and other stake holders; professional capacity to incorporate green building issues and opportunities and; financial resources to undertake green building construction and upgrades, (Journal of Sustainable Development, 2011).

Construction has significant impacts on the natural environment (Hendrickson and Horvath, 2000). Despite the fact that construction has contributed to global environmental problems, buildings are still being erected without taking the climatic consequences into account, (Kennedy, Smith and Wanek, 2002). This can possibly be attributed to a lack of knowledge or because people prefer simple and cheaper buildings.

Sev (2009) stated that all building operations involve the use, redistribution and concentration of some elements of the earth's resources such as water, energy and materials. During these activities, an effect occurs changing that part of the biosphere (Hudson, 2003).

According to Green Home Guide (2007), that people who live in green homes save money by consuming 40% less energy and 50% less water than standard homes, on a month to month basis. Therefore, it could be said that sustainable design is a thoughtful integration of architecture with electrical, mechanical, and structural engineering. In addition to concern for the traditional aesthetics of massing, proportion, scale, texture, shadow, and light, the facility design team needs to be concerned with long term costs: environmental, economic, and human.

Study objectives are to: (1) identify constraints limiting involvement of built environment professionals and other built environment professionals in sustainable development practices in Nigeria; (2) determine the respondent's perception of the importance, affordability, and adoptability of sustainable development in Nigeria. (3) access respondent's perception of Nigerian regarding green building attributes, and (4) access respondents perception of Nigerian regarding green building attributes. Four research questions were identified as follows: a) What are the barriers to sustainable real estate development in Nigeria? b) What are the respondents' perceptions of the importance, affordability, and adoptability of sustainable development in Nigeria? c) What are the perception of Nigerian regarding green building attributes? and d) What are the respondents' perceptions of sustainable development practices in Nigeria?

2. Methodology

There were many steps involved in the design of the research. The procedure involved design of the survey instruments, validating the survey instruments, identifying the population for the study, selection of the samples, conducting pilot survey, conducting the survey, analysis of the collected data, and writing and disseminating the report.

The population of the study consists of stake-holders which include building owners, investors, developers, architects, engineers and facility managers. A random sampling method was used to administer 74 questionnaires to build environment professionals in Minna, Niger State, Nigeria. The sample size was calculated using a simplified formula proportion as illustrated by Glenn (2013) as follows:

$$n = \frac{N}{1 + N(e)^2} \tag{1}$$

Where; n = Sample size

N = Population size in the sample unit

e = Level of precision which is + 5% (0.05), at 95% confidence level.

In the study, a five degree Likert-type scale was adopted and arbitrary values of 1-5 were assigned to each of the degree of agreement, awareness, involvement, or participation, respectively. Disagree, somewhat agree, agree, strongly agree and very strongly agree responses were used depending on whether the particular response were considered to be acceptable or unacceptable based on the form of statement.

3. Results

The result of the fieldwork response rate is provided in Table 1 As shown, all the 74 (100%) questionnaires were returned, completed and analysed.

Table 2 reveals the respondent's gender. As shown, 64 (84.5%) of the 74 respondents were male and only 10 are females.

Table 1: Field Work Response Rate

Description	Numbers	Percentage

Total target population (users)	74	100
Undelivered survey (questionnaire)	0	0
Delivered questionnaire (users)	74	100

N =74

Table 2: Respondents' Gender

Parameters response	Frequency	Percent
Male	64	84.5%
Female	10	15.5%
N =	74	100%

Source: Authors field survey, 2016

Table 3: Respondents' Ages

Parameters response	Frequency	Percent
Under 20	9	12.2%
20 – Under 30	21	28.38 %
30 – Under 40	24	32.43%
40 – Under 50	14	18.92%
N =	74	100%

Source: Authors field survey, 2016

Table 3 reveals the respondent's age groups. As shown, 60 of the 74 respondents were under 40 years of age.

Table 4: Respondent's profession.

Parameters	Frequency	Percent
1 Real Estate Developer	9	12.2%
2 Architect/Designer	9	12.2%
3 Quantity Surveyor	12	16.22%
4 General Contractor	14	18.92%
5 Educator (University or Polytechnic institutions)	6	8.11%
6 Engineer: civil, environmental, electrical, etc	21	28.38%
7 Others	3	4.05%
N =	74	100%

Table 5: Respondent's primary employment

Parameters	Frequency	Percent
1 Public Sector (e.g. Government, Local Authority)	28	37.84%
2 Private Sector (e.g. For Profit, Not for Profit)	26	35.14%
3 Non-governmental organization (e.g. environmental lobby group, volunteer group, International or foreign organization)	8	10.81%
4 Higher institution of learning (Universities or Polytechnics)	12	16.22%
N =74		

Table 4 reveals the respondents profession. As shown, only six respondents are educators and 21 (28.4%) are engineers.

Table 5 reveals the respondents primary employment. As shown, 28 are in the public sector, 26 are in the private sector, and only eight respondents are employed in non-governmental organizations.

Table 6 reveals respondent's experience in the Nigerian Construction Industry. As shown, only six respondents has over 20 year experience and 27 respondents have less than five years experience working in the construction industry.

Table 6: Respondent's experience in Nigerian Construction Industry

Description	Numbers	Percentage
1 Under 5 yrs	27	36.5
2 5 to Under 10 yrs	21	28.4
	12	16.2
3 10 to Under 15 yrs		
	8	10.8
4 15 to Under 20 yr		
	6	8.1
5 Over 20 yrs		

Table 7 reveals respondent's perception of the importance of sustainable development. As shown, over 60 of the 74 respondents agreed that sustainable development is feasible in Nigeria, affordable by Nigerians, and that the need is urgent. Majority of the respondents also agreed that sustainable design and construction can help provide a healthier environment for living. The respondents agreed that lack of government support and incentives, lack of funding from public and private housing finance institutions, lack of relevant building codes and standards, lack of training or certification, and inconsistencies in government policies due to change in regime were identified as barriers to sustainable development in Nigeria.

Table 8 reveals respondent's understanding (perception) of green building attributes such as the use of renewable energy, treat or re-use water in building, or maximizing open spaces around building. As shown, majority of the respondents perceived that these attributes are somewhat important, important or very important.

Table 7: Barriers to Green Building Development Practices

Please rate the following potential attributes and/or barriers to green building development practices in Nigeria.

The rating scales are: **1 = No Opinion; 2 = Disagree; 3 = Somewhat Agree; 4 = Agree; 5 = Strongly Agree.**

	Questions on Sustainable Construction Practices.	**1**	**2**	**3**	**4**	**5**
1	Do you agree that sustainable development is feasible in Nigeria?	0	3	14	27	30
2	Do you agree that Nigerians can afford to build sustainable buildings?	0	2	22	34	17
3	Do you agree that you can encourage Nigerians to adopt green construction instead of conventional construction?	3	2	26	28	15
4	Do you agree that sustainable development is practicable in Nigeria, considering the present economic level and the shortage of decent and energy efficient homes?	2	3	30	26	13
5	Do you agree that there is an urgent need for sustainable development in Nigeria?	1	2	25	28	17
6	Do you agree that sustainable design and construction can help provide a healthier environment for living?	3	2	23	36	10
7	Do you agree that lack of government support and incentives is a barrier to sustainable development in Nigeria?	1	3	12	28	30
8	Do you agree that lack of funding from public and private housing finance institutions is a barrier to sustainable development in Nigeria?	2	2	16	30	24
9	Do you agree that lack of relevant building codes and standards is a barrier to sustainable development in Nigeria?	2	6	27	32	7
10	Do you agree that lack of training or certification such as LEED or a University degree in sustainable development is a barrier to sustainable development in Nigeria?	2	5	23	21	23
11	Do you agree that inconsistencies in government policies due to change in regime is a barrier to sustainable development in Nigeria?	0	7	16	32	19
12.	Do you agree that the conservation of cultural diversity is a barrier to sustainable development in Nigeria?	6	12	22	13	21

Table 8: Potential Green Building Attributes

Please indicate or circle between 1 and 5 against each statement, depending on your perception.

NOTE: 1 = No Opinion/ Do not know; 2 = Not Important; 3 = Somewhat Important; 4 = Important; 5 = Very Important.

	Questions on Sustainable Construction Practices.	**1**	**2**	**3**	**4**	**5**
1	Prevent construction activity from causing site and air pollution.	0	13	20	21	20
2	Use strategies to minimize the amount of water used in the building.	0	6	21	31	16
3	Protect or restore the natural state of the building site in terms of ecosystem, agriculture, plants and animal habitat.	0	10	29	28	7
4	Use strategies to minimize the amount of energy used in the building.	0	10	21	32	11
5	Build/construct on a previously developed site.	2	7	44	21	10
6	Re-use an existing building structure instead of constructing a new one.	0	27	29	14	4
7	Build/construct in a densely populated neighborhood.	0	19	30	25	0
8	Use strategies to prohibit smoking inside the building.	0	9	17	16	32
9	Build/construct on a contaminated site (e.g. industrial site or brownfield).	0	17	32	15	10
10	Treat and re-use waste water in the building.	0	0	16	25	33
11	Build/construct near to existing transport and utilities infrastructure.	0	2	14	30	28
12	Use renewable energy that is generated on the building site (e.g. solar or wind).	0	0	17	28	29
13	Provide secure bicycle storage space for building occupants.	7	29	20	8	10
14	Build/construct with recycled or salvaged building materials.	8	29	18	9	10
15	Encourage building occupants to use vehicles that are fuel-efficient and emit lesser pollutants.	0	0	36	22	16
16	Provide walk-off mats, grills, or grates at building entries.	10	28	20	16	0
17	Minimize the number of car parking spaces at the building premises/site.	20	27	24	13	0
18	Collect rainwater for use in the building.	27	28	10	9	0
19	Maximize open space at the building/site.	0	0	38	19	17
20	Use strategies to measure and verify energy use in the building.	0	0	27	31	16
21	Control the quantity of storm water runoff from the building/site.	0	6	25	24	19
22	Use materials that are available close to the building/site.	16	25	9	24	0
23	Control the quality of storm water runoff from the building/site.	0	20	29	18	7
24	Use strategies to achieve maximum daylight entering the building.	0	0	17	28	29
25	Use building materials that can be renewed or replenished rapidly.	0	0	30	26	18

Table 9: Perceptions and Awareness of Sustainable (Green Building) Practices in the Nigerian Construction Industry.

NOTE: 1 = No Opinion; 2 = Disagree; 3 = Somewhat Agree; 4 = Agree; 5 = Strongly Agree.

	Questions on Sustainable Construction Practices.	**1**	**2**	**3**	**4**	**5**
1	I am familiar with sustainable construction practices in Nigeria.	3	5	17	24	25
2	There are government policies, mandates, or incentives to promote green buildings in Nigeria	3	5	20	29	25
3	I am aware of building codes and/or regulations to promote green buildings in Nigeria	2	5	36	20	11
4	Our professional organization plays a major role in reducing climate change.	1	10	28	24	11
5	I am aware of individuals in Nigeria who are green building-accredited professionals or associate members of an international green building standard	9	7	22	31	5
6	Climate change and other environmental issues are often discussed in our organizational meetings.	11	10	33	13	7
7	Our company has a staff with knowledge and experience to implement sustainable construction practices.	7	12	25	18	12
8	There are financial benefits to our organization to produce energy-efficient buildings.	10	17	20	23	4
9	I am aware of at least one building in Nigeria that is certified as Green.	5	10	28	20	11
10	I know of at least one green building that has been certified in Nigeria by Green Building Council, LEED, or any other organization	20	5	21	17	11
11	I know of some past projects in Nigeria that were designed based on sustainable design principles.	2	1	16	30	25
12	On some of our projects, sustainable construction practices were implemented during design and preconstruction phases.	6	4	24	21	19
13	There is at least one public organization or institution in Nigeria that has taken initiatives to develop a green building standard	18	14	28	9	4
14	There is at least one non-governmental organization in Nigeria that has taken initiatives to develop a green building standard. (N/B: This includes national and international organizations).	14	12	21	17	10
15	A green building is more expensive (in Naira) to build than a non-green building.	1	4	16	30	23
16	Green building should be important to Nigeria	1	1	14	30	28

4. Discussion

The four research questions identified as follows: a) What are the barriers limiting involvement of built environment professionals and others in sustainable real estate development in Nigeria? b) What are the respondents' perceptions of the importance, affordability, and adoptability of sustainable development in Nigeria? c) What are the perceptions of Nigerian regarding green building attributes? and d) What are the respondents' perceptions of sustainable development (green building) practices in Nigeria?

Discussion of Research Question Number One: Research question number one addresses the issue of identification of the barriers limiting involvement of built environment professionals and others in sustainable real estate development in Nigeria. Five degree Likert-type scale was adopted and arbitrary values of 1-5 were assigned to each of the no opinion, disagree, somewhat agree, agree and strongly agree response depending on whether the particular response were considered to be acceptable or unacceptable based on the form of statement. As shown in Table 7, majority of the respondents indicated somewhat agreed, agreed and strongly agreed to each of the identified factors. These responses affirmed the responses from other previous studies regarding identification of the barriers to sustainable real estate development.

Discussion of Research Question Number Two Research questions two addresses the respondents' perceptions of the importance, affordability, and adoptability of sustainable development in Nigeria. As shown in Table 7, majority of the respondents indicated somewhat agreed, agreed and strongly agreed to each of the questions regarding affordability of sustainable buildings by Nigerians, practicability, and whether sustainable design and construction provide healthier living environment for Nigerians. These responses affirmed the responses from other previous studies regarding identification of the barriers to sustainable real estate development.

Discussion of Research Question Number Three: Research question of the respondent's the perceptions of Nigerian regarding green building attributes. As shown in Table 8, majority of the respondents indicated no opinion, not important or somewhat important as regards re-using existing building structure instead of constructing a new one, providing bicycle storage space , collecting rain water and using locally found building materials. Majority of the respondents stated somewhat important, important or very important on each of the other factors.

Discussion of Research Question Number Four: Research question four accessed respondents perception of Nigerians regarding green building (green building) practices. As shown in Tables 7, 8, and 9, majority of the respondents claimed that green construction is important to the Nigerian construction industry. Most of the respondents agreed and strongly agreed to this statement, respectively.

Most of the built environment professionals agreed or strongly agreed, respectively, that the establishment of green building is feasible and practical in Nigeria. None of the respondents strongly disagreed to the question. 44(55.0%) agreed that green construction is practicable of in Nigeria. However, 29(36.2%) of the built environment professionals are neutral to the statement that there is/are green building(s) in Nigeria at the time of this research. 43(53.8%) of the built environment professionals agreed to this statement while none strongly disagreed to the statement.

Built environment professionals that responded to this statement with highest frequency of 43(53.8%) agreed to it. None disagreed nor strongly disagreed. This table below represents the frequencies of the built environment professionals that remain neutral, strongly agreed, agreed to this statement. It was found that none of the respondents disagreed nor strongly disagreed to this statement.

The respondents were asked whether they believe that design and construction of sustainable building is feasible in Nigeria and the result is shown in Table 7. As shown, majority of the respondents agreed and only 3 respondents disagreed that sustainable building is feasible in Nigeria.

Other critical issue identified in the literature include lack of government support and incentives, and lack of relevant building codes and standards. At the moment, the government is yet to pass a 2006 Building codes and standards into law. In addition, the majority of the built environment professionals lack technical knowledge such as professional and scientific training on complexities of the construction and operation of intelligent buildings, lack of government support and incentives, and lack of relevant environmental laws and regulations are some of the critical barriers.

5. Conclusion

The level of development of green building in Nigeria is not satisfactory. This paper investigated issues limiting involvement of built environment professions awareness, involvement, perception, believes of the respondents regarding green building and sustainability issues. Data collected indicated high levels of awareness existing within the built environment professionals.

In a recent survey by the Nigerian Institute of Quantity Surveyors (NIQS), only 14% of the quantity surveyors claimed to be very active and visible in promoting green building issues (Waniko, 2013). This is probably because there is a lack of institutional structure for promoting sustainability issues in the country and the difficulty of understanding and incorporating the idea of green building innovation into building practices. This can possibly be attributed to a lack of knowledge or because people prefer simple and cheaper buildings. The creation of awareness about the importance of green construction as a sustainability process for structures would probably increase the demand for sustainability developments.

The researchers concur with the respondents' claims that the provision of sustainable development is important to the Nigerian construction industry, that it will improve the standard of living, provide healthier environment for living, and should be encouraged in Nigeria. However, respondents claims that green housing (sustainable development) is affordable by Nigerians and the practicability, considering the current state of housing conditions in the country and the government housing policy is unrealistic and over ambitious (Gilbert, 2004). Finally, review of the literature revealed that technical knowledge such as professional and scientific training on complexities of the construction and operation of intelligent buildings, lack of government support and incentives, and lack of relevant environmental laws and regulations are some of the critical barriers to sustainable development. At the moment, the country does not have a building code setting the minimum design standards for health, safety and welfare of occupant and the government is yet to pass a 2006 Building codes and standards into law. It is overambitious to start taking of implementing a sustainable development standard when basic standards for conventional housing do not exist.

REFERENCES

Chambers, (1993). The Chambers Dictionary. Chambers Harrap Publishers Ltd., Edinburgh.

Dahiru, D. (2005) Measures for Ensuring Sustainability in the Nigerian Construction Industry. "*Towards a Sustainable Built Environment": Proceedings of the 2nd National Conference* Organized by Department of Building, Ahmadu Bello University, Zaria. 21st-23rd September, 2005

Dania, A. A., Kehinde, J.O. and Bala, K. (2007). A Study of Construction Material Waste Management Practices by Construction Firms in Nigeria.

ECONorthwest (2001). *Green Building: Saving Money and the Environment; Opportunities for Louisiana*. Eugene, Oregon:

Fisher, T.A. (1992), *Principles of Environmental Architecture*, AIA, Nov. 1992

Gilbert, A. (2004). "Housing in Third World Cities: The Critical Issues". JSTOR, (85), 145 -155. Retrieved on 20/02/2014 from .

Glenn, D. I. (2013). "Determining Sample Size". Institute of Food and Agricultural Science (IFAS), University of Florida, Gainsville, FL 32611. Retrieved on June 3, 2013 from edis.ifas.ufl.edu/pdffiles/PD00600.pdf,

Horvath, A. (2004) *Construction Materials and the Environment.*

Kats, G and Capital, E (2003). *The cost and financial benefits of green buildings: a report to California's sustainable building task force.* Developed for the Sustainable Building Task Force, California, USA.

Mbamali, I. (2005) Stone Quarrying in Nigeria: An Overview of Necessary Initiatives Towards a Sustainable Built Environment. "*Towards a Sustainable Built Environment": Proceedings of the 2nd National Conference* Organized by Department of Building, Ahmadu Bello University, Zaria. 21st-23rd September, 2005

Samari, M., Godrati, N., Esmaeilifar, R.,Olfat, P., Shafiei, M., and Wira M. (2013). The investigation of the barriers in developing green building in Malaysia. Journal of Modern Applied Science 7, 2, 1- 10.

Sev, A. (2009) how can the Construction Industry Contribute to Sustainable Development? A Conceptual Framework, Sustainable Development, 17,161-173

building is feasible in Nigeria Spires, M., Shackleton, S., and Cundill, G. (2014). Barriers to implementing planned community-based adaptation in developing countries: a systematic literature review. Journal of Climate and Development, 6, 3, 277-288

Waniko, D. P. (2013) "Green Building in Nigeria: Emerging Opportunities for the Quantity Surveying Profession". .

WCED, (1987). Our Common Future. (Brundtland report). World Commission on Environment and Development. Oxford University Press, Oxford.

Zhang, X., Shen, L., Wu, Y. and Qi, G. (2011). Barriers to Implement Green Strategy in the Process of Developing Real Estate Projects. *The Open Waste Management Journal* . 4, 33-37.

EVALUATION OF THE EFFECTS OF ABANDONED BUILDINGS ON SUSTAINABLE DEVELOPMENT OF RESIDENTIAL AREAS IN MINNA, NIGER STATE

OTACHE, A.A. & ANUNOBI A.I.

Department Of Architecture, Federal University of Technology, Minna

The sustainable development of residential building environments entails a residential environment that provides residents better environmental conditions that can be easily maintained. It incorporates environmental protection, economic growth and social equity in planning and organisation of residential areas. This study explores the effects of abandoned buildings in residential areas of Minna, Niger state on sustainable development of the town. It exposes the causes and effects of abandoned buildings on the residential areas of the town. Research methods used for this study include the use of descriptive, qualitative and quantitative methods. A thorough review of literature on building abandonment, the causes and effects on the environment was carried out. Data was collected from selected residential areas in Minna using structured observation schedules and personal interviews with residents of residential areas selected and officials of the Niger state ministry of lands, survey and housing. The data collected were then analysed using SPSS10 and MSExcel 2010 from where tables were developed. The findings indicate that the major cause of abandoned buildings in Minna is poor pre construction planning on the part of the building owners. Building construction project in residential areas in Minna are carried out over an unregulated period of time based on discretion and availability of resources to the owner. During the period of time in which the buildings is under construction, it is left abandoned and mostly becomes an environmental dilemma posing health risk to the residence and also acting as a haven for anti- social activities. Enacting laws that ensures proper pre construction planning in residential areas and the provision of a workable mortgage system in the Niger state will go a long way in dealing with building abandonment.

Keywords: abandoned buildings, building owners, residential areas, sustainable development

tonyagada43@gmail.com

Otache, A.A. & Anunobi A.I (2016). **EVALUATION OF THE EFFECTS OF ABANDONED BUILDINGS ON SUSTAINABLE DEVELOPMENT OF RESIDENTIAL AREAS IN MINNA, NIGER STATE** Sustainable Built Environment and Climate change; The challenges of Post 2015 Development Agenda. School of Environmental Technology Conference, SETIC, 2016

INTRODUCTION

Housing is one of the physiological needs of humans that provides protection and shelter and from where day to day activities can be carried out. (McLeod, S. A. 2014). It is habitual of humans to build houses to meet their housing needs. An increase in human population results to a corresponding increase in the demand for houses. Residential building areas refer to the section within the city or town where residential housing units are found. The residential area is primary to every human settlement because it provides a pivotal base for man's day to day activities. No definite definition exists for a sustainable residential area. However, sustainable residential area refers to a healthy green environment built and maintained on the principles of ecological protection, consideration for density and urban design, affordable local economy, convenient and ozone friendly transportation, affordable houses, aesthetically pleasing environmental conditions, sewage and storm water disposal and control and availability of water and energy (Steven pecks and Guy Dauncey, 2013).

An abandoned building is one which is ''truly unsafe'' and often without necessary elements such as a floor, wall or roof (O'Connell, 2005). It is a fact that not all building construction projects that start gets finished (E.H. Yap, H.C. Tan, and F.C. Chia, 2010). The Nigerian Federal Ministry of Works and Housing (2002) defines an abandoned building as one which has recorded inactivity on the construction site for at least a year. The increasing amount of abandoned buildings in residential areas in developing countries like Nigeria has become a course of concern (Ayodele and Alabi, 2011). In typical Nigerian context, it is hard to tell which buildings are abandoned especially in residential areas. This is because in residential areas occupied by mostly middle and low income earners, the time taken for the construction of a building is primarily based on the availability of resources and the discretion of the building owner. Building abandonment in residential areas in Minna, Niger state presents lots of challenges to achieving sustainable residential development in residential areas. Abandoned buildings constitute a mechanism for the gradual decay of a residential area from within resulting primarily from poor planning, monitoring and control of the construction of new buildings and the maintenance of existing buildings (Kontangora O.O, 1993).

The array of problems caused by building abandonment in residential areas cut across the economic, environmental, socio-cultural wellbeing of the residents of the area. The ideal sustainable residential area constitute of all elements of the settlement working unanimously at optimum levels where maximum efficiency of all the inputs can be adequately monitored and controlled to achieve a green, safe, waste free and aesthetically pleasing environment. An abandoned building constitutes grave health risks, encourages crime and other anti-social activities, distorts the aesthetic value of the area and also encourages wastefulness.

Sustainable Residential Development

Sustainable development entails the development that meets the needs of the present without compromising the ability of future generations to meet their own needs; it incorporates environmental protection, economic growth and social equity (World Bank Group, 1987). There have been rising concerns that resources both artificial and natural, may deplete rapidly and become exhausted if no better way is found to optimise the use of these resources (Cohen, 2001). Sustainable residential development is primary to ensuring a healthy crime free and safe environment. In achieving sustainable development in residential areas, all constituent features must have high sustainability ratings (Steven Pecks, Guy Dauncey, 2013). Planning for public purposes entails a basic preoccupation to make the residential area safe, healthy and aesthetically pleasing (Ijaz, A and Ihsan, U.B, 2005) and also to achieve a reasonable level of sustainability (Nenno, M.K. 1996).

Sustainable development in high and medium density residential areas in Nigeria is a herculean task that requires the inputs of related experts and the cooperation of the general public. The major stumbling blocks to achieving sustainable development is poor planning (Akindele, O.A 2013) and inspection of development of residential areas. Owing to the haphazard building projects in most high density residential areas, some buildings exists without foresight for users comfort implying the absence of toilets, proper ventilation, drainage systems and parking spaces. In already existing residential areas, achieving sustainable development requires the inputs of experts in residential planning and development, government and corporate organization intervention and the cooperation of the general public to incorporate the fundamental framework of sustainable residential development which includes application of green design ideals, , provision safe internal conditions, encouraging affordable and equitable distribution of housing resources, supporting the financial viability for housing procedures, promoting occupant- neighbourhood linkages, maximizing access to healthy environment and support services, supporting the wellbeing of workers, preservation of cultural and housing heritage, foster participation and harmonious decision making and increase the adaptability and flexibility of developmental processes in residential areas (Eziyi O. I, and Dominic E. A, 2011).

Cause of Abandoned Buildings in Residential Areas of Nigeria

An abandoned building is building that was started at an earlier date but which the construction has stopped for one reason or the other (Olapade O and Anthony O, 2012). The causes of abandoned building projects in residential areas in Nigeria are not farfetched. Studies have shown that housing provision is one of the major challenges facing developing countries (Abu Hassan, Arman Abd, Shardin Abdullah and Aidah Awangi, Vasanthi Perumal, 2010). Lots of building projects in residential areas across the country where initiated with good intentions but where abandoned at different stage of the construction. As postulated by psychologist Abraham Harold (1984), every human desires a house of their own. This fact coupled with the observed rural to urban drift in Nigeria since 1999 (NPC, 2013) in search of greener pastures has caused uneven and haphazard development in residential areas. Abandoned buildings are more predominant in high and medium density area where low income and medium income earners are found (Adedibu A and Akindele O, 2007).

The major cause of abandoned building in residential areas in Nigeria is due to poor planning, monitoring and implementation modalities to guide construction activities in residential areas in the country. Ibrahim, F. (2006) suggests that land owners often go into projects with the intension of completing the buildings over a significant period of time. He asserts that the resources required for the completion of the project is not usually available at the inception of the project. Mismanagement, unfavourable government policies, inefficient public delivery system and unfavourable economic conditions are major causes of building abandonment (E H Yap et al 2014). Studies by hKhalid, 2005; Ng 2009b, Lim, 2009; Fernandez Z, 2009 shows that the unavailability of adequate financial resources results in building abandonment.

Effects of Abandoned Buildings on the Sustainable Development of residential areas in Nigeria

Sustainable development of residential areas was identified by Maliene and Malys (2009) as housing planned in a clear way which should be able to create high quality in technic and supply, economic opportunity to cover purchase and exploration expenses for greater number of households, ecological outputs in energy savings, ecological building materials, comfortable and satisfying socio-cultural aspects. This entails a guided step by step careful planning of the residential area. Abandoned buildings have effects that negate the achievement of sustainable residential development. The principles of sustainable development are centred on environmental protection, economic growth and social equity. Abandoned buildings in residential areas contribute to neighbourhood decline by depressing nearby property values (Hye-Sung Han, 2013). According to Accordino, J. and Johnson, G.T. (2000) an increase in the rate of abandoned buildings in residential areas points to residential areas in crisis. Abandoned buildings are magnet for crime because they create hideout for anti- social activities such as drug dealings, alcohol abuse, theft and unlawful occupation (Kidd, 1995). Residential areas with abandoned buildings would provide avenue for successful criminal activities than residential areas without abandoned buildings.

As stated by Agbola (2002), a study in Abuja Nigeria showed that major dangerous or hot points in Abuja are areas where developments are not complete. Olapade, O. and Anthony, O(2012) assert that the socio economic effects of abandoned buildings are huge considering the huge amount of resources that are expanded. In residential areas with abandoned buildings, unhealthy pollution activities are common especially when waste disposal systems like refuse bins and toilet are inadequate or non-existent (Olaniyi, 2005). Outbreak of disease such as diarrhoea, cholera, malaria and typhoid fever are always common in residential areas with abandoned buildings (Akindele O. A, 2013). Abandoned buildings in residential areas can be liken to a cancer in the human body which starts from a single part of the body but spreads to other parts with time. This implies that a single abandoned building has the potential to affects negatively the achievement of sustainable development from within the residential areas itself.

RESEARCH METHODOLOGY

The research method for this study included the use of primary and secondary data. Primary data sources used included firsthand information from field visits and interviews with building professionals while information sourced from the internet constituted secondary information Ten (10) residential areas in Minna, Niger state were selected for this study. The residential areas were grouped into low and high density areas according to the size of the residential areas and the amount of buildings in each area and five residential areas where selected randomly from each group. An average of ten residents selected randomly based on the availability and willingness to be interviewed were interviewed in each of the residential areas visited. Structured observation schedules were also used to record the amount of abandoned buildings and their physical attributes. Interviews with residents were geared towards ascertaining the activities that occur in neighbouring abandoned buildings and the corresponding effects it has on the residents. Interviews were also conducted with two officials of the Department of Housing in the Niger State Ministry of Lands Survey and Housing to obtain official record of building abandonment in Minna, Niger state. Their professional opinion on the causes and effects of building abandonment in Minna was also recorded. The data collected were analysed using SPSS10 and MSExcel 2010 were used to generate tables. The results obtained where then discussed and conclusions drawn.

FINDINGS AND DISCUSSION OF RESULTS

The analysis of data obtained from the observation schedule and structured interview carried out is presented in tables 1.0, 2.0 and 3.0. In table 1.0, the estimated number of abandoned buildings in selected low and high density residential areas is shown. Buildings in various uncompleted state that have not been worked upon for at least six months were selected. The duration of inactivity of the building was obtained from neighbouring residents in the area. Typical characteristics of abandoned building include the change in colour of the entire frame work of the building to dark brown, the gradual degrade of the structural frame work of the building, and the presence of outgrown grasses and debris.

Table 1.0: Number of abandoned buildings in selected in selected Residential areas in Minna

S/N	Residential Area	Density	Estimated Number of Abandoned Buildings
1	Angwan Kampani, Estern Bye Pass	Low	16
2	F Layout Extension	Low	14
3	Maikunkele Low Cost	Low	23
4	Sabon Angwan	Low	20
5	Umaru Shaba Road, Tungan Goro	Low	18
6	London Street 1&2	High	8
7	Maitumbi	High	12
8	Angwan Biri	High	9
9	Tayi Village	High	11
10	Shango	High	10

Source: Authors' fieldwork (2015)

From table 1.0, abandoned buildings were found to be more prevalent in low density residential areas than in high density residential areas. The highest count for abandoned buildings in low density residential areas is twenty (20) while that of high density residential areas is twelve (12). The total number of abandoned buildings in the low density residential areas under study was found to be 91 while that of the high density residential areas have a total count of 56 as shown in table 2.0 below.

Table 2.0: Total number of abandoned buildings

S/N	DENSITY	TOTAL NUMBER OF ABANDONED BUILDINGS ESTIMATED
1	LOW	91
2	HIGH	56

Source: Authors' fieldwork (2015)

This stems from the fact that building activities have shifted from the already developed residential areas to less developed residential area where land is still available. Although most of the high density residential areas in Minna lack the qualities of a sustainable residential environment, most of the building areas have been put into use.

The data obtained from the interview with residents in the selected residential areas was analysed using a rating scale geared towards revealing the level to which respondents agree or disagree with selected effects of abandoned buildings in their neighbourhood the rating scale is shown in table 3.0 below.

Table 3.0: Respondents' opinion on how they have been affected by abandoned buildings in their residence based on level of agreement

S/N	Effects	Residential Area	Stongly Disagree (1)	Disagree (2)	Neither Agree Nor Disagree (3)	Agree (4)	Strongly Agree (5)	Total Respondents
1	Crime Promotion and social vices such as drug dealing and smoking.	Angwan Kampani,	0	0	1	3	4	8
		F-Layout Extension	0	0	0	2	8	10
		Maikunkele Low Cost	0	0	1	4	4	9
		Sabon Angwan	0	0	3	2	4	9
		Umaru Shaba Road, Tungan Goro	0	0	3	1	4	8
		London street 1&2	0	0	0	2	7	9
		Maitumbi		1	2	3	5	10
		Angwan Biri	0	1	2	2	5	10
		Tayi Village	0	0	0	4	6	10
		shango	0	0	3	1	6	10

Source: Authors' fieldwork (2015)

Table 3.0b: Respondents' opinion on how they have been affected by abandoned buildings in their residence based on level of agreement

S/N	Effects	Residential Area	Stongly Disagree (1)	Disagree (2)	Neither Agree Nor Disagree (3)	Agree (4)	Strongly Agree (5)	Total Respondents
2	Breading of dangerous animals such as snakes and scorpions	Angwan Kampani	0	0	2	1	3	6
		F-Layout Extension	0	0	0	2	8	10
		Maikunkele Low Cost	0	0	0	3	6	9
		Sabon Angwan	0	0	0	5	5	10
		Umaru Shaba Road, Tungan Goro	0	0	0	4	3	7
		London street 1&2	0	1	1	3	1	6
		Maitumbi	0	1	2	2	5	10
		Angwan Biri	0	0	3	3	4	10
		Tayi Village	0	0	2	2	6	10
		Shango	0	0	2	4	2	8
3	Promotion of environmental pollution and disease outbreaks	Angwan Kampani	0	1	1	1	4	7
		F-Layout Extension	1	0	1	4	2	8
		Maikunkele Low Cost	1	0	3	1	5	10
		Sabon Angwan	3	0	2	0	5	10
		Umaru Shaba Road, Tungan Goro	0	0	0	3	7	10
		London street 1&2	0	0	0	5	5	10
		Maitumbi	0	1	1	1	7	10
		Angwan Biri	1	0	2	4	3	10
		Tayi Village	0	0	0	7	3	10
		Shango	2	1	2	2	1	8
4	Illegal Occupation	Angwan Kampani	5	3	1	1	0	10
		F-Layout Extension	3	3	2	3	0	10
		Maikunkele Low Cost	2	1	3	3	1	10
		Sabon Angwan	3	1	1	4	1	10
		Umaru Shaba Road, Tungan Goro	4	2	2	0	0	8
		London street 1&2	6	1	0	1	1	9
		Maitumbi	2	3	1	1	0	7
		Angwan Biri	2	3	0	3	2	10
		Tayi Village	3	5	0	1	1	10
		Shango	7	1	1	1	0	10

Source: Authors' fieldwork (2015)

Table 3.0c: Respondents' opinion on how they have been affected by abandoned buildings in their residence based on level of agreement

S/N	Effects	Residential Area	Stongly Disagree (1)	Disagree (2)	Neither Agree Nor Disagree (3)	Agree (4)	Strongly Agree (5)	Total Respondents
5	Reduction in Property Value	Angwan Kampani	2	1	2	2	1	8
		F-Layout Extension	4	3	0	1	2	10
		Maikunkele Low Cost	2	1	1	2	2	8
		Sabon Angwan	4	2	1	0	0	7
		Umaru Shaba Road, Tungan Goro	2	1	1	2	2	8
		London street 1&2	2	1	2	1	1	7
		Maitumbi	7	2	1	0	0	10
		Angwan Biri	6	2	0	1	1	10
		Tayi Village	4	3	0	2	1	10
		Shango	3	3	1	1	2	10
6	Distortion of the Beauty of the Neighbourhood	Angwan Kampani	0	0	1	3	5	9
		F-Layout Extension	0	0	0	2	4	6
		Maikunkele Low Cost	0	1	1	4	4	10
		Sabon Angwan	0	0	3	2	3	8
		Umaru Shaba Road, Tungan Goro	0	0	0	2	8	10
		London street 1&2	0	1	3	3	3	10
		Maitumbi	0	1	1	2	6	10
		Angwan Biri	0	0	5	4	1	10
		Tayi Village	0	0	3	5	2	10
		Shango	0	0	2	6	2	10

Source: Authors' fieldwork (2015)

The interpretation of the rating scale used in table 3.0 above is shown below

1 ~ strongly disagree
2 ~ disagree
3 ~ neither agree nor disagree
4 ~ agree
5 ~ strongly

The percentage summary of the residents' opinion is shown in table 4.0

Table 4.0: percentage scores of residents' opinion

S/N	Effects	Total Respondent	Percentage Of Residents Opinion				
			Strongly Disagree	Disagree	Neither Agree Nor Disagree	Agree	Strongly Agree
1	Crime Promotion and social vices such as drug dealing and smoking.	93	0	2.15	16.13	25.8	55.92
2	Breeding of dangerous animals such as snakes and scorpions	86	0	2.33	14.00	33.70	49.97
3	Promotion of environmental pollution and disease outbreaks	93	8.60	4.30	12.90	30.11	44.09
4	Illegal Occupation	95	39.79	24.73	11.83	23.65	6.4
5	Reduction in Property Value	88	40.91	21.59	10.23	13.64	13.63
6	Distortion of the Beauty of the Neighbourhood	93	0	3.23	20.43	43.01	33.33

Source: Authors' fieldwork (2015)

From table 4.0, 81.72% of respondents agree that the presence of abandoned buildings in their neighbourhood contributes to the increase in criminal activities and other social vices, 83.67% agree that the abandoned building aid the breeding of dangerous animals such as snakes and scorpions, 74.09% suggests that abandoned buildings around them contribute to the pollution of the environment especially the generation of foul smells.

Plate 1 and 2: abandoned residential buildings in F-layout extension and London Street respectively where residents in neighbouring buildings have complained about the series of attacks by snakes and scorpions and foul odour.

Though abandoned buildings attract illegal occupants, 69.95% of the respondents disagree with this premise. Only abandoned buildings with completed roofs are occupied by illegal occupants mostly with the permission of the owner of the building or a caretaker. 30.05% of respondents suggested that abandoned buildings roofed or not attract illegal occupants, mostly homeless individuals especially during the dry periods of the year.

Fig3.0: An abandoned building in London street 1 occupied by illegal occupants

According to Ayodele, et al 2011, abandoned buildings contribute to the fall in property value where they are found. 62.50% of respondents refute this claim. In the study area, even where abandoned buildings are dominant, the cost of land and the cost of rent and lease of buildings have not been affected. 10.23% of the respondents suggested that the presence of abandoned buildings do not affect property values and that the main determinant of property value is the location where the property is found. Abandoned buildings are usually converted into dumpsites for refuse which affects the aesthetic value of the environment. 76.34% of the respondents agree with this submission.

Fig 4.0: An abandoned building in Umaru Shaba road, Tungan Goro converted into a refuse dump site

However, 20.43% suggests that the beauty of a residential area is dependent on the willingness of residents to work toward achieving a beautiful environment and can be achieved with or without the presence of abandoned buildings.

CONCLUSIONS

The effects of abandoned buildings in residential areas are far reaching and affect the day to day lives of residents. Abandoned buildings attract criminal activities and other social vices, provide platform for environmental pollution and the defacing of the surrounding creates a habitable environment for wild and dangerous animals such as snakes, scorpions and termites and makes it impossible to achieve a sustainable residential area. Building abandonment is on the increase in Nigeria as a result of poor preconstruction planning which stems from the mentality that building construction projects especially in residential areas can be carried out over a long period of time at the discretion of the owner and the inability of the government and other relevant authorities to properly regulate building construction activities in residential areas

REFERENCES

Abu, Hassan Abu Bakar, Arman Abd Razak, Shardy Abdullah, Ardah Awang and Vasanthi Perumal. (2010) Critical success factors for sustainable Housing, *A framework from the project management view*. Asian Journal of management research.

Accordino, J. And Johnson, G.T. (2000). Addressing the Vacant and Abandoned Property problem. Journal of Urban Affairs, 22(3), 301.

Adedibu, A.A. and Akindele, O.A. (2007). "The significance of landed property Abandonment in Oshogbo : a planners perspective" *Journal of Nigerian Institute of Town Planners*. 20(1), 4.

Agbola S. (2005). A profile of violence, urban security and prevention in the city of Abuja Nigeria. Report of the good urban governance in Nigeria.

Akindele, O.A. (2013). Environmental Effects of Abandoned buildings In Ogbomosho and Osogbo Nigeria. *Ethiopian Journal Of Environmental Studies and Management* 6(2)

Ayodele, E O and Alabi, O.M. (2011). Abandonment of construction projects in Nigeria: causes and effects; *Journal of Emerging trends in Economics and Management science (JETEMS)*, 2(2), 142-145.

Cohen, J.R (2001). Abandoned housing: exploring lessons from Baltimore. Housing policy Debate, 12(3), 415-448.

E.H. Yap, H.C. Tan and F.C. Chia. (2010). Causes of Abandoned Construction Projects. Retrieved From http//:www.researchgate.net/publication/263087852 on 29th November 2015 at 9:01am

Eziyi, O I. And Dominic E.A. (2011). Frameworkfor evaluating the sustainability of public housing programmes in developing countries*; Environmental journal of sustainable development and environmental protection.*

Fernandez, C. (2009, February 13). Abandoned projects mar Seremban's image. *The Star Online.* Retrieved December 20, 2009, from http://www.thestar.com.my/metro/story.asp?file=/2009/2/13/central/3212997&sec=central on 21st December 2015 at 10:55am

Hye-sung Han, (2013). The impact of abandoned properties on nearby property values: housing policy debate

Ijaz, A. And Ihsan U.B; Regional development planning- issues and realities. Retrieveed from http//:www.isocarp.net/data/case/649.pdf

Kontangora, O.O. (1993); Project Abandonment, Nigeria Tribune

Lim, C. Y. (2009, November 2). New builder on the scene. *The Star Online.* Retrieved December 20, 2009, from http://www.thestar.com.my/metro/story.asp?file=/2009/11/2/central/4981392&sec=central on 22nd January 2015 at 7:45am.

Maliene, V. And Malys N. (2009). High-quality housing. A Key Issue in delieveing Sustainable Communities, building and environment , 44: 426-430.

McLeod, S.A. (2014). Maslow's Hierarchy of Needs. Retrieved from http//:www.simplypsychology.org/maslow.html on 14th November 2015 at 2:30pm

Nenno, M.K. (1996). Ending the stalemate. University Press of America, Newyork

Ng, A. (2009b, November 7). CP Group shuns listing. *The Star Online*. Retrieved December 20, 2009, from http://biz.thestar.com.my/news/story.asp?file=/2009/11/7/business/5046706&sec=business on 18th December, 2015

O'Conner, A. (2005). Preplanning Semi vacant Homes. *Journal of Fire Engineering,* 158, 85-86.

Olapade, O. And Anthony, O. (2012). Abandonment of building projects in Nigeria- A review of the causes and solution. *International conference on chemical, civil and environmental engineering* (ICCEE'2012). March 24-25,2012.

Steven P. And Guy D. (2013). 12 features of sustainable community development: Social, Economic and Environment and two case studies. Retrieved From http//:www.cardinalgroup.ca/nua/ip/ipoi.htm. on 4th November , 2015 at 2:44pm

Steven, M.B. (2010). Analysing the problem of abandoned, vacant and unoccupied buildings in Middletown Ohio. Retrieved From http//:www.usfa.fema.gov on 12th 21st November,2015 at 5:37am

The world Bank Group, (2001). What is sustainable development. Retrieved from http//:www.worldbank.org/depweb/English/sd/html on 31st October at 11:47am

URBAN RESILIENCE AND ENERGY CONSERVATION

ADAPTATION OF PASSIVE COOLING STRATEGIES IN HOSTELS OF TERTIARY INSTITUTIONS, NIGER STATE.

BELLO Joseph Enesi, ORIWOH Akhabue and ADEDAYO Olatunde Folaranmi
Department of Architecture, Federal University of Technology, Minna, Niger State, Nigeria.

Hostel buildings serve to provide a low cost, safe and comfortable environment where students can relax after a hectic day of lecture and engage in activities that aid in the attainment of their academic pursuits. However, where factors relating to the building's micro-climate are not adequately considered costly mechanical systems may be required to maintain balanced indoor conditions especially in hot-humid climates. Passive cooling strategies focuses on how buildings can be adapted to the already changing climate to maximize occupant health and comfort by natural means. This paper shows the extent to which passive cooling strategies have been used in hostels of tertiary institutions in Niger State. Observation schedule and personal interviews were used to obtain data and analyzed using descriptive statistics. The results obtained from this study shows an average use of passive cooling techniques in hostel buildings which needs to be improved upon. Therefore as a result of the immense benefits inherent in passive cooling design of buildings, it is recommended that architects, planners and concerned parties in the building and construction industry emphasize a climate based design approach for building projects in Nigeria. Adopting the strategies will minimize energy consumption, provide comfortable indoor spaces for occupants and also support the agenda for a sustainable built environment.

Keywords: *Energy consumption, Hostel, Passive cooling, Thermal comfort.*

joebellobje@yahoo.com

arcadedayo@gmail.com

Bello, J.E et al (2016). **ADAPTATION OF PASSIVE COOLING STRATEGIES IN HOSTELS OF TERTIARY INSTITUTIONS, NIGER STATE** Sustainable Built Environment and Climate change; The challenges of Post 2015 Development Agenda. School of Environmental Technology Conference, SETIC, 2016

INTRODUCTION

Student hostels are a special type of residential building designed and erected for the purpose of providing low cost accommodation for students undergoing a training or programme in an educational institution. The words "hostel" and "hotel" are etymologically related and derived from the Latin word 'hospitale' which means a place of rest. The concept of hostel was introduced by a German school teacher Richard Schirrmann in 1909 who began a youth hostel movement to provide safe and affordable accommodation for students to travel and experience new things. The first hostel in the world, Alena Castle located on the Lenne river valley, West Germany was opened in 1912. Today there are many types of youth hostels of various kinds in many countries of the world (Stephen, 2011). The benefits students derive from hostel living cannot be over emphasized. It provides a better atmosphere for serious studies which may not be obtainable at home and also promotes learning through social interaction among students (Husainan, 2008). To enjoy these benefits, it is essential that the hostel environment is qualitative enough for students to live, sleep and perform activities that will enhance their physical, psychological and intellectual development. It has been revealed that man's physical strength and mental activities are optimum when they are satisfied with their physical environment including thermal comfort and indoor air quality, otherwise efficiency lessens with an increase in stress levels that may cause ill-health (Bako-Biro, Clements-Croome, Kochhar, Awbi and Williams, 2012).

The climatic conditions of hot humid regions requires that special design steps be taken in order to provide thermally comfortable spaces within buildings because of high humidity and indoor temperature. Hot humid regions are warm all year round with daytime maximum temperature of $30^oC – 35^oC$. There is little seasonal variation in the climate with a constant annual average temperature and humidity. Annual rainfall is greater than 1500mm and the range of average monthly temperature is 1-3^oC with a mean temperature of about 27^oC (Hyde, 2008).

According to Parlour (2000), cooling of buildings is a major issue in hot humid climates. Most of the year, 34% of energy is used to tackle cooling needs in a bid to lessen the effect of heat gain from solar radiation which in many cases is caused by poor design of the building envelope. This is usually accomplished through the use of mechanical air conditioning to maintain balanced indoor conditions resulting in high energy usage and high greenhouse gas emissions into the environment.

The design of climate responsive residential facilities offers better solutions in the drive towards achieving comfortable indoor spaces and sustainable environmental development rather than energy intensive buildings. By adopting passive cooling techniques to improve hostel environmental conditions, students' need for thermal comfort can be met at a minimal level of energy consumption and environmental impact. The influence of radiant heat, temperature, humidity, air movement and psycho-sociological factors play a vital part in the design process (Nyuk & Yu, 2009).

The aim of this study is to determine the extent to which various possible methods or techniques of passive cooling have been utilized in the design of hostel buildings of tertiary institutions in Niger state, Nigeria.

The Concept of Passive Cooling

Passive cooling is a subset of Passive solar design which involves the use of natural processes for heating or cooling to achieve balanced interior conditions. The flow of energy in passive design is by natural means: radiation, conduction, or convection without using any electrical device. It is heating or cooling without any form of energy input, other than renewable energy sources. In Passive cooling design, the flow of moving air is used to dissipate heat from a space by exchanging heat with cool air in order to achieve a lower internal temperature than that of the natural surroundings.

Most buildings currently run air conditioning systems to regulate the temperature, moisture content, circulation and purity of the air within their spaces, in order to achieve the desired comfort conditions for the occupants. The shortage of conventional energy sources and escalating energy costs have caused the re-examination of the general design practices and applications of air conditioning systems and the development of new technologies and processes for achieving comfort conditions in buildings by natural means.

According to Kamal (2012), to prevent heat from entering into the building or to remove once it has entered is the underlying principle for accomplishing cooling in passive cooling concepts. It involves technologies or design features adopted to reduce the temperature of buildings and also considers the local climate conditions of the site such that the health and comfort of building users can be maximized with minimal energy consumption. Renewable energy sources such as the wind and sun are used to improve thermal comfort and indoor environmental quality (Taleb, 2014). Passive cooling helps to maintain a comfortable environment within a building in a hot climate by reducing the rate of heat gain into the building and encouraging the removal of excess heat from the building (Agboola, 2011).

Strategies used in Passive Cooling design of buildings

There are several strategies or methods that can be used by designers to cool buildings naturally without the aid of mechanical air conditioning yet achieving comparable comfort levels and a resultant savings in energy consumption and atmospheric pollution. These methods function by controlling the amount of heat gain from solar radiation that can enter into the building and then reducing the effect of unwanted solar heat within the building envelope (The European Passive Solar Handbook, 1992).

Geetha and Velraj (2012) broadly categorized passive cooling strategies into three. Firstly, Heat prevention/reduction method (Reduce heat gains). This technique seeks to minimize internal heat gains from solar radiation in a building by adapting the building to the region's climate and micro-climate through appropriate use of landscape features and solar control measures such as shading, glazing and insulation of building elements to prevent high indoor temperatures. Secondly, thermal moderation method (Modify heat gains). This involves minimizing the effect of heat gain within the building through the use of thermal mass and night ventilation. Lastly, heat Dissipation method (Remove internal heat). This involves heat rejection from the building to heat sinks using strategies such as wind driven or displacement natural ventilation, evaporative, radiative or ground cooling.

Passive cooling methods can also be classified according to their cooling mechanisms. They are ventilative cooling, evaporative cooling, thermal mass, radiant cooling and dessicant dehumidification (Tantsavadi, Chenvidyakarn and Pichaisak, 2011). According to Ahsan (2009), passive cooling strategies may be classified into two. The first comprises those that involve planning such as site analysis, building form, building orientation, room orientation and landscaping while the second comprises those involving the building envelope such as external wall, thermal insulation, building material, roof, window sizes, orientation and shading.

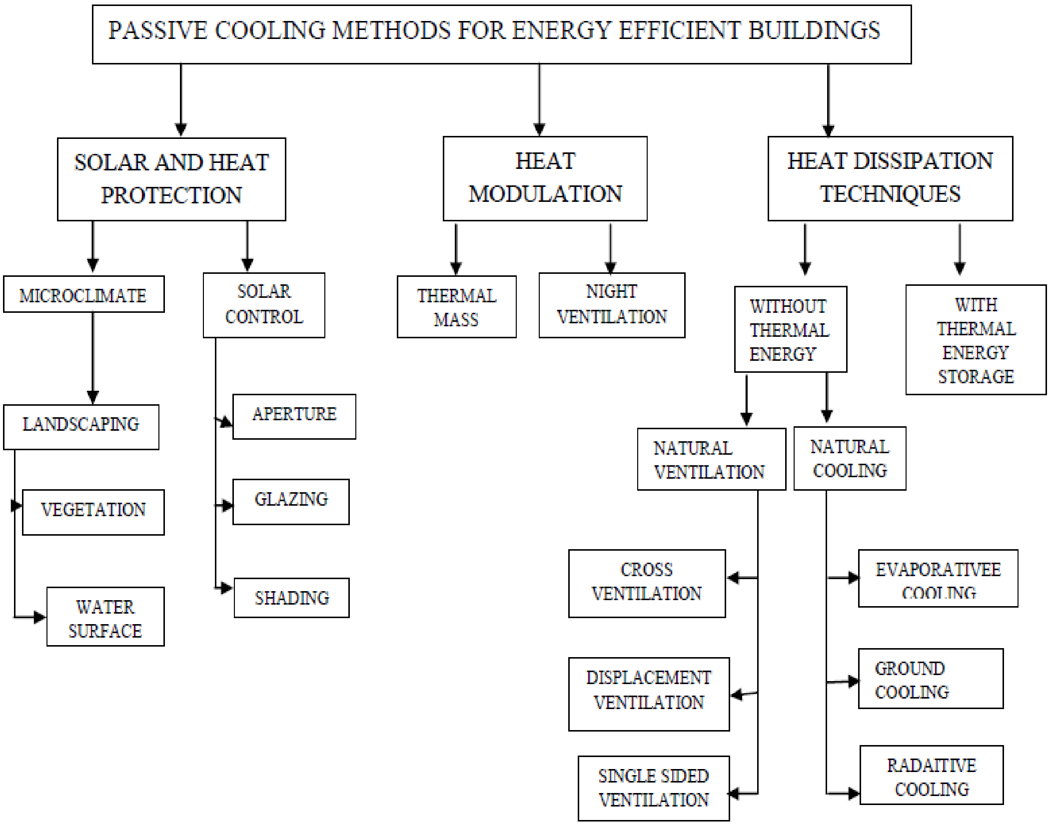


Fig. 1. Chart showing passive cooling techniques for energy efficient buildings.
Source: Gertha and Velraj (2012)

Likewise, Hyde (2008) stated that strategies that minimize cooling needs in warm and hot climates should include; climate responsive layout of the area and orientation of the building façade's windows, adequate size and details of window openings, the use of shading devices for fenestrations, the use of insulation, the inclusion of vegetation in the building's surrounding's and the use of courtyards.

RESEARCH METHOD

This study involved a research survey into the adoption of passive cooling techniques in the design of hostel buildings of tertiary institutions in Niger State. It involved the use of a structured observation schedule and personal interviews to provide basis for the analysis of the study. A field trip was undertaken in September, 2015 and 9 randomly selected hostels located in 5 tertiary institutions in Niger state were studied.

Table 1: Surveyed Institutions and Hostels

S/N	NAME OF INSTITUTION	NUMBER OF HOSTELS STUDIED	NAME OF HOSTEL
1	Federal University of Technology, Minna, Niger State	2	P Block Bosso Campus FUT, Minna
			A Block Gidan Kwano Campus FUT, Minna
2	Ibrahim Badamasi Babangida University, Lapai, Niger State	1	B Block IBB University, Lapai
3	The Federal Polytechnic Bida, Niger State	1	A Block Federal Polytechnic Bida
4	Niger State Polytechnic, Zungeru	2	C Block Federal Polytechnic Zungeru
			D Block Federal Polytechnic Zungeru
5	Federal College of Education, Kotangora, Niger State	3	NCE Block FCE Kotangora
			Undergraduate Block A FCE Kotangora
			Undergraduate Block B FCE Kotangora

Source: Field work, 2015

The method of selection of the hostels were based on those tertiary institutions within the study area having standard student accommodation as well as high student population and were available for study. The data collected from the field were analyzed using descriptive statistics.

FINDINGS AND DISCUSSION OF RESULTS

The results obtained from the research are discussed based on the observations made and highlights the analysis of passive cooling strategies adopted in hostels of tertiary institutions in Niger state.

Building Orientation to Minimize Solar Heat Gain and Maximize Air Flow

Orientation is a major design consideration that affects the amount of solar radiation and wind flow that a building experiences. It affects the amount of heat gained through the building's envelope and increases the cooling load. It also determines how fenestrations are designed to maximize natural airflow. In tropical climates like Nigeria, the best orientation is for long facades to face the north and south directions as the east and west directions receive maximum solar radiation during summer. In relation to the sun path and hostel orientation, table 2.0 shows that 11.1% of the buildings were very adequate, 77.8% were adequate and 11.1% were not adequate while for wind orientation, 44.4% were very adequate, 11.1% were adequate and 44.4% not adequate. This shows that more emphasis was laid on solar orientation. Compromise between sun and wind orientation can be made through landscape design to modify or deflect available winds.

Table 2.0: Building Orientation to Minimize Solar Heat Gain and Maximize Airflow

0	**NAME OF HOSTEL**	**BUILDING SHAPE**	**BUILDING ORIENTATION**	**SOLAR ORIENTATION (E-W AXIS IDEAL)**	**WIND – ORIENTATION (NW - SE AXIS IDEAL)**
1	P Block Bosso Campus FUT, Minna	Rectangular	NE – SW	Adequate	Very Adequate
2	A Block Gidan Kwano Campus FUT, Minna	Rectangular	NW – SE	Adequate	Very Adequate
3	B Block IBB University, Lapai	Rectangular	NW – SE	Adequate	Not Adequate
4	A Block Federal Polytechnic Bida	Rectangular	NW – SE	Adequate	Not Adequate
5	C Block Federal Polytechnic Zungeru	Rectangular	E – W	Very Adequate	Adequate
6	D Block Federal Polytechnic Zungeru	Rectangular	N – S	Not Adequate	Not Adequate
7	NCE Block FCE Kotangora	Rectangular	NE – SW	Adequate	Very Adequate
8	Undergraduate Block A FCE Kotangora	Rectangular	NW –SE	Adequate	Not Adequate
9	Undergraduate Block B FCE Kotangora	Rectangular	NE – SW	Adequate	Very Adequate

Source: Fieldwork, 2015

The Use of Landscape/ Vegetation to Minimize Heat Gain

Landscaping by vegetation is an effective way of altering the micro-climate around buildings through evapotranspiration. Trees act as buffer to lower air/ surface temperatures, increase the relative humidity, control air pollution and contribute to natural cooling. They also help shade the building from intense radiation and heat island effect. Deciduous trees provide shade in summer and sunlight in winter when their leaves are shed while evergreen trees provide shade and wind control all year round. Table 3.0 shows the presence of trees in 88.9% of the buildings, 22.2% had shrubs and 55.6% had lawns. Only 11.1% of the buildings had trees, shrubs and lawn, 22.2% had trees and shrubs and 44.4% had trees and lawns.

Table 3.0: The use of landscape to minimize heat gain

S/N	NAME OF HOSTEL	VEGETATION		
		TREES	SHRUBS	LAWNS
1	P Block Bosso Campus FUT, Minna	YES	NO	YES
2	A Block Gidan Kwano Campus FUT, Minna	YES	NO	YES
3	B Block IBB University, Lapai	YES	YES	YES
4	A Block Federal Polytechnic Bida	YES	YES	NO
5	C Block Federal Polytechnic Zungeru	YES	NO	YES
6	D Block Federal Polytechnic Zungeru	YES	NO	YES
7	NCE Block FCE Kotangora	NO	NO	NO
8	Undergraduate Block A FCE Kotangora	YES	NO	NO
9	Undergraduate Block B FCE Kotangora	YES	NO	NO

Source: Fieldwork, 2015

Fig. 2. B Block Hostel IBB University, Lapai

Fig. 3 C Block Hostel Niger State Polytechnic Zungeru

Figures 2 and 3 showing the use of Landscape vegetation in hostels. Source: Fieldwork, 2015

The Use of Shading Devices for Heat Protection

Shading devices are necessary to shade buildings from the sun to minimize heat gain. Shading devices placed outside windows block sunlight before it reaches the glass and also enhance the effect of natural ventilation. Shading devices can be fixed or adjustable. The art and form of windows strongly depend on the location of the windows. For North – South facades horizontal shading devices are more effective while vertical shading devices are best for East – West facades.

Table 4.0: The use of shading devices for heat protection

S/N	HOSTEL	PRESENCE OF SHADING DEVICE	TYPE OF SHADING DEVICE			LOCATION OF SHADING DEVICE	
			VERTICAL	HORIZONTAL	EGG CRATE	N – S	E – W
1	P Block Bosso Campus FUT, Minna	YES	YES	NO	NO	YES	NO
2	A Block Gidan Kwano Campus FUT, Minna	YES	NO	NO	YES	YES	YES
3	B Block IBB University, Lapai	YES	NO	NO	YES	YES	YES
4	A Block Federal Polytechnic Bida	YES	YES	NO	NO		YES
5	C Block Federal Polytechnic Zungeru	YES	NO	NO	YES	YES	NO
6	D Block Federal Polytechnic Zungeru	YES	NO	NO	YES	NO	YES
7	NCE Block FCE Kotangora	NO	NO	NO	NO	NO	NO
8	Undergraduate Block A FCE Kotangora	NO	NO	NO	NO	NO	NO
9	Undergraduate Block B FCE Kotangora	YES	YES	NO	NO	YES	NO

Source: Fieldwork, 2015

Table 4.0 shows the presence of shading devices in 77.8% of the buildings. 33.3% of the buildings had vertical shading devices, none used horizontal shading devices while 44.4% used egg –crate shading devices. 55.6% of the buildings had shading devices located along the North and South facades while 44.4% had them along the East – West facades

Fig. 4 B Block hostel, Gidan Kwano Campus FUT Minna

Fig. 5 Undergraduate hostel A, FCE Kotangora

Figures 4 and 5 showing the use of shading devices and casement windows respectively
Source: Fieldwork, 2015

Window Type, Location and Shading

Windows provide natural ventilation and light into a building as well as a view out. They can also be a major source of solar heat gain when exposed to direct sunlight. Therefore, proper location, sizing, shading and detailing are important factors that must be considered in its design. Windows should be placed according to the direction of wind and be well protected from the sun. Double glazing is also recommended as it minimizes heat loss in winter and reduces heat gain in summer.

Table 5.0: Window type, Location and Shading

S/N	HOSTEL	TYPE OF WINDOWS			SHADING OF WINDOW	LOCATION OF WINDOW	
		CASEMENT	SLIDING	LOUVRES		N – S	E – W
1	P Block Bosso Campus FUT, Minna	YES	NO	YES	YES	YES	YES
2	A Block Gidan Kwano Campus FUT, Minna	YES	NO	YES	YES	YES	YES
3	B Block IBB University, Lapai	NO	YES	NO	YES	YES	YES
4	A Block Federal Polytechnic Bida	NO	NO	YES	YES	YES	YES
5	C Block Federal Polytechnic Zungeru	YES	NO	NO	YES	YES	NO
6	D Block Federal Polytechnic Zungeru	YES	NO	NO	YES	NO	YES
7	NCE Block FCE Kotangora	NO	NO	YES	NO	YES	YES
8	Undergraduate Block A FCE Kotangora	NO	YES	NO	NO	YES	YES
9	Undergraduate Block B FCE Kotangora	YES	NO	NO	YES	YES	YES

Source: Researcher’s fieldwork (2015)

Table 5.0 shows that 55.6% of the buildings made use of casement windows, 22.2% sliding windows and 44.4% louvered windows. 77.8% of the buildings had their windows shaded and 88.9% had windows located in both the north – south façade and east – west façade.

The Use of Natural Ventilation for Heat Removal

Ventilation involves an exchange of air between the inside and outside of a building. It has three major functions: supply of fresh air, body cooling and structural cooling. Natural ventilation is generated by either wind driven or thermal (displacement) buoyancy. There are basically three types of natural ventilation. Single sided ventilation, cross ventilation and stack ventilation. In single sided ventilation fresh air enters through the same side as exhaust air. Ventilation air does not penetrate far into the space while in cross ventilation air moves from the windward side to the leeward side. Stack ventilation requires that fresh air enter from a low level window and is exhausted from a high level window.

Table 6.0: Natural ventilation for removal of heat

S/N	NAME OF HOSTEL	SINGLE SIDED	CROSS – VENTILATION	STACK VENTILATION
1	P Block Bosso Campus FUT, Minna	NO	YES	NO
2	A Block Gidan Kwano Campus FUT, Minna	NO	YES	NO
3	B Block IBB University, Lapai	NO	YES	NO
4	A Block Federal Polytechnic Bida	NO	NO	YES
5	C Block Federal Polytechnic Zungeru	NO	NO	YES
6	D Block Federal Polytechnic Zungeru	NO	NO	YES
7	NCE Block FCE Kotangora	NO	YES	NO
8	Undergraduate Block A FCE Kotangora	NO	YES	NO
9	Undergraduate Block B FCE Kotangora	YES	NO	NO

Source: Fieldwork, 2015

Table 6.0 shows that 11.1% of the buildings operated on single sided ventilation five 55.6% made use of cross ventilation and 33.3% made use of stack ventilation.

CONCLUSION

The application of different passive cooling strategies can be influenced by factors ranging from climatic, cultural and situational issues but the most important factor to consider is the climate. The research examined six (6) passive cooling design strategies in hostels of tertiary institutions in Niger state. The Study showed that most of the hostels were designed and built with limited number of passive cooling measures and thus will require some form of mechanical assistance to improve interior conditions It is important that building designers understand the principles of passive cooling and how they apply to student hostels and that they incorporate passive cooling strategies right from the initial design phase. This will make the building more climate responsive and environmentally friendly as their dependency on mechanical means for thermal comfort will be largely eliminated. The implementation of passive cooling design strategies such as building orientation, the use of landscape vegetation and, shading techniques, for solar control, thermal insulation and thermal mass materials for buildings, natural ventilation and other passive cooling techniques needs to be explored much more so that better solutions can be discovered for hot humid climates.

REFERENCES

Agboola O. P. (2011). Importance of Climate to Architectural Designs in Nigeria *Journal of Environmental Issues and Agriculture in Developing Countries, Volume 3 number 1, April 2011*

Ahsan, T (2009). Passive Design Features for Energy-Efficient Residential Buildings in Tropical climates: the context of Dhaka, Bangladesh. *MA. Environmental Strategies Research Group-fms, KTH-Royal Institute of Technology.*

Ajibola K (2001). Design for comfort in Nigeria – A Bioclimatic Approach. Oxford U.K, Pergamon, J. *Renewable Energy*, 23:57-76

Bako-Biro, Z., Clements-Croome, D.J., Kochhar, N. Awbi, H.B. and Williams, M.J. (2012) Ventilation rates in schools and pupils` performance. *Building and Environment* 2012; 48; 215-223.

Geetha N. B. and Velraj R. (2012), Passive cooling methods for efficient buildings with and without thermal energy storage – A review. Energy Education Science and Technology Part A: *Energy Science and Research 2012* volume (issues) 29(2): 913-946. Anna University, institute for energy studies, college of engineering, Chennai, India

Hassanain, M.A. (2008). "On the performance evaluation of sustainable student housing facilities", *Journal of Facilities Management*, Vol. 6 No. 3, pp. 212-25.

Hyde, R. A (2008). *Bioclimatic Housing: Innovative designs for warm climates.* Cromwell press, Trowbridge, UK.

Kamal, M. A. (2012). An Overview of Passive Cooling Techniques in Buildings: Design Concepts and Architectural Interventions. *Acta Technica Napocensis: Civil Engineering and Architecture* Vol: 55 No: 01

Nyuk, H., & Yu, C. (2009). *Tropical Urban Heat Islands: Climate Buildings and Greenery*. London: Taylor & Francis Group

Parlour, R. (2000). Building Services; A Guide to Integrated Design- Engineering for Architects, Integral Publishing, Pymble. ISBN 0646342606

Stephen (2011). A brief history of hostelling international. Retrieved from http://blog.hihostels.com/2011/05/brief-history-of-hostelling/

Taleb M. Hanan (2014). Using Passive cooling strategies to improve thermal performance and reduce energy consumption of residential buildings in United Arab Emirate buildings.

Tantasavasdi, C, Chenvidyakarn, T and Pichaisak, M (2011). Integrative passive design for climate change: A new approach for tropical house design in the 21st Century.

The European Passive Solar Handbook (1992). Energy in Architecture, the Energy Research Group, School of Architecture, University College, Dublin

RESILIENT CITIES AS A PIVOTAL COMPONENT OF CLIMATE VARIABILITY MITIGATION: LESSON FOR NIGERIAN CITIES

Medayese, O.B., Abd'Razack, N.T.A, Medayese, S.O and Dalil, M
Department of Urban and Regional Planning, School of Environmental Technology, Federal University of Technology, Minna, Niger State Nigeria

An important way in which climate variability affect humanity is through its effects on human settlements, especially cities. Cities are engine for civilization, primary generators of human wealth and social interaction. Climate variability could affect the sustainability of human settlements through its impact on quality of life, flooding, pollution, demand for water, assimilation capacity of wetlands and changing the economic underpinnings of the settlement through changing productivity of croplands, forests, and fisheries etc. The aim of this paper is to explore the various global case studies on designing resilient cities across the global landscape. The methodology adopted for this research is a comprehensive review of literature on the pivotal role of building resilient cities in changing climate at the global level, exploring regional disparities in building resilient settlements; and the situation in the third world countries. Extant literature have shown that, while, most advanced economies and nations are breaking new grounds in building resilient cities, the sub-Saharan Africa are still enmeshed in acute web of Poverty, Food insecurity, Maternal and Infant Mortality, Perennial Flooding and other environmental issues thereby shifting their focus from the dangers of climate variability and its overall impact on their survival. It is therefore imperative for these third world countries to begin an integrated analysis of their challenges and mark the nexus between the various challenges observed in the human settlement and the scenarios of the global changing climate. It is therefore concluded that priority is necessary to build resilient cities in Africa to combat the menace of climate variability.

Key Words: Variability, Climate change, Poverty, Cities, Sustainability, Challenges

wummore@yahoo.com

Medayese et. al. (2016). **RESILIENT CITIES AS A PIVOTAL COMPONENT OF CLIMATE VARIABILI TY MITIGATION: LESSON FOR NIGERIAN CITIES** Sustainable Built Environment and Climate change; The c hallenges of Post 2015 Development Agenda. School of Environmental Technology Conference, SETIC, 2016

Introduction

Resilience is a term that emerged from the field of ecology in the 1970s, to describe the capacity of a system to maintain or recover functionality in the event of disruption or disturbance. It is applicable to cities because they are complex systems that are constantly adapting to changing circumstances. Resilience is the capacity of a community or society to adapt and react when exposed to a hazard in order to reach or maintain an acceptable level of functioning. A resilient city is one that is able to cope with disaster and climate impacts now and in the future, thereby limiting the magnitude and severity of those impacts. Given the close links between disaster risks and climate risks, efforts to build resilience in cities by integrating climate change adaptation with existing efforts in disaster risk management can be beneficial. However, even if strongly intertwined, adaptation is different from disaster risk reduction. Adaptation to climate change requires cities to plan based on current exposure but also on projected future changes that may unfold through gradual incremental changes (e.g., temperature increases) as well as extreme events (e.g., heat waves). Prasad 2009 explained resilient cities in the light of climate change as been able to develop plans for future development and growth bearing in mind the climate impacts that the urban systems are likely to face, Ensuring long term sustainability and preparedness to climate change. Climate resilient cities are distinct because of their capability to reduce and manage the negative impacts of climate change because they have planned and factored these changes in their development goals and planning by:

- Utilizing climate information (past and future) to identify climate stressors typical to their cities/region
- Preparing and implementing strategies to reduce vulnerability of population and city systems.
- Adapting to change, preparing and responding to disasters, mitigating GHG emissions.

Urban centers nowadays hold more than half the world's population (United Nations, 2012), and much of the gross domestic product (GDP) of most nations is concentrated there (World Bank, 2008). Most of the population in wealthy nations live in urban areas, and rapid urbanization is also occurring in low and middle-income nations as they experience rapid economic growth and associated increasing needs for critical resources such as water and energy. According to the last IPCC report on Impacts, Adaptation and Vulnerabilities (IPCC, 2014), rapid urbanization has been accompanied by rapid growth of highly vulnerable communities associated with low adaptive capacity.

Future demographic projections suggest that the global population will keep growing this century (United Nations, 2006), and that the world´s population living in the largest agglomerations will be exposed to the direct impacts of climate change. According to the Urban Chapter of the latest IPCC assessment (2014) some of the urban risks related to climate change include storm surges, heat stress, extreme precipitation, inland and coastal flooding, landslides, drought, increased aridity, water scarcity and air pollution. Drought can have many effects in urban areas, including increases in water and electricity shortages. Rising sea levels, storm surge and heavy rainfall could have large effects on populations and infrastructure (Nicholls, 2004), while saline intrusion as a result of sea level rise could also constrain groundwater availability and quality. Climate change also creates several challenges for air quality, drinking water, food security and shelter (WHO/WMO, 2012 and Barata *et al.*, 2011).

While Climate changes is defined by the Intergovernmental Panel on Climate Change (IPCC) is a change in the state of the climate that can be identified by changes in the mean and /or the variability of its properties, and that persists for an extended period, typically decades or longer. It is a long-term continuous change (increase or decrease) in the average weather conditions (e.g. average temperature) both climate change and climate variability can happen simultaneously. Long-term means at least many decades. Climate change is slow and gradual, and unlike year-to-year variability, is very difficult to perceive without scientific records.

The United Nations Framework Convention on Climate Change (UNFCCC) also defines climate change as the change that can be attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods. Climate variability in essence is the way climate fluctuates yearly above or below a long-term average value. Climate variability refers to variations in the mean state and other statistics (such as standard deviations, the occurrence of extremes, etc.) of the climate on all temporal and spatial scales beyond that of individual weather events.

Need For Resilient Cities

Abundant evidence on resource consumption and emissions, biodiversity and land use change shows that cities are responsible for many of the unsustainable trends which push the planet beyond its ecological boundaries (Alberti 1999, 2003). These urban contributions to global challenges are likely to continue, given that urban population is expected to increase 25% by 2050, leading to a global population of 9.3 billion (UN 2012). We argue that global sustainability pivots largely on cities, and that meeting this challenge requires an urgent change in urban policy making and planning.

Perspectives Around The World

Resilience comes at a cost, and understanding the impacts of global environmental change on infrastructure systems is an urgent task. City dwellers find themselves served by infrastructure that has been in place for decades, or even centuries, and which was not designed to meet the needs of today. Urban populations nowadays are much larger than they were during the original construction of roads, train lines, electricity and water distribution networks and drainage systems, to name but a few. Other causes are the inadequacy of existing infrastructure including lack of maintenance and low public awareness. Leading to issues of flooding resulting from blocked drains, roads becoming dangerous, and ineffective waste management creating health problems. Some examples of positive steps being taken in terms of improving the climate resilience of urban infrastructure included:

Infrastructure systems and services including transportation, sanitation, waste management, energy provision, and communications are at the heart of urban life and development. In order to simultaneously accommodate urban growth and unavoidable climate change impacts, cities are advised to embed resilience thinking into current and future infrastructure decisions and investments. The first step is to understand how different systems intersect. One concept, presented by Resilient Regions Association, explains the city as a symbiotic system of six Urban Flows: goods, services, money, people, energy, and information. Disasters and other disruptions can shake the operability of these flows, jeopardizing the whole functionality of a city. *Green infrastructure is an interconnected network of open and green spaces, both natural and designed, that can provide multiple functions and services such as water and air purification, aesthetics, cultural and socio-economic benefits, recreation, and habitat." (Kato 2013).*

Green infrastructure (GI) is praised for providing a range of co-benefits with relatively low operating costs and energy requirements. However, GI solutions are not always the best option, and may be hindered by a lack of awareness, space, or initial funding. UNPDHI's Green Infrastructure Guide for Water Management prompts cities to use available tools, compare results, and make informed decisions for green or gray infrastructure. In the cases of ***Howard Beach, New York, USA and the City of Essen, Germany, a hybrid "green gray" approach proved to be the best way to reduce flooding and leverage co-benefits. Mining heat from urban infrastructure Observed temperatures in cities are often several degrees higher than in their rural counterparts – a phenomenon that will be exacerbated in some cities by climate change.*** Several architectural and green/blue infrastructure solutions have been identified to mitigate the Urban Heat Island (UHI) effect. These include simple strategies like ***painting rooftops white to increase reflectivity (albedo), ecosystem based approaches like routing streams through urban areas and planting trees, and more complex regulations for building design and materials.*** As the UHI effect intensifies, cities may consider more innovative methods such as converting waste heat to energy, or urban zoning according to energy demand (i.e. building multi-family residential homes next to hospitals for sharing/reusing energy from space heating and cooling).

According to the IPCC (2007) report, the transport sector accounted for 23% of the world's greenhouse gas emissions related to energy in 2004, although in some cities, the percentage is much higher, a reflection of local land use and mobility patterns. Cities are adopting a range of strategies to reduce transport-related emissions, including promoting transit-oriented development, reclaiming roadways to provide more space for bicycles and pedestrian walkways, and increasing the amount of mass transit systems available around the city. Regulatory and pricing instruments are also increasingly being deployed to reduce the volume, timing, or location of private vehicle use, often with significant impact. ***In London, a congestion pricing program resulted in a 12% decrease in traffic levels in the congestion pricing zone, while in Stockholm; there was a 22% reduction in vehicle passages in the congestion zone. Beijing, Bogota, and Mexico City have all pursued limits on the number of days vehicles can be driven, but this approach may penalize households in locations where public transportation is inadequate. Other cities have focused on promoting more efficient fuels and technology as a means of reducing transport-related***

carbon emissions. In Delhi, for instance, all public transport buses were converted to compressed natural gas (CNG)-operated systems, in response to public action and right-to-clean-air campaigns that brought the issue to the attention of the Supreme Court of India. The Court subsequently issued a series of judgments regulating public transport and air quality.(Rosenzweig et al., 2011)

Mumbai city recognizes 20 discrete vulnerabilities, including inadequate water and sewage systems and much of its building stock being in a state of imminent collapse. Many of these challenges have not been fully addressed, but Mumbai has taken several steps to mitigate the damage of flooding from heavy rainfall and cyclones. Several of its main rivers have been deepened and widened with the excavation of millions of cubic meters of silt and rock; storm water runoff systems have been de-silted and expanded with new pumping stations to discharge storm water to the sea; flow gauges have been installed upriver to provide early warning of river flooding; and four Cyclone Mitigation Shelters have been built with the help of the World Bank.

New York City's resilience, as demonstrated following Super storm Sandy in 2012, and, previously, after the 9/11 terrorist attack in 2001. This was due to the city's relative prosperity, but also to collective identity and effective city leadership. These factors meant that people were willing to help each other and unite around the common goal of getting the city back to normal as quickly as possible. Emergency plans were in place that meant that urban systems and services were rapidly reinstated and civil order was maintained. Wealthier cities are not necessarily more resilient, as demonstrated by the decline of the US city of Detroit, which became overly dependent on a single industry, or the flooding which brought Bangkok, Thailand, to a standstill in 2010, affecting supply chains globally. Conversely, relatively poor cities can make choices that build resilience. Gorakhpur, India, is working to build resilience at the ward level in response to annual water logging in poorer parts of the city. By improving solid waste management practices to unblock drains, and increasing drainage of waterlogged areas, the city has reduced incidences of diseases such as malaria and Japanese encephalitis, which are spread by vectors that breed in water logged areas.

Urban agriculture can be briefly defined as the growing of plants and trees and rearing of livestock within or on the fringe of cities (intra-urban and peri urban agriculture, respectively), including related input provision, processing and marketing activities and services (Smit *et al*., 1996). Many national and local authorities, especially in developing countries, previously viewed intra-urban agriculture mainly as a source of problems (due to perceived health and environmental risks associated with it as well as being a nuisance to traffic and neighbors), or at best as a survival option for the urban poor in times of crisis. Peri-urban agriculture was mainly seen as a temporary use of land until such time as this open space would be incorporated into the city and developed for other uses (Bourque 2000). Peri urban agriculture uses urban resources (land, labor and urban organic wastes), grows produce for urban citizens, is strongly influenced by urban conditions (urban policies and regulations, high competition for land, urban markets, prices, etc.) and impacts the urban system (having effects on urban food security and poverty, as well as having impacts on ecology and health). If fundamental climate change mitigation and adaptation goals are to be met, agriculture needs to be included in the strategies to be developed (IPCC, 2014). Innovations in urban agriculture can play an important role in mitigating the impacts of climate change, and are also an effective tool for adaptation. Urban agriculture itself is characterized by innovation and adaptation to specific urban needs. These innovations include micro-gardens, which can provide an emergency food source in the context of disaster risk management; green rooftops, which represent a built environment adaptation to climate change impacts; planting of trees, which serve as green "lungs" contributing to improved air quality; and rainwater harvesting systems, which can help lessen the effects of flooding.

The urban demand for fresh water is rising rapidly and availability of fresh water is becoming a serious problem (UNESCO 2003). At the same time, rapid urbanization and changing consumption patterns lead to the generation of vast amounts of urban wastes and wastewater, the management of which is a growing concern and high cost for many cities (Veenhuizen 2007). In most developing countries, only a small proportion of urban wastewater is treated and most of it is discharged untreated into the environment (Obuobie 2006). Most of the solid wastes, if they are collected at all, are disposed in dump sites (Drechsel & Kunze 2001). Climate change adds to the challenges faced by cities and is recognized as one of the most serious environmental, societal and economic challenges (IPCC 2007). The UN Populations Fund (UNFPA) indicates that climate change disproportionately affects people 'who live in slum and squatter settlements on steep hillsides, in poorly drained areas, or in low-lying coastal zones' (UNFPA 2007). Peri urban agriculture can play a role in improving the urban environment and adaptation to climate change (and to a lesser extent in mitigation). The World Meteorological Organization (WMO) suggested that more urban farming should take place as a response to climate change and as a way to build more resilient cities (WMO, 2008). Urban agriculture and urban forestry were also mentioned at the International Conference Urban Challenges and Poverty Reduction in African, Caribbean and Pacific Countries, jointly organized by World Bank and the European Union in Nairobi in June 2009, as having a high potential for improving the urban environment and climate change adaptation (UN-Habitat, 2009). FAO concluded that it is crucial to build more resilient cities by enhancing local food production and diminishing the dependency on food imports (FAO, 2008).

Urban agriculture helps cities to improve the urban environment and become more resilient by:

Reducing vulnerability of specific urban groups and strengthening community-based adaptive management by diversifying urban food sources and income opportunities of the urban poor and being a source of innovation and learning about new strategies/technologies for land and water-efficient food production (Smit & Bailkey, 2006).

Maintaining green open spaces and enhancing vegetation cover in the city with important adaptive (and some mitigation) benefits. (including urban forestry) helps to improve the urban microclimate (Tidball & Krasny 2006). Urban agriculture may also prevent building on risk-prone land, and by maintaining such areas as, for instance, agro forestry spaces, not only are the impacts of climate change due to flooding, landslides and other disasters reduced but also urban biodiversity and living conditions are improved (Dubbeling, 2009). Such open green spaces also help to control storm water flows by allowing water storage and increased infiltration of excess storm water (Dubbeling 2009a). open green spaces in and around the city, food production can be combined with other services to urban citizens, such as agro-tourism (Jiang, 2005) or park and landscape maintenance (e.g. 'productive parks'; Lattuca, 2005).

Reducing energy use and greenhouse gas emissions by producing fresh food close to the city: The UN Comprehensive Framework for Action of the High Level Task Force on the global Food Crisis (FAO, 2008) states: 'A paradigm shift in design and urban planning is needed that aims at reducing the distance for transporting food by encouraging local food production, where feasible, within city boundaries and especially in immediate surroundings'. The current food system in many industrialized countries uses over four times more energy in the process of getting food from the farm to the plate than is used in the farming practice itself (Heinberg & Bomford, 2009) and many cities in developing countries are moving quickly in that same direction. Encouraging food production close to cities helps in reducing the ecological foot- (and food-) print of the city, which may also enable synergistic and cyclical processes between urban domestic and industrial sectors and agriculture, for example the use in greenhouses of excess heat, cooling water or CO_2 from industry (Smeets, 2007).

Decentralized reuse of wastewater and composted organic waste in urban agriculture Productive reuse of wastewater in urban agriculture will help to reduce the demand for fresh water supplies as well as reducing the discharge of wastewater into rivers, canals and other surface water sources and thus diminish their pollution (Buechler *et al.*, 2006). Use of urban wastewater as a source of irrigation will help to adapt to risks of drought and flooded roads (hampering the transport of food from rural areas) by facilitating year-round production close by. Urban wastewater can be recycled for irrigation/ fertilization of horticultural crops, i.e. floriculture and fruit crops, as well as for irrigation of forest plantations that combat desertification and provide wood for fuel. In many cities, attempts to decrease pressure on wood energy (fuel wood and charcoal) by subsidizing gas or electric technologies have not succeeded. The prognosis for many regions, such as in sub-Saharan Africa, is that wood will continue to be the main source of energy for cooking and heating of the majority of their population (Baudoin & Drescher, 2008). Forest plantations can turn steep slopes and low-lying lands into urban 'green areas'.

There are important relationships between *biophilia* or *biophilic cities* and urban sustainability and resilience and, more specifically, that the former helps to advance the latter. That is movement in the direction of making cities greener, more natural, more *biophilic,* will also help to make them more resilient. There are many pathways from biophilic design and urban biophilia to urban resilience, many ways in which the conditions of green and biophilic cities will also serve to make a city more resilient in the long run, ecologically, economically and socially. Some of these biophilic pathways are direct: as when investments in green infrastructure (say restoring wetlands or planting drought tolerant vegetation in cities) serves to yield resilience benefits and outcomes (e.g., reduced summer temperatures, reduced flooding from coastal storms). There are a number of primary pathways, we believe, by which biophilic cities or biophilic urbanism will enhance or increase urban resilience. Some of these pathways and relationships have been well-researched and well-established. Others are more tentative and in need of additional work.

One of the clearest pathways is biophysical, the resilience benefits provided through the protection and enhancement of the natural systems and features in and around a city. We know that the green infrastructure of a city and region—rivers and riparian areas, floodplains and wetlands and large swaths of forested land—all provide essential services, that help cities and urban regions respond to and spring back from climatic and natural events. Cities with large natural wetland systems will be better able to absorb flood waters from hurricanes and storms, for instance. In New Orleans, for instance, vulnerability to storms and flooding has been significantly increased as a result of a long history of wetlands alterations. Costanza and Mitsch 2006 have argued compellingly for giving renewed importance to preserving and protecting an intact system of wetlands around New Orleans as a key strategy for long term resilience. These flood protection services carry a considerable economic value that must be recognized: ―Had the original wetlands been intact and levees in better shape, a substantial portion of the US$100 billion plus damages from this hurricane [Katrina] probably could have been avoided (Costanza 2006). In a more recent paper, Costanza and colleagues estimate that coastal wetlands provide some $23 billion a year in hurricane protection benefits (Costanza 2008). It has been estimated that every mile of protected forested cypress swamp in Louisiana, reduces flood surge heights by a foot or more. Protecting and restoring these larger ecological systems is a wise move in becoming more disaster-resilient.

Recent planning and policy initiatives around water and water supply for cities further suggest the direct resilience benefits of green infrastructure for enhancing water supply and water system resilience. The story of New York City's investment in the conservation and protection of its upper watersheds in the Catskills Mountains is suggestive of the power of this framework. Here, the city has invested in acquisition and long term management of land (more than 70,000 acres protected through fee-simple or less-than-fee simple acquisition), a far more cost-effective method than the multi-billion dollar costs of water filtration plants and a model strongly supporting green or ecological infrastructure (USEPA, 2013).

Cities with extensive tree canopy coverage provide many ecological benefits that will make cities more resilient—including moderation of air pollutants, cooling through evapo-transpiration and shading and reduction in urban flooding and runoff. Protection and restoration of urban streams and rivers will reduce vulnerability again to floods, provide important cooling benefits and help to moderate the weather and temperature changes predicted as a result of climate change (e.g., east coast American cities are predicted to have substantially higher summer highs by 2050). The cumulative impacts of green features, such as green rooftops and vertical gardens, can be significant indeed. In Toronto, the first North American city to now mandate installation of green rooftops for roofs over a certain size, estimates suggest that conversion of flat roofs to green rooftops would reduce urban temperatures by 1.5 degree Celsius or more (Ryserson, 2005).

Cities with more extensive networks of parks and green spaces (though their design and configuration will matter) are also likely to fare better in the face of long term climate change. The City of Brisbane, Australia, a remarkably green city, aspires to create a connected network of natural areas, with topographic variation and diversity that will allow native biodiversity to adapt and shift as climate changes (Beatley, 2008). Trees and natural vegetation in cities and urban neighborhoods can help protect property and reduce damage from wind, rain and flooding. Some communities, such as Charleston County, SC, have developed programs for encouraging hazard-resistant landscaping‖, planting native trees, such as live oaks, that tend to fare well in the face of high winds (Hazard Resistant Landscape, 2013). Working to make a neighborhood or community's landscape more resilient means finding ways to insert trees, landscaping, green rooftops and use of water sensitive urban design features, such as bio-swales and rain gardens.

A Case for Urban Resilience in Nigeria

In many human settlements, current and potential dangers posed by rainstorms and related hydro-meteorological disasters can hardly be overlooked, however, the manifest devastating effects on life and property can be reduced or completely eliminated by instituting principles of sustainable urban management. Building community resilience is one of the ways to reduce the effects of disasters (Tall, Patt, and Fritz, 2013). Flooding is becoming an increasingly severe and more frequent problem in African cities. Unfortunately, the impact is more felt by the urban poor in such a way that recovery is unlikely to be achieved without external aid (Blaikie, 1994). In other words, the urban poor are the most vulnerable to impacts of flood because they occupy the floodplains for settlements (informal). Coupled with lack of attention to household waste collection, construction and maintenance of drainage channels, flood disasters is becoming more pronounced (Satterthwaite *et al.*, 2007; Douglas et al., 2008; Potschin, 2009). It should however be noted that, flooding is a natural phenomenon that has surmounting effects on human livelihoods. Nelson (2001) viewed flood as a natural consequence of stream flow in a continually changing environment. Sada (1988) defines flooding as unusually high rates of discharging; often leading to inundation of land adjacent to streams, and it is usually caused by intense or prolonged rainfall. The occurrence of the flood represents a major risk to riversides populations and floodplains, in addition to causing substantial impacts on the environment, including aquatic fauna and flora, and bank erosion. Flooding is often exacerbated by human activities (Olanrewaju & Fadairo, 2003) such as the presence of riverside infrastructure (dams, piers, and lands); and by poor development practice, including riverside development, excessive cleaning, encroachment upon waterways, dredging which may cause changes in the hydrological balance of waterways involved (Nolan & Marron, 1995).

In Nigeria, particularly cities; flooding is a critical environmental problem or major hazard that continuously affects effective functioning of the urban environment, especially in the areas of sustained infrastructure and services, which are germane to a sustainable livelihood. It often arises as a result of the extension of urban areas unaccompanied by the development of strong drainage systems, adequate planning and disaster management strategies. Indeed, flooding is one of the most devastating hazards that are likely to increase in many regions of the world, partly due to global climate change and poor governance. According to Action Aid (2006) four types of

Urban flooding can be recognized:

(i) Localized flooding- occurring many times in a year due to fewer and blocked drains
(ii) Small streams in urban areas rise quickly after heavy rain, but often pass through small culverts under roads
(iii) Major rivers flowing through urban areas
(iv) Wet season flooding in lowland and coastal cities

In Nigeria, flooding occurs in three main forms; river flooding, urban flooding and coastal flooding (Gwary, 2008; Adeoti, 2010). The heavy rainfall coupled with bad human activities in relation to the environment and lack of drainage infrastructure in most Nigerian cities has left hundreds of people distressed and homeless. It should be mentioned that flooding in cities can contaminate water supplies and intensify the spread of epidemic diseases, diarrhea, typhoid, scabies, cholera, malaria, dysentery and other waterborne diseases. Frequent occurrence of floods can be attributed to the impositions made by cities on their environment. In some cases, natural ecosystems are often destroyed owing to demand for renewable resources, such as water, fossil fuels, land and building materials (development). Also, human influences in urban areas have considerably altered the hydrological system and the nature of the ground surface, causing destructive flood disaster and its attendant physical and socio-economic outcomes (e.g. Disruption of socioeconomic activities, loss of properties, inaccessibility and reduction of the aesthetic quality of the environment).

Overall, in view of the recent inundation of both the coastal, rural and the urban areas of Nigeria, without a corresponding improvement in the provision of drainage infrastructure, proper embankment in the coastal plains and continuous deforestation; the Nigerian urban environment currently requires a high level of development and capacity building in the area of building sustainable and resilient urban areas that can withstand the current impact of the global climate change and vulnerability.

Recommendations

The recommendation for building resilience which is basically an adaptation process are divided into two in this review; the supply driven adaptation and demand driven adaptation. Adaptation is employed here because most of the measures adopted for building a resilient city is only to make such cities adapted to the contemporary challenges of climate change and vulnerability in the human environment. These two measures are therefore enunciated below.

Supply Adaptation

(1) **Comprehensive watershed management**

One major concern with respect to the water resources sector is the considerable decline of watersheds. Excessive logging and shifting cultivation in the watersheds trigger widespread degradation and consequent erosion and siltation of rivers, lakes, and reservoirs (Santos 1997). Both concerned government and private entities should also undertake strict implementation of existing forestry rules and regulations.

(2) **Water allocation system and procedures.**

Water allocation is a powerful tool for managing the demand for water. In the Angat Reservoir, irri2gation and hydropower have priority over the domestic water supply under normal, non-emergency conditions. However, in times of drought or emergency, domestic water supply gets priority over all others within the limits of its water rights (National Water Resources Board 1976).

Demand Adaptation

(1) Enhancement of irrigation efficiency

As the greatest overall consumer of water, the agricultural sector should strive to increase its efficiency in water use, so that water saved could be used for other purposes. The main problem in the irrigation subsector is low water use efficiency due to technical and institutional deficiencies flooding in the wet season an inadequate water availability during the dry season. The dilapidated state of canal structures in the systems and the low water use efficiencies result in water loss that goes back to the stream draining the system.

(2) Introduction of low water use crops and efficient farming practices

The need to look for alternative crops that use less water is then imperative. With the necessary support and assistance from the Department of Agriculture, introduction of such crops can be started. Use of drip irrigation, mulching, and other improved irrigation practices and the use of windbreaks to reduce wind speed and evapo-transpiration are some farming practices that could be adapted.

(3) Recycling (reuse) of water.

Due to recurrent shortages of water, the policy of the government is to encourage reuse of effluent in agriculture and industry. Industries are encouraged to save water and adopt measures to reuse their effluents for other secondary uses.

Overall, promoting urban agriculture is another veritable means of enhancing city resilience and consequent adaption of such cities to the adverse conditions of climate change. Neighbourhoods and households should promote cultivation of vegetables, fruit crops and trees that will help in promoting good air quality around households and food security among urban dwellers in Nigeria.

Conclusion

There is a mounting recognition among policymakers at all levels that disaster risk reduction, climate change adaptation, and sustainable development are inextricably linked. These issues present mutually dependent challenges, which require collaborative, integrated strategies, strong, inclusive governance structures, sound urban planning practices, and innovative technological and financial solutions. Because economic growth and risk accumulation follow the same path, as cities' populations and economies expand, local governments will play an increasingly important role in confronting the challenges arising from more frequent, localized extreme events, which can negatively impact the social, environmental, and financial infrastructure and institutions on which urban lives and livelihoods depend.

Furthermore, concerted efforts must be geared towards adequate city planning, policy formulation, enhanced public enlightenment programmes, integration of environmental planning and education to curriculum of schools at all levels, capacity building towards adaptation and mitigation of climate change. Government at all levels should ensure proper and effective use of ecological fund; and encourage the integration of environmental disaster insurance to take care of the fallout of flood disaster. It should be emphasized that corrupt environmental practices at all levels should be properly addressed. National disaster and emergency policies should be strengthened to facilitate effective disaster preparedness and response. This approach will not only save lives and livelihoods, but it will equally reduce vulnerability to disasters. Adequate and long-term environmental and natural resource management practices can help to reduce the risk and vulnerability of people in disaster prone areas.

REFERENCE

Alberti M, J Marzluff, E Shulenberger, G Bradley, C Ryan, and C Zumbrunnen, 2003. "integrating humans into ecology: opportunities and challenges for studying urban ecosystems", bioscience **53** (12): 1169–1179.

Barata, M., E. Ligeti, G. De Simone, T. Dickinson, D. Jack, J. Penney, M. Rahman, and R. Zimmerman. (2011). Climate Change and Human Health in Cities. In: Climate Change and Cities: First Assessment Report of the Urban Climate Change Research Network. [Rosenzweig, C., W.D. Solecki, S.A. Hammer, and S. and Mehrotra (eds.)]. Cambridge University Press, Cambridge, UK, pp. 179-213.

Baudoin, W. & Drescher, A. (2008). Urban agriculture for sustainable poverty alleviation and food security. Rome: fao.

Beatley, T.; Newman, P. *Green Urbanism Down Under*; Island Press: Washington, DC, USA, 2008.

Bourque,M. (2000). Policy options for urban agriculture. In growing cities, growing food, urban agriculture on the policy agenda (eds m. Bakker, n. Dubbeling, s. Guendel, u. Sabel koschella & h. De zeeuw), pp. 119– 145. Feldafing, germany: dse.

Buechler, S., Mekala, G.D. & Keraita, B. (2006). Wastewater use for urban and peri-urban agriculture. In cities farming for the future: urban agriculture for green and productive cities (ed. R. Van veenhuizen), pp. 243– 273. The philippines: ruaf foundation/idrc/iirr. City resilience framework - the rockefeller foundation | arup 2014

Costanza, R.; MItsch, W.J.; Day, J.W. *(***2006)**. A new vision for New Orleans and the Mississippi Delta: Applying ecological economics and ecological engineering. *Front. Ecol. Environ. 4*, 465–472.

Costanza, R.; Pérez-Maqueo, O.; Martinez, M.L.; Sutton, P.; Anderson, S.J.; Mulder, K. (**2008).**The value of coastal wetlands for hurricane protection. *AMBIO J. Hum. Environ.*, *37*, 241–248.

Drechsel, P. & Kunze, D. (2001). Waste composting for urban and peri-urban agriculture: closing the rural– urban nutrient cycle in sub-saharan africa.wallingford, Uk/colombo, sri lanka/rome, italy: cabi/iwmi/ fao

Dubbeling, M., Caton Campbell, M., Hoekstra, F. & Van Venhuizen, r. (2009a). Editorial: building resilient cities. Urban agriculture magazine 22, 3–11.

FAO (2008). State of food insecurity in the world: high food prices and food security – threats and opportunities. Rome: fao. Global climate change impacts in the united states. 2009. U.s. global change research program. Available at: http://globalchange.gov/publications/ reports/scientific-assessments/us-impacts Hazard Resistant Landscaping. Charleston, South Carolina. Available online: http://www.charlestoncounty.org/printer/www/departments/BuildingInspections/ProjectImpact/landscaping_Brochure.pdf (accessed on 7 June 2013).

Heinberg, R. & Bomford, M. (2009). The food & farming transition. Toward a post carbon food system. Sebastopol, ca: post carbon institute. Idrc.

Intergovernmental panel on climate change (IPCC) (2007). Climate change 2007: synthesis report. Summary for policymakers. Geneva: ipcc.

IPCC (2014). Summary for Policymakers. In: Climate Change 2024: Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change Ipcc fourth assessment report, working group ii, glossary of terms http://ipcc-wg1.ucar.edu/wg1/report/ar4wg1_print_annexes.pdf.unfccc article definitions:nhttp://unfccc.int/essential_background/convention/background/items/1349.php.

Jiang, F., Yuan, H., Liu, S. & Cai, J. (2005). Multifunctional agrotourism in beijing. Urban agriculture magazine 15, 14–15.

Lacoste, E. & Chalmin, P. (2007). From waste to resource: 2006 world waste survey. Paris, france: economica.

Lattuca, A., Terrile, R., Bracalenti, I., Lagorio, I., Ramos, G. & Moreira, F. (2005). Building food secure neighbourhoods in rosario. Urban agriculture magazine 15, 23–24.

Nicholls, R.J., (2004). Coastal flooding and wetland loss in the 21st century: changes under the SRES climate and socio-economic scenarios. Global Environmental Change, 14(1), 69-86.

Obuobie, E., Keraita, B., Danso, (2006). Irrigated urban vegetable production in ghana:characteristics, benefits and risks. Accra, ghana: iwmi/ruaf foundation/idrc/cpwf.

Prain, G. (2010). Effects of the global financial crisis on the food security of poor urban households. Leusden, the netherlands: ruaf foundation/un habitat/ idrc.

Prasad Neeraj, Federica Ranghieri, (2009). Climate resilient cities: a primer on reducing vulnerabilities to disasters, p. 160. Washington dc: the world bank).

Rosenzweig C., William D.S, Stephen A. (2011). climate change and cities first assessment report of the urban climate change research network

Ryerson University, (2005). Report on the Environmental Benefits and Costs of Green Roof Technology for the City of Toronto. Available online: http://www.toronto.ca/greenroofs/pdf/ fullreport103105.pdf (accessed on 7 June 2013). Sadahisa kato, research associate, icas, ibaraki university, japan 2013

Smeets, P. J. A. M., Van Mansfeld, (2007). Master plan. Greenport shanghai agropark. Wageningen, the netherlands: alterra.

Smit, J. & Bailkey, M. (2006). Building community capital and social inclusion through urban agriculture. In cities farming for the future: urban agriculture for green and productive cities (ed. R. Van veenhuizen), pp. 145–170. Manilla, the philippines: iirr/ruaf foundation/

Smit, J., Ratta, A. & Nasr, J. (1996). Urban agriculture: food, jobs and sustainable cities. New york: undp

Tidball, K.G. & Krasny, M. (2006). From risk to resilience: what role for community greening and civic ecology in cities? In social learning towards a more sustainable world (ed. A. Wals), pp. 149–164. Wagening, the netherlands: academic press UN/ISDR (Inter-agency secretariat of the international strategy for disaster reduction), 2004: living with risk – a global review of disaster reduction initiatives

UNESCO (2003).water for people, water for life. Unworld water development report. Paris, france: UNESCO

UNFPA: UN populations fund (2007). State of the world population; unleashing the potential of urban growth. New york: unfpa. Baudoin, w. & drescher, a. (2008). Urban agriculture for sustainable poverty alleviation and food security. Rome: fao.

UN-HABITAT (2009). Report of the international tripartite conference urban challenges and poverty reduction in african, caribbean and pacific countries, 8–10 june 2009, nairobi. Nairobi, kenya: unhabitat.

Tall, A., Patt, A. G., & Fritz, S. (2013). Reducing vulnerability to hydro-meteorological extremes in Africa . A qualitative assessment of national climate disaster management policies : Accounting for heterogeneity. *Weather and Climate Extremes*, *1*, 4–16. doi:10.1016/j.wace.2013.07.007

United Nations. (2012). World Urbanization Prospects: The 2012 Revision. UN Department of Economic and Social Affairs, Population Division, esa.un.org/unpd/wup/index.htm. US Environmental Protection Agency. Filtration

Avoidance. Available online: http://www.epa.gov/region2/water/nycshed/filtad.htm/ (accessed on 7 June 2013).
Van Veenhuizen, R. & Danso, G. (2007). Profitability and sustainability of urban and peri-urban agriculture. Fao agricultural management, marketing and finance occasional paper no 19. Rome: fao.
WMO. (2008). Future Climate Change Research and Observations: GCOS, WCRP and IGBP Learning from the IPCC Fourth Assessment Report. Workshop and Survey Report, IGBP Report No. 58 (WMO/TD No. 1418) World Meteorological Organization, Geneva, pp. 57
World Bank (2008). Reshaping Economic Geography: World Development Report 2009. World Bank, Washington D.C.

MODELING THE ENERGY PROFILES OF TYPICAL BUILDINGS IN NIGERIA: A CASE STUDY OF SOKOTO, OSHOGBO AND MINNA

MAMBO Abdulhameed Danjuma[1] & MUSTAPHA Zubairu[2]
[1]Department of Building, Federal University, Birnin Kebbi, Kebbi State, Nigeria.
[2]Department of Architecture, Federal University of Technology, Minna, Niger State, Nigeria.

The issues surrounding the need to cut carbon emissions in buildings include climate chang e, increasing energy cost and instability in major world supply sources of fossil fuel and the need to ensure energy security and create more employment. In many countries, the contrib ution of buildings to global carbon emission has already surpassed that of every other secto r of the economy. The question of how much energy does the average Nigerian building co nsume is still an open ended one. This paper presents a synthesis of energy supplied and uti lized in 50 buildings based on building energy audit using survey forms, physical examinati on, onsite measurements and discussions with relevant stakeholders, conducted in three citi es from different ecological belts of Nigeria to draw a basic energy consumption profile of residential, commercial and institutional buildings. The survey found the preponderance of the use of energy inefficient products, inadequate utilization of daylighting, complete absen ce of building energy management systems, extremely low adoption of renewable energy s ystems and orienting building without due consideration to climatic variables.

Keywords: *Design Assumptions, Design Process, Mass Housing, Perception, User*

abdmambo@gmail.com

MAMBO Abdulhameed Danjuma & MUSTAPHA Zubairu (2016). **MODELING THE ENERGY PROFILES OF TYPICAL BUILDINGS IN NIGERIA: A CASE STUDY OF SOKOTO, OSHOGBO AND MINNA** Sustainable Built Environment and Climate change; The challenges of Post 2015 Development Agenda. School of Environmental Technology Conference, SETIC, 2016

INTRODUCTION

In a rapidly changing and urbanising Nigeria, the provision of adequate and affordable housing remains a key concern for all governments and individuals. However, the concept of housing requires a new understanding to effectively and synergistically address the pressing issues of economic and human development as well as climate change. Housing is no longer regarded as simply a roof over one's head because it plays a crucial role in achieving sustainable development – as envisaged by the idea of low carbon housing.

The main concern here is that, the current Nigeria standards (Ministry of Environment, 2013) for new conventional construction result in buildings that are not energy efficient(Nduka, 2015) and therefore use significant amounts of energy to cool the buildings, which results in increased greenhouse gas emissions nationwide. There is therefore the need to evolve a new standard that set the minimum level that will take into account energy influential factors in the life cycle of buildings(Dahiru, Abdulazeez, & Abubakar, 2012).

One of the benefit of energy efficiency standard for buildings is that it will help to stretch the availability of non-renewable resources of energy to meet current demands while also providing the time to develop renewable energy sources. Other benefit is that it will reduce water and air pollution thereby improving health conditions of the people.

Energy audit is the first step in increasing the energy efficiency of buildings (Etiosa, 2008). It is often said; if you cannot measure it, you cannot manage/control it. This energy audit involves visiting building facilities for a walkthrough survey, undertaking measurement of the orientation and building extents, material, size and orientation of openings, collection of electricity bills and interacting with building owners to know the duration of use of appliances, to determine the fuel type and the pattern of fuel use.

The purpose of this paper is to build an energy consumption profile of institutional, residential and commercial buildings, using some selected buildings in Minna (north central), Sokoto (North-West) and Oshogbo (south-west) Nigeria. The objectives of this paper was to provide information about energy consuming factors in the selected buildings, develop an energy profile of various building types in Minna in the selected towns and to make recommendation on the inputs for energy efficiency in propose amendment of the National Building Code to incorporate energy efficiency.

Material and Methods

During the course of this work, data were collected from two major sources which included; the use of Energy audit forms and interviews. The forms consists of tables with the variables of interest alongside spaces for respondent's answers as well as enumerators' measurements and observations. The enumerators carried out measurements to determine orientation of the buildings, size of façade and other building element of interest. The audit forms were subjected to thorough review and testing before being administered to willing respondents. 105 pieces of detailed audit forms were distributed to three towns in the North West in the short grass savanna area, South West rain forest region and North Central woodland and tall grass savanna ecological zones of Nigeria. See figure 1. The buildings selected were in the same area of each town so as to eliminate the factor of climate. The buildings were either of residential, commercial and institutional functions.

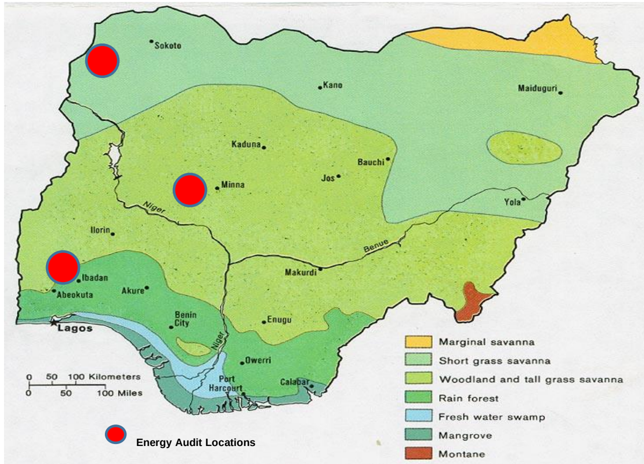


Figure 1: Ecological map of Nigeria Showing location of audit cities

Source: (CIA, 1979)

The enumerators ask questions from owners and/or occupants. The respondents were asked questions to extract information on energy use in their respective buildings. The Interviews took care of questions that cannot be obtained from physical measurement and observation. For example asking about for the actual duration of use of each appliances in the building. Other information such as year and nature of refurbishment or conversion were also asked.

Spreadsheets were developed and used to calculate and analyze the data gathered from the energy audit. The spreadsheet results of the survey was then used to develop the energy consumption pattern. The profile shows variations across building types as well as across the region. Charts and graphs were used where appropriate to provide pictorial information.

Estimation of Energy

Energy has come to mean many things. In this context, energy is referred to as the multiplication of an appliance power rating (wattage) by time. Total energy in kilowatts hour can be gotten by multiplying power which in kilowatts by time in hours.

Energy (kWh) = Power (kW) x Time (h) …….. eq1

It can be used to represent the total annual energy consumed for lighting and appliances, cooling and hot water per square meter of conditioned floor area. Kilo Watt hour per square meter (kWh/m^2) is an energy indicator that is spatial, describing where energy is consumed in space.

Energy Intensity (kWh/m^2) = eq1/Square Meter (m^2) ………eq2

The formulae above was used to calculate energy intensity of each of the buildings. A brief explanation is warranted of units of measurement commonly used to describe and compare energy use. A kilojoule (KJ) is a metric unit into which energy consumed from all energy sources can be converted (Hofstrand, 2007); as such, it is a useful measurement for establishing a baseline, comparing one house or apartment with another.

In this survey, electricity consumption in kWh per month was derived from the bill collected from the building owners. Where electricity bill was not available, the estimate amount of money paid for the electricity for each building obtained from the house owners and used to compute the amount of electricity (in KWh per month) supplied to each building as follows:

Estimate amount paid/month – Disco Fixed Charge (based on building type) = Actual amount paid/month for electricity

Actual amount paid/month for electricity ÷ Disco Energy Charge (kWh/naira) = Energy supplied KWh/Month

In order also to get a more accurate value of energy supplied into the building, the amount of electricity supplied by the generators were also calculated. This was done by getting a good estimate of how much litres of fuel was used per month and multiplying it by 11.02 (Hofstrand, 2007).

In other words:

Generator fuel (litre/month) × 11.02 = Energy (kwh/month)…….eq3

The summation of these two values (Electricity from Abuja Energy Distribution Company in KWh/Month and Electricity from generators in KWh/Month) gave rise to the total energy supplied into each building. That is: Energy Generated from Generator (KWh/month) + Electricity supplied (KWh/month) = Total Energy (KWh/Month).

For the purpose of this study, it was assumed that a month for residential building is 30days while that of institutional buildings which are occupied during working days only is 20days. Commercial building such as banks and company offices, operates like institutional buildings while other commercial building types such as restaurants and corner shops are occupied for 30 days in a month. Duration of occupancy per day was determine from individual occupants and owners.

RESULTS AND ANALYSIS

Sources of electricity

In all the buildings audited, sources of electricity was mainly from the national grid which is inadequate and epileptic in all the cities considered. The supply of electricity to households, commercial and institutional buildings averaged about 8 hours per day across the zones. The supply from the grid was often augmented by private generators. The generators uses petrol or diesel to produce power. Very few buildings have storage batteries and inverters used to store power whenever is available from the grid for use during the periods of outages. None of the building surveyed uses any form of renewable energy although about 30% of Nigeria's electricity comes from hydropower stations.

Energy supply profile

About 45 residential buildings were audited in the three ecological zones of the South-West, North-Central and the North-West. This number is a mixture of different types of residential accommodation such as low income, medium income and high income. The profile of energy consumption obtained from electricity bill and estimated fuel consumption from generators in Kwh/year/sqm is shown in figure 2 below.

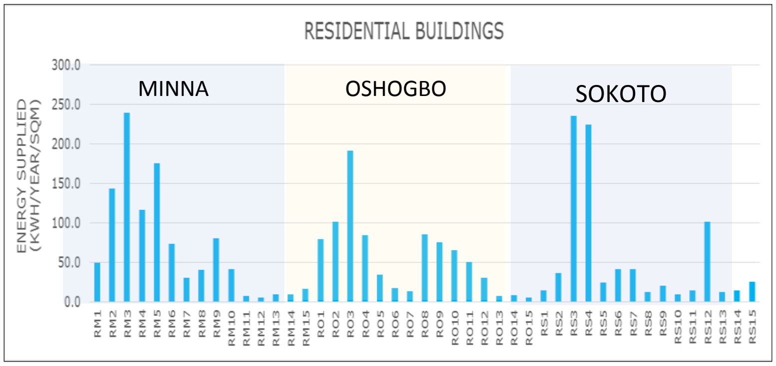


Figure 1 Energy Consumption Profile of Residential Buildings

It can be seen that the consumption level differs remarkably from house to house. From the chart, it may be concluded that Nigerian residential buildings are generally energy efficient since more than half of the building falls below the 50kWh/year/ sqm and none of the buildings exceeded 750kWh/year/sqm. This assumption can be erroneous because the case with Nigeria is that of suppress demand. At the time of this survey, maximum number of hours of electricity supplied from the grid to consumers ranges from 8 to 12 hours per day. The consumption for those that augment grid supply with private generation was higher than those that rely exclusively on the national grid.

The same can be said for commercial and institutional buildings as shown in figure 3 and 4. Institutional buildings comprise school, hospitals, libraries and government offices. 30 buildings were analyzed. The results shows that consumption ranges from zero to 450kWh/year/sqm. The zero consumption comes from some public schools that do have electricity at all and the highest consumers augment their electricity supply from the grid with private generators.

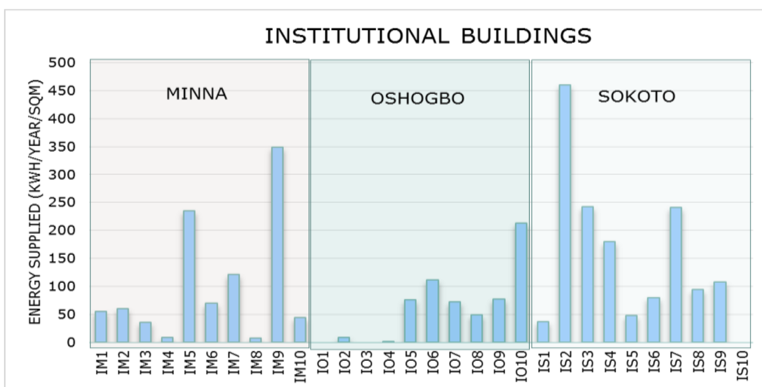


Figure 3: Energy Consumption Profile of Institutional Buildings

A total of 30 commercial buildings were considered, 10 from each zone. The consumption pattern was similar to that of residentail and institutional buildings.

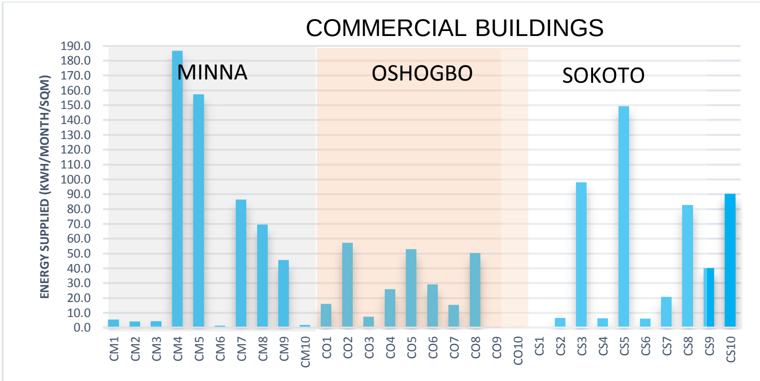


Figure 4: Energy Consumption Profile of Commercial Buildings

Energy Use by Sector

In order to analyze the energy use pattern for the buildings, energy consuming equipment were categorized based on their functions as in table 1. The number of such equipment, their power ratings and hour of use per day was used to compute energy use in kWh/year/sqm.

Table 1: Equipment categories

Ventilation & Cooling	i) Air conditioning ii) Fans
Hot water & Cooking	i) Water Heater ii) Boiling rings/kettles iii) Oven/microwave iv) Cooker
Appliances	i) Fridge/freezer ii) Washing machine iii) Dish washer iv) Television v) Computer vi) VCR/DVD players vii) Electric iron viii) Vacuum cleaner ix) Photocopiers x) Printer xi) scanner xii) water dispenser xiii) stabilizers xiv) radio xv) Satellite decoder etc.
Lighting	i) Energy bulbs ii) Conventional bulbs

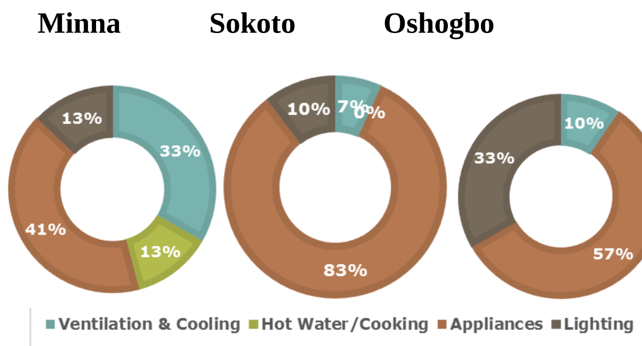


Figure 2: Energy use pattern of commercial buildings

From figure 5, energy consumption of appliances dominates. It also appears that lighting contribution increases as one progresses southward of the country. Sokoto (North West) 10% is least followed by Minna (North Central) and the highest contribution from lighting (33%) comes from Oshogbo (South-West). Cooling energy consumption per floor area of Minna is higher (33%) because the type of commercial buildings surveyed comprise mainly of those with prestige air conditioning such as banks, telecom companies and big restaurants (explain the reason for 13% for hot water and cooking in Minna). In Sokoto and Oshogbo, the buildings comprise mainly of small scale retail shops where cooling is mainly achieved by natural ventilation and the use of fans.

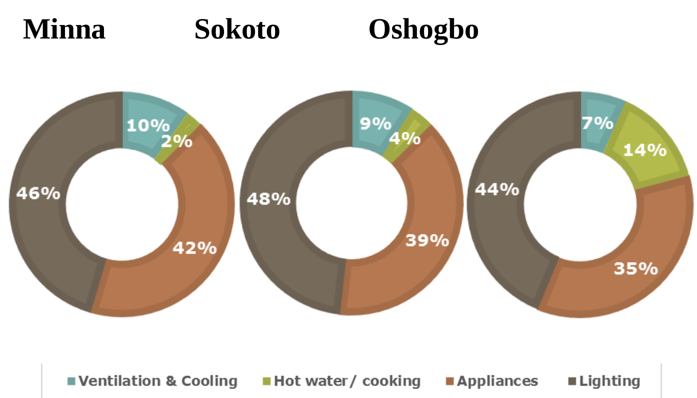


Figure 3: Energy use pattern of residential buildings

From figure 6 lighting dominates the consumptions in residential buildings because of the duration of use. In commercial and institutional buildings, lighting is smaller because activities in those buildings occur mostly in the day time while occupancy for residential buildings occur throughout the day.

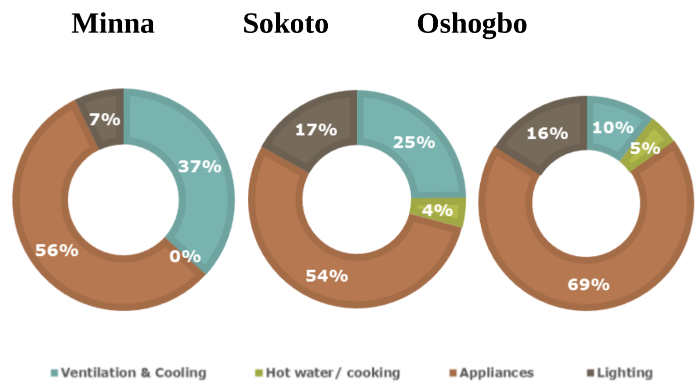


Figure 4: Energy use pattern of Institutional buildings

From figure 7, appliances energy consumptions dominate in Institutional buildings followed by ventilation and cooling. Lighting was smaller because period of use of most institutional buildings was during the day when little or no daylight will be required. Ventilation and cooling energy consumption was significant because appreciable number of these buildings air-conditioning and all the buildings uses fans. Expectedly hot water/cooking was the least energy consumer for most of the buildings in this category.

Orientation of building major façade

In the survey a major energy influential factor was considered, which the orientation of the building's major façade. Selecting the most optimal building orientation is one of the critical energy efficient design decisions that could have impact on building envelope energy performance, as it can be used to minimize the direct sun radiation into the buildings through windows, building openings as well as external opaque walls. It will be most affected for full glazed building. Buildings that are long should be oriented in the north to south direction. This allows the avoidance of direct solar gain in to a greater path of the building. It also helps to reduce areas subject to frequent energy fluctuations due to the rising and setting of the sun. Solar heat gains from the east may be a least nuisance since it often occur in the morning after the cooler night compare to the gains from the west which usually occurs after an already warm day.

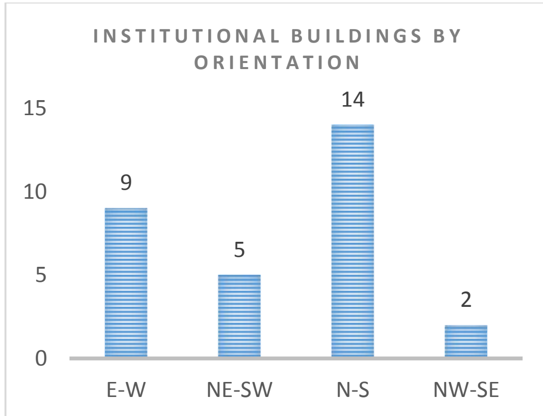


Figure 5: Orientation of Institutional buildings

From Table 4.5 above we can see that 9 out of the 30 institutional buildings surveyed have the orientation of their long axis facing East-West, and 14 out of the 30 buildings have their orientations in the N-S direction. The remaining buildings surveyed have their orientations in the NE-SW or NW-SW direction.

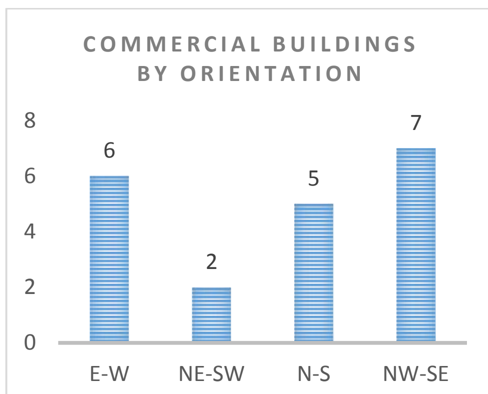


Figure 6: Orientation of Commercial buildings

Similarly, except for 5 building with their long axis in the N-S direction, the orientation of the remaining 25 buildings ranges from E-W, NE-SW and NW-SE.

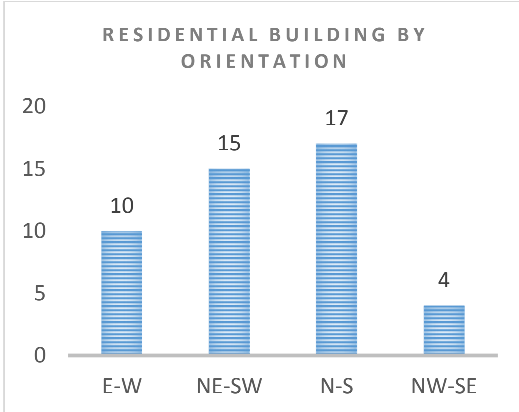


Figure 7: Orientation of Residential buildings

As shown in table 4-7, out of 45 buildings surveyed only about 17 were oriented in the N-S direction. Overall, most of the buildings long axis were not oriented to offer protection to the façade against solar radiation.

Building Fabrics: Window, roofs and floor

The wall fabrics of all the building surveyed were made up of (from external to internal) paint, plaster, hollow concrete block (6 or 9 inches thick), plaster and paint resulting in very similar u-values, varies only according to the expertise of the builder. The roofs materials ranges from galvanized roofing sheets, alloyed zinc roof sheets or aluminum sheets and concrete slabs.

Window sizes are very similar, however openings may differ from using sliding windows (allowing 50% opening) to louvres (allowing over 80% opening). This is significant because appropriate selection for windows orientation, optimal size of the glass and applying natural ventilation system, can reduce the negative effect of solar radiation in increasing indoor air temperature.

It was observed in the survey that majority of the rooms in the building types surveyed had very poor ventilation, most of them being single sided ventilation. Most buildings adopt the sliding window types which offers only 50% of the window area for natural ventilation. Also the glazing of most of the windows, even of those in the major building façade were of single glazing and they had poor sealing quality. This could increase energy consumptions of air-conditioning system.

The lack of appropriate natural ventilation and presence of fairly good sealing quality of windows, could increase the use of energy in these commercial buildings.

LIMITATION OF THE STUDY

The cooking fuel consumption from gas, electricity and kerosene was considered while that from other sources such as firewood and charcoal was ignored due to the difficulties in estimating the unit consumed. It is possible that the actual consumption from cooking and hot water could be more than reported.

There are three type of electricity billing system in Nigeria; the bulk billing (mostly used for institutional and large commercial buildings, the fixed billing which is based on estimation of consumption by the utility companies and pre-paid metering where billing is based on actual consumption. The first two methods are less accurate than the last method and this could affect the quality of data collected.

It was not possible to get the same type of building in each categories across the zones. This will make it difficult to compare variations in energy use in the zones.

The sample size of 105 buildings is small but could still provide some insight especially for a basic energy audit.

CONCLUSION AND RECOMMENDATIONS

This report is a basic building energy audit of some 105 buildings in three cities of Nigeria from three different ecological zones. The report studied Energy supply and Use pattern, orientation of major building façade, types of wall, roof and window fabrics and their influence on energy consumption. From the observations, physical measurements, and interview with occupants and owners of buildings surveyed, the following concussions can be reached:

1. It was obvious that buildings are being built without any recourse to energy efficiency issues. Orientation of majority of the building does not seek to harness bioclimatic factors of the building site. Therefore, a policy encouraging the siting of building in such a way that the major façade is oriented to face north or south direction will have a far reaching implication in energy consumption of buildings.
2. Nigeria's electricity is still predominantly sourced from the national grid generated predominantly from gas thermal stations and from petrol or diesel generators. Renewable energy uptake has remained remarkably low in spite of the huge potentials. A policy encouraging the increase use of renewable energy to power buildings will improve the environment, stretch the existing energy capacity, introduce stability in supply of power and provide gainful employment.
3. Although the buildings varies in size and outlook, they are about the same in terms of the fabric layers. Across the region, there was no clearly discernable difference in the features of the buildings to suggest that the slight different in climate of the three cities has any influence on the design of the building fabric, window, floor or roofing. A policy encouraging climate specific design and construction could be helpful.
4. Appliances energy consumption in almost all the building types audited across the three zones was comparatively high. A policy encouraging the use of energy efficiency appliances, switch offs of appliance when not in use and banning the use of second hand electronics will have tremendous impact.
5. Although energy consumption of cooling and ventilation appears comparatively low, it is a components with perhaps great future implication. As Nigeria's electricity supply increases and stabilize, there is likely to be an increase in the use of air-conditioning and refrigeration as is the pattern in other tropical countries. A policy laying emphasis on passive cooling, use of solar air-conditioning, energy efficiency labelling and reduction in the importation of old fridges and air-conditioners will be in the right direction. Discouraging the use of sliding windows that leaves only 50% of the widow size should be discouraged. Households should be encourage to plant trees on the eastern and western sides of their building to provide solar shading against morning and evening sun heat as the sun rises and fall in the horizon respectively.

REFERENCE

CIA. (1979). The Human and Physical Characteristics of Nigeria. *Geographical Alliance of Iowa*. Retrieved from http://www.uni.edu/gai/Nigeria/Background/Standard4.html

Dahiru, D., Abdulazeez, A. D., & Abubakar, M. (2012). An Evaluation of the Adequacy of the National Building Code for Achieving a Sustainable Built Environment in Nigeria, *4*(March 2010), 857–865.

Etiosa, U. (2008). The Concept of Energy Efficiency. In U. Etiosa, A. Matthew, Edevbaro, & Agharese (Eds.), *The report of a National Dialogue to Promote Renewable Energy and Energy Efficiency in Nigeria* (p. 16).

Hofstrand, D. (2007). British thermal unit (Btu) measurements and conversions.

Ministry of Environment, G. of F. (2013). National Building Code. *Nbd 2013*.

Nduka, D. O. (2015). Stakeholders Perception of Factors Determining the Adoptability of Green Building Practices In Construction Projects In Nigeria, *5*(2), 188–197.

DAY LIGHTING AND SUSTAINABILITY OF OFFICE COMPLEXES IN NIGER STATE.

Dauda Abubakar Dada[1], I M Kontagora[2], Ibrahim S.Mohoro[1], Abubakar Wuna[1], Yalwa A. Tukur[3].
1 Department of Building Technology. Niger State Polytechnic Zungeru[1].
2 Department of Quantity survey. Niger State Polytechnic Zungeru[2].
3 Department of Industrial and Technology Education, FUT Minna[3].

Office complex is a collection of spaces or rooms that perform different services usually during the day which usually require adequate day lighting. Office complex must posses' adequate day lighting to ease movement of occupant, increase in the productivity of the staff and make conducive the office activities. With the recent development of model office complexes constructed in Niger state. Reports indicates that there is inadequate day lighting in office complexes, which affects office activities, discomfort to the occupant of the buildings complex, and frequently cause health problems to workers or accident while moving in the office building. This paper evaluates the causes of insufficient day lighting within the office complexes in Niger state and the rate at which artificial lighting is used in the office during the day. Information was collected through personal observations, and questionnaire administration to analyse the causes in the increase in the use of artificial lighting and insufficient day lighting in office building complex. The result shows the technological and human factors that are responsible for insufficient day lighting in office complexes, which include poor building design, poor finishes and materials used in windows at office complexes, and poor management. Finally outcome concludes that architects should design office complexes with consideration of natural lighting, and that building laws and regulations should ensure maximum opening to enhance sufficient daylight. These will minimize cost and positively boost the activities of the workers in the office.

Keywords: *Day Lighting, Office Complex.*

abudada4real@gmail.com

Dauda et. al. (2016). **DAY LIGHTING AND SUSTAINABILITY OF OFFICE COMPLEXES IN NIGER STATE** Sustainable Built Environment and Climate change; The challenges of Post 2015 Development Agenda. School of Environmental Technology Conference, SETIC, 2016

INTRODUCTION

Daylight is a means of bringing natural light into a space to provide comfort and a connection to the outdoors. It has many benefits, including the ability to provide a better indoor environment as well as save energy by replacing electric lighting (Building Energy Code, 2012). Studies indicate that daylight can improve worker productivity in office buildings and student performance at schools, and it certainly provides a more natural lighted environment that is generally preferred by most occupants (Building Energy Code, 2012). Electricity is indisputably the fundamental energy resource for industrial, commercial and domestic activity in the modern world. Although investor in the electricity sector, Nigeria holds a low 69th place in per capita electricity consumption globally (Proceedings for building simulations, 2011). (CIA World factbook, 2011). The country has large amounts of natural resources utilized for energy generation (both conventional and renewable sources); but yet is bedevilled with unexpected and long periods of power outage, or fluctuating currents (Proceedings for building simulations, 2011). Ibitoye and Adenikinju (2007) estimated that up to 60% of the population are unconnected to the national grid, especially those in remote areas. Political instability, mismanagement, limited funds, long period of return of investment and maintenance neglect all result in electricity generation deficit, poor utility performance, and weak transmission and distribution infrastructure; all factors contributing to the electricity crisis..

Office complex is a very important unit in city settings which increase quality of life of its inhabitants, by providing varieties of services that improves the standard of living of the inhabitant. These also attract people to migrate to cities that have ample of Office complexes, and help in generating revenue to the government. Modern office complex are design by Architects to serve many various office functions and services. Beyond office activities they also provide for services like banks, stores, and restaurants . This attract investors to the city and also help in improving the infrastructures and social amenities of the city. Therefore putting consideration of sufficient adequate daylight in the design of office complex is of paramount importance, as well as proper arrangement of opening and increasing the size of windows.

The effective use of natural lighting as an architectural principle is basic to building design. The advantages attached to adequate daylight and view in office buildings includes but is not limited to; improved health of workers, increased productivity in the offices, improved perception of safety and workers preferences concerning the location of windows (AfolamiA.J. Aluko O.O. 2013) (National Renewable Energy Laboratory, 2002).

In summary, the research is aimed at an in depth study the effect of day lighting in public offices spaces in Minna as a case study, it effect to the occupants and built environment. Therefore rendering a probable possible solution towards it. And to achieves the following objectives. The study area is Minna the capital of Niger state which lies on longitude 9^{o} 33North and latitude 6^{o} 33 East on geographical bed of undifferentiated basement, which is surrounded by Bosso local government area. Due to the population growth in minna there are ample of office complexes along linear settlement. Minna is having about 10 office complexes located along major streets in Minna town.There are some main office complexes within Minna that are listed below according to capacity, size of window . For the purpose of this research.

- Abdulkareem lafeni secretariat complex (minna central area)
- Federal secretariat complex(off western bye pass)
- FUT senate building (Gidan mongoro area)
- Niger state development company (old airport road)
- Neco head office (Bida, road)
- Niger state college of education admin office (Shango minna)
- Niger state one-stop investment company (bosso road area)

RESEARCH METHODOLOGY

To evaluate insufficient lighting in office complexes in Minna, Information where obtain by both primary and secondary data. Primary data were obtain by personal observations, camera and administered questionnaire to both visitors and staffs of some selected office complex at minna.

The secondary data consist of data generated by persons, government agencies providing additional information different from the field study. They include books, maps, theses, texts, journals, libraries and visits to websites. 100 questionnaires were administered to two selected office complexes during the field survey by the researcher, the questionnaire were distributed around 10am to 4pm working days because that is the critical time were most of the office activities is going on. For which 50 questionnaire are for each office complex to get their opinions from visitors and staffs.

DISCUSSIONS OF RESULTS AND ANALYSIS

Brief Description of Office Complexes In Minna.

The buildings listed are government public office complexes ranges from four to three floors in the central area of Minna. They are of cellular plan with security bars; transparent glazing, and window hood for shading. The building is constructed by sand Crete hollow block which is of 225x225 and 450mm size. The complexes comprises of passages and court yards.

Table 1.0 Shows Sizes of windows In some Office Spaces In Minna.

Office complex	1.2X1.2	1.2X2.4	1.5X2.4	1.5X1.2	1.2X1.5	1.5X1.5
Abdulkareem lafene secretariate complex minna. Central area.	0	136	0	0	136	0
Federal sectariate complex minna. Off westhern	0	400	0	0	400	0
College of education minna admin building shango minna.	0	0	20	0	0	0
Niger state dev. Company	0	0	0	22	0	0

Source:(Authors field work 2015)

Table 1.0 Shows the various sizes of windows used in each office complex visited during field survey, All the windows are not high enough that will provide maximum day lighting in the office buildings. These is a major factor that lead to insufficient day light in the study area, because light travel for long distance in high level windows than low level windows.

Table 2.0 Shows Shapes of windows In some Office Spaces In Minna.

Office Complex	No Of Office	Plan	Vertical Windows	Horizontal Windows	Exterior Window Per Office	Interior Window Per Office
Abdulkareem Lafene Secretariate Complex Minna.	136	CELLULAR PLAN	0	272	1	1
Federal Sectariate Complex Minna. .	400	CELLULAR PLAN	0	800	1	1
College Of Education Minna Admin Building Minna.	20	CELLULAR PLAN	0	20	1	1
Niger State Dev. Company	22	CELLULAR PLAN.	0	22	1	1

Source: (Authors field work 2014)

The table above shows number of offices in each office complex, the type of office plan. And the number of windows in each office and the shape of windows in office, either vertical windows or horizontal windows. The windows are horizontal because they have wider width shorter height, and this will not provide adequate day light as light travel at long distance if the window height is higher. And also cellular plans reduce day light as some office will be

Table 3.0 Shows Orientations of windows In some Office Spaces In Minna.

Office Complex	Nomber Of Windows	North Windows	South Windows	East Windows	West Windows
Abdulkareem Lafene Secretariate Complex Minna.	**136**	**4**	**4**	**50**	**78**
Federal Sectariate Complex Minna.	**400**	**130**	**150**	**65**	**55**
College Of Education Minna Admin Building	**20**	**4**	**8**	**10**	**6**
Niger State Dev. Company	**22**	**2**	**5**	**5**	**8**
Total	**578**	**140**	**167**	**130**	**145**

Source:(Authors field work 2015)

Table 3.0 shows the total numbers of windows in the study areas and numbers of windows facing various directions. The sun rises from east and set in the west, but most of the windows are facing north and south directions which the sun moves in those directions. There these lead to insufficient day light in the office spaces. And also windows at north directions require shading device because the glare of the sun is more at that directions.

Table 4.0 Shows Relationship of windows area to wall area ratio In Office Spaces

Office Complex	**Window Ratio To Wall Area Ratio**	**Window Height To Office Depth Ratio**	**Size Of Court Yards**	**Area Of Office**
Abdulkareem Lafene Secretariate Complex Minna. Central Area.	8%	1:5	8mx16m 34mx15m	$24m^2$
Federal Sectariate Complex Minna.	15%	1:3	56mx25m	$36m^2$ $18m^2$
College Of Education Minna Admin Building.	10%	1:5	8mx12m	$24m^2$
Niger State Dev. Company	16%	1:3	7mx8m	$20m^2$

Source: (Authors field work 2015)

Table 4.0 are observations made on relationship of window area to wall area ratio, that is how many percentages those the window occupy in the total area of the office. The window do not occupy more that 16% of the wall area, this will not provide enough day light in the office as it does not reach up to 50% of the office area. The table also shows the window height to office depth ratio like ratio 1:5 it means that the depth of the office is 5 times the height of the window, And light will travel twice the height of the of the window. Therefore daylight will not reach some path of the office.

Table 5.0 Shows types of glass use at of windows In some Office Spaces In Minna.

Office Complex	**Transparent Glass**	**Translucent Glass**	**Tinted Glass**	**Smart Glass**	**Shading Device**
Abdulkareem Lafene Secretariate Complex Minna.		Nil	Nil	Nil	Curtain
Federal Sectariate Complex Minna.		Nil	Nil	Nil	Curtain
College Of Education Minna Admin Building		Nil	Nil	Nil	Curtain
Niger State Dev. Company		Nil	Nil	Nil	Curtain

Source: (Authors field work 2015)

The table shows the type of glass use at the windows and also the type of shading device used. All the windows glass are transparent glasses which allows direct sun radiation (glare) to penetrate, and also encourage the use of shading device like curtain , which prevent the sun from passing through, and there reduce day light in the office. There is no any special glass that are used to reduces sun radiations as to allow day light into the office spaces.

Table6.0 users perception on day light in some office spaces in minna.

WHAT IS YOUR PERCEPTION OF NATURAL LIGHTING IN THE OFFICE/ PASSAGE.			
Respondant 100	Very Sufficient	Sufficient	Insufficient
State Secretariate Complex Minna.	10	15	25
Federal Sectariate Complex Minna.	7	13	30
Total	17	28	55
.			
HAVE YOU EVER ENCOUNTER A PROBLEM(S) WITH LIGHTING DUE TO THE DESIGN			
Respondant 100	Yes	No	Not Respondent
State Secretariate Complex Minna.	34	10	6
Federal Sectariate Complex Minna.	30	11	9
Total	64	21	15

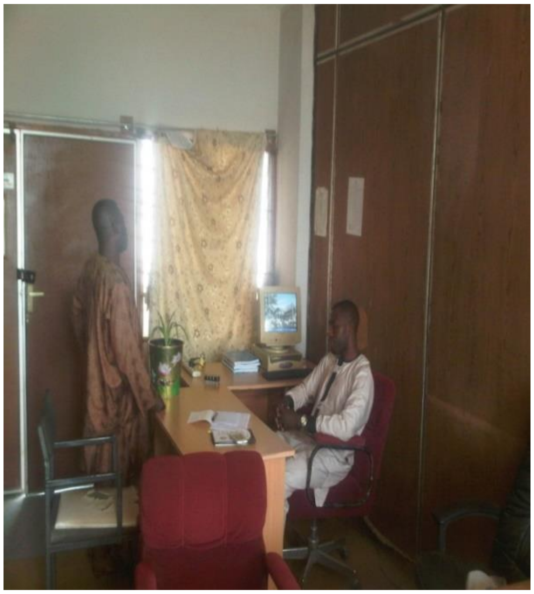
Source:(Authors field work 2014)

The table shows users perceptions on effective day light in some office buildings, as 55% of the staff feels that day light is insufficient because they depend on artificial light in doing the office activities during the day. And 64% of the staff encounters problems in their office activities due insufficient day light, the design of the office do not provide adequate day light as the court yards are narrow which could not allow sufficient light to reach the ground floor offices. The lobbies are long and the windows are small that could not light it, and most of the interior windows do not provide daylight as it is enclose.

Plate 1.. showing courtyard and office at state secretariat.

Source (field survey 2015)

Plate 2.0. showing courtyard and office at state secretariat.



Source (field survey 2015)

CONCLUSION

Based on the data collected and analysed by the researcher, deductions that show the level of inconveniency caused by insufficient day light in office spaces. As a result of windows are small to the size of office, the office has wide windows which do not increase in the distance that light will travel, because the higher the size of the window the increase in the distance the light will reach. The offices have bright colours which also help in visibility. Curtain also contribute in providing darkness in the office, therefore curtains should be roll up during the day, It was also observed that generally architect in design of office should improve in providing adequate day light by emphasizing on the openings that is the size in proportion to the size of office, shape and the arrangements.

RECOMMENDATIONS

SIZE OF WINDOWS

The size of windows required in a office complex depends on the size of the office spaces. Therefore in the design of office space, The designer should ensure that there is a balance proportion between the size of windows and the size of office spaces. And also the designer should have a full knowledge of the basic element and facilities needed in achieving adequate natural lighting.

POSITIONING OF WINDOWS

This is a very important factor to be considered in the design of office complex. The orientation of the window facing east direction will provide maximum daylight than windows facing north and south. The worst of all are windows facing west direction, because they are backing the east were the sun rise. Also windows at lobbies do not provide any daylight as it was close in between offices. More also windows at courtyards were the courtyards are narrow to provide little or no daylight, but if the courtyard is wide it will increase in providing much daylight. There for architect should considered orientation of windows in design of office complex. `

PLANNING LAWS

Building regulatory body like Niger State Urban Development board should strictly consider sustainable design of various office building. Finally the planning regulatory body should also make sure that only professionals are involve in the design office buildings.

REFERENCE

Afolami, A. J., Aluko O.O. & Adegbie, M.O (2013). Journal of Environmental Management and Safety. 4(1), 18–34.

Addington, M. & Schodek, D. (2005). *Smart Materials and Technologies for the Architecture and Design Professionals*. Oxford : Architectural Press.

Baiche, B. & Walliman, N (2000). *Neufert Architects' Data*. UK: Blackwell Science Limited. Building Energy Code, Lighting Development, Adoption, a 34 nd Compliance Guide BUILDING TECHNOLOGIES PROGRAM SEPTEMBER 2012

Ibitoye, F. I. & Adenikinju, A (2007). 'Future demand for electricity in Nigeria'. *Applied Energy*, 84 (5). 492-504.

Central Intelligence agency (2011) [Online]. Accessed: from https://www.cia.gov/library/publications/the -world-factbook/geos/ni.html

Journal of Science and Technology, Vol. 32, No. 3 (2012), pp 38-48 © 2012 Kwame Nkrumah University of Science and Technology (KNUST

National Renewable Energy Laboratory (2002). A Literature Review of the Effects of Natural

Light on Building Occupants. (NREL/TP-550-30769) Technical Report. Colorado, US. ACT: Author. Retrieved from http://www.osti.gov

Proceedings of Building Simulation 2011: 12th Conference of International Building Performance Simulation Association, Sydney, 14-16 November.

Fischer, H., Freymuth, H., Haeupl, P., Homann, M., Jeninsch, R., Richter, E. & Stoehrer, M. (2008). *Theory of Building Physics*. Germany: Vieweg and TaubnerVerlag.

Stein, B. & Reynolds, J. S (2000). *Mechanical and Electrical Equipment for Buildings*. New York, USA: John Wiley & Sons, Inc.

WALK-THOUGH ENERGY AUDIT EXERCISE ON OFFICE BUILDINGS OF KADUNA CENTRAL BUSSINESS DISTRICT; NIGERIA

SALIHU Murtala Muhammad, EJEH David and HASSAN Ozovehe Saliu
Department of Architecture, Ahmadu Bello University, Zaria

The purpose of the study is to examine the pattern of demand, supply, distribution and consumption of energy in office buildings of Kaduna metropolis. To achieve this, a walkthrough energy audit was conducted on six purposively sampled office buildings through the collection of relevant data from their three-year bills of utility and back-up sources of electricity supply, and undertaking a survey of all energy consuming appliances and systems in the facilities to obtain its energy use index, estimated energy supply and put forward some energy saving opportunities through retrofitting. Results showed that cooling has the highest magnitude of energy consumption with 51% of the total energy consumption, while electrical equipment and lighting consume about 35% and 14% respectively. In conclusion it revealed that the annual energy supply on office buildings in Kaduna metropolis fall short of meeting up with their required annual demand, with cost of providing such energy heightened by the excessive use of backup generation systems due to inadequate and epileptic supply from the national grid. It was also discovered after the normalization exercise that; the cost of energy supply in the smaller buildings per square meter is higher than that of the larger ones. To evaluate the value of carrying out an energy audit, the energy-saving opportunities explored through retrofitting recorded an estimated 41% saving in energy cost and consumption. The relevance of this study therefore, is to provide a clear understanding of the energy supply and consumption pattern in office buildings of Kaduna metropolis, in order to help all related stakeholders pin point areas where cost of operation and maintenance of such a building stock can be focused open, and the kind of retrofitting measures to be subsequently adopted.

Keywords; Walk-Though Energy Audit, Energy Demand, Energy Supply, Normalization.

murtalasg@gmail.com
archejeh@yahoo.com
elozove@yahoo.com

SALIHU Murtala Muhammad, EJEH David and HASSAN Ozovehe Saliu (2016). **WALK-THOUGH ENERGY AUDIT EXERCISE ON OFFICE BUILDINGS OF KADUNA CENTRAL BUSSINESS DISTRICT; NIGERIA** Sustainable Built Environment and Climate change; The challenges of Post 2015 Development Agenda. School of Environmental Technology Conference, SETIC, 2016

RESEARCH BACKGROUND

One of the major challenges our world faces today is the constant search of ways to increase the efficiency in production, distribution, and consumption of energy. The hope is to always do so in a manner that is sustainable in term of cost and reduced environmental impact. This problem cannot be separated from the fact that there is a rapid increase in energy demand as a result of constant rise in living standards and population growth the world faces today (Rai, 2004). This scenario has been recognized to be in direct proportion with the rising demand of the building industry, which has been revealed to be the major consumer of up to 70 % of the that energy, where about 40- 60 % of it goes to either heating or cooling of building interiors alone (Haoyang Liu, 2012 & U.S. Department of Energy (DOE), 2011). This has always been a great challenge to cope with especially in the office buildings where uninterrupted energy supply is required within its activity period.

In terms of energy consumption per meter square, office buildings consume about 70-300KWh/m2 of energy to function effectively, which is 10-20 times higher than the residential sector (Sadrzadehrafiei et al, 2012). This sort of energy requirement requires a great deal of effort to sustain building performance, a task that has been identified as a key area where significant progress towards meeting the global ambitions of energy efficiency can be made (Ausiello & Raimondo, 2014). To curve the excesses of energy demand and consumption in office buildings therefore; a primary starting point is to conduct an energy audit exercise on such facilities, so as to pave way for the adoption and implementation of more sustainable practices.

Energy audit is one of the first tasks to be performed in accomplishing an effective energy management program designed to improve the energy efficiency and reduce the energy operating costs of any facility (DOE, 2011 pp1 & Atikol, 2014). It is carried out by conducting regular energy audits, where inspection, analysis and evaluation of a facility's energy consumption is done to allow energy managers pinpoint opportunities for potential energy and cost saving measures (Energy Audit Electrical & Mechanical Services Department (EMSD), 2007).

This measure has been adopted in many parts of the world where some countries have targeted certain specified years to achieve a total cut of energy consumption by buildings to the barest minimum. This endeavor needs to be actively adopted in Nigeria, being a developing economy that suffers inadequate supply of usable energy across all spheres of development (Okafor & Joe-Uzuegbu, 2010). It has been revealed by Oyedepo (2012) that, within that limited energy supply in the country, a lot of it still gets wasted because buildings use more energy than is actually necessary to fulfill their needs. By adhering to the advocations of energy audit exercise in the country, some of these challenges may squarely be addressed.

Several researchers have reported various conclusive findings on energy consumption, conservation potential and other related environmental impacts in Nigeria. Instances of such studies include Aderemi, et al (2009) and that of Noah et al (2012), where they revealed that energy supply is not commensurate to its demand in a country; and that most vital sectors of production, development and living conditions suffer insufficient and epileptic energy supply all year round. This forces a large portion of the industry to rely on diesel and petrol generators as primary or back-up source of electricity, which can be expensive, polluting and a significant source of greenhouse gas emission (Energy Commission of Nigeria (ECN) 2015).

Since office buildings constitute a large percentage of the building stock that dominates the central business district of any city, and houses the workforce that renders services to its entire economy (Mu'azu, 2012).); there is need to constantly revisit all faculties of the building fabrics that are instrumental to providing good working environments in these buildings. In that light this study delves into highlighting the value and modalities of conducting energy audit that is especially geared towards improving and adjusting the pattern and attitude of energy consumption in favorable relation to its supply.

The aim of this exercise therefore, is to uncover the explicit cost, pattern and magnitude of energy demand, supply and mode of consumption in office buildings in Kaduna metropolis, using the walkthrough method of energy audit. This was carried out through extensive energy auditing process which allowed for presentation of calculated theoretical consumptions.

The steps outlined in carrying out energy audit by Krarti, (2000), and DOE, (2011) involves preliminary review of utility data, walk-through survey of facility, determination of baseline for building energy use and establishment of evaluated energy savings measures, as expanciated in the literature review presented ahead.

ENERGY AUDIT FOR OFFICE BUILDINGS

The building energy audit seeks to analyze the energy consumptions produced by a building with the aim of proposing measures to reduce them, as well as the related emissions and the economic cost of the energy used (Generation 2015; DOE, 2011). It is designed to determine where, when, why and how energy is being used. This information can then be used to identify opportunities to improve efficiency, decrease energy costs and reduce greenhouse gas emissions that contribute to climate change (Canadian Industry Program for Energy Conservation (CIPEC), 2014).

Running an office building is capital intensive either in the public or private sector, operating it in an energy efficient manner therefore is as good as protection of investment. The International Energy Agency (IEA) 2014 stated that; investment in energy conservation provides a better return than investment in energy supply. The act of conservation can only be achievable by adhering to the code of regular energy audit; which can only be termed successful when all its guiding principles and general goals, process, measures, and overall projections are met and satisfied.

The major goals of the Energy Audit in office buildings are to clearly identify patterns and costs of energy use, understand how energy is being used and possibly wasted, identify and analyze more cost-effective ways of using energy to improved operational techniques and shift to the use of new equipment, processes and technology. It is also geared towards performing an economic analysis on those alternatives and determine which ones are cost-effective for any given facility or system (Atikol, 2014). Like in all such exercises, energy audit for office buildings typically involves data collection and review, facility surveys and system measurements, observation and review of operating practices and data analysis (CIPEC, 2014). According to Atikol (2014), the major components and systems to be universally considered and reviewed in energy auditing include; the building envelope, ventilation, electrical Supply systems, HVAC System, lighting, and other related supplies and their technologies.

CHOICE OF ENERGY AUDIT FOR OFFICE BUILDINGS

The choice in type of energy audit depends on the funding available for the audit; its cost potential, and the required accuracy for the audit information. It may also depend on the type of facility, its function, and processes within a facility (Atikol, 2014; and Centre for Renewable Energy Sources (CRES, 2000). Generally, four types of energy audits can be distinguished as briefly described by Krarti, (2000), ASHRAE (2012), IEA (2014); they are walk-through, utility cost analysis, Standard energy audit, and detailed energy audits.

Sources as stated above also further iterated that; a walk-through audit consists typically of a short on-site visit of the facility to identify areas where simple and inexpensive actions can provide immediate energy use or operating cost savings. Utility cost Analysis in its part, involves a careful evaluation of metered energy uses and operating costs of the facility. The third is the Standard Energy Audit type which consists of a comprehensive energy analysis for the energy systems of the facility; in particular, it includes the development of a baseline for the energy use of the facility, evaluation of the energy savings and the cost effectiveness of appropriately selected energy conservation measures. However, the most comprehensive type of energy audit for office buildings is detailed energy audit; a time-consuming energy audit type that includes the use of instruments to measure energy use for the whole building and for some energy systems within the building, it also in addition, uses sophisticated computer simulation programs that are typically considered for detailed energy audits to evaluate and recommend energy retrofits for the facility.

PROCEDURE FOR A WALK-THROUGH ENERGY AUDIT

The execution of an energy audit is often not a linear process and is rather iterative. However, a general procedure outlined for most facilities as forwarded by Krarti (2000) and DOE

(2011) involve four basic steps, even though this study as iterated in the scope is interested only in the first two steps. The steps include;

1: Preliminary review of utility data

2: Walk-through Survey

3: Evaluation of Energy Savings Measures

Preliminary Review of Utility Data

The main purpose of this step is to evaluate the characteristics of the energy systems and the patterns of energy use for the building or the facility by examining utility data, building or system diagrams, equipment lists, and other facility information

1. Collecting at least two years of utility data to identify a historical energy use pattern.
2. Identifying the fuel types and magnitude in used, such as natural gas and oils.
3. Determining the patterns of fuel use by fuel type and identify it's the peak demand. In the form of account for seasonal variations and patterns of energy use
4. Determining facility's Energy Utilization Index (EUI) value (annual energy use/square meter) and energy end uses (energy used by each building system) to enable the auditor in benchmarking the data against energy use of similar buildings
5. Understanding utility rate structure of energy and demand rates to propose alternatives
6. Preparing preliminary report which includes a summary of data and graphs and other visuals to allow for easy interpretation

Walk-Through Survey

This step involves conducting a physical assessment of a facility and its operations where potential energy savings measures should be identified. The results of this step are important since they determine if the building warrants any further energy auditing work. Some of the tasks involved in this step are:

1. Identifying the users concerns and needs
2. Inspection and inventory of the building's key elements, including Construction details of the building envelope.
3. Checking the current operating and maintenance procedures
4. Determining the existing operating conditions of major energy use equipment
5. Estimating the occupancy, equipment, and lighting (energy use density and hours of operation)
6. Develop a baseline model for building energy use by using the utility data and/or metered data.

Evaluation of Energy Savings Measures

In this step, a list of cost-effective energy conservation measures is determined using both energy savings and economic analysis. To achieve this goal, the following tasks are recommended:

1. Prepare a comprehensive list of energy conservation measures (using the information collected in the walk-through survey)
2. Determine the energy savings due to the various energy conservation measures pertinent to the building using the baseline energy use simulation model developed in phase 3
3. Estimate the initial costs required to implement the energy conservation measures
4. Evaluate the cost-effectiveness of each energy conservation measure using an economic analysis method.

METHODOLOGY

This research involves the use of both qualitative and quantitative research, where purposive sampling method was adopted in selecting six office buildings within Kaduna metropolis based on their variation in size, floor area, verticality, number of room spaces, type of ownership, track record of optimum utilization of the facility and ease of access for data collection. This information is reflected as shown in Table 1 where all the criteria stated above have reasonable representation in any one or more of the selected facilities. The buildings selected are Northern Nigerian Development Company (NNDC) which is public owned composed of ten floor heights, over $5000m^2$ floor area and in full use. The Bank of Industry is government owned with nine floors and more than $3000m^2$ floor area. At the intermediary scale is the High Point Building with five floors and over 1500 m^2 floor area; so also is the Investment House which is state government owned representing buildings with 2 to 4 floors and above 1000 m^2 floor area. At the lower level is the Federal Inland Revenue Office (Katsina Road Branch), and Kaduna State Microfinance Bank (Rigachukum Branch) with a single storey and 500 m^2 floor area; and single floor below 50 m^2 floor area, respectively.

Data collection was conducted through the use of self-administered questionnaire, interviews, physical visual count of appliances/systems, and also through the collection of maintenance records, utility bills, and back-up generator usage. To achieve the aim of the research, analysis of the building was carried out through a Walkthrough type of Energy Audit, which is the Level I audit as outlined by ASHRAE, 2012; but limited to Lighting, HAVC systems, and other electrical appliances.

To conduct calculations and/or estimations in demand and supply of electrical energy on the case studies, various formulas as forwarded by Batagarawa (2013) were adopted and adapted from a study; the formulas are stated as follows;

1. Total electricity demand (TED): $Qt= Qc + Ql + Qa$ ………..……..……… Eq (1)
2. Cooling/Ventilation demand (QC) is: $QC=Qc1+Qc2+Qc3+Qcn$…………….……Eq (2)
3. Lighting demand (Ql) is: $Ql=Ql1+Ql2+Ql3+\cdots Qln$……………………....…….Eq (3)
4. Appliances demand (Qa) is: $Qa=Q-(Qc+Ql)$…………..………………………Eq (4)
5. Demand load = Energy rating x Quantity x hours of usage ………..……....Eq (5)
6. Total electricity supply (Qt); $Qt=Qu+Qg$ ……………………..…….……..Eq (6)
7. Supply by back-up generator $Qg=(Qu \times G)/U$ ….……………..…………….Eq (7)

Where U and G are the percentages of the time utility and the back-up power are in use respectively.

To Evaluation of energy savings measures, data collected was analyzed to identify measures which when adopted will ensure a substantial cut in energy consumption with better efficiency and cost effectiveness. To achieve this suggested energy consuming appliances and practices will be placed side by side the existing scenario, after which potential energy savings can be determined per annum on each facility.

To acquire a breakdown of the cost implication a formula the total energy consumption cost (TECC) is obtained by inputting the actual rate of unit electricity tariff on the estimated energy demand earlier determined; it is computed as adopted from Oyedepo et el, (2015) given as:

TECC = TED x CUE (in NGN) ……….Equation 4

Where TED is the total energy Demand, and CUE is the current cost of a unit electricity in Nigerian tariff, which is 26.24NGN for commercial buildings. Calculations for the TED remain as in equation 1.

At the end of the audit, the findings were documented and computed in an audit report. Data analysis and presentation of results were discussed.

FINDINGS AND DISCUSSION

An Inventory of the Walkthrough Exercise of the Facilities

The foremost objectives was to conduct a walkthrough exercise on all the selected facilities were the findings revealed; that the N.N.D.C Building has the highest number of floors (eleven floors) and total floor area of up to 11,312 m^2 from four different blocks. It is used in full capacity, and is a publically owned facility rented to individual occupants. The BOI main building is next in size with nine floors and 112 rooms and an approximate area of 3816 m^2, it is government owned and partly rented to individuals and also used in full capacity. Next in size is Investment House which has four floors and 68 rooms an approximate area of 2653 m^2, it is owned by the Kaduna state government used in full capacity and rented to individuals as well. Within the intermediary representation is the High Point building with five floors, 19 rooms and an approximate area of 446 m^2 area. FIRS building is relatively small in representation with two floors and 18 rooms an approximate area of 528 m^2, it is federal government owned and used in full capacity. The smallest is the Microfinance Bank with 10 rooms and about 40m^2 area.

The major energy consuming systems found are Lifts, HAVC systems, lighting appliances, and other office equipment like computers, printers, photocopiers, refrigerators, televisions and many other related appliances. Major electricity supply is via National Grid that alternates with backup systems throughout the activity period of 8 hours (8am-4pm). A wide range of generators are used in the facilities; the largest is a 625KVA found in the NNDC, followed by a 500KVA in the BOI, Investment House has 250 KVA; while High Point and F.I.R.S Buildings have 100KVA each, and Microfinance Bank has a 20 KVA generator.

Three year record of utility and back up bills were collected and recorded on average annual basis. The highest rate in utility bills and cost of managing the backup system was found in NNDC, where records of the annual average for utility and backup system are to the tune of 10,011,240NGN and 14,005,800NGN respectively. The B.O.I has an average of 6,922,800NGN for utility and 1,682,997NGN for backup system. For the Investment House it is to the tune of annual averages of 3,299,400NGN and 1,004,400NGN respectively. High Point has 150,000NGN and 120,000NGN; while F.I.R.S Building recorded 920,000NGN and 1,272,000NGN. Micro finance bank, the smallest building studied has an average annual utility and back up rate of 120,000NGN and 13,200NGN respectively.

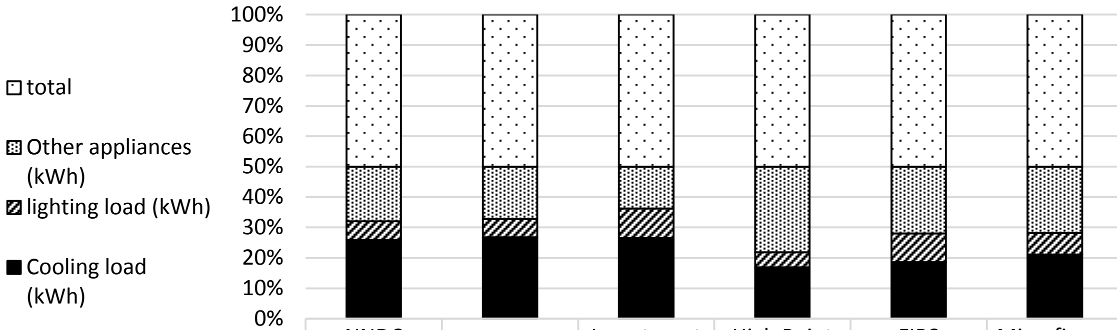
Energy Use Index

To determine the Total Estimated Demand (TED), a structured classification was made based on three set of categories namely cooling, lighting and a group of other electrical appliances like computers, printers, scanners, photocopiers, and utility machines like refrigerators, televisions, fans, and lifts to obtain the monthly and annual energy demands, all categories were calculated based on the activity period of the buildings only; which is eight hours of the working days of the calendar; except for the exterior lighting which was calculated for all year functioning. On the field, the number of each appliances and its wattage are recorded; after which formula from equations 1 to 4 are used for estimation on the appliances and equation 5 for estimating the Demand load.

In the N.N.D.C Building cooling load from the air conditioning system was estimated to be 1,012,868KWh, lighting recorded 236,144 KWh, and other appliances had 702,100 KWh, which sums to a total energy demand of 1,951,112 KWh. The BOI Building has an estimated cooling load of 586,470KWh, lighting of 131,004KWh, and other appliances had 376,909KWh, summing it up to a total energy demand of 1,094,384KWh. Estimations for the Investment House were; cooling load had 387,377KWh, 141,004KWh for lighting, and 199,848KWh for other appliances, giving a total of 728,229KWh. High Point Building had 56,022KWh for cooling, 16,023KWh for lighting, and 93,222KWh for other appliances, giving rise to a total of 165,267KWh. FIRS Building represents one of the smaller buildings and recorded an estimate of 45,677KWh for cooling, 23,166KWh for lighting, and 53,877KWh for other appliances, giving a total of 122,721KWh. The building with the smallest representation is the Microfinance Bank, and it has an estimated demand of 12,450 KWh for cooling, 4,099KWh for lighting, and 12,900 KWh for other appliances, totalling up to 29,449 KWh.

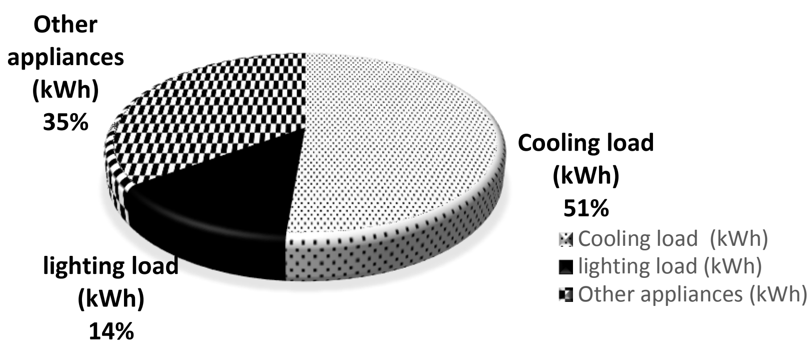
Table 1 expresses the disaggregation of energy demand across the six office facilities, where cooling takes the highest demand of about 51% of the total demand. Energy demand by the office appliances about 35%, and lighting being the least of all consuming about 14% of the energy demand as shown in Figure 1.

Table 1: Disaggregation of energy demand across the six offices



	NNDC Building	BOI Building	Investment House	High Point Building	FIRS Building	Microfinance Bank
total	1,951,112.53	1,094,384.25	728,229.76	165,267.70	122,721.80	29,449.00
Other appliances (kWh)	702,100.00	376,909.00	199,848.60	93,222.50	53,877.80	12,900.00
lighting load (kWh)	236,144.53	131,004.65	141,004.06	16,023.00	23,166.90	4,099.00
Cooling load (kWh)	1,012,868.00	586,470.60	387,377.10	56,022.20	45,677.10	12,450.00

Figure 1: Disaggregation of load in cooling, lighting and other appliances



Normalized electricity consumption per meter square of each disaggregated end-use and the averages per annum across all the studied facilities was carried out. NNDC has 172.48KWh/m2, Building BOI Building recorded 286.79 KWh/m2, and Investment House has 274.49KWh/m2. High Point building recorded an estimated requirement of 370.56 KWh/m2 while the FIRS Building and the Microfinance Bank had 232.43 KWh/m2 and 736.23 KWh/m2 respectively.

Estimated Electricity Supply

To estimate the amount of electricity supplied utility supply bills of three years were collected and analyzed. The other supply system also calculated were the three year output value of the power generators against the target backup hours laid out by the facility managers. The hours of distribution from both utility and backup were considered, were it was found that utility hours are in all cases more than the backup hours all year round.

Total electricity supplied per annum in the N.N.D.C Building was estimated to be 34,679KWh monthly rate for the utility, and 15,468KWh for the backup system running at 1.5 hours daily, totaling up to 220,304KWh per annum. The BOI Building has an estimated monthly supply of 23,740KWh for utility, and 16,500KWh for backup at 2 hours daily giving a total of 221,740KWh per annum. Estimations for the monthly rate of supply for Investment House were; utility bills at 11,296KWh, while backup had 10,312KWh at 2.5 hours daily giving a total of 135,046KWh per annum. High Point Building recorded monthly rate of 555KWh for utility and 1,500KWh for backup at 1 hour a day giving a total of 18,555KWh per annum. FIRS Building had an estimate monthly rate of 3,148KWh for utility and 3,300KWh for backup at 2hours a day summing up to a total of 41,077KWh per annum. Microfinance Bank on the other hand recoreded an estimated monthly rate of supply to the tune of 370KWh for utility, and 9,900KWh for backup at 1.5 hours a day giving a total of 14,344KWh per annum.

The Estimated Annual Energy Supplied per square meter therefore is 19.64 Kwh/M2 for the N.N.D.C, 58.11 Kwh/M2 for B.O.I Buildings, 50.90 Kwh/M2 Investment House, and 41.60 Kwh/M2 for the High Point Building, FIRS Building recorded 77.80Kwh/M2, and the Microfinance Bank had 358.61 Kwh/M2

Cost Saving Opportunities

To ascertain how energy audit exercise can be used as yardstick of measuring the major areas to be targeted in ensuring energy reduction, a task of suggesting some retrofitting options was carried out. This is to explore the application of energy efficient options in lighting, ventilation and cooling. Cooling has been identified to be the major energy consumer in all the facilities. It is therefore the primary target in proposing energy reduction measures, followed by other electrical appliances and lighting.

Retrofitting Options

To achieve a good degree of cost saving opportunities, the existing air conditioning systems that is composed of window type and split Air conditioning systems of different brands and wattage ranges between 1200-1800W are substituted with energy saving Air conditioners not exceeding 900W. As recorded, the common types of lighting fittings used throughout the facilities are incandescent light bulbs (40W-200W), compact fluorescent lamp (40W), fluorescent tubes (40W) and waterproof exterior floodlight (200W-400W). These lighting fittings are substituted with more energy efficient lamps and LED lights ranging from 12-48W for the interior, and outdoor energy saving lamps and LED floodlight of appropriate wattage between 120W-250W

Other existing electrical fittings as reported, are replaced with more energy efficient ones. Ceiling fans (90W) and standing/table fans (65-90W) are replaced with those from an energy efficient brand with a load of 31W, refrigerators (300-600W) are replaced with self-regulating types. Other high energy consuming systems including lifts, water pumps, pressure pumps, and water heaters are also substituted with the more energy efficient systems in today’s market.

Total Energy Consumption of the Retrofitted Options

The appliances used in retrofitting the cooling, lighting and other electrical appliances are replaced with the existing ones by adopting the same calculations used in the energy demand estimation process from the methodology. The result obtained on the estimated energy used index per annum are; a total of 721,911.64kWh for NNDC, 503,416.76kWh for BOI, 276,727.31kWh in Investment House, 80,980.93kWh for Highpoint building, and a total of 38,043.51kWh and 2,131.48kWh for FIRS and Microfinance Bank respectively.

Total Energy Consumption Cost

This when placed side by side the existing situation, ensures a good degree of cost saving on energy consumption. To obtain this, the total energy consumption cost (TECC) is calculated using equation 4 from the methodology. This task is carried out for both the existing situation and the retrofitted option to form a good basis for comparison.

In the existing situation, energy consumption per annum in the NNDC is to the tune of 51,197,192.79NGN, 28,716,642.72NGN was recorded for BOI, 19,108,748.90NGN for Investment House, 4,336,611.33NGN for Highpoint building, and a total of 3,220,199.04NGN and 107,557.76NGN for FIRS and Microfinance Bank respectively.

After retrofitting, the total cost energy consumption cost incurred per annum were recorded, where; 18,942,961.33NGN was realized for NNDC, 13,209,655.65NGN for BOI, 7,261,324.58NGN for Investment House, 2,124,939.55NGN for Highpoint building, and a total of 998,261.70NGN and 55,930.04NGN for FIRS and Microfinance Bank respectively.

By simply targeting the electricity consuming appliances, fittings and fixtures in the facilities a great deal of savings have been incurred. The total annual savings realized in energy consumption and cost for NNDC are 37%; for the BOI an estimated 46% was realized, 38% for Investment House, 49% for Highpoint building, while 31% and 52%, was realized for FIRS and Microfinance Bank respectively. In total an estimated 41.16% saving in cost of energy and consumption has been realized in all facilities.

CONCLUSIONS AND RECOMMENDATIONS

This research through disaggregation of energy use pattern in all facilities concludes that; cooling for thermal comfort of the interior takes the highest rate of energy demand in the buildings; it is responsible for about 51% of the energy use index, and therefore has that equal bearing on the resultant cost of energy consumption. Other electrical appliances constitute 35%, while lighting has the least with 14% due to the presence of adequate natural lighting during the activity period.

The estimated energy demand observed in the study revealed that the annual energy supply falls short of meeting up with the required annual demand in all the office buildings. In terms of cost of electricity supply, it was observed that the rate of supply is higher in the bigger facilities; though the same was also recorded on the backup generation systems, it was discovered that the rate of consumption is usually dependent on the target hours of use and the output capacity of the power generators, which at the moment is very high in Kaduna metropolis as the cases have presented. The estimated normalized energy supply was also found to be higher in the smaller buildings than the larger ones, alluding to the fact that cost of energy supply in the smaller buildings per square meter is higher than in the larger ones.

To evaluate the relevance of energy audit; the energy-saving opportunities explored through retrofitting recorded an estimated 41% saving in energy cost and consumption throughout the facilities.

The study was driven by the need to minimize the cost of operation and maintenance of office building stock in general; the above stated deductions to an extent gives a clear understanding of the pattern of energy demand, supply and subsequent distribution in office buildings of Kaduna metropolis. this endeavor is therefore generally an investigative tool that clearly identifies the core areas in which energy challenges lie in such facilities in the region; it may therefore pave way in pin pointing the basic areas in which retrofitting options are required in order to reap the economic, social and environmental benefits of running and maintaining such facility in a sustainable manner.

REFFERENCES

Aderemi, A.O; Ilori, M.O; Aderemi, H.O, and Akinbami, J.F.K (2009): Assessment of Electrical energy use efficiency in Nigeria food industry, *African Journal of Food Science,* Vol. 3(8): 206-216.

American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) 2012: Audit Procedures. Retrieved ^ "ASHRAE Audit Procedures". Techstreet.com. on 2015-03-29.

Atikol. U. (2014): *Energy Audit*; Energy *Management & Utilization*. EMU Energy Research Centre

Ausiello, G.L., Raimondo, M. (2014). *Modulation performances in the building envelope: Strategy and project*. World sb 14 Barcelona

Batagarawa, A. (2011): Disaggregating primary electricity consumption for office buildings in Nigeria. Proceedings of Building Simulation, 2011: 12th *Conference of International Performing Simulation Association.*

Canadian Industry Program for Energy Conservation (CIPEC) 2014. *An Energy audit Manual and Tool.* Office of Energy Efficiency of Natural Resources, Canada. Retrieved from info.ind@nrcan.gc.ca. on 25th November 2015.

Centre for Renewable Energy Sources (CRES), 2000: *Energy Audit Guide Part A: Methodology and Technics*

Electrical & Mechanical Services Department (EMSD) 2007; *Guidelines on Energy Audit.* The Government of the Hong Kong Special Administrative Region

Energy Comission of Nigeria. (2015). *Energy Commission of Nigeria*. Retrieved fromAboutushttp://www.energy.gov.ng/index.php?option=com_content&view=article&id=48&Itemid=53 on 2015/06/14

Energy Information Administration (EIA), 2014: Annual Energy Review. Department of Energy, Energy Information Administration, retrieved from http://www.doe.eia.gov, 2014 on 20th November 2015.

Generation. (2015*). Green Energy Auditing for a Low Carbon Economy'Simplified Energy Audit Methodology*; Energy Efficiency in Public Buildings,
Recommendations for policy makers Project. Retrieved; http://www.powerprogramme.eu/uploads/WhitePaper%20GENERATION%20final.pdf on 26/09/2015

Haoyang, L.(2012): The Development of Novel Window Systems Towards Low Carbon Buildings Thesis submitted to the University of Nottingham for the degree of Doctor of Philosophy September 2012.

International Energy Agency (IEA).2010: *Energy Efficiency Governance Handbook*. France: European Commission. Retrieved September 25, 2014

International Energy Agency (IEA), 2014: Energy in Buildings and Communities ProgramShining Examples of Cost-Effective Energy and Carbon Emissions Optimization in Building Renovation (Annex 56) Retrieved from "IEA EBC Annex 11". Iea-ebc.org. on 2015-03-29.

Krarti, M (2000); *Energy Audits for Buildings.* University of Colorado. Retrieved; http://civil.colorado.edu/~krarti/Efficiency-EPT.pdf on 26/10/2014

Mu'azu, A.I. (2012). Scenario of Energy Consumption of Office Buildings in Abuja, Nigeria. *International Journal of Science and Advanced Technology (ISSN 2221-8386)* Volume 2 No 9 September 2012 http://www.ijsat.com 96

Noah, O.O; Obanor, A.I and Audu, M.L (2012): Energy Audit of a Brewery-A Case Study of Vitamalt Nig. Plc, Agbara', *Energy and Power Engineering*, 2012, 4, 137-143.

Okafor, E.C.N; Joe-Uzuegbu C.K.A, (2010): Challenges to Development of Renewable Energy for Electric Power Sector in Nigeria. *International Journal of Academic Research* 2(2):211–216

Oyedepo, S. O, (2012): Energy and sustainable development in Nigeria:the way forward. Energy, Sustainability and Society. *Springfield Journal*. Retrieved from http://www.energsustainsoc.com/content/2/1/15. On 20th Nov. 2015

Rai, G.D (2004). *Non- Conventional Energy Sources*. Khanna Publishers, Delhi

Sadrzadehrafiei, S., Sopian, K., Mat, S., Lim, C., Hashim, H.S., Zaharim, A. (2012): Enhancing energy efficiency in office buildings in a tropical climate, Malaysia. *International journal of energy and environment.6* (2), 209.

U.S. Department of Energy (DOE), 2011. *A Guide to Energy Audits*. Pacific Northwest National Laboratory Portland Energy Conservation, Inc.

U.S. Department of Energy, Energy Efficiency and Renewable Energy, Building Technologies Program, “Commercial Buildings, Heating, Ventilating and Air Conditioning,” U.S. Department of Energy, http://www1.eere.energy.gov/buildings/ commercial/hvac.html (accessed October 21, 2009)

MUNICIPAL SOLID WASTE CONVERSION TO ENERGY AND DERIVED CHEMICALS USING PYROLYSIS

Muhammad Abdul-Qdir, **M.A. Olutoye*, D.O. Agbajelola, O.D. Adeniyi, E.J. Eterigho**
Department of Chemical Engineering, Federal University of Technology, Minna, Niger State, Nigeria

This research work on municipal solid waste conversion to energy and derived chemicals was investigated using pyrolysis. The variables such as time and temperature were used to determine the highest bio-oil yields. Slow pyrolysis was adopted in a drop type chemical vapour depositor (CVD) pyrolyser given the highest bio-oil yields of 32.50 %wt. at 500 ^{0}C for 30 min. The bio-oil properties (CHNS-O) at various temperatures were evaluated. Carbon, hydrogen, Nitrogen and calorivic values were observed to increased as the temperatures increases, having highest values at 500 ^{0}C with a sudden declined at 550 ^{0}C. While oxygen, water contents, densities and pH values decreases as the temperature increased, with lowest values obtained at 500 ^{0}C and sharp increase at 550 ^{0}C. Hence, the degrees of de-oxygenation was observed to increased as the temperature increases with 20.25 %wt. at 500 ^{0}C and decreased at 550 ^{0}C. The results of FTIR analysis of the bio-oils produced at 500 ^{0}C indicate functional groups such as alkanes, alkenes, amines, terminal alkynes and aromatic ether with their areas.

Keywords: *Pyrolysis, Bio-oil, Derived chemical, Energy*

m.olutoye@futminna.edu.ng

MUHAMMAD et. al. (2016). **MUNICIPAL SOLID WASTE CONVERSION TO ENERGY AND DERIVED CHEMICALS USING PYROLYSIS** Sustainable Built Environment and Climate change; The challenges of Post 2015 Development Agenda. School of Environmental Technology Conference, SETIC, 2016

INTRODUCTION

Back in ages, the amounts of waste generated by humans were insignificant due to low population density and low societal level of natural resource exploitation. Common wastes produced at these times were mainly ashes and human biodegradable waste, and these were sent back to the ground locally to decompose with minimum environmental impact, Bogner *et al., (*2007) and Alison *et al., (*2001). However, with the onset of industrialization and the sustained urban growth of large population centres, the build-up of waste in the cities caused a rapid deterioration in the levels of sanitation and general quality of urban life, Bogner *et al., (*2007) and Alison *et al.,* (2001). These enormous increase in the quantum and diversity of waste material and their potential harmful effects on general environment and public health calls for a pressing need to better waste management methods in which the treatment and handling can lead to safe disposal, cleaner and healthier environment with sustainable use of the earth's resources, Salman, (2009). Also couple with the demand for fuel and various chemicals increasing day by day, the country has been spending lot on refining petroleum and related products putting pressure on the conventional sources of energy which have been depleting at an alarming rate and hence the focus on alternative renewable source of energy. As a result of these twin reasons, biomass as a renewable energy source has continued to attract more attention and a lot of research in this area is in progress using different solid biomass as the feed material, Islam *et al., (*2010). Needless to say, municipal solid waste (MSW) is a common waste management problem with biomass obtained from any city area of all over the world as well as in Nigeria. Although for many years, opposition to the use of MSW as an energy resource has been nearly universal among activists and regulators. This opposition has been largely based on bad experiences with traditional garbage incineration facilities, which are associated with high levels of toxic emissions, as well as the perception that using MSW for energy will compete with recycling efforts, Brian and Justin, (2009). But for growing climate, energy, and environmental concerns, coupled with technological developments and regulatory changes have ignited a new interest in MSW as an energy source with the potential to provide renewable energy while reducing greenhouse gas emissions and the need for landfill space, Brian and Justin, (2009). Thus, pyrolysis may be considered as a promising option for resource recovery from MSW combined with ARM catalyst, which is abundantly available to produce quality bio-oils. It is therefore, a great potential in converting solid wastes which are very difficult and costly to manage into fuels and chemicals, reducing waste management cost. Due to the low contents of sulphur and nitrogen utilization of the derived energy, it does not add sulphur dioxide, nitrogen oxides and no net carbondioxide, which are greenhouse gases to the atmospheric environment, in contrast to fossil fuels, Ani and Islam, (1997). These also addressed an economical and ecological solution of transforming abundant naturally available materials into something useful to humanity. Considering the above advantages, this research work was undertaken to produce renewable energy and derivable chemicals from MSW using pyrolysis. According to daily assessment report of Niger State Environmental Protection Agency (NISEPA) 300 to 400 tons of MSW are generated daily on an average from Minna metropolitan area, this is a great potential for renewable energy conversion and derived chemicals. Although, these waste are mostly mixtures of substances whose constituents widely vary on location. Thus sorting is required to classify them into groups and their composition such as organic food wastes, papers, broken glasses and ceramics, metals, plastics, rubber and leather, textiles, wood, yard wastes, e.t.c. The organic solid wastes that are lignocellulosic biomass were the target raw materials in this study.

RESEARCH METHOD

2.1. Feedstock preparation

The MSW used in this study was obtained from Kampalla dump site of Niger state environmental protection agency (NISEPA). The site covers about 20 hectares of lowland area of Maikunkele along Minna – Zungeru road; headquarter of Bosso local government area of Niger state on latitude 54^0 W and longitude 108^0 S. The heterogeneous mixture of the wastes were sorted and separated out. The residues which were lignocellulosic material (papers, wood, yard trim and food wastes) were taken as the feedstock as shown in figure 2. Prior to pyrolysis, some of the wastes were shredded while others passed through a high speed rotary cutting mill and then sieved to obtained the required particle size of 1.75 mm, then dried to 10 wt. % moisture in an electric oven for 24 hrs at 105 ^{0}C. The proximate analysis of MSW was performed to measure the moisture content, ash content, fixed carbon contents and volatile matter using the TGA method. The ultimate analysis were also carry out using Liebig's, Kjeldahl's and TGA method of elemental analysis to determine properties of MSW and bio-oils which mainly consist of CHNS, while oxygen contents was determine using calculation difference as shown in Eq. (1).

$$O = 100 - (C\%wt. - H\%wt. - N\%wt. – S\%wt.) \qquad \ldots (1)$$

The high heating value (HHV) of MSW and bio-oils was calculated from the elemental and ash analysis based on Channiwala and Parikh's formula, Lim *et al.,* (2014) as shown in Eq. (2) below.

$$HHV = 0.3491C+1.1783H-1054O-0.0151N+0.1005S-0.0211A \qquad \ldots (2)$$

Thus, from the elemental compositions of MSW O/C and H/C ratios are to be calculated. The FTIR analysis was performed on bio-oil yields at minimum operating temperature.

2.2. Pyrolysis experiment

2.2.1. Apparatus

Figure 1 below shows the schematic diagram of a batch type vacuum pump reactor called carbon vapour depositor (CVD) used to carry out the non-catalytic and catalytic slow pyrolysis of MSW for this study. The experimental setup consists of a cylindrical reactor made up of horizontal glass (borax) tube furnace with length-1010mm, internal diameter-60mm and outer diameter-65mm. The pyrolyzer was installed in an electric heater and was insulated to enable the heating capacity of the reactor reached 1200 ^{0}C. The reactor was equipped with a biomass holder (cubit) and connected to both vacuum and nitrogen source. To record the pyrolysis temperature, a K-type thermocouple was inserted inside the pyrolyzer. The pyrolyzer was connected to ice-trap immersed in ice-water bath to condense the pyrolysis vapours at 0–5 ^{0}C. The outlet of the ice-trap was connected with the gas sampling bag to collect the non-condensable gases.

2.2.2. Procedure

Slow pyrolysis was adopted in all the experiments, 20g of MSW was loaded into the cubit and fixed into the reactor. A vacuum pump was set to obtained high vacuum inside the pyrolyser between 0.003 to 0.001 mmHg pressures (< atmospheric pressure). The experiments were carried out to determine the effect of the pyrolysis temperature on products yield. The temperature of the pyrolyser was set between 400-550 ^{0}C with intervals of 50 ^{0}C for the range of periods 10–40 min with constant heating rate of 20 ^{0}C/min and N_2 flow rate of 50 ml/min. the durations of the experiments were held at that temperature until there was no significant gas observed to be released and the CVD reactor automatically terminated at that fixed period. Same procedures were repeated for 20, 30, and 40 min. The products from the pyrolysis process are char, bio-oil and gases. The fluid gas comes out through the vacuum line of the pyrolyser and the solid char remain in the cubit as residue. The fluid from the pyrolyzer was then cool through the condenser. The condensate (bio-oil) was collected and stored in a sample bottle for further analysis, while the uncondenseable gas was given off as syngas (flue gas) and collected in a sample bag. Mass balance calculations were used to estimate the yield; char (wt. %) + bio-oil (wt. %) + gas (wt. %) = 100. The yields of char and bio-oil were determined based on change in weight of the reactor and the condenser respectively, before and after the experiment. The mass of liquid and solid are given within the experimental error of <±2.

2.2.3. Analysis of pyrolysis products

At the end of each pyrolysis experiments; the bio-oil collected was found to be in a single phase dark brown colour with a distinct odour similar to smoke from a wood fire and was quite pungent. The pyrolysis oils obtained at pyrolysis temperature of 500 ^{0}C for 30 min was characterized by using the following methods. The elemental analysis of the biomass and bio-oils were determined through Liebig's, Kjeldahl's and TGA method of estimating CHNS-O and their calorific values were calculated by difference. The water content of bio-oils was measured using proximate analysis. The pH value was obtained by a pH probe with a digital meter. The densities were calculated by mass/volume ratio in the lab. According to Naqvi *et al.,* (2014), a formula to estimate the degree of de-oxygenation was proposed by Zabeti as shown Eq. (3) below:

$$Degree\ of\ deoxygenation = \left(1 - \left(\frac{[O]\,bio-oil}{[O]\,biomass}\right)\right) x\ 100 \quad (3)$$

Where [O] is oxygen content (mass)

Degree of de-oxygenation is used to judge the amount of oxygen that has been rejected from the biomass and retained in the bio-oil.

2.3. ***Figures and Tables***

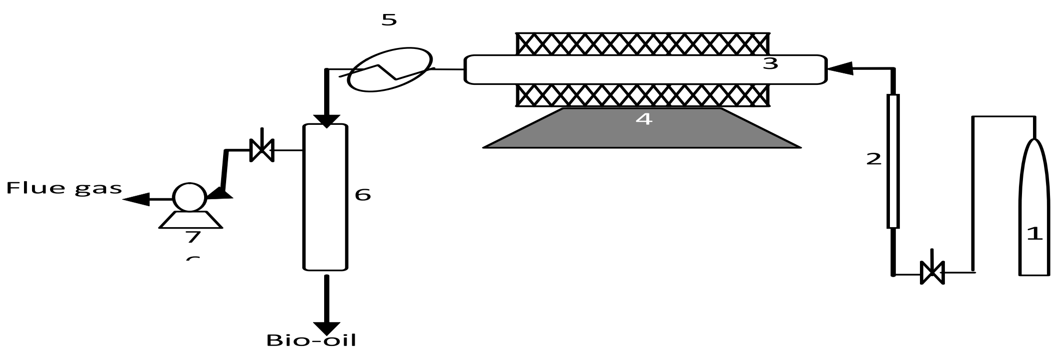


Figure 1: Layout of the pyrolysis process

1-N_2 gas cylinder, 2-Flow meter, 3.-Glass pyrolyser, 4-Reactor Controls, 5-Coolant, 6-Condenser, 7-Suction Pump.

FINDINGS AND DISCUSSION OF RESULTS

3.1. Analysis on feedstock

The heterogenous nature of the different materials involved in MSW made it nearest to impossible, to use it as raw material for this study. This was due to presence of metals, broken glasses and ceramics. After the raw materials were manually sorted and separated into their various compositions; out of 1 kg of the raw sample collected 71.7g of it contains lignocellulosic materials as demonstrated in figure 2 below.

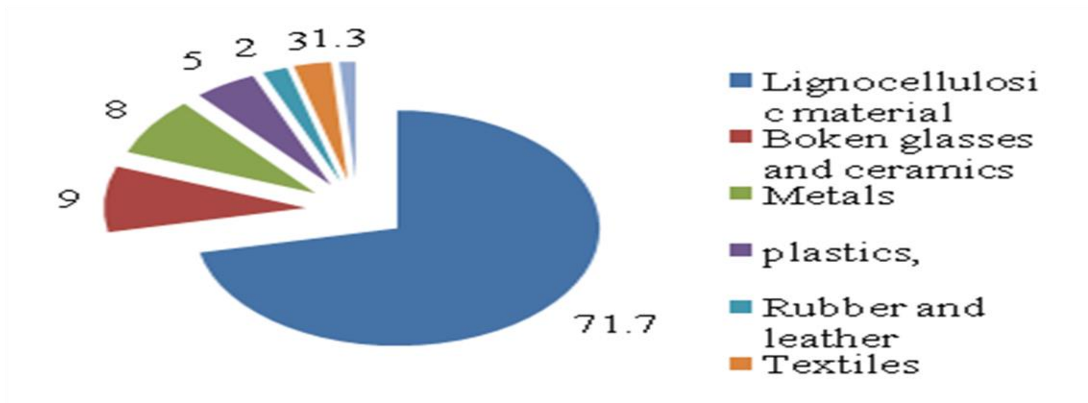


Figure 2: Compositions in 1 kg sample of MSW

The major components of the lignocellulosic material in 71.7g of MSW are shown in figure 3.

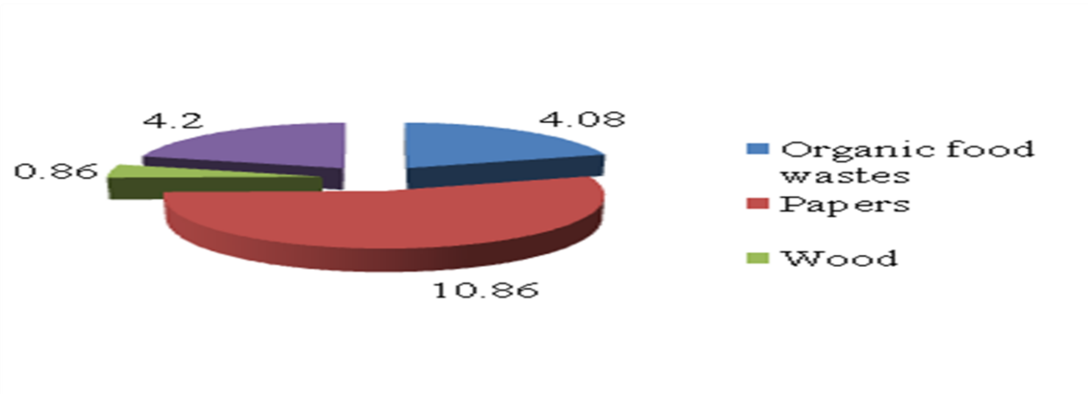


Figure 3: Component of lignocellulosic material in 71.7g of sample MSW

3.1.1. Thermal gravimetric analysis:

TGA4000 was used to determine the mass change of a sample with increasing temperature and time. The main aim of the TGA analysis on MSW is to find (1) the degradation profile, (2) calculate the proximate analysis by monitoring the weight loss. The plot between temperature and percent weight loss for MSW at heating rate of 20 ^{o}C/min and the result is as shown in Figure 4 below.

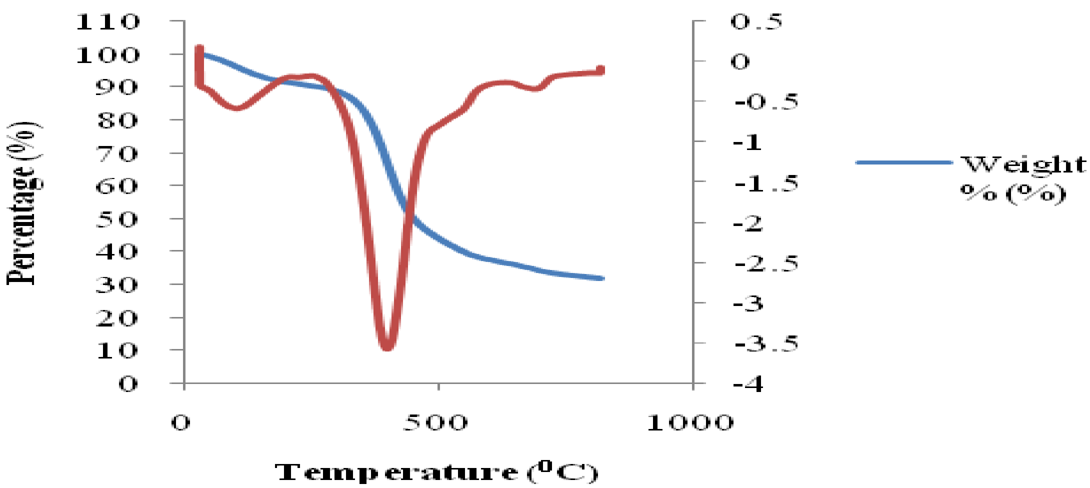


Figure 4: Thermo-Gravimetric Analysis of MSW

The graphical illustration of the TGA–DTA curves of MSW is as shown in figure 4 above. The TGA result shows three distinct weight losses. The first weight loss occurred between 28.98 and 200 ^{o}C corresponding to the endothermic peak at 100.55 ^{o}C in the DTA curve. These observations related to the vaporization of light volatile matters and water. The second weight losses occurred between 264.71 and 576.64^{o}C corresponding to the endothermic peak at 390.80°C in the DTA curve. This observation can be attributed to the defragmentation of the polysaccharides (hemicelluloses and celluloses). The third weight loss occurred at the temperature higher than 500°C and this correspond to the endothermic peak at 688.05 °C in the DTA curve. This may be attributed to the burned and evaporated (lignin) carbon char.

The graphical interpretation agrees with Yathavan, (2013) and Suwanmaneechot *et al.*, (2015).

According to Yathavan (2013), lignocellulosic biomass usually comprises of three major components namely cellulose, hemicelluloses and lignin. Hemicelluloses which is characterized by amorphous and irregular shape degrades at low temperature 250 – 400^{o}C; cellulose which has crystalline structure degrades between 310 – 430 ^{o}C; and lignin which is a complex aromatic heteropolymer, degrades in a wide range of temperature 300 – 500 ^{o}C. Table 1 below shows 8.087 %wt. moisture content, 54.141%wt. volatile matter, 36.315 %wt. fixed carbon and 1.612 %wt. ash content of the biomass estimated from the weight loss curve. These results were also in line with those obtained by Suwanmaneechot *et al.*, (2015) and Gopakumar *et al.*, (2011). The ultimate analyses were done separately done using classical methods and the results are equally presented in Table 1 below.

Table 1: Proximate analysis from TGA weight loss thermogram and ultimate analysis of MSW

Properties	**MSW**
Proximate analysis	
Moisture (%)	8.087
Ash (%)	1.612
Volatile component (%)	54.141
Combustible matter (%)	36.160
Ultimate Analysis	
C (%)	46.81
H (%)	13.30
O (%)	37.92
S (%)	0.05
N (%)	0.58
Ash content (%)	1.34
Caloric value (MJ/kg)	27.98
O/C (molar ratio)	0.61
H/C (molar ratio)	3.41
Empirical formula	$CH_{3.41}O_{0.61}\ N_{0.0106}$

3.2. Analysis of pyrolysis products

3.2.1. Effect of time on oil yields

To determine the effect of time on bio-oil yields, the series of experimental pyrolysis performed at constant times of 10, 20, 30 and 40 min between the ranges of 400–550 ^{0}C were plotted. The **results are as** shown in figure 5 which **agrees** with those obtained by Islam *et al.,* (2010).

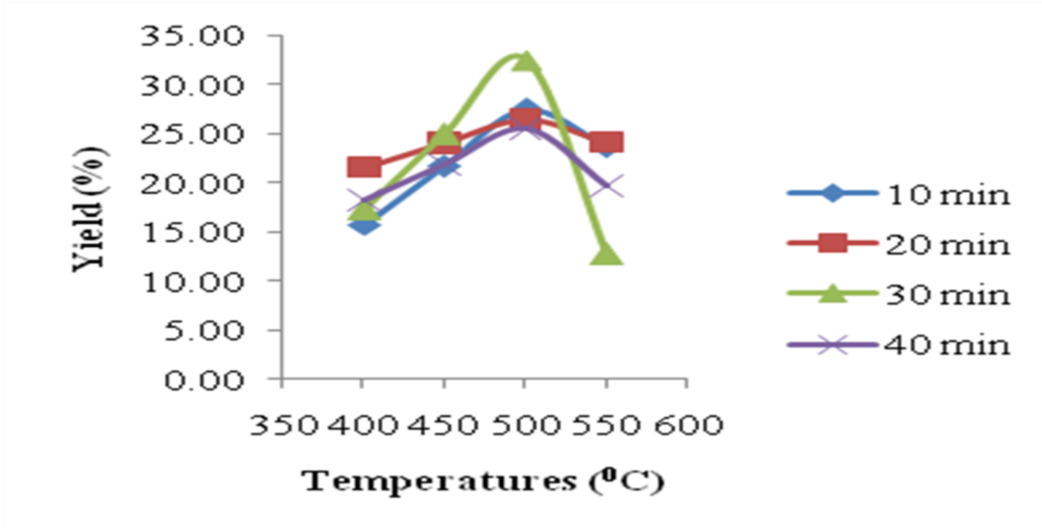


Figure 5: Effect of constant pyrolysis time on oil yields at various temperatures

The best time of 30 min pyrolysis produced the highest oil yield of 32.50 %wt. at temperature of 500 ^{0}C as shown in figure 5 above, and this was used to study the impact of temperature on product yield at 500 ^{o}C.

3.2.2. Impact of temperature on product yields

It is a well established fact that the main parameter among the operating factors is the temperature; hence the impact of pyrolysis temperature on products yields were investigated and illustrated in figure 6 below. To do this, the pyrolysis experiments conducted for 30 min at the various temperature range of 400-550 ^{o}C with intervals of 50 ^{o}C was isolated and under study. On a general note, higher gaseous yield were obtained at all temperatures as shown figure 6. These were due to continuous decomposition of bio-char as it remained for too long in the furnace. An increased in the bio-oil yields were observed from 400-500 ^{o}C and a sudden decreased at 550 ^{o}C. Thus the highest bio-oil yield of 32.50 %wt. was recorded at the pyrolysis temperature of 500 ^{o}C and termed as the best temperature. At lower temperatures (<500 ^{o}C), the oil yield was lesser and char yield was more. On the other hand, at higher temperature (>500^{o}C) the char and the oil yield were less; however the gas yield was observed to be higher. The reason for less oil yield at lower temperatures (<500 ^{o}C) may be due to incomplete pyrolysis which result from insufficient energy required, thereby yielding less oil and more char. On the contrary, the high gaseous yields at higher temperature (>500 ^{o}C) may be attributed to the secondary cracking of the pyrolyzed vapour and decomposition of the bio-char, which lower oil and char yield. Similar pattern was observed by other researchers, Salman, (2014), Naqvi *et al.*, (2014) and Nikos, (2012).

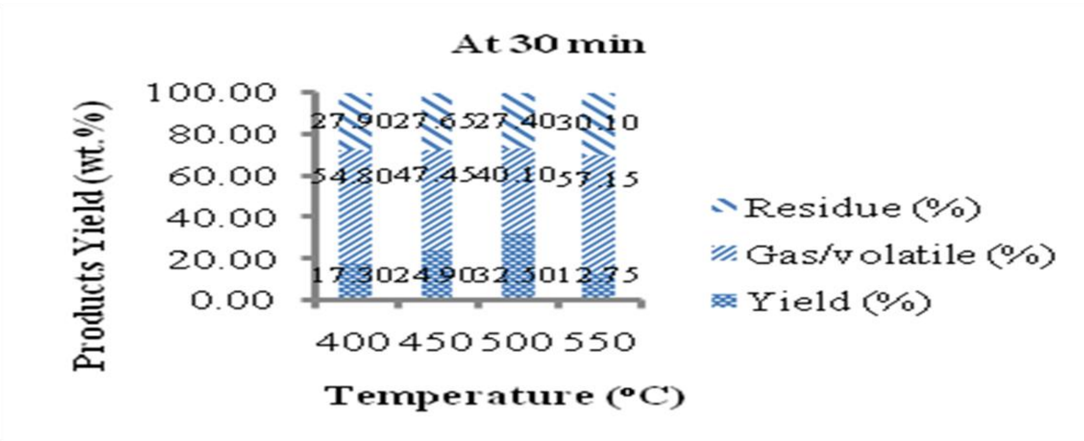


Figure 6: Impact of temperatures on products yield

According to Jahirul *et al.,* (2012), Brown (2009) and Naqvi *et al.,* (2014), the gases formed during pyrolysis experiments comprise of H_2, CH_4, CO and CO_2. These gases were used to calculate the compositions (vol. %) as the temperature increases and the results are as shown in Table 3 below. The total gases yield at 400 ^{0}C is 54.80 vol. %, which decreased to 47.45% vol. % at 450 ^{0}C and the least volume of 40.10 vol. % was recorded at 500 ^{0}C, while further increase in temperature to 550 ^{0}C lead to an increase of 57.94 vol. %. At 500 ^{o}C where the least volume was obtained it shows that some of the gases wevre converted to straight chain hydrocarbon thereby given rise to more energy density of the bio-oil.

Table 3: Composition of gases (Vol. %) for non-catalyst and catalyst

Gases	**400**	**450**	**500**	**550**
H_2	1.22	1.05	0.89	1.27
CH_4	9.74	8.44	7.13	10.16
CO	17.05	14.76	12.48	17.78
CO_2	26.79	23.20	19.60	27.94
Total	**54.80**	**47.45**	**40.10**	**57.15**

As the temperatures increases the ability to de-oxygenate undesirable constituents of bio-oil to form CO_2 and H_2O increases. While as the temperature of the system cools below 300 ^{o}C there is reduction of CO_2 and H_2O **leading formation of** straight chain hydrocarbon. This is demonstrated in table 3 above, where the volume of CO and CO_2 were least recorded at 500 ^{0}C compared to others, this clearly shows that de-oxygenation of harmful oxygenates from the vaporized bio-oil has been achieved by converting them to CO and CO_2 at a temperature below 500 ^{o}C. The volume of CO and CO_2 decreasing at temperature below 500 ^{0}C, which indicates inability of the temperatures to de-oxygenate harmful oxygenates and increased above 500 ^{0}C.

3.3. Analysis of the oil yield

3.3.1. Thermo-physical properties of bio-oil

The key bio-oil properties obtained varies with pyrolysis temperatures as depicted in Figure 7(a-c). It appeared dark brownish free from visible sediments; highly acidic with high water content, low heating value and very low sulphur content. The ash content in the oil is very negligible which agrees with other research conducted by Naqvi *et al.*, (2014). The sulphur contents of the bio-oil produced was relatively lower than petroleum fuels. The low sulphur contents are positive property for application as fuel. Compared with all pyrolysis temperatures, the bio-oil produced at the 500 ^{o}C had higher Carbon (21.70%wt.), Hydrogen (11.7%wt.), Nitrogen (1.86%wt.) and lower energy density (18.15%wt) than others as shown in figure 7(a). The higher nitrogen contents are greater than petroleum irrespective of pyrolysis temperature and are not favourable due to causing NO_x emission in fuel use. These results imply that the bio-oils should be de-nitrogenated to improve their applicability as fuels. The lower heating value of the oil is due to high water content and presence of carbonyl compounds. These results agreed with an earlier study by (Islam et al., 2014), (Naqi., *et al.*, 2014) and (Kim *et al.*, *2014)*.

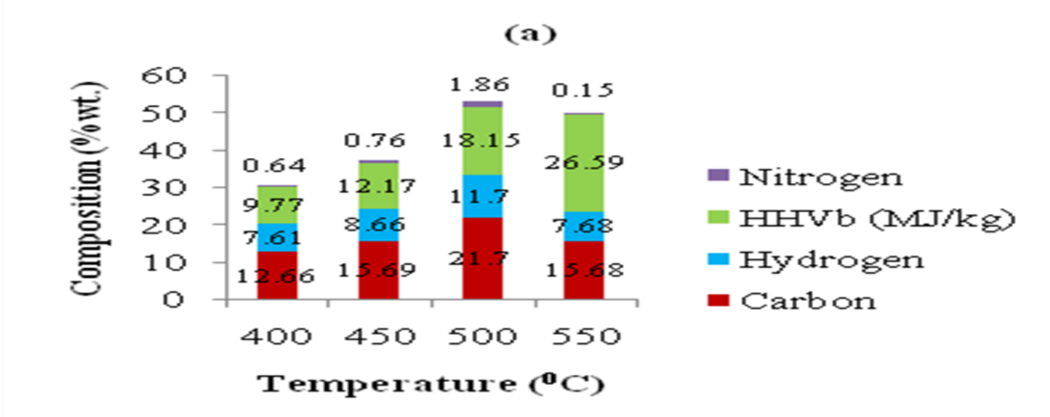


Figure 7(a): Properties of bio-oil yields

The density and oxygen content decreases as the pyrolysis temperatures increased from 400–500 ^{0}C, and at 500 ^{0}C the bio-oil has minimum values as demonstrated in figure 7(b). Compared with petroleum standard the minimum oxygen content is higher in the bio-oil which results in acidic, unstable and corrosiveness with a relatively low energy density. The varying quantities of water formation which forms a stable single-phase mixture decreasing as the temperature also increases, ranging from 44.86, 41.71, 34.50 to 41.22 %wt. water. The high water content of bio-oil is due to formation of water in pyrolysis process. These all agrees with the early study by Naqvi *et al.*, (2014).

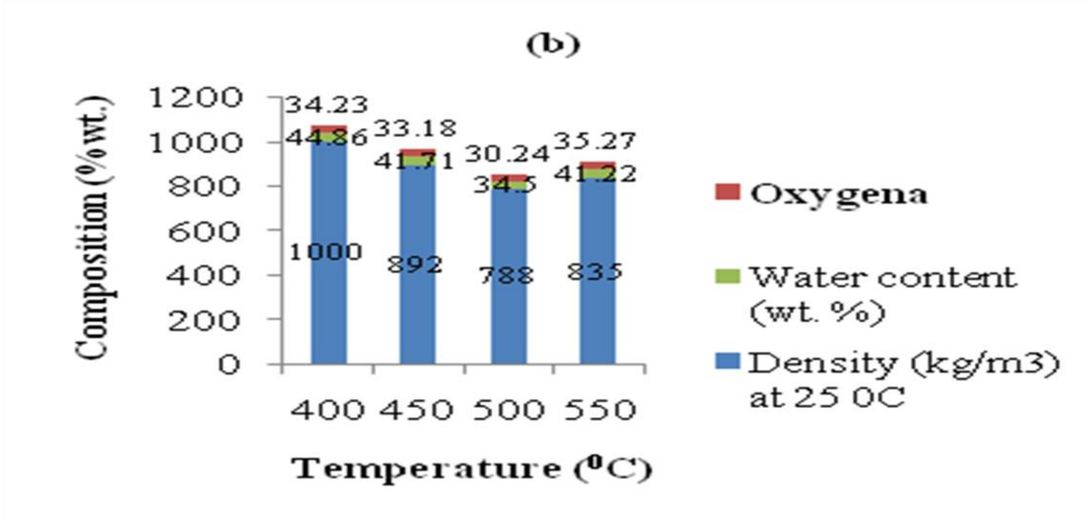


Figure 7(b): Properties of bio-oil yield

In all experiments, the bio-oils consisted of higher acidity (pH) values and decreases as the temperatures increases, while at 500 ^{0}C it recorded the lowest acidity (pH) value (3.42) as shown in figure 7(c). This value is lower than 4 indicating it`s corrosive nature and resulted from high oxygen content **from the biomass, this also agreed with early study by Naqvi *et al.*, (2014).**

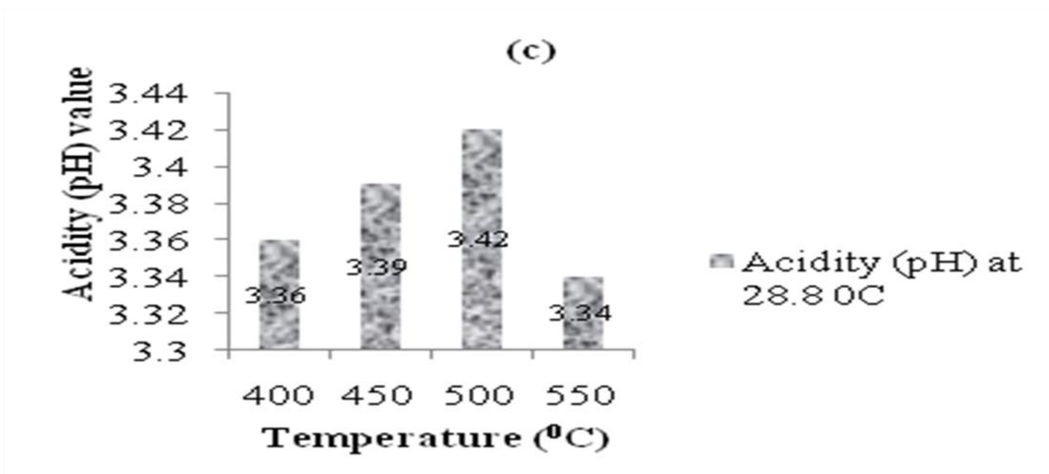


Figure 7(c): Properties of bio-oil yield

3.3.2. Impact of temperature on the degree of de-oxygenation of bio-oil

The degree of de-oxygenation of bio-oil at various pyrolysis temperatures are shown in figure 8. This **is** aimed at reducing the oxygen content of biomass through various pyrolysis temperatures to get high quality bio-oil. It focuses on how much oxygen has been removed from biomass and retained in the bio-oil.

At temperatures below 500 ^{0}C, the oxygen removal was less compared to at 500 ^{0}C. Higher temperatures helped to remove more oxygen from the original biomass. The results showed that more oxygen is been removed ~20.25%wt. at 500 ^{0}C as compared to ~9.73%wt. 400 ^{0}C, ~12.50%wt. 450 ^{0}C, and ~6.99%wt. at 550 ^{0}C pyrolysis temperature. It was also observed that the oxygen in the biomass was removed mostly as H_2O and as CO_2/CO, the result also agreed with the study carried out by Naqvi *et al.*, (2014).

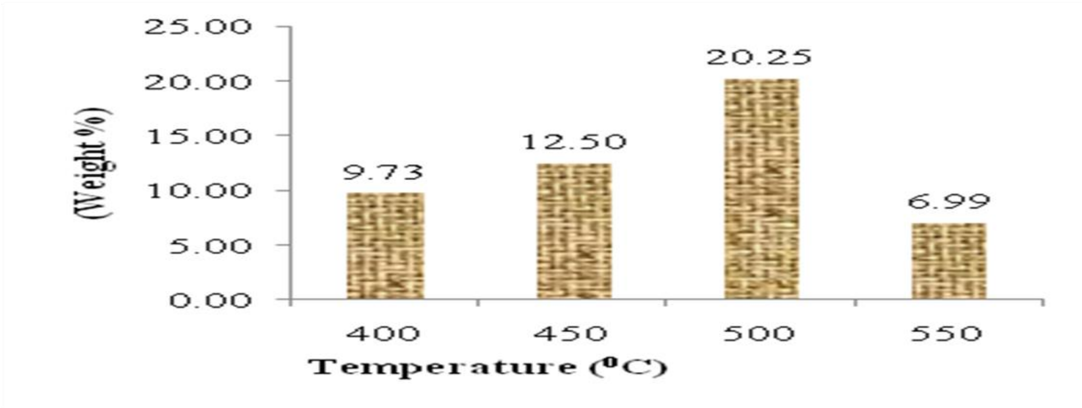


Figure 8: Degree of de-oxygenation of catalytic and non-catalytic bio-oil

3.3.3 Impact of Temperature on the composition of bio-oil

The bio-oil is a mixture of different compounds and reflects the decomposition of the lignocellulosic contents of MSW. To understand how temperature of 500 ^{0}C influences the pyrolysis of MSW; the functional groups present in the bio-oils were analyzed using FTIR. These were classified into different groups (such s are alkanes (C-H), alkenes (C=C), amines (N-H), alkanol (O-H) e.t.c.) and their areas. The total peak areas of these groups for bio-oils are as shown in figure 9.

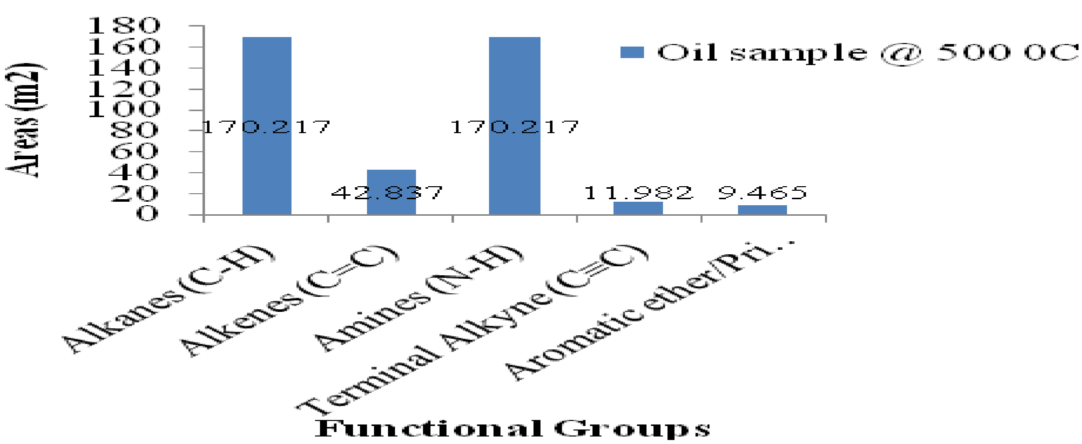


Figure 9: Functional groups of bio-oils and their areas at 500 ^{0}C

From figure 9, the functional groups and areas of the bio-oil revealed the different components of MSW with nitrogen-containing compounds and complex carbohydrates. This may suggest that food waste component of MSW contains high source of amino acid (high crude protein). At 500 ^{0}C where the degree of de-oxygenation is high, carboxylic oxygenates are formed through decarboxylation of organic acids (such as acetic, formic, fatty and amino acids) from cellulose, hemicelluloses, esters and nitrogen-containing compounds. De-carbonylation of aldehyde, phenol, ketones and carbohydrates compounds to form aliphatic and aromatic hydrocarbons. Amines are also formed through depolymeriztion of amino acids (protein and amides), catalytic hydrogenation of nitriles groups (R-C≡N) and nitro-alkanes (CH_3-CH-NH_2). The areas of the functional groups are 42.837m^2 alkenes, 170.217m^2 amines, 11.982m^2 terminal alkynes and 9.465m2 aromatic.

CONCLUSION

Much attention has been given to biomass pyrolysis lately; because of clean energy production. The bio-oil yields for the best operating temperature (500 ^{0}C) was 32.50%wt. whereas the highest degree of de-oxygenation was 20.25%wt., respectively. Meanwhile, the carbonyl and acidic components that cause instability and acidity of the bio-oil were reduced to the form of H_2O and CO_2 by oxygen removal. The results of FTIR analysis of bio-oils at 500 ^{0}C indicate functional groups (such as alkanes, alkenes, amines, terminal alkynes and aromatic ether) with their areas. The presence of amines may likely be from amino acid and amides in the food wastes which make it unfavourable due to emission of NO_X for the oil use. Thus, food wastes can be isolated from the feedstock or better still further study may revealed an efficient way of nitrogen removal in the bio-oil in consideration to a specific fuel use.

ACKNOWLEDGEMENTS

The lead author acknowledges the financial support of Niger State Secondary Education Board (NSSEB), Minna for the accomplishment of the research.

REFERENCES

Alison S., Keith, B., Steve, O., Kathryn, R., & Judith, B., (2001). Waste Management Options and Climate Change, *Final report to the European Commission,* DG Environment, ISBN 92-894-1733-1, retrieved from http://europa.eu.int.

Ani, F.N. and Islam, M.N. (1997). Liquid oil from fluidized bed pyrolysis of rice husk. *In Proceeding of Second Jordanian International Conference of Mechanical Engineering*, JIMEC 97. Amman, Jordan, June 2-5, pp. 270-276.

Brian, G. and Justin, M. (2009). Reconsidering Municipal Solid Waste as a Renewable Energy Feedstock, *Environment and Energy Study Institute (EESI),* 1112 16th Street, NW, Suite 300 Washington, DC 20036, (202) 628-1400, www.eesi.org

Brown J.N., (2009). Development of a lab scale auger reactor for biomass fast pyrolysis and process optimization using response surface methodology, *graduate thesis and dissertation Paper 10996,* Retrieved from http://lib.dr.iasttate.edu/etd.

Bogner, J., Abdelrafie, A.M., Diaz, C., Faaji, A., Gao, Q., Hashimoto, S., Mareckova, K., Pipatti, R., & Zhang, T., (2007). Waste Management, In Climate Change: *Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Gopakumar, S.T., Adhikari, S., Gupta, R.B., Tu, M., & Taylor, S. (2011). Production of hydrocarbon fuels from biomass using catalytic pyrolysis under helium and hydrogen environments, vol. 102, pp 6742-6749

Islam M.S., Miah M.Y., Ismail M., Jamal S. M., Banik K. S., & Saha M. (2010). Production of Bio-oil from Municipal Solid Waste by Pyrolysis, 45(2), 91-94, retrieved from www.banglajoi.info

Kim, S.W., Koo, B.S., and Lee, D.H. (2014). Catalytic pyrolysis of palm kernel shell in a fluidized bed reactor, 167, 425-432.

Lim, X., Sanna, A., & Andresen J.M. (2014). Influence of red mud impregnation on the pyrolysis of oil palm biomass-EFB, pp 119-265. Retrieved from www.elservier.com/locate/fuel

Naqvi S.R., Uemera Y. and Yusup S.Bt. (2010). Catalytic pyrolysis of paddy husk in a drop type pyrolyzer for bio-oil production: *The role of temperature and catalyst*, 106; 57-62.

Salman Zafar, (2009). Gasification of Municipal Solid Waste; e-mail: salman.alg@gmail.com

Yathavan B.K., 2013, Conventional and Catalytic Pyrolysis of Pinyon Juniper Biomass, *All Graduate Theses and Dissertations*, Paper 2053, Utah State University, DigitalCommons@USU, http://digitalcommons.usu.edu/etd/2053

ASSESSMENT OF QUALITY OF NEIGHBOURHOOD AS DETERMINANT OF CHOICE OF LOCATION AMONG RESIDENTS IN BOSSO AND KPAKUNGU RESIDENTIAL AREAS OF MINNA, NIGER STATE.

Altine Maxwell Kyon, Sum Habila Ezekiel & Terzungwe Dugeri
Department of Estate Management and Valuation, Federal University of Technology, Minna, Nigeria

There are several empirical evidences that affirm the fact that the quality of the neighbourhood is a significant reason for choices of location among residents. The identification of household's level of education, income availability, crime rate, friendship, etc, has helped to understand why household would prefer a particular location over another. This paper evaluates the quality of a neighbourhood in relation to the choice of residence among households of Kpakungu and Bosso. Literature reviews, interviews and observations were employed to investigate the choice of residence among households in Kpakungu or in Bosso. Discussions and conclusions were made afterwards.

Keywords:

Households, Neighbourhood, Choice, Determinant, Kpakungu, Bosso.

bmailabari@gmail.com

Altine Maxwell Kyon, et al (2016). **ASSESSMENT OF QUALITY OF NEIGHBOURHOOD AS DETERMINANT OF CHOICE OF LOCATION AMONG RESIDENTS IN BOSSO AND KPAKUNGU RESIDENTIAL AREAS OF MINNA, NIGER STATE.** Sustainable Built Environment and Climate change; The challenges of Post 2015 Development Agenda. School of Environmental Technology Conference, SETIC, 2016

INTRODUCTION

Housing is a key need in the life of humans and constitutes one of the major reasons why man works to support life. Whatever the class a person belongs to, urban or primitive; where to lay his/her head after a hard day's job is of utmost importance because of the need for rest. Individually, we have differences in tastes, needs and aspirations. Ours choices in life are determined by influences, affluences, friendship and personal reasons to say the least. Households are a key factor in the development of any society and constitute roughly about 60% of urban land use, (Bina, Kara & David, 2006). While households are important in choice of location it is often interdependent with accessibility to firms, manufacturing sites and retail centres for commercial activities are equally important and are interwoven one to another with households. According to Lekan & Akinyemi (2009), there is a strong relationship between individual's travel pattern and residential location preference. Travel distance to workplace, market, school etc all contribute in choices of location among residents. But how does the quality of the environment affect the choice even when travel time is put side by side quality of the neighbourhood. A lot of studies have been carried out on location choice where quality of housing, prices or rents on property, distance from & to work and other key competing factors has been examined to establish when, why and where do household choose to move, Anderson, Palma, Thisse (1992). Quality is the standard of something as measured against other things of a similar kind; the degree of excellence of something.

Background of the Study

The state capital of Minna is located within the central part of the country and serves as a transit hub to the northwest and the southwest states of the country. The city of Minna is indigenously a Gbagyi settlement which has over time, being flooded by other ethnic groups within the state. In the same vein, several migrants from various part of the country have constituted a major part of the population. The indigenous occupants of the state capital Minna are mainly situated around the central part of the state capital along Tunga which extends through Bosso road. With the central residential area concentrated, the city has expanded in order to accommodate the increasing population. The expansion of the former Minna town is visible along the by-pass at the western parts of Minna and also in the eastern parts likewise. The expansion is a direct result of the increase in the population of migrants into the town either as civil servants, businessmen or opportunity seekers. Both Bosso and Kpakungu are residential areas, while Bosso is a medium density neighbourhood, Kpakungu on the other hand is basically a high density layout also comprising of residential cum commercial land-uses. The areas are occupied mostly by non-indigenous civil servants, businessmen, students, petty traders etc. This is obvious when observed, that there is a high traffic activities by private cars owners in the morning within the hours of 7a.m to 9a.m. and also between 4p.m to 6p.m in the evening thereby creating a heavy traffic around the neighbourhoods in consideration. Both Kpakungu and Bosso are residential areas housing civil servants, students and businessmen/women alike with mixed density. This paper attempts to examine the choices of households in relationship to the quality of the neighbourhood.

Objective of the study

This paper seeks to examine how the quality of the neighbourhood determines and influences the choice of residence among households in Kpakungu and Bosso neighbourhoods of Minna, Niger state.

Methodology

Literature review and interview survey and observation methods were adopted in the research. Residential areas in Minna town were classified and divided into either high density or medium density zones while randomly selecting Bosso and Kpakungu was selected to represent medium and high residential density zones respectively, while leaving out the low density areas. Secondary data where compiled from published journals on the internet, textbooks and dictionary. Primary sources where compiled from interview and simple random sampling method was used by clustered method of selection of residents of Bosso Estate in Bosso and Beganu in Kpakungu, about 30 to 50 houses were randomly selected to represent the areas. Interviews were conducted with landlord/landlady or tenants in occupation. Observation of traffic, rush hours, development pattern, basic amenities where observed within a period of six months between 2015 and 2016.

Review of Related Literature

An understanding of residential location choice is fundamental to behavioural models of land use, and ultimately, travel demand, (Atkinson 2002). Various factors are attributes to choice of household, and include standoffs between transport costs and housing prices, (Dietz, 2002). Since accessibility is a major theme in residential location theories, transportation has been a focus on many models. But most of such theories assume that all jobs or occupation are located in the central area which is not so. Two key weaknesses in many older studies include the assumption of a single-worker households and a mono-centric city, (Greenberg, 1999). There are many classes of household owners, basically three classes namely; low-class, middle-class and the high-class. Each of these classes has different circles with common household location basically determined by price of housing. A trader living at the city's fringe has little business with town as most of his activities and circulation is centred at the outskirts particularly if his goods can be delivered to him at his shop. Nevertheless, medical care and some other needs may take him right to the city centre. The characteristics of housing structure itself will be an important determinant of a household's choice of residence (Greenberg, 1999).

The choice of location choice can be influenced by social benefit in interactions between households, (Kiefer, 2012). He points out the benefits of social interactions among people by stating that people will have better social interactions when they are around others who share same values and similar attitudes. This statement can be further broadened to suggest people will choose to stay within environments with common cultures, religion, social class, and business affiliations. Hua Kiefer applied the cost benefit analysis to interpret these findings by saying; the benefit of social interaction is based on the similarity of the two individuals involved in the interaction, and the cost of it is the effort and expense that must be spent on the social interaction, which can be measured by proximity in physical space. This is based on the logic that a household will tend to search for potential neighbours with similar socio-economic backgrounds in order to maximize its utility.

Recent researchers have revealed neighbourhood quality as one of the determinants of household's residential choice. (Kiefer, 2012) included a large set of community quality indicators, such as public expenditure, tax, crime rate, commercial activity, etc, in their logit community choice model pointing their results to an individual household's location decision been significantly affected by local public services and community entry prices. What are the public services provided that could bring attraction to a searcher? Of course better road networks, tarred streets, provision of electricity, accessibility to a nearby hospital or clinic, pipe borne water, less crime and availability of security, are but some of the attractions to a neighbourhood. (Kiefer, 2012) grouped neighbourhood quality into two subsets; first the nature of the community by focusing on factors, which describes the natural and socio-political environment, such as tax rates, the crime rate and available parks within the vicinity. The second set describes the inhabitants of the community which includes such thing as the median level of education, median income, and median age, capturing the features of the socioeconomic environment. It is observed that every neighbourhood has a common class of residents' maybe because it is easier to pick a choice of household from information gotten from an acquaintance on the state of the neighbourhood. This feature may not fully capture one of the reasons to attract a potential incoming household, but it still gives insight into the possibility of influence from relationship among friends & relatives in the choice of household.

Another study has suggested that as a household progresses through their lifecycle, e.g. as household size increases due to children and incomes rise over time, demand for newer and larger houses is hypothesized to increase and, as a result, households who have a preference for larger houses and lots are more inclined to locate in the suburbs where land is available in larger quantities, Dietz R. (2002). This is evident in most parts of the town of Minna as the better and bigger accommodations are not located with the central part of the town. It can be observed that apart from areas like Tunga, and railway quarters, Emir's palace, which are mainly high density areas cum medium density in a spatial distribution, at least mostly or all medium and low density layout are located at the suburban areas. Because of the limitation of available land and high cost in the urban centres, households would look to the suburb because of the advantage of available land at cheaper rates. During the initial phases of city formation, houses are built within the central part of the city to minimize the cost of commuting to employment. Take for instance the railway quarters that is just behind Central Bank building. Workers with the railway corporation will find easy access to work as close to the railway station as they can be.

On the other hand, the "flight from blight" hypothesis emphasizes the role of declining public services and quality of life in the central city relative to suburban and rural locations. Tiebout's (1956) notion that households have preferences over local public goods that vary across local jurisdictions underlies this second theory of suburbanization, which argues that amenities, as well as distance and land costs, influence households' location choices. The uneven distribution of private and public amenities across local jurisdictions—in particular, the inferior amenities associated with central cities relative to suburbs—are viewed as the main determinants of suburbanization. These problems include crime, violence, racial issues, low quality of schools and public services, and poor environmental quality that are often associated with central cities. The "flight from blight" hypothesis maintains that households that can afford to move to the suburbs will do so, in search of safer neighbourhoods, better schools, nicer environments, and communities comprised of people more like themselves.

Empirical evidence in support of the “flight from blight” theory, in which fiscal and social problems in central cities induce movement out of the city among more affluent households, has, for the most part, provided evidence of a relationship between the quality of local private and public services and household location choices. Cullen and Levitt,(1996) find evidence of the responsiveness of households to crime rates; specifically, that higher income, being white and the presence of a child under age 18 increase the responsiveness of a household to a change in crime rate. Declining quality of life in central cities not only has a direct impact on a household’s willingness to relocate, but also an indirect impact on the value of the neighbourhood housing stock.

Quality of the neighbourhood is characterised by the planned layout of area, appearance of the building, the people who live in the neighbourhood, proximity to shops, schools, parks and access to work, absence of crime and nuisance, etc, Koopman, (2012). Gaining access to decent housing and pleasant communities with high quality facilities and environments is fundamental in the housing choice process. Most households would rather live in good quality houses and in neighborhoods which feel safe and provide the amenities which ameliorate the stresses of urban living. The presence of parks, good road networks make a neighbourhood attractive, but so too is the presence of friendly neighbors and the absence of crime and deteriorating physical structures. How then does quality of the neighbourhood affect the choice of households among prospective land owners? Every neighbourhood has characteristics that differentiate it from another neighbourhood. A good neighbourhood should have the following characteristics among many others;

1. Has a variety of functional attributes that contribute to a resident's day-to-day living (i.e. residential, commercial, or mixed-uses).
2. Accommodates multi-modal transportation (i.e. pedestrians, bicyclists, drivers).
3. Has design and architectural features that are visually interesting.
4. Encourages human contact and social activities.
5. Promotes community involvement and maintains a secure environment.
6. Promotes sustainability and responds to climatic demands.
7. Has a memorable character.

(American Planning Association, APA, 2015)

On the other hand factors that determined choice of location among high density location residents where; availability of free accommodation, living with family members, proximity to family compound, familiarity with neighborhood due to long stay in the area. Medium density areas preferred their neighborhood as a result of vacancy availability, free plot to build on, closeness to work, security of land ownership and free accommodation.

The Case of Bosso and Kpakungu

Before we can analyse the probable choice of households’ location in either of Bosso and Kpakungu areas of Minna, we have to first describe the neighbourhoods.

Bosso is located at the southern part of Minna town and is the home of one of the campuses of the Federal University of Technology Minna. The campus which was originally the main/only campus before the school moved to the new campus at Gidan Kwano. It is mainly a medium populated residential area and home to many civil servants especially staffs of the university of Minna, Niger state. The Bosso layout is characterized by the presence of Bosso Estate, F-layout among others. The neighborhood is also lightly a commercialized area. The neighborhood is serviced with pipe-borne water from the Niger State Water Board although not in full capacity as water supply has become epileptic. The provision of electricity is visibly adequate in comparison to the general situation of electricity supply in the country. In 2014, Bosso became home to thousands of refugees fleeing fighting in Borno State causing an increase in the population growth of the area and consequently over-stretching the already peaked supply of basic amenities like water and electricity.

The neighborhood appears safe and the absence of hoodlums is noticeable apart from the hawkers which can be seen from time to time moving around with their wares. Crime rate is low as such with a mild social bustling during the evenings. By most standards, Bosso is an area that best suites the medium income earner as the landed properties within the neighbourhood is within affordable range for most civil servants and business classes. The roads in the other hand are motorable but are mostly untarred evidenced with the absence of drainages and gutters along the roads.

Kpakungu is likewise a residential cum commercial layout with intermixes of high and medium density in some parts and is located off Minna – Bida – Mokwa road. Kpakungu is faced with the problem of over-crowding resulting from massive urban influx. The neighborhood is a mixed class neighborhood which houses both medium and low income earners. The medium income earners are mainly the civil servants and business owners. Land is more affordable and accessible to the less privileged and it is notable to find most households build on what is referred to as half plot or otherwise known as 50ft/50ft. It is home to about three motor garages that provide commuter services within the state and transport services across the country. It is a populated area housing most of the transport service provides and other low income earners. It is characterized by the presence of hoodlums and could be vulnerable to high crime rates because of the presence of seasonal residents who come around during the dry season to trade and return back to their hometown in the raining season. Apart from the commercial activities on the major road, the interior is basically residential housing mostly built haphazardly without setbacks and drainages. The situation is worsened by the absence of pipe borne water and poor sanitation. Usually poor sanitation arises when there is no cleaning. Either the cleaning of gutters, roads, households etc, water is important for any cleaning to be effectual. In the general Assembly of the human right to water and sanitation, the Assembly established the right of every human being to have access to sufficient water for personal and domestic uses (between 50 and 100 litres of water per person per day), which must be safe, acceptable and affordable (water costs should not exceed 3% of household income), and physically accessible (the water source has to be within 1,000 metres of the home and collection time should not exceed 30 minutes). According to the Millennium Development Goals (MDGs) Report 2012, estimation was made to the number of people who hardly have access to pipe borne water stood at about 783 million. Such sources of water for use included household connections to public water from the state's Water board, boreholes, protected dug wells, protected springs and rainwater collections. It is obvious that the Government of Niger State has not given much attention and control to the activities and development of the Kpakungu area and thereby the neighborhood is as such.

Conclusion and Recommendation

Every decent household would like to live in a neighborhood which provide a serene environment where lives and property are safe, sanitations is provided, low crime rate, having variety of functional attributes to meet the needs of the occupants, having design and architectural features that are visually interesting, encourages human contact and social activities, promotes community involvement and maintains a secure environment and finally, promotes sustainability and responds to climatic demands.

Where these features are missing, then adequate neighbourhood has not been provided. The major road linking Minna to Bida is also of major concern as it has gradually diminish in its function as a major road, causing untold holdup and difficulty in navigation especially during rush hours by commuters to workplaces and back home. Hence, road expansion and rehabilitation is necessary. The place of the Town and Country Planners must be felt in these neighbourhoods in order to meet the requirement of a safe and desirable neighbourhood. In providing an adequate neighbourhood, the stakeholders must be involved in every stage of the household provision scheme. From site acquisition, to approval of building plans, right up until the construction activities, the presence of the stakeholders must be felt and impact must be made in order to create an environment that is safe and friendly not only for the present generation but also for the generations unborn.

The basic infrastructure that makes for a suitable neighbourhood must also be put in place. Pipe borne water, drainages and colverts are some of the simple infrastructures that will go a long way in addressing the issues raised especially in Kpakungu area.

REFERENCE

American Planning Association (2005). Volume 71, Issue 3, pages 123-124.

Anderson, A.P., De Palma, A., & Thisse, J. F. (1992). Discrete Choice Theory of Product Differentiation. MIT press.

Charles M. Tiebout (1956). The Journal of Political Economy, University of Chicago Press, Vol. 64. No.5. http://www.jstor.org/stable/1826343.

Dam, F. van, S. Heins & B.S. Elbersen (2002), Lay discourses of the rural and stated and revealed preferences for rural living. Some evidence of the existence of a rural idyll in the Netherlands. Journal of Rural Studies18: 461-476

Dietz, R. (2002) The estimation of neighborhood effects in the social sciences; an interdisciplinary approach, Social Science Research 31, 539-575

Duncan, G. Brooks-Gunn, J. and Klebanov, P. (1994) Economic Deprivation and early childhood development, Child Development 65, 296-318

Ellen, I.G. and Turner, M. (1997) Does neighborhood matter? Assessing recent evidence. Housing Policy Debate 8, 833-866

Galster G. (2003) Investigating Behavioral Impacts of Poor Neighborhoods: Towards New Data and Analytic Strategies. Housing Studies 18, 813-914

Greenberg, M. (1999) Improving Neighborhood Quality: A Hierarchy of Needs, Housing Policy Debate 10, 601-624

Hua Kiefer (2012). Residential Location Choice : The Role of a Taste for Similarity. International Journal of Economics and Finance, Vol. 4, No. 9 2012. ISSN 1916-971X.

Iklanfeldt, K.R. and D.L. Sjoquist (1998). The Spatial Mismatch Hypothesis: A Review of Recent Studies and Their Publications for Welfare Reform, Housing Policy Debate, 9, 849-892

Ioannides, Y. (2002). Residential neighborhood effects. Regional Science and Urban Economics 32, 145-165

Jackson, R. J. (2003) The impact of the built environment on health: an emerging field, American Journal of Public Health 93, 1382-13-84.

Julie Berry Cullen and Steven D. Levitt (1999). Crime, Urban Flight and the Consequences for Cities. The Review of Economics, Vol. LXXXI, No. 2, pages 159-167.

Lekan Sanni, Felicia O. Akinyemi (2009). Determinants of Households' Residential Districts' Preferences within Metropolitan City of Ibadan. J Hum Ecol, 25(2): 137-141 (2009)

Marnix johan Koopman, (2012). Economic Analysis of Neighbourhood Quality, Neighbourhood reputation and Housing Market, PhD Thesis. IOS Press under the imprint Delft University Press. ISSN 1879-8330, 44

Parkes, A. Kearns, A. and Atkinson, R. (2002) What makes people dissatisfied with their neighborhoods? Urban StudiesVol. 39, 2413-2438

Pauleit, S. (2003) Perspectives on Urban Green space in Europe. Built Environment. Vol 29, 2, 89-93

Sampson, R., Raudenbush, S. and Earls, F. (1997) Neighborhoods and violent crime: A multilevel study of collective efficacy. Science277, 918-924 SCP (1998).

LIGHTING PERFORMANCE OF A FACULTY BUILDING: A CASE STUDY OF FEDERAL UNIVERSITY OF TECHNOLOGY MINNA

MAMBO Abdulhameed Danjuma[1] & OPAYEMI Idowu Opeyemi[2]
[1] Department of Building, Federal University Birnin Kebbi, Kebbi State, Nigeria.
[2.] Physical Planning Department, University of Abuja, FCT, Nigeria.

Energy crisis is a major problem faced by the world today. Lighting system consumes a sig nificant amount of world energy resources. In educational buildings, a major portion of po wer is consumed by lighting. Continuous increase in energy cost also forces a search for a possible minimisation of energy in this area considering that adequate lighting is essential f or the visual comfort of humans and their performance. Therefore, it is very essential to ana lyse the lighting factors and energy consumption of buildings to provide comfortable lighti ng environment. In this work, a dynamic model of a faculty building with its existing lighti ng installations was developed using DIALux Evo 3 software. Measured illuminance level at various points within the building was used as input into the base case model. A propose d upgrade of this model using energy efficient installations such as the use of lighting emitt ing diode (LED) lamps and lighting control strategies was investigated. Thereafter, energy consumption calculations were carried out using the software. The upgrade to LED lighting results in about 71.66% of energy saving compare to exiting lighting installation. Similarly, the use of automatic switching on/off control and switch off using lighting energy numeric indicator (LENI) lead to an energy and cost reduction of 53% and 72% respectively.

Keywords: *DIALux Evo, Lighting Modeling, Energy Efficiency, Lighting Control*

abdmambo@gmail.com

MAMBO Abdulhameed Danjuma & OPAYEMI Idowu Opeyemi (2016). **LIGHTING PERFO RMANCE OF A FACULTY BUILDING: A CASE STUDY OF FEDERAL UNIVERSITY OF TECHNOLOG Y MINNA** Sustainable Built Environment and Climate change; The challenges of Post 2015 Development Agenda. S chool of Environmental Technology Conference, SETIC, 2016

INTRODUCTION

Lighting is an essential requirement for human comfort. Its quantity and quality influences how man perceives the quality of his environment(Ryckaert, Lootens, Geldof, & Hanselaer, 2010). Also, whether in an office, an educational institutions or a household, lighting consumes a major portion of electric power consumption reaching about 20 to 50 % in the world(Mills, 2002) (Roisin, Bodart, Deneyer, & D'Herdt, 2008). Thus it is very important that lighting in a functional space should be proper, adequate and efficient. Especially in a Classroom, lighting should be very proper because visual tasks like reading and screen based work are done. Also in terms of energy efficiency considerations, high quality lighting will have high illumination with minimum power consumption.

Lights originates from either natural or artificial light sources. The sun is the supplier of natural lights. The light from the sun is reflected/refracted, diffused or scattered by water vapour and other particulate matter in the atmosphere. Artificial lights is generated from a device that produces electromagnetic radiation due to the passage of electric current (incandescent lights, fluorescent lights, LED etc.) or from the direct combustion of some materials such as oil and gas.

There are several techniques (Roisin et al., 2008) to minimise energy in a building such as the analysis of lighting quality, proper design of buildings and lighting systems, selection of proper lamp types and their fixtures, maintenance of lighting system, maximise the use of daylight to reduce artificial light consumption, load shedding or automation of lighting system.

In recent decades, applications of computer simulation emerged as a promising and cost effective method in building science to test new technologies and demonstrate the effectiveness of existing systems (Salsbury, 2005). Designers often use dynamic lighting simulation programs to analyse the visual comfort and energy behaviours of a building in order to achieve specific targets like reducing cost of building energy consumption and environmental impacts or improving indoor lighting environment.

This project combined building lighting condition survey with advance lighting simulation software, DIALux Evo, to investigates, quantify and evaluate the physical system requirement for sustainability in an educational building.

This software has been validated for use in the calculation of indoor and outdoor electric lighting systems (Ochoa, Aries, & Hensen, n.d.). It is equipped with a fast and accurate latest external radiosity and an interactive 3-D visualization capability. It also boast of extensive libraries of shapes, textures and furniture.

Some noteworthy scientific studies that used DIALux included its use in determining criteria for energy efficient lighting (Ryckaert et al., 2010) or simulating luminaire arrangements for a study of patients suffering dementia (Hoof & Westerlaken, 2012)(Hoof & Aarts, 2009). Another notable study is its use in classroom modelling of Energy Centre, MANIT Bhopal (Dixit & Sudhakar, 2015) and in the optimum selection of a sustainable lighting system for a University Class Room in Saudi Arabia (Mohammed & Shaawat, 2014). In spite of its inherent advantages, there is no evidence in literature that suggest that this method has been used to analyse lighting system in Nigeria.

The use of this simulation model in building performance modelling is to display energy usage trends over time and to facilitate assessment of different lighting control load-reduction strategy. It is hoped that this work will provide some background information that will enable a designer to make some informed judgements on the potential of the current state-of-the-art in computer prediction of lighting in buildings and how this may be used to assist in building design.

MATERIALS AND METHODS

The method used here included a walkthrough survey of the case study building to take stock of existing lighting appliances in terms of number, types and quality and to gauge the lighting energy management strategy. This is to gather sufficient information for the computer modelling of a base case scenario and identify energy conservation opportunities to be confirmed in the test case scenario. For the purpose of this research DIALux Evo lighting simulation software was selected because of it essential feature for the base and test case model development.

The methodology comprise of modelling the entire building for testing lighting control strategy and using one of the lecture hall for optimum selection of a sustainable lighting.

Building Description

The case study is a two story building of School of Environmental Technology complex located at Federal University of Technology Minna, main campus lying at longitude of 06˚ 28‟ E and latitude of 09˚ 35‟ N. It occupies an area is $6325.00m^2$ and height of 12.00m made up of lecture hall, studio, offices, laboratory, and student sit out and shops. The building wall thickness is 0.23m, slaps 0.15m, beams 0.300m, and columns of various sizes with building utilities. The various views of the building is shown in figure 1.The building comprise of 16 lecture halls, 25 staff offices, 22 corridors, 15 studios and 12 studio corridors.

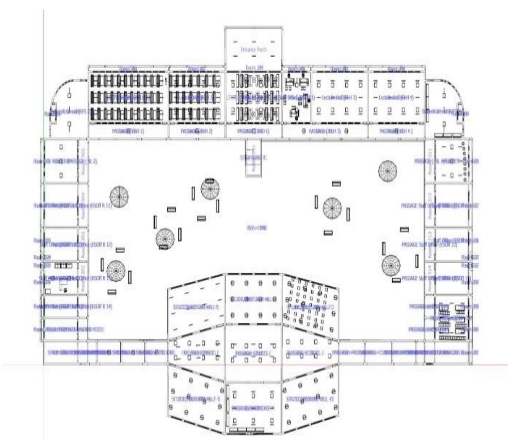
a. Front view **b. Inside view**

c. Back view **d. Corridor**

Figure 8: a,b,c,d - Some pictorial views of the case study building

Description of model of the Building

A DIALux evo 3 model was developed using the imported AutoCAD 2D model. The 2D model specifies the room extents (length, breadth) but the room height were provided to the software from actual measurements. Furniture positions was specified based on actual observations. Figure 2 shows the 2D floor plan view and 3D front views of the school building respectively.



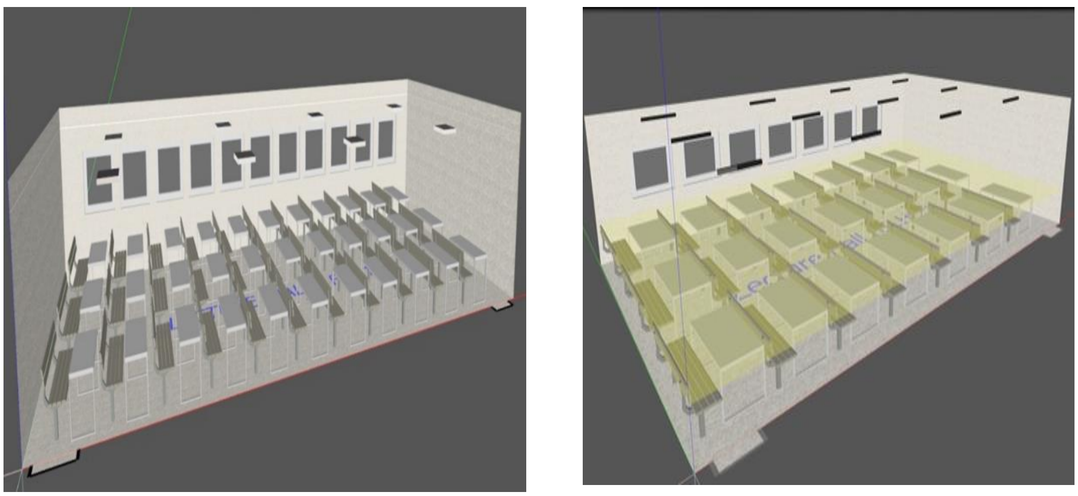
a. 2D Floor plan view **b. 3D front view**

Figure 9: 2D (a) and 3D (b) Model of the case study building

Description of Lecture Halls

From the Dialux model, a lecture hall was selected for this lighting analysis. The room illustrated in *figure 3* is about the same size with other rooms in the building. The total floor area is $84.3m^2$ height of the room is *2.8m*, working plane was specified as *0.8m*, the reflectance of the ceilings, walls and floors was calculated as *70%, 71.2% and 71.2%* respectively. These values were the same as that of the test case.

The orientation of the room is well lighted with natural daylight. The doors are opaque and the windows are translucent in the simulation model for daylight transmission. This allows the quantification of the effect of direct lighting, indirect lighting, texture, virtual surfaces and visual task in the simulation model. The walls and ceiling of the classroom were coloured off-white and white respectively in the computer model to match corresponding colouring for the surfaces as observed in real life. This is to account for the reflectance of surfaces in the model. Reflectance influenced how surfaces reflect and absorb light. There are eight luminaires made up of single compact fluorescent lamp of 38.4 W which were installed in the lecture hall as shown in *Figure3*.



a. Luminaire arrangement based on CFL **b. Luminiare arrangement based on LED**

Figure 10: 3D visualization of existing (a) and proposed (b) luminaire arrangement

Optimum Selection of a Sustainable Lighting

The proposed case test 35W incandescent, 36W T8 florescent, 38.4W CFL and an 11W LED Luminaires. Other parameters, illuminance pattern and energy performance analysis of the building used in this work are educational illuminance value of 500lx, uniformity coefficient of 0.6, glare limitation: for Indoors (UGR) of 19, 22, 24 and 25 respectively, absence factor of from 0.70 to 0.45, colour rendering of 80 and reduction factor of 0.92. The model also assumes a maintenance Interval of 1year and maintenance interval for luminance of 3years.

Lighting Control system evaluation

This section deals with the analysis of luminary parameters and illuminance pattern in the existing and proposed cases applied to the whole building. The building model was used to evaluate the benefit of using lighting control in our choice building. All these calculations are of daytime and night time use of lighting in the educational building per year. The energy consumption was calculated in Kwh/annum (kwh/a), Energy cost was calculated as naira (#), the currency unit in Naira and price per Kwh was set according to the local tariff. The lighting energy numeric indicator (LENI) was calculated as Kwh/a/m^2. It was the total amount of energy used by a lighting system per square meter, per year [(LENI=W/A) in Kwh/m^2/a, where W= total power consumption and A=total area] with different absence factor according to the purpose of usage by the occupant. It is the factor relating to the period of absence of occupants. For standard calculations some other parameters which were defined or calculated.

RESULTS AND DISCUSSIONS

The result is based on the evaluation of lamp type's performance and lighting control system.

Evaluation of lamp types

The simulation uses the lecture hall described in the previous section to compare the lamp types based on the measure of lumens, length operating hours, light output ratio and luminous flux to propose the most efficient, economical and high performing lamp for the building. The summary of these parameters is shown in table 1.

Table 1: Summary of parameters

Lamp	Light output ratio (%)	Luminous Flux/Lamp (lm)	Power (w)	Rated life time (h)
Incandescent	74.36	930.00	35.00	2000.00
Fluorescent	96.00	3072.00	36.00	30000.00
CFL	69.51	3379.00	38.40	10000.00
LED	100.02	3851.00	11.00	50000.00

Table 2: Cost and Energy implications of lamp types

Lamp	Energy Consumption (kw/a) / Lamp	Cost (N/a)
Incandescent	50.00	643.00
Fluorescent	50.00	660.00
Compact Fluorescent	56.25	705.00
Light emitting Diodes	16.67	191.00

Based on the result presented in *table2*, Light Emitting Diodes (LED) offer the greatest prospect in design and energy cost of installation. The use of LED lamp is therefore suggested as a proposed replacement to existing CFL for performance analysis in building zones compartments.

Evaluation of lighting control system

Table 3: Energy and Cost Performance of building without LENI

Zone	No. of rooms	Energy consumption (kwh/a)	Leni (kwh/a/m^2)	Cost (#/a)	Energy consumption (kwh/a)	Cost (#/a)
Lecture halls	16	450.00	4.00	5640.00	7200.00	90240.00
Staff office	25	200.00	5.00	2720.00	5000.00	68000.00
Student sit-out	6	275.00	4.50	3265.00	1650.00	19590.00
Passage	22	100.00	3.00	1360.00	2200.00	29920.00
Studio/lecture hall	15	1250.00	15.00	16330.00	18750.00	244950.00
Passage studio	12	850.00	9.00	10880.00	10200.00	130560.00
Total					***28,125***	***583260.00***

Table 4: Energy and Cost Performance of building with LENI

Zone	No. of Zone	Energy consumption (kwh/a)	Leni (kwh/a/m^2)	Cost (#/a)	Energy consumption (kwh/a)	Cost (#/a)
Lecture halls	16	500.00	2.00	6070.00	3300.00	39930.00
Staff office	25	50.00	2.00	820.00	1250.00	20500.00
Student sit-out	6	100.00	1.00	1095.00	600.00	6570.00
Passage	22	50.00	1.00	390.00	1100.00	8580.00
Studio/lecture hall	15	350.00	4.00	4670.00	5250.00	70050.00
Passage studio	12	150.00	1.00	1640.00	1800.00	19680.00
Total					***13,300***	***165310.00***

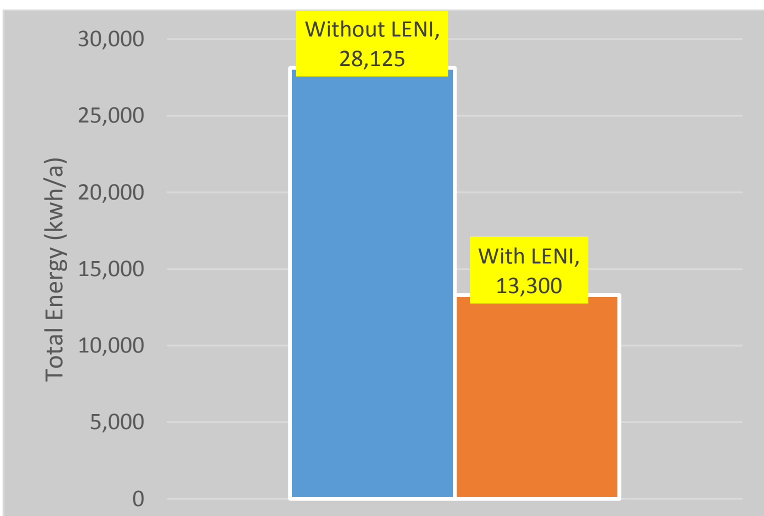


Figure 11: Comparing Total Energy Consumption

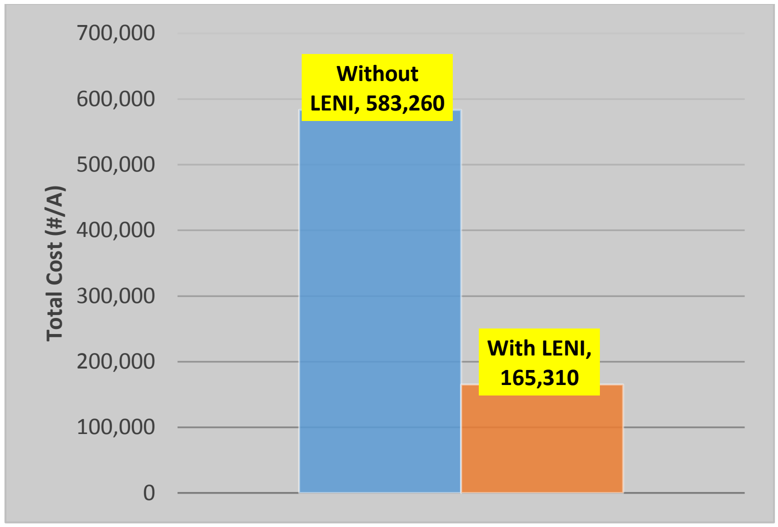


Figure 12: Comparing Total Cost per Annum

From the table 3 and 4 and figure 4 and 5, it can be seen that implementing lighting control in the building will bring benefit both in cost and energy saving. The results shows that a cost and energy savings of about 72% and 53% is possible.

CONCLUSIONs

The faculty building of School of Environmental Technology of Federal University of Technology Minna, Niger State, was modelled in an advanced lighting simulation software together with its associated installed lighting system. A detailed classroom model was used to gauge the performances of various lamp types in terms of cost and energy consumption. It was concluded that LED lamps offers the greatest prospect in terms of cost and illuminance quality and energy consumption while the use of incandescent lamps offers the worst prospect. Using the whole building model, lighting control strategy based on LENI was simulated and results was compared with a base case scenario without the use of LENI. The use of this lighting control result in energy and cost savings of about 53% and 72% respectively.

This project recommends the adoption of LED lighting and the use of lighting control as a strategy to save cost and energy in the School of Environmental Technology, Federal University of Technology, Minna. The wider application of this study is feasible in other buildings across the country and will result in huge savings in cost and electrical energy. Since our electricity is sourced largely from fossil fuel, this strategy could lead to a huge savings in carbon emissions.

REFERENCES

Dixit, A., & Sudhakar, K. (2015). Impending Power Demand and Innovative Energy Paths Performance and Energy Consumption Analysis of Artificial Lighting in a Classroom Using DIALux Simulation. *Impending Power Demand and Innovative Energy Paths*, 43–49.

Hoof, J. Van, & Aarts, M. (2009). Ambient bright light in dementia: effects on behaviour and circadian rhythmicity. *Building and …*. Retrieved from http://www.sciencedirect.com/science/article/pii/S0360132308000279

Hoof, J. Van, & Westerlaken, A. (2012). Light therapy: Methodological issues from an engineering perspective. *... and Health Care- …*. Retrieved from http://www.researchgate.net/profile/Joost_Van_Hoof/publication/221798739_Light_therapy_Methodological_issues_from_an_engineering_perspective/links/53fd9fc80cf22f21c2f819be.pdf

Mills, E. (2002). Why we ’ re here : The $ 230-billion global lighting energy bill. *Proceeding from the 5th European Conference on Energy Efficient Lighting*, (May), 369–385.

Mohammed, B. U., & Shaawat, M. E. (2014). Optimum Selection of a Sustainable Lighting System for a University Class Room in Saudi Arabia. *Civil and Environmental Research*, *6*(4), 41–51.

Ochoa, C., Aries, M., & Hensen, J. (n.d.). State of the Art in Lighting Simulation for Building Science: A. *Bwk.tue.nl*. Retrieved from http://www.bwk.tue.nl/bps/Hensen/publications/12_jbps_ochoa.pdf

Roisin, B., Bodart, M., Deneyer, A., & D’Herdt, P. (2008). Lighting energy savings in offices using different control systems and their real consumption. *Energy and Buildings*, *40*(4), 514–523. http://doi.org/10.1016/j.enbuild.2007.04.006

Ryckaert, W. R., Lootens, C., Geldof, J., & Hanselaer, P. (2010). Criteria for energy efficient lighting in buildings. *Energy and Buildings*, *42*(3), 341–347. http://doi.org/10.1016/j.enbuild.2009.09.012

Salsbury, T. (2005). A survey of control technologies in the building automation industry. In *16th IFAC World Congress*.

.

ASSESSMENT OF NATURAL VENTILATION IN PUBLIC OFFICE BUILDINGS: CASE STUDY OF SELECTED PUBLIC OFFICE BUILDINGS IN NIGER STATE

IGWE, Echezona Chukwuebuka and Abdulrahaman, Mukaila El-hussain.
Department of Architecture, Federal University of Technology, Gidan Kwano,

Natural ventilation is the sustainable means of ventilating spaces in a built environment. This process involves replacing air in any space to provide high indoor air quality and to control temperature. In office buildings, ventilation is very relevant as it aids the productivity of workers. Overtime, study has shown that most offices rely more on mechanical means of ventilations as a result of improper and inadequate provision of fenestrations in office spaces. This research aims to evaluate the adequacy of fenestrations provided in selected office buildings in Minna, Niger state. The research methodology to be employed will be a well-structured observation schedule to determine the position, number, size and type of fenestration provided in the selected public office building.

Keywords: *building, fenestration, office, sustainable, ventilation.*

igweechezona@yahoo.com

IGWE, Echezona Chukwuebuka and Abdulrahaman, Mukaila El-hussain (2016). **ASSESSMENT OF NATURAL VENTILATION IN PUBLIC OFFICE BUILDINGS: Case Study of Selected public office buildings in Niger State** Sustainable Built Environment and Climate change; The challenges of Post 2015 Development Agenda. School of Environmental Technology Conference, SETIC, 2016

INTRODUCTION

Natural ventilation is the sustainable means of ventilating spaces in a built environment. This process involves replacing air in any space to provide high indoor air quality and to control temperature.

Office building is a large building with multiple floors holding offices used primarily for the conduct of several businesses relating to administration, clerical services, consulting, and other client services not related to retail sales. Office building can hold single or multiple firms with diverse business activities. In office building, natural ventilation provides the needed amount of good air quality through a natural process of allowing air in and out of the buildings through fenestrations (openings), in order to achieve thermal comfort.

Natural ventilation has experienced a strongly growing interest, relying on wind and thermal buoyancy as the driving forces for natural ventilation is surely not a new phenomenon or invention. Its utilization for the purpose of ventilation has for several millennia provided the desired thermal comfort and air quality for both man and animals (Tommy, 2003).

Therefore, this research highlights those window types, the use of courtyards, orientation of windows, and vegetation that are effective in allowing natural air into office buildings. This research is borne out of the fact that the wrong choice of windows causes poor ventilation in office buildings and in order to solve the poor ventilation problem, window types used in the offices are going to be assessed. Window sizes and types used in the selected offices were analyzed in order to specify effective types for office buildings. Windows play an important role in ventilation of buildings. Its position and type matters allot on the amount of air that comes into the building. In order to get a good air exchange, windows will have to be opened for five to ten minutes in every three hours, (Passive House Resources, 2014). The amount of air that comes in will depend on the openings, verticality and its area, and this is where how the windows open comes to play. Cai Feng & Wai (2010) found out that ventilation performs better with a bigger inlet than with a bigger outlet. It is effective when the inlet is bigger so as to allow enough air into the room. The outlet can be smaller and on the leeward side to let out stale air. Designers tend to understand and provide adequate opening sizes than the types of windows to be used in the openings. This is why there could be big enough opening, but when the wrong window type is used, it impedes the flow of air and poor ventilation is experienced.

DESIGNING OF WINDOWS TO MAXIMIZE NATURAL VENTILATION

Hazim, (2010) stated that windows should be designed to achieve natural ventilation. But an important issue is whether the windows are single-sided or cross-ventilated to the interior spaces. Windows that are pivoted at the centre have less ventilation capacity, but they can act as wind scoops

Casement windows have the same advantages of the vertical pivot windows but have the likelihood of being by wind. If casement windows must be used to channel wind, they should be opened in the wind direction when they are used as inlets and they should be opened away from the direction of wind when they are used as outlets. (Dutton, 2010).

Kevin, (2006) stated that fins or overhangs can be incorporated, if not part of the design, to create high and low areas of wind pressure and this will channel incoming air. Bay windows can be incorporated for instance, to create localized pressure difference and place windows on the opposite faces of the protuberance of the bay as inlets and outlets.

The windows located on the leeward side. Windows no matter the efficiency in design, if they are not located in consideration to the wind direction, they are not going to maximize natural ventilation.

ANALYSING VARYING PRINCIPLES OF NATURAL VENTILATION IN BUILDING

There are basically three principles of natural ventilation which include:

- Cross ventilation
- Stack effect
- Single sided ventilation.

These principles work very differently from each other with different level of effectiveness. They also have different pattern of air flow in and out of the building

Cross ventilation

In this principle there must be more than one window in a room and on different wall, wind force pushes in air through one window and the contaminated air goes out through the other window. These window can be directly opposite each other or adjacent to each other, having windows on adjacent walls guaranties the circulation of air in the room before it's exist thereby making the room comfortable for guest.

Stack effect

Stack effect work with temperature different in the air. Fresh air from outside enters the building through opening at a lower level; because this air is fresh and cool it is denser it therefore circulates at low level in the room. When the air gets warmed up it then rises because it has become less dense and exist the room through opening at a higher level.

Single sided ventilation

Single sided ventilation occurs where there are one or more window on only one side of the room. The air enters and exist the room through the same window if there is only one window. another way is for the cool air to enter through one window and the hot air exist through a higher window directly above the lower window .of all the principles analyzed above ,cross ventilation is the most effective followed by the stack effect. The single sided ventilation utilizes stack effect, when cross ventilation and stack effect principle are used with adequate window sizes in combination with proper orientation of the window.

ANALYSES OF VARIOUS TYPES OF WINDOWS

The types of windows analyzed are based on the common window types used in the study. Which are casement windows, sliding windows, projected windows, fixed light, and Louvre window.

Casement Window

According to Breezeway Technical Bulletin (2012), the sashes of casement windows can only minimally reduce air flow when the window is opened with the sash in a perpendicular position. Casement windows are hung on the vertical sides of the frames, that is, if the window has double leaves. It can have single leaf and be hung on one side. The leaves can open 90-180 degrees allowing maximum air flow in the room.

Sliding Window

Sliding windows usually have panels or sashes that slide along tracks on the window sill. The sash that slides, sits directly behind the fixed pane when the window is completely opened. The amount of air that is offered by this type of window is half of the entire window size. Very big window sizes will be needed if sliding window is the specification. This is to achieve maximum air flow when the panel slides.

Projected Window

This type of window is hung on the top and can open at different angles up to 90 degrees, depending on the amount of air that is to be allowed in. In any case it allows for maximum air inflow when opened.

Fixed light window

These types of windows are not meant for ventilation because they are not made up of operable partitions (panels) or sashes. They are permanently fixed just to allow light into a space in the building.

Louvre Window

This type of window has horizontal blades that open perpendicular to the window when completely opened. The blades to an extent impede the air flow, but a great amount of air still gets into the room.

COURTYARDS IN OFFICE BUILDINGS

Courtyard in office building serves the main purpose of creating an air and light inlet to building beside of the courtyard condition, the effect of air movement on human thermal comfort is important and also, is different. It depends on environmental temperature and humidity, as well as on the clothing and metabolic rate.

When air temperature is above the skin temperature (like sub-Sahara condition, but daytime), the effect of air movement will be the same as other climatic factors and the increase of air movement will raise the skin temperature. Air movement is more noticeable when the air is cool and the difference between skin and air temperature is large (like sub-Sahara condition, but night-time). Conversely, if the air is only slightly below skin temperature, very large

Increases in air speed are needed to achieve an increase in convective cooling. However, variation in air velocity is important. The air movement, in combination with air temperature, will affect the rate at which warm air or vapor. The courtyard can also be utilized for other purpose such as recreational, green areas and relaxation during and after work.

AIM AND OBJECTIVES:

AIM

This research is aimed at assessing the level of natural ventilation in the selected public office buildings in Niger state.

TO ACHIEVE THE AFOREMENTIONED AIM, THE FOLLOWING OBJECTIVES ARE SET:

- Identifying public office buildings in Niger state.
- By determining the position, number, size and type of fenestration provided in the selected public office building.
- By identifying public office buildings with court yards
- By identifying the effectiveness of various passive cooling strategies to achieve an efficient interior cooling.

RESEARCH METHODOLOGY

The research was carried out by using a practical observation field work which depended on data extraction of public office buildings in Niger state through observation schedules, structured interview, and photograph. Secondary source of data was extracted from published and unpublished materials. The research was carried out in order to check the types of window used, to determine the position, number, size and type of fenestration provided in some selected public office buildings in Niger state. These studies were conducted in ten different public office buildings by the use of random selection. The areas were studied using observation schedule to analyses the window size and types, after that, the data was analyzed using Statistical Package for Social Sciences (SPSS), and was represented in figures showing bar, and pie charts.

STRUCTURED OBSERVATION SCHEDULES

For the purpose of this research this instrument is the back bone of this work because of the size of the data that was obtained by this source. This instrument was designed based on some pre-conceived information on the physical appearance of office buildings and their courtyard in the study area. This was done after a detailed review of related literature, which helps in informing the research questions to ask and what to look out for while in the field. For the purpose of this study, observation schedule was carried out for each study area.

STUDY AREA

Niger state is the preferred location for the research Niger state is located in north central geopolitical zone of Nigeria. Minna; is a city in west central Nigeria. It is the capital of Niger State, one of Nigeria's 36 federal states, and is the headquarters of Chanchaga Local Government Area.

Niger state is connected to neighboring cities by road. Abuja, the capital of the country. Niger state is also connected by railroad to both Kano in the north and Ibadan and Lagos in the south which is also border by Ilorin city.

For the Purpose of this research, ten (10) public office buildings were selected randomly in order to assess the level of natural ventilation. Ten observation schedules were produced for the ten buildings, and at the end of the field work the ten was properly observed and analyzed.

Data Analysis

Table 1: Fenestrations (Window)

S/N	Study Samples	Type Of Windows Used	Sizes Of Window	Type Of Glazing	Are The Windows Properly Oriented		Cooling Method Employed	
					Yes	No	Active	Passive
1	Post-Graduate School Bosso, Minna	Sliding	1200x1200 1200x1800 900x1200	Transparent	✗	✓	✓	✗
2	Senate Building Gidan Kwano	Fixed, Sliding, Casement	900x3000 1200x3000 1000x1200	Transparent	✗	✓	✓	✗
3	Neco Building, Bida Road Minna.	Sliding	1800x2400 1200x1800 1200x6000	Transparent	✓	✗	✗	✓
4	State Secretariat Complex Tunga, Minna	Sliding	600x600 1200x1200 1200x2700	Transparent	✗	✓	✓	✗
5	Local Govt. Secretariat Suleja	Sliding, Fixed And Louvres	1200x1400 400x1200 700x1200	Transparent	✗	✓	✓	✗
6	Administrative Block C.O.E. Minna	Sliding And Louvres	1200x1200 600x1200	Transparent	✗	✓	✓	✗
7	I.N.E.C. Office Kwamba Suleja	Louvres	1500x1500 700x800, 1200x1400	Transparent	✗	✓	✓	✗
8	Phcn Office Kwamba Suleja	Sliding	600x600 1200x1200	Transparent	✗	✓	✓	✗
9	Ministry Of Education Bahago Drive Minna	Sliding	600x600 1200x1200	Transparent	✗	✓	✓	✗
10	Ministry Of Tertiary Institution Old Sec. Minna	Awning	800x800 800x1200	Transparent	✗	✓	✓	✗

Table 1 above shows the various sizes and types of windows used in the study areas.

It shows that casement window can give 80% ventilation as the most effective in the table. Louvre window is a type of window can offer 75% ventilation. Projected window can offer 50-80% ventilation depending on the winder or the opening angle. The least percentage is sliding window with 40% ventilation, and it is the most used type in the selected study areas.

PLATE 1: showing the façade of the senate building Gidan Kwano, Niger state.

Source: Researcher's field work (2015).

PLATE 2: showing the side view of the state secretariat Minna, Niger state.

Source: Researcher's field work (2015).

The use of courtyards as a design element is common to residential, office, commercial/retail, and even manufacturing buildings. Courtyards are typically defined as an open space with a building or walls on all four sides. Spaces surrounded on three sides by a building or walls with an open end can also be classified as courtyards. Courtyards were once a viable way to create large school buildings while still providing natural ventilation and light to all classrooms. In the early 20th century, schools were designed as low-slung courtyard buildings to give students light, air and access to open space.

Table 2: Courtyards

S/N	Study Samples	Presence Of Courtyrd		Shape Of Courtyard	
		Yes	No	Squared	Rectangular
1	Post-Graduate School Bosso, Minna	✓	✗	✗	✓
2	Senate Building Gidan Kwano	✓	✗	✗	✗ /Parallelogram
3	Neco Building, Bida Road Minna.	✓	✗	✗	✓
4	State Secretariat Complex Tunga, Minna	✓	✗	✗	✓
5	Local Govt. Secretariat Suleja	✗	✓	✓	✗
6	Administrative Block C.O.E. Minna	✗	✓	✓	✗
7	I.N.E.C. Office Kwamba Suleja	✗	✓	✓	✗
8	Phcn Office Kwamba Suleja	✗	✓	✓	✗
9	Ministry Of Education Bahago Drive	✗	✓	✓	✗
10	Ministry Of Tertiary Institution Old Sec. Minna	✗	✓	✓	✗

The courtyard plan is not fixed. Though the basic courtyard form of dwelling is rectangular or cubic in shape, it may be round or curvilinear too.

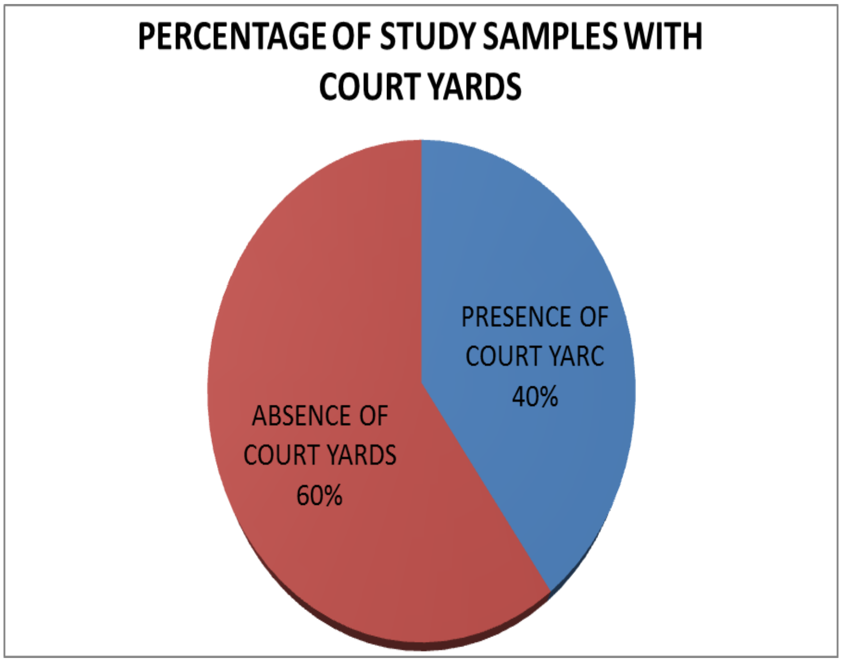


FIGURE 1: Showing the percentage of study samples with courtyards. Source: researcher field work (2015).

PLATE 3: showing the courtyard. Source: researcher field work (2015).

Table 3: Indoor and Outdoor Temperature of the study areas.

S/N	STUDY SAMPLES	TEMPERATURE		TIME INTERVAL
		INDOOR	OUTDOOR	
1	POST-GRADUATE SCHOOL BOSSO, MINNA	28`C	35.5`C	3:00PM-4:30PM
2	SENATE BUILDING G. KWANO.	30`C	36.5`C	3:00PM-4:30PM
3	NECO BUILDING, BIDA ROAD MINNA.	26`C	35`C	3:00PM-4:30PM
4	STATE SECRETARIAT COMPLEX TUNGA, MINNA	29`C	35`C	3:00PM-4:30PM
5	LOCAL GOVT. SECRETARIAT SULEJA	27`C	33`C	3:00PM-4:30PM
6	ADMINISTRATIVE BLOCK C.O.E. MINNA	30`C	36`C	3:00PM-4:30PM
7	I.N.E.C. OFFICE KWAMBA SULEJA	27.5`C	33`C	3:00PM-4:30PM
8	PHCN OFFICE KWAMBA SULEJA	28`C	33`C	3:00PM-4:30PM
9	MINISTRY OF EDUCATION BAHAGO DRIVE MINNA	29`C	35.5`C	3:00PM-4:30PM
10	MINISTRY OF TERTIARY INSTITUTION OLD SEC. MINNA	27`C	35`C	3:00PM-4:30PM

PASSIVE COOLING STANDARDS FOR INDOOR TEMPERATURE IS: 24`C – 25`C.

According to literature, the temperature will actually peak between 3 pm and 4:30pm each afternoon, dependent to some extent on variable cloud cover and wind speed. After that, as the sun gets lower in the sky, the temperature will begin to fall gradually back from its high, and drop in temperature accelerates after sundown.

PLATE 4: Satellite image of Neco building Minna, Source: Google map (2015).

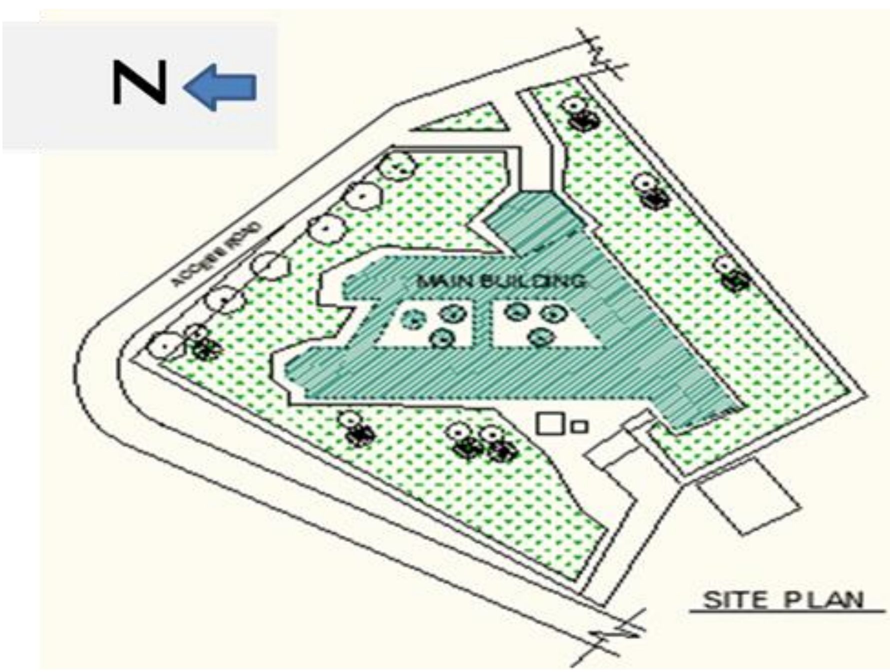


FIGURE 2: 2d sketch of senate building Gidan kwano, Source: Author's field work (2015).

Table 4: Type of courtyard/Landscape

S/N	STUDY SAMPLES	TYPE OF COURTYARD		LANDSCAPE	
		OPEN	COVERED	SOFT	HARD
1	POST-GRADUATE SCHOOL BOSSO, MINNA	✗	✓	✓	✓
2	SENATE BUILDING GIDAN KWANO	✓	✗	✓	✓
3	NECO BUILDING, BIDA ROAD MINNA.	✓	✗	✓	✓
4	STATE SECRETARIAT COMPLEX TUNGA, MINNA	✓	✗	✗	✓
5	LOCAL GOVT. SECRETARIAT SULEJA	✗	✗	✗	✗
6	ADMINISTRATIVE BLOCK C.O.E. MINNA	✗	✗	✗	✗
7	I.N.E.C. OFFICE KWAMBA SULEJA	✗	✗	✗	✗
8	PHCN OFFICE KWAMBA SULEJA	✗	✗	✗	✗
9	MINISTRY OF EDUCATION BAHAGO DRIVE	✗	✗	✗	✗
10	MINISTRY OF TERTIARY INSTITUTION OLD SEC. MINNA	✗	✗	✗	✗

Landscape is more than just scenery: it is the interaction between people and place; the bedrock upon which our society is built. The European Landscape Convention defines landscape as 'an area, as perceived by people, whose character is the result of the action and interaction of natural and/or human factors. Landscape underpins our economy, offering a superb natural and cultural environment that sustains agriculture, attracts inward investment, and supports one of the most vibrant tourism industries in Nigeria.

CONCLUSION AND RECOMMENDATION

Office building is a large building with multiple floors it was discovered that in order to achieve the amount of natural ventilation required, the use of courtyards has to be considered,

Window types also have great impact in determining the amount of ventilation that windows will provide in tackling poor ventilation. The most effective window types should be used in the ventilation of office spaces. Sliding windows were mostly used because it is considerably cheaper and the prevailing type that is in use, but not because it is good for ventilation. Using window types that provide the least percentage of ventilation in a standard window sizes that should have provided enough ventilation is a serious challenge. This research shows the need to understand the position, types and sizes of fenestration to be used in office building designs so as to achieve a breakthrough in office ventilation. Therefore, it can be recommended that;

Sliding windows should be replaced with casement, louver windows or projected window, and the use of courtyards should also be considered for effective cross ventilation.

If sliding window most be used, its size should be big enough for the slide sash or sashes to offer maximum ventilation, Windows, no matter the size or type should be located to take advantage of the prevailing winds. During the design stage, windows such as casement, louver and projected windows should be specified for maximum and effective ventilation.

REFERENCES

Aaron w (2000) An Exploration of the Natural ventilation strategies at world tradeCentre Amsterdam. How to achieve Thermal Comfort in Kano State Luxury Homes. March 27, 2014, from http://www.iiste.org

Andy W, (2011). Natural Ventilation: Nation Renewable Energy Laboratory.

Breezeway Technical Bulletin (2012). *Comparative Openings of Various Window Types*. Retrieved from Breezeway: http://www.breezway.com

Brett, M. (2008). *Natural Ventilation System analysis* Stanford Stanford University Press.

Cai Feng G. A. O., Wai, L. L., (2010). Influence of Window Types on Natural Ventilation Of

Residential Buildings in Hong Kong. *International High Performance BuildingsConference* Purdue, 15-12 July.

Dutton, S. (2010). Window Opening Behavior in a Naturally Ventilated School.*Fourth National Conference of IBPSA*-New York USA, 13– 11 August.

Hall, L. (2011). *Natural Ventilation Theory.* Indiana: Greenwood Publishing Group.

Hazim, A. (2010). Basic Concepts for Ventilation of Buildings. *Technology for Sustainable Built Environment Conference*, Accra, Ghana. 9-15.

Kevin, J.L. (2006). Architectural Design of an Advanced Natural Ventilated Building Form. *Energy and Buildings* 1(1), 166-181.

Passive House Resource, (2014). Principle of Natural Ventilation. Retrieved from Passipedea Inc: http://www.passipedea.com on 15th March 2014, 02:15pm

Sustainability and the Environment. (2010). Envelope and Space Planning: Natural Ventilation. Retrieved from: Sustainability Inc.: http://www.smgov.net on 15th March, 2014 03.31pm.

Tine, S. L. (2006). *Natural Ventilation Driven by Wind and Temperature Difference*. Chicago Christie's publishers,11-15

Tommy, K. (2003). *Natural Ventilation in Buildings: Architectural Concepts, Consequences and Possibilities*. London: Cambridge University Press. 23-28.

Tong,Y.(2004)CFD and Field Testing of a Natural ventilation full scale Building. Unpublished Doctoral Dissertation school of Civil Engineering, University of Nottingham

ASSESSMENT OF USER'S PERCEPTION OF LANDSCAPE PROVIDED IN FACULTY BUILDINGS IN TERTIARY INSTITUTION, KOGI STATE

OTIJELE Godwin Omachoko, SALIHU Usman Tyabo, MUHAMMAD Bello Ndawashi & MORENIKEJI Fisayo Teniola
Department of Architecture, Federal University of Technology, Minna, Niger State, Nigeria.

People in the world today experience constant pressure and these pressures are products of cooperate forces which are increase in world population, technological advancement, and explosion of knowledge. Meanwhile, these developments have the tendency to get worse than better; they give a practical working assumption as to what future inhabitants might face or look like in respect to pressure. Although these developments each have different manifestation, they share similar effects. Specifically, they generally contribute to the occurrence of mental fatigue, which can make humans to be less healthy, less tolerant, and less effective. The above-mentioned problems are common with the learning environment which faculty buildings falls under. Contact with natural environment can perform a core role in decreasing this disastrous effect. This research focuses on the impact caused by the absence and inadequacy of landscape elements; using faculty buildings of tertiary institutions in Kogi State as area of the study. Data was collected using observation schedule and questionnaires of the forty three approved faculty buildings in the eight existing tertiary institutions. From the analysed data, it was observed that 88% of the faculty buildings were not properly landscaped. The research further seek to know how comfortable are the users in these environments, and it was discovered that a total of 86% of the users were not comfortable due to the lack of basic landscape elements that were not adapted, thereby reducing the hours willing to spend in the environment. Data showed that over 80% of users agreed that the adaptation of basic landscape elements will help increase productivity and also agree to spend more time leaning if the environment is well landscape. The research provides workable ways of improving the learning environment by adapting the relevant landscape elements, by the use of various plants that depict a particular function, activities, and feeling of a space. Spaces for indoor plants should be design to accommodate them, and architects should design landscape layouts in every faculty building design, putting into consideration their maintenance technique.

Keywords: *Knowledge Explosion, Mental Fatigue, Natural Environment, Landscape Elements, Maintenance.*

otijeleg@gmail.com

OTIJELE Godwin Omachoko et al (2016). **ASSESSMENT OF USER'S PERCEPTION OF LANDSCAPE PROVIDED IN FACULTY BUILDINGS IN TERTIARY INSTITUTION, KOGI STATE** Sustainable Built Environment and Climate change; The challenges of Post 2015 Development Agenda. School of Environmental Technology Conference, SETIC, 2016

INTRODUCTION

Tefere and Greijn (2010) noted that worldwide, alterations have been made in the methods used in creating, delivering, assessing and distributing knowledge and information in tertiary institutions, and this was further said to have contributed to the major challenges facing the sub- Saharan African countries. To support this, Oyewole (2010) explained that creation of wealth in any nation has a significant relationship with how knowledge is generated and distributed, because the achievement of any nation's economy largely hinged on the capacities to generate, develop and disseminate knowledge in the right environment. Economic growth and technological advancement of any society is greatly dependant on education as the basic instrument (Moti, 2010) and it is very significant to the advancement of nations due to the fact that it act as a remedy to poverty in the arising knowledge world (Dauda, 2010; Obe, 2010) and any nation which is unable to maximize the skills and knowledge for successful national economy will be unable to build up anything else (Olugbadewo, 2007; Akpan and Ekor, 2012) because it is the process use at schools to give out systematic instructions (www.oxforddictionaries.com/definition) and facilitate the functioning of students effectively in a society (Akinjide, 2011). In respect to this, education is very important to any society, and its relevance to human beings should not be underestimated in totality in order to have a functioning society (Amadi, Adeyemi & Ogundiran, 2007; Ajeyalemi, 2009).

Today, the process of teaching and learning has advanced beyond the tutor standing and disseminating relevant information to students in an enclosed space without the students having the right environment (Ajayi and Ekundayo, 2009). Many African institutions still face challenges of having a poor learning environment that lacks the basic landscape elements that can enhance the teaching and learning process (Shabani, 2010). In order to discharge information appropriately, the teaching environment must be considered in totality. The key goal of Nigeria educational system from inception as noted by (Ajidade, Oloyede, Adeleke & Awopetu, 2011) is to give practicable educational system for its citizens in order to make them employable or self employed. Nevertheless, Shabani (2010); Bon (2010) noted that majority the country's academic institutions are faced with difficulties that have resulted to the insufficient creation of the right learning environment. Therefore, Nakpodia (2009) maintains that the major contributor to the nation's political, economic, industrial and technological growth is the Nigerian tertiary institutions; which calls for a learning that permits and encourage the kind of environment needed to attain excellence in the process of teaching and learning.

In Nigeria today, the quest for education is increasing the population of people seeking admission annually. Tertiary institutions are expanding continually to accommodate more students at all levels. The constant focusing of these students on learning tasks will cause mental fatigue if not given urgent attention. Mental fatigue can lead to irritability, lack of concentration, inability to solve problems, and increased likelihood of making mistakes or causing accidents (Berto, Baroni, Zainaghi & Bettella, 2010). Grinde and Patil (2009) explain that as complex and expose as the brain, it is the only organ that goes through considerable maturation after the birth of any individual. This process is formed partially by reaction to stimuli in our environments (inclusive of positive and negative conditions), and last throughout our lives. The concept of Attention Restoration Theory has been proven to be the most suitable approach in solving this challenge of mental fatigue in the learning environment. Attention Restoration Theory (ART) proposed that certain environments help individuals recover from mental fatigue and act as restorative elements, by creating time away from tasks that need voluntary or directed attention, permitting the mind to be renewed (Berman, Jonides & Kaplan 2008). Setting or objects that are compulsory interesting can serve as a particular effective cure as they permit the mind to focus its attention with little energy and subsequently to rest and recover (Berto et al, 2010), and natural environments are particularly effective as restorative environments. Berman, Jonides & Kaplan (2008) started that even a little glimpses or small amount of time spent in a natural environment improve the performance of the brain, as cognitive respite take place when the captivating stimuli of the natural settings involves our involuntary, effortless attention.

In this part of the world, faculty buildings are designed and constructed without any consideration to the end users of the building. Based on this, users are usually on the receiving end of the problem of mental fatigue. They go through constant focusing on a particular task per time, this generates stress overtime, and focusing or concentrating becomes very difficult. Learning, like engaging in tasks at work, requires focused, direct attention and high-degree cognitive functioning. A good number of researches prove that natural settings triggers positive emotions, simplify cognitive functioning, and encourage recovery from mental fatigue for individuals who are in better mental health. According to Han (2010), those who experience short term and chronic mental illness can get respite when experiencing nature. According to Kahn and Keller (2002), Nature can offer both objects and background for learning and play. Among older children, contact with nature help in exploration and building activities, which can enhance problem solving abilities, ability to react to changing contexts, as well as getting involved in group decision making. Heerwagen (2009) explains how younger children usually use outdoor spaces having plants, stones, sticks, and stones as props for imaginative play, which is the key to cognitive and social development. Schools are becoming frequent in the integration of the natural environment into education, using gardens and outdoor classrooms. This concept uses direct contact with nature in inquiry-based and experiential learning. In their works, Ozer (2007), Thorp and Townsend (2001) stated that nature-based learning can support education about environmental stewardship, science, natural and plant processes, math, ecology, recycling, soil, reuse of materials, food and nutrition, plant propagation, and language arts.

The way spaces are designed can affect the work and learning environment. Several studied have looked at spaces that best promote mental development and productivity in the works place and learning environment. Explaining how various species of plants increase human wellbeing, Fuller et at (2007) stated that individuals who stay in parks with more plant species richness performed higher on different measures of psychological wellbeing compare to the subjects in less bio diverse parks. Heerwagen (2009) in his work stated that planters, green roofs, gardens, a plant filled atrium and other elements can be integrated into the design of buildings in resolve mental health and cognitive function. For instance, the soft rhythmic movements of a grass or trees in a light breeze or the light and shade created by cumulus clouds, called Heraclitean motion, are movement styles that are related with safety and tranquillity, supporting the development of a relaxed, stable mental state; space or lighting design that imitates Heraclitean motion could be integrated into building designs to have a peaceful, calm area that help patients' recovery or improve the productivity of students or workers. According to Shibata and Susuki (2002), performances of participants were better on tasks that deal with creativity in spaces having foliage plants, compared to spaces without, and the authors concluded that nature may give inspiration and a foundation of stimulation to be creative. In recent times, Maller, Henderson & Townsend (2009) explain how children have fewer chances to be outdoors, in respect to time and space. Few schools provide nature experience as part of classes, recess, or special activity, as they are aware of the potentially important effects on mental wellbeing and learning. Theory of education by Isenberg and Quisenberry (2002) suggest that having contact with nature aids in the development of a child's emotional, cognitive, and spiritual connection to social and biophysical settings around them.

The problem identified with most faculty buildings of tertiary institutions is the inadequacy and unavailability of proper landscaping environment that contribute in making the learning environment uncomfortable. Continuous focusing on a particular task has being proven to be a major contributor that leads to mental fatigue; and users of faculty buildings undergo this process. The immediate, nearby natural setting has been shown to play an important role in human wellbeing, particularly in the contexts of hospitals, prisons, and residential settings (Kam and Siu, 2010; Raanaas, Patil & Hartig, 2012; Nadkami and Pacholke, 2013; Jiler, 2009; Tyrvainen, Makinen & Schipperijn, 2007; Farmum, Hall & Kruger, 2005). In contrast, surprisingly little attention has been devoted to the role of nature in the context of the learning environment. Yet a large proportion of students and lecturers spent a substantial amount of time at a place of study; the faculty building. Many faculty buildings are devoid of nature availability, while other settings include a major commitment to plantings. There are no ready answers to whether the space devoted to faculty buildings landscaping is 'well used', nor whether the lack of nature availability is directly detrimental to student's well-being. However, it is time to raise these issues and to examine the potential benefits of landscaping in the learning environment context.

RESEARCH METHOD

Data was obtained from both primary and secondary sources. The primary data obtained was obtained from field work through the use of observation schedule, structured questionnaires, and field measurement, while the secondary data was gotten from the review of relevant literature in the area of research. Descriptive and inferential statically Survey method of research was adopted and Forty-three faculty buildings in eight tertiary institutions in Kogi State were surveyed, Eighty six questionnaires were produced for the forty three faculty buildings; two per faculty and at the end of the field work the eighty six questionnaires were collected and analysed. The questionnaires were administered to a male and a female final year students of each faculty who had spent the longest time in the environments. Data was collated and analysed using Statistical Package for Social Sciences (SPSS) as the analysing medium through tables and chats to give a better understanding of the level of mental fatigue experienced. This was done in order to ascertain the degree of mental fatigue experienced by the users; in generating solutions that will adapt the landscape element suitable for the wellbeing of users in faculty buildings designs.

Table 1.0 Administered are Returned Questionnaires

Tertiary Institution	Number of Faculty Buildings	Administered Questionnaires	Returned Questionnaires	Percentage Returned
Federal University	2	4	4	04.70%
Kogi State University	8	16	16	18.60%
Salem University	8	16	16	18.60%
Federal Polytechnic	5	10	10	11.60%
Kogi State Polytechnic	5	10	10	11.00%
Federal College of Education	6	12	12	14.00%
State College of Education	5	10	10	11.60%
College of Agriculture	4	8	8	09.30%
Total	43	86	86	100%

Source: Field Work 2015

FINDINGS AND DISCUSSION OF RESULTS

From the questionnaires administered in study areas, it was observed that users of the faculty buildings are not satisfy with their environment. Other issues like availability, adequacy and maintenance of faculty building landscape were not encouraging, and this calls for improvement in most of the studied areas in other to increase the productivity of users.

The Type of Landscape Found In the Faculty Buildings.

From the analysis, it was discovered that 7% of the studied faculty buildings were basically made of hard landscape. While the faculty buildings with partial and inadequate soft landscape have 37.2% of the total studied faculty buildings. Most of the faculty buildings were not properly landscaped after construction in these areas. A total of 23.3% of the faculty buildings were not landscape at all in these areas, making it difficult for users to be comfortable in the learning environments. The pie chart below shows the explanations in percentages and figures.

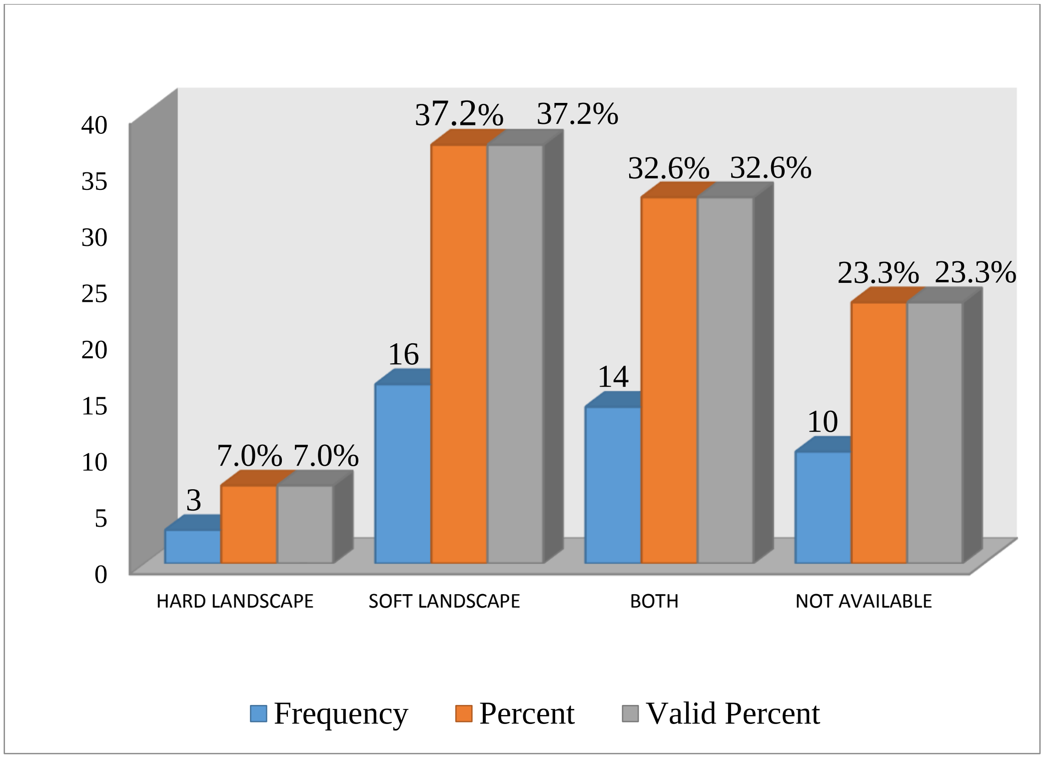


Figure 1: Actual types of landscape found in the study area

Source: Field Work (2015)

Proper Landscaping Of the Faculty Buildings in the Study Areas

It was observed that 88.4% of the total studied faculty buildings were not properly landscaped; representing a good number of the faculty buildings. A number of thirty eight (38), out of the forty three (43) studied. Only 11.6% of the studied faculty buildings were properly designed to standard, which take a number of five (5) faculty buildings. Therefore, it was concluded that majority of the faculty buildings in the studied area were not properly landscaped, and this may lead to users discomfort in respect to undefined walkways, noisy leaning scenes, atmosphere not relaxed, and increase in the pollution of air quality, leading to the increase of constant mental fatigue among users. More explanations are showed in the pie chart below

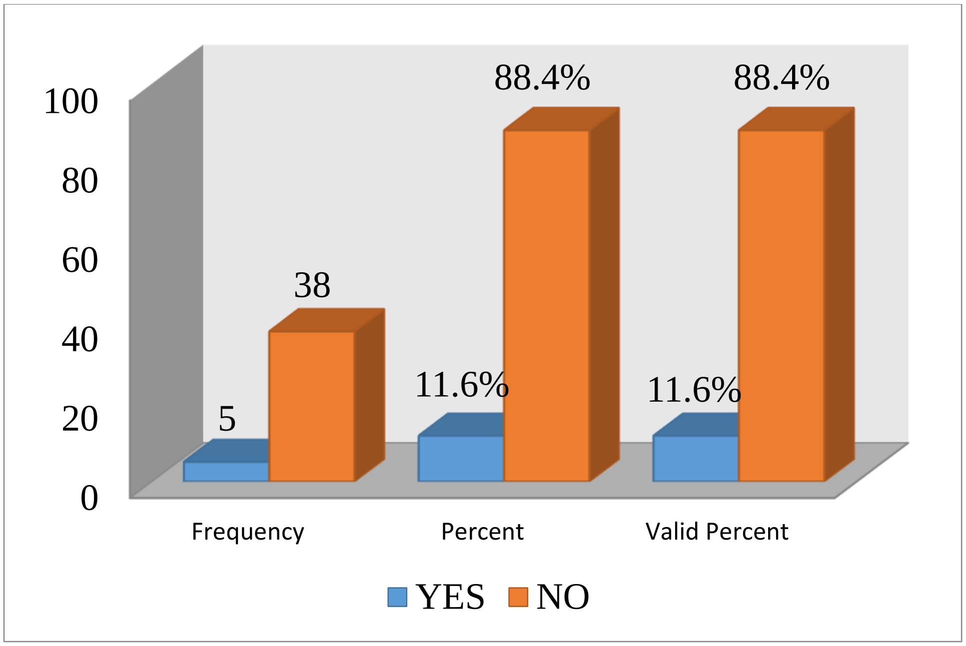


Figure 2: Proper landscaping of faculty buildings in the study areas

Source: Author's Fieldwork (2015)

The Correlation between the Proper Landscaping of the Faculty Buildings, And User's Feelings around the Faculty Buildings

The in proper landscaping of the faculty buildings was shown to be more in the study areas. The data shows that none of the respondents in the faculty buildings, which were not properly landscape felt very comfortable. Only 4.7% felt very comfortable in the faculty buildings that were not landscape properly. 4.7% of the respondents felt they were comfortable in faculty buildings that were not properly landscaped, while 4.7% felt comfortable in faculty buildings that were properly landscaped. The respondents that felt uncomfortable in faculty buildings that were not properly landscaped was 53.5%, while 6.9% felt uncomfortable in faculty buildings that were properly landscaped. None of the respondent felt very uncomfortable in faculty buildings that were properly landscaped, while 25.5% felt very uncomfortable in faculty buildings that were not properly landscaped. From the analysis, it shows that majority of the users or respondents are not comfortable in faculty buildings is as a result of the faculty buildings that lack proper adaptation of landscape elements in them. The chat below gives a better illustration on the result discussed.

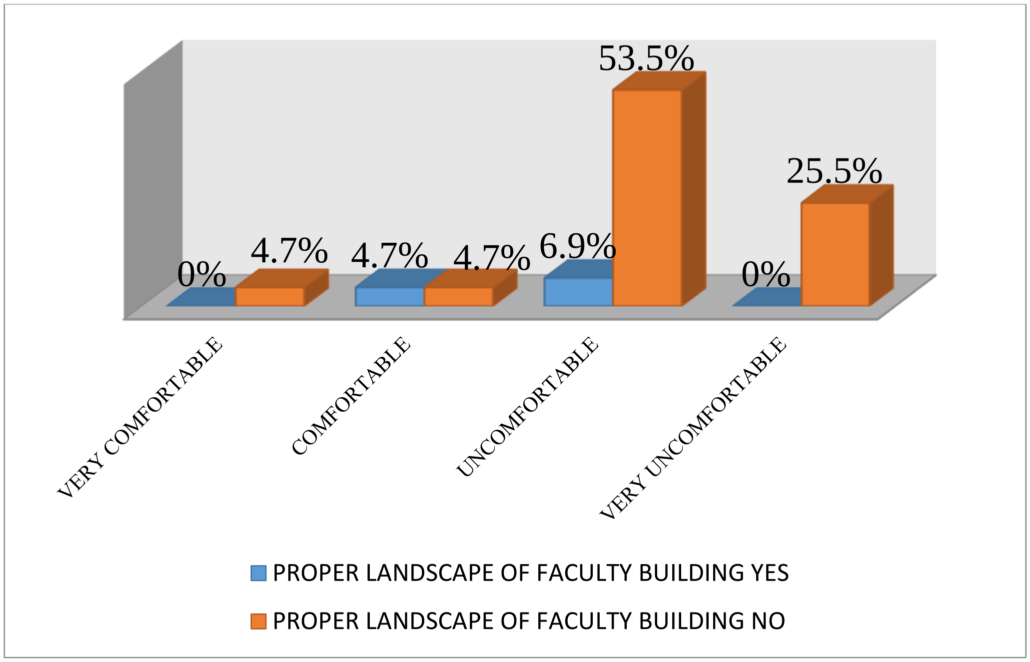


Figure 3: Correlation between proper landscaping of the faculty buildings and users feelings

Source: Author's Fieldwork (2015)

The Correlation between the Availability of Indoor Plants and Users Comfort with Indoor Air Quality

From the result observed, only 2.6% of the respondents are very comfortable in faculty buildings that had indoor plants. None of them are very comfortable in faculty buildings that lack indoor plants. For faculty buildings that do not have indoor plants, 3.8% felt comfortable, 51% felt uncomfortable, and 40% felt they were very uncomfortable in those spaces. While faculty buildings that have indoor plants had 2.6% of who felt comfortable, none felt comfortable and uncomfortable in those spaces. It shows that majority of the faculty buildings that do not have indoor plants in them has more correspondents who are not comfortable or very comfortable due to less amount of good air in them because certain indoor plants help to increase the air quality of indoor spaces. Therefore, respondents who felt comfortable or very comfortable in their spaces had indoor plants in their spaces. These respondents are from federal university lokoja, and salem university lokoja. The chat below gives a clearer explanation.

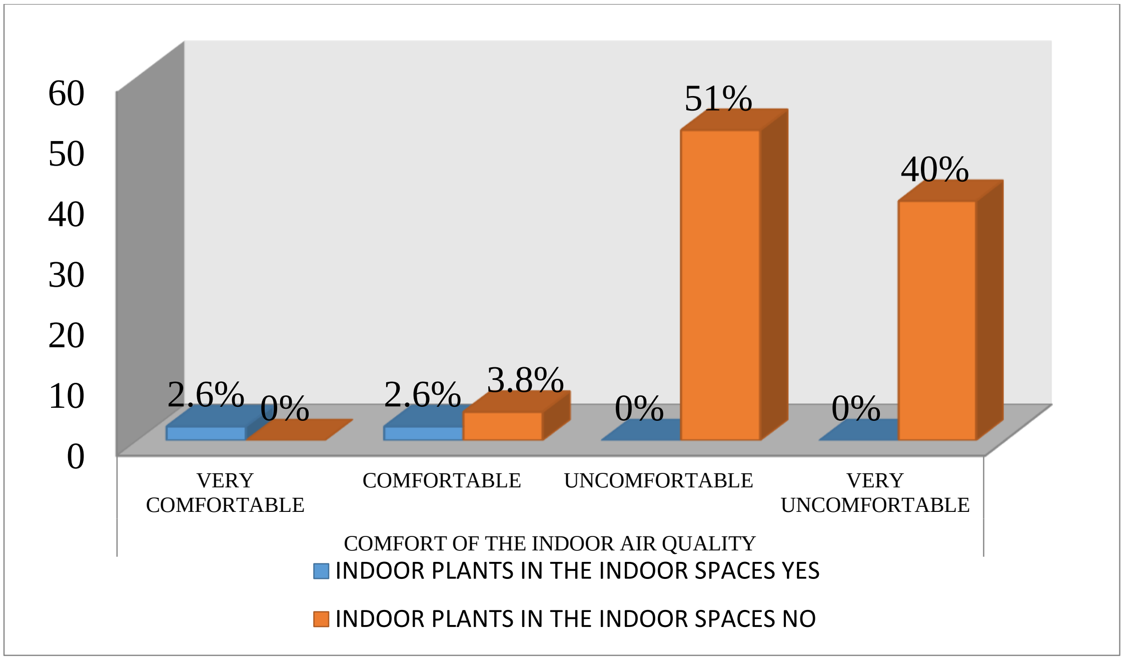


Figure 4: Correlation of availability of indoor plants and users comfort with indoor air.
Source: Author's Fieldwork (2015)

The Correlation between the Numbers of Plants Species Available, And Users Having Stress after Lectures

From Analyses collected data's shows that faculty buildings that had less than five (5) species of plants used for their landscape had 35% of the total correspondents that usually go through stress after lecture. While 14% of respondents go through stress, in faculty buildings that had less than six (6) to ten (10) species of plants used for their landscape. A total of 23% go through stress in faculty buildings that do not have any element of landscape. Only 7% and 9% of the respondents do not go through stress in faculty buildings that has less than five (5), and six (6) to ten (10) species of plants respectively. Faculty buildings that had ten species of plants used for their landscape had none of the respondents that go through stress after lectures. 2% of felt they do not go through stress in faculty buildings that were not landscaped properly; making it difficult for student to assimilate doing learning. Therefore, faculty buildings that are not designed with the necessary species of plants that can help reduce pressure and fatigue can contribute to the amount of time spent by users; which can be a factor to their poor performance.

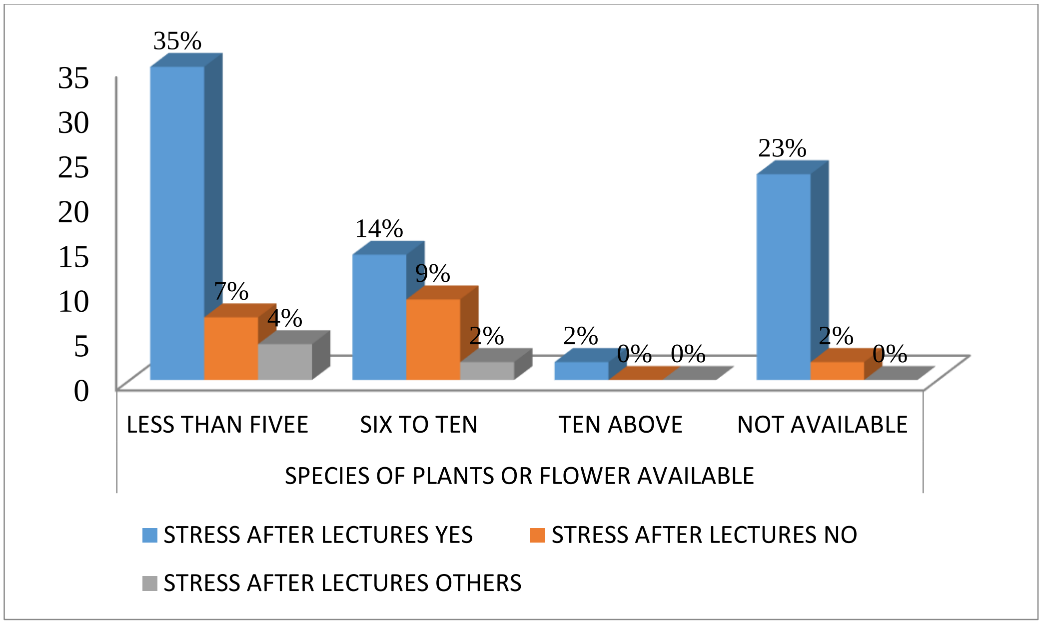


Figure 5: Correlation between the species of plants available and having stress after lectures.

Source: Author's Fieldwork (2015)

The Correlation Between Proper Landscaping Of Faculty Buildings, And How Attracted Are The Users.

The analyzing shows that faculty buildings having proper landscaping has only 5% of the total respondents that are attracted to the environment, while 2% are not attracted, and 5% are very not attracted to the faculty building environment. The data shows that faculty buildings that are not properly landscaped has 7% of the respondents who are attracted to the environment, a large percentage of 49% says they are not attracted, while 32% of the respondents says that they are very not attracted to the faculty buildings environment. Therefore, the proper landscaping of faculty buildings can greatly affect how much interest the users can have to the environment, and also how long they can willingly stay in these environments. In order words, we can state that there is a relationship between users' interest in faculty buildings, and the proper landscaping of the faculty buildings environments. The chat below helps to explain the analyzed data better in a graphical format.

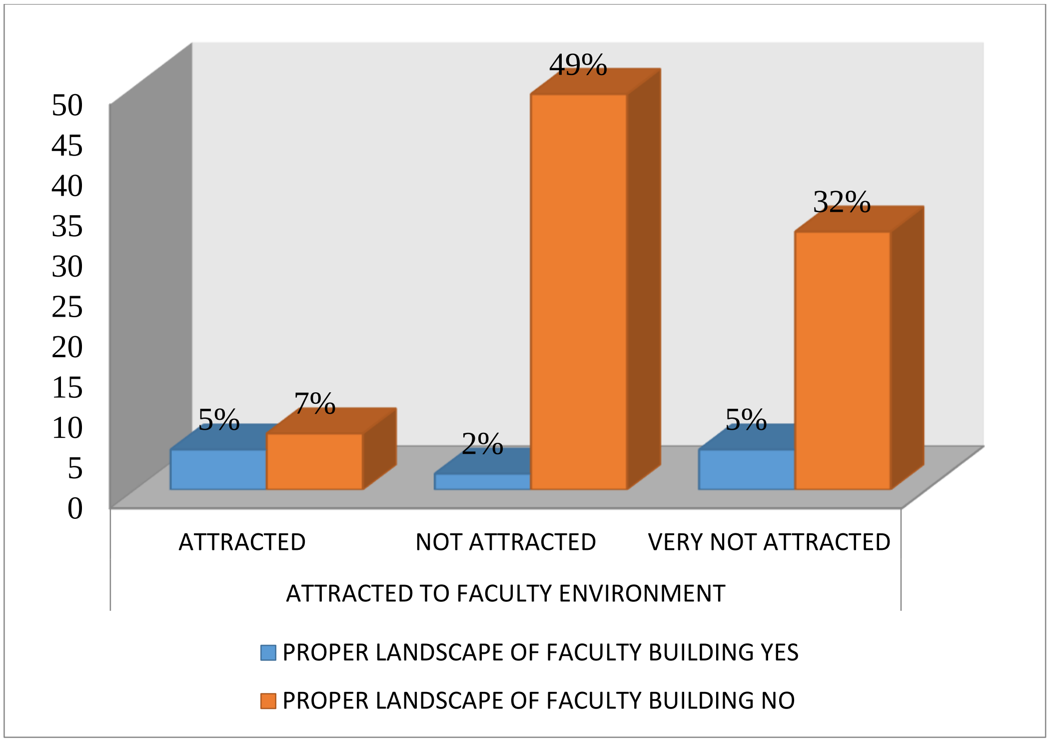


Figure 6: Correlation between proper landscaping and user's attraction to the faculty buildings

Source: Author's Fieldwork (2015)

Users Respond To More Time To Be Spent In Faculty Buildings If Landscaping Is Done Properly.

The data collected and analyzed from respondents clearly shows that a good percentage of the respondents will spend extract time learning in the faculty environment if the landscaping is done properly. 88.4% of respondents say that they will spend extract time, while only 9.3% says they will not spend extract time in the faculty buildings. 2.3% of the respondent did not actually state whether they will spend more time or not. The respondents who feel they will not spend more time may have adapted to other areas since the environment did not presently meet their demands, or expectations. Therefore, if faculty buildings will adopt to use of landscape elements, it will help increase the time users will spend in a quite environment; thereby increasing their productivity academically and otherwise. Illustration by the chat below gives a clearer explanation.

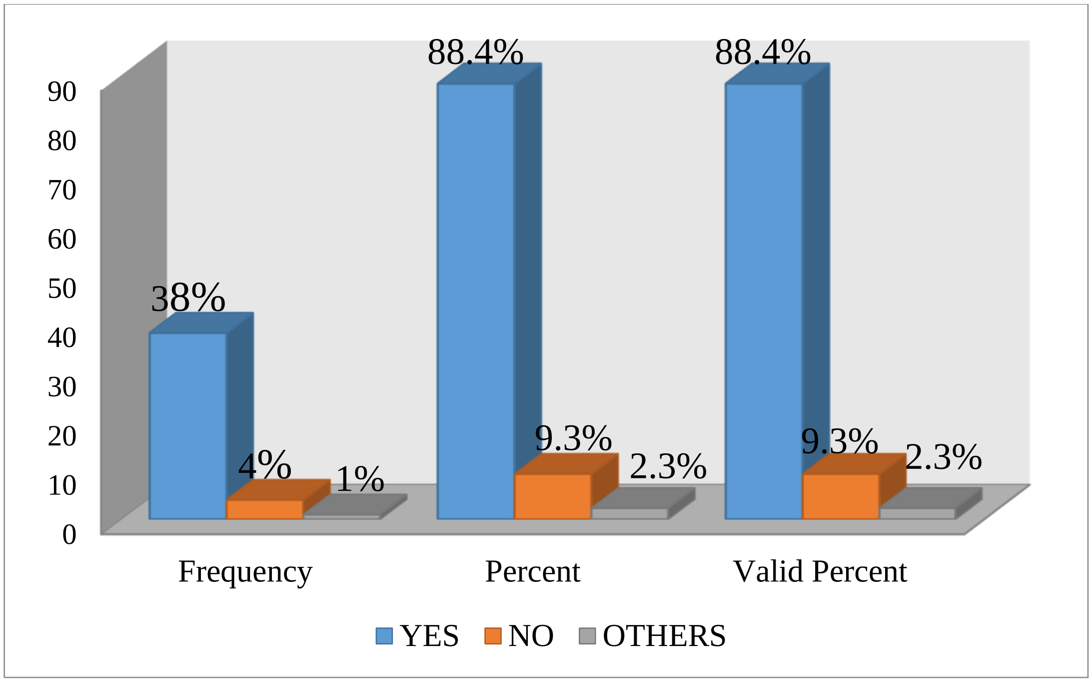


Figure 7: Responds of respondents if faculties are landscaped properly.

Source: Author's Fieldwork (2015)

CONCLUSION

The absence of landscape elements contributes majorly to users' constant stress and mental fatigue in the study area because there is a great relationship between the natural environments and man's well being. As a result of this, users' productivity will decrease over time due to the harsh learning environment. Only few of the faculty buildings shows a lower percentage of landscape elements adapted in their environments, and this is as a result of some natural landscape that were not discarded doing their construction. Species, types, and colours of plants and indoor plants were not adopted in the faculties. Analysis from the collected data shows that there is a great relationship between proper landscaping of the faculty buildings, and users comfort in respect to mental fatigue. This indicates that improper landscaping of faculty buildings affects the comfort of users per time in that environment. The analysis shows that users will spend more time in their faculty environments if the faculty if the basic landscape elements is adopted.

In other to achieve a conducive learning environment in reducing mental fatigue, the proper landscaping of faculty buildings and their environments must be treated with great importance. Architects should have a better understanding of how landscape can be adapted in the design of faculty buildings and its environments. They should know how to design garden layouts in institutional environments; in respect to the type of plants needed in a particular layout and environment. The architect should design faculty buildings to accommodate inbuilt plant systems that can harbour indoor plants, in order to increase the indoor air quality of the spaces. Atriums and courtyards should be design with the right species of landscape to create a calm learning environment, and relaxation areas should be designed with plants that depict its function in respect to relaxation. Parking and walkways should be well define, and design with materials that will absorb less heat in order to reduce heat island effect; a situation that causes the emission of heat from paved and other none reflecting surfaces.

REFERENCES

Ajayi, I. A., & Ekundayo, H. T. (2009). The Application of Information and Communication Technology in Nigeria Secondary Schools. *International NGO Journal, 4*(5), 281-286.

Ajeyalemi, A. (2009). New Directions in the Nigerian Education System. *Contemporary Issues in Education Research, 2*(3), 33-34.

Ajibade, Y. A., Oloyede, E. O., Adeleke, A., & Awopetu, E. O. (2011). Lecturers' Views on and Attitude of Pedagogical Skills Training; O A U as Case Study. *2*(1), 45-64.

Akinjide, A. (2011). Education for Social Reconstruction: Implication for Sustainable Development in Nigeria. *International Journal of Humanities and Social Sciences, 1*(21), 84-91.

Akpan, C. P., & Ekor, C. R. (2012). Challenges of Human Capacity Development in Federal Universities in Akwa Ibom and Cross River States, Nigeria. *Education and Practices, 3*(19), 25-34.

Amadi, M. N., Adeyemi, J. K., & Ogundiran, S. O. (2007). Concept of Education: Higher Education and Policy. Retrieved from www.nouedu.ng/noun/NOUN_OCL/PDF/PDF2/eda%20756.pdf on 25th February, 2015, 10:38am

Berman, M. G.,Jonides, J., & Kaplan, S. (2008). The Cognitive Benefits of Interacting with Nature. *Psychological Science* 19, (12) 1207-212.

Berto, R., Baroni, M. R., Zainaghi, A., & Bettella, S. (2010). An Exploratory Study of the Effect of High and Low Fascination Environments on Attentional Fatigue. *Journal of Environmental Psychology* 30, (4) 494-500.

Bon, A. (2010). Information and Communication Technologies in Tertiary education in Sub-Saharan African. In D. Tefera & A. Greijn (Eds.), *Higher Education and Globalization;Challenges, Threats and Opportunities in Africa*. Netherlands: Maasctricht University Centre.

Dauda, R. O. S. (2010). Investment in Education and Economic Growth in Nigeria: An Empirical Evidence. *International Research Journal of Finance and Economics* 18, (55), 158-169.

Farnum, J., Hall, T., & Kruger, L. E. (2005). *Sense of Place in Natural Resource Recreation and Tourism: An Evaluation and Assessment of Research Findings. General Technical Report PNW-GTR-660.* Portland, OR: USDA Forest Service, Pacific Northwest Research Station.

Fuller, R.A., Irvine, K. N., Devine-Wright, P., Warren, P. H., & Gaston, K. J. (2007). Psychological Benefits of Greenspace Increase with Biodiversity. *Biology Letters* 3, (4), 390-94.

Grinde, B., & Patil, G. G. (2009). Biophilia: Does Visual Contact with Nature Impact on Health and Well-Being? *International Journal of Environmental Research and Public Health* 6, 9; 2332-343.

Han, K. T. (2010). An Exploration of Relationships Among the Responses to Natural Scenes: Scenic Beauty, Preference, and Restoration. *Environment and Behavior* 42, (2), 243.

Heerwagen, J. (2009). Biophilia, health, and well-being. In: Campbell, L., and A. Wiesen (eds.), *Restorative Commons: Creating Health and Well-Being Through Urban*

Landscapes. Gen. Tech. Rep. NRS-P-39. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northern Research Station.

Isenberg, J. P., & Quisenberry, N. (2002). *Play: Essential for All Children; A Position Paper.* Association for Childhood Education International, 9 pp.

Jiler, J. (2009). Restoring Lives, Transforming Landscapes: The GreenHouse Program at Rikers Island Jail. In: L. Campell and A. Wiesen (Eds.) *Restorative Commons: Creating Health and Well-Being Through Urban Landscapes.* U.S. Department of Agriculture, Forest Service, Northern Research Station.

Kahn Jr., P. H & Kellert, R. S. (2002). *Children and Nature: Psychological, Sociocultural, and Evolutionary Investigations.* MIT Press, Cambridge MA.

Kam, M .C. Y., & Siu, A. M. H. (2010). Evaluation of a Horticultural Activity Programme for Persons with Psychiatric Illness. *Hong Kong Journal of Occupational Therapy,* 20, (2), 80-86

Maller, C. J., Henderson-Wilson, C., & Townsend, M. (2009). Rediscovering Nature in Everyday Settings: Or How to Create Healthy Environments and Healthy People.*Ecohealth*, 6, (4), 553-56.

Moti, U. G. (2010). The Challenges of Access to University Education in Nigeria. *DDM Business Review*, *2*(2), 27-56.

Nadkarni, N. M., & Pacholke, D. J. (2013). Bringing Sustainability and Science to the Incarderated. In: J. Appleton (Ed.) *Values in Sustainable Development.* London: Routledge, pp. 235-243.

Nakpodia, E. D. (2009). implication and Challenge of Nigerian Universities as Learning Organisations. Retrieved from www.articlebase.com/college-and-universityarticles/ implications . on 29th November 2014, 9:39am

Obe, I. (2010). *The Nigerian University System:* Backward Glance Moving Forward Paper presented at the Plenary Lecture at AVCNU, 20th April, 2010, Osun State.

Olubadewo, S. O. (2007). Contemporary Issues in Nigerian Education. *Multidisciplinary Journal of Research Development*, *8*(1). Organizations. Retrieved from www.articlebase.com/college-anduniversityarticles/implications. on 14th November 2014, 10:08am

Oyewole, O. (2010). Africa and Global Knowledge Domain. In D. Tefera & A. Greijn (Eds.), *Higher Education and Globalization: Challenges, Threats and Opportunities in Africa*. Netherlands: Maastricht University Centre.

Ozer, E. J. (2007). The Effects of School Gardens on Students and Schools: Conceptualization and Considerations for Maximizing Healthy Development. *Health Education & Behavior* 34, (6), 846-863.

Raanaas, R. K., Patil, G. G., & Hartig, T. (2012). Health Benefits of a View of Nature Through the Window: A Quasi-experimental Study of Patients in a Residential Rehabilitation Center. *Clinical Rehabilitation,* 26, (1), 21-32.

Shabani, J. (2010). Regionaland International Academic and Research Cooperation in Africa. In D. Tefera & A. Greijn (Eds.), *Higher Education and Globalization; Challenges, Threats and Opportunities in Africa*. Netherlands: Maasctricht University Center.

Shibata, S., & Suzuki, N. (2002). Effects of the Foliage Plant on Task Performance and Mood. *Journal of Environmental Psychology*. 22, (3), 265-272.

Tefera, D., & Greijn, A. (2010). *Higher Education and Globalization; Challenges, Threats and Opportunities in Africa*. Netherlands: Maasctricht University Center.

Thorp, L., & Townsend, C. (2001). Agricultural Education in an Elementary School: An Ethnographic Study of a School Garden. *Proceedings of the 28th Annual National Agricultural Education Research Conference in New Orleans, LA*, pp. 347-360.

Tyrväinen, L., Mäkinen, K., & Schipperijn, J. (2007). Tools for Mapping Social Values of Urban Woodlands and Other Green Areas. *Landscape and Urban Planning,* 79; 5-19.

WASTE MANAGEMENT AND SANITATION

ASSESSMENT OF SOLID WASTE MANAGEMENT IN AKURE, NIGERIA

ADEBAYO, Michael Adedayo and MBAZOR, David Ngwoke
Department of Estate Management, Federal University of Technology, Akure.

Solid waste collection is one of the most difficult operational problems faced by many cities in Nigeria of which Akure is not exclusive. This situation has rendered our cities to become the eyesore of the nation and an invitation to health hazards. This study therefore, aims at assessing the methods of managing solid wastes in Akure with a view to achieving the desired environmental sanitation for good health of the people. Data on sources and types of wastes generated, methods of disposal, regularity of disposal, dumping sites and processing were obtained from 368 sampled respondents coupled with information gathered from the Ondo State Waste Management Authority (ODSWMA). Descriptive statistics of frequencies, percentages and Likert scale were used to analyse data got. The results showed that most solid wastes were from residential houses and the refuse were dumped at roadsides waiting for government truck. It was also found that ODSWMA truck cleared the wastes at least once in a week which the respondents adjudged satisfactory. It is recommended that the authority's refuse disposal trucks are well maintained while modern equipment for collection, recycling, processing, disposal and reuse should be procured for better efficiency.

Keywords: solid waste; refuse disposal; waste management; environmental sanitation.

adebayomaa@gmail.com

davembazor@gmail.com

Adebayo, M.A and Mbazor, D. N (2016). **ASSESSMENT OF SOLID WASTE MANAGEMENT IN AKURE, NIGERIA** Sustainable Built Environment and Climate change; The challenges of Post 2015 Development Agenda. School of Environmental Technology Conference, SETIC, 2016

INTRODUCTION

Proper management of waste is critical to the health and well-being of urban residents (World Bank, 2003). The volume of waste generated in any city is often a reflection of the intensity of human activities such as increase in population, urbanization and social development, industrial development, resource exploitation and unchecked technological advances (Olanrewaju and Ilemobade, 2009). All these activities generate one form of waste or the other such as garbage, rubbish, ashes, trashes and dead animals. Most of our towns and cities are becoming more populated every day because of migration from rural to urban areas; the volume of solid waste generated has also increased tremendously and this makes solid waste a vital issue among the communities.

The production of waste material incudes the entire variety of refuse generated during domestic, industrial, construction and commercial processes (Bello, 2009). Solid waste is the term used to describe non-liquid waste material arising from domestic, trade, commercial, agricultural, industrial activities and from public services (Aibor and Olorunda, 2006). Solid waste management involves the storage, collection, and transportation of disposed refuse in a manner that is hygienically and aesthetically acceptable to avoid being detrimental to human health (Emeribe, 2000). The disposal of solid waste generated and the rate of evacuation or accumulation is an index of the degree of the effectiveness of solid waste management in an urban environment. Ojolowo (2007) was of the opinion that generation and disposal of waste is an intrinsic part of any developing or industrial society. Solid waste management is also an integral part of property management. It concludes that waste generation as an activity is not problematic per se, but subsequent phenomenal collection, storage and disposal are, in the face of urbanisation, pose challenges in many cities in Nigeria.

A study in Nigeria by Sridhar and Ojediran (1989) showed that municipal solid wastes are produced in the urban areas at a mean rate of 0.43 kg/head/day. Onibokun, Adedipe and Sridhar (2000) also noted that it was not uncommon going through the length and breadth of the country (Nigeria) to find heaps of refuse littering the entire landscape, road sides and commercial centres, even on the premises of primary, secondary and tertiary institutions as a result of poor management strategies. Ossai (2006) discovered that waste generation nationally was alarmingly on the increase with an estimated annual rate of about 0.5 -0.7% and current figures ranging from 0.4 to 0.8 ton /capital /annum. It further stated that complexity in waste is also increasing with biodegradable waste currently accounting for over 50% amounting to an annual average of approximately 50milion tons per annum of waste burden on the nation with less than 10%waste management capacity. Yusuf and Ojo (2007) were of the view that about 75percent of solid waste collected in Nigeria cities is disposed in open sites thus marginalising the urban environment as a result of negative externalities generated.

The state of domestic solid waste management in Akure is of a serious concern. Wastes of all descriptions find their ways into public places such as open space, drainage channels, and road verges. The body in charge of Waste management in Ondo State is the Ondo state Waste Management Authority (ODSWMA) which was established in 1999, when solid waste management situation in Akure was chaotic and embarrassing to most of her residents. ODSWMA is solely responsible for the collection and disposal of waste in Ondo State. The desire of the state government to derive value from waste while at the same time effectively protecting the environment also led to the creation of the Ondo State Integrated Waste Recycling and Treatment Project under the Waste Management Authority. Though, waste management by nature is capital intensive and many state governments spend a good percentage of their funds on domestic waste management but what this amount could accomplish is dwarfed by the population it caters for. Moreover, the state of physical environment, especially in urban centres is a major source of concern and it is increasingly confronted with the necessity of developing more capacity to safely dispose of waste. With various strategies tried so far, to improve the situation, the success recorded has not been remarkable enough as noticeable in the heaps of wastes dumped by roadside road divides bus stops and other strategic points on the streets. It is therefore, imperative that an assessment of solid wastes management in Akure, the state capital is made with a view to improving on the existing strategies and exploring new methods as applicable.

LITERATURE REVIEW

According to Benneh, Songsore, Nabila, Amuzu and Tutu (1993), residential domestic wastes form the bulk of all sources of solid waste produced in urban areas. These household wastes are known to have high densities with high moisture content and the organic component of solid wastes, which properly accounts for about 70% to 90%, while tins, cans and paper are probably responsible for about 5% to 10% of the total waste produced. The study noted that because the capacity to handle all the household waste generated is still weak, about 83% of the population dump refuse in either authorized or unauthorized sites in their neighbourhood which creates unsanitary conditions. Ogedengbe and Oyedele (2006) showed that the rate of change in domestic waste quantities and composition in developing and developed countries is unprecedented. It further asserted that, generally the greater the economic prosperity and the higher the percentage of urban population, the greater the amount of solid wastes generated. Akinola and Salami (2001) observed that solid wastes have a lion's share among the total pollution of the earth's surface. Mainly solid waste composed of municipal and solid wastes (MSW), hazardous waste, plastic waste and e-waste. Municipal solid waste also called trash or garbage, is composed mainly of everyday items that are discarded by the public. Municipal solid waste can either be biodegradable (recyclable) and non-biodegradable.

Solid Waste Disposal and Management

Marshal (1995) states that, waste materials that are organic in nature, such as plant material, food scraps, and paper products, are increasingly being recycled. These materials are put through compost and/or a digestion system to control the biological process to decompose the organic matter and kill pathogens. The resulting stabilized organic material is then recycled as mulch or compost for agricultural or landscaping purposes. Ajadike (2001) observed that most city residence dispose of their refuse either in open gutters, rivers, streets, open dumps, without regard to the environment and associated health hazards.

According to Medina (2002), the major models of disposal of solid waste in the United States were land filling or dumping and incineration. People want their refuse taken away and do not want it disposed of near their habitat, or at least not to where they can see or smell it. However, the European countries have resolved to improving waste disposal practices of solid wastes (including sludge), which may reduce the adverse environmental effects of such disposals and other aspects of solid waste disposals on land. This includes means of reducing the harmful environmental effects of earlier and existing landfills, means for restoring areas damaged by such earlier or existing landfills, means for rendering landfills safe for purposes of construction, and other uses and techniques of recovering materials and energy from landfills.

Solid waste management means the collection, keeping, treatment and disposal of waste in such a way as to render them harmless to human and animal life, the ecology and environment generally (Atsegbua, 2003). A survey conducted in urban centres in Iraq by UNEP (2008) revealed that solid waste management practices were generally very poor and these unsatisfactory practices were found in the collection, transportation, and disposal of wastes of all descriptions. The most serious challenge of the waste management situation in our cities is open dump systems adopted to manage solid waste.

Waste management requires a huge capital outlay. According to Akinwale (2005), Lagos state government spend between 20 and 25% of its funds annually on domestic waste management. The Waste regime in the UK provides a quintessence of a system that makes for effective monitoring of domestic waste prior to disposal and the steps to be taken on disposal. The regime distinguishes between controlled and special waste. Under Section 30 of the EP A, 1990, waste authorities in charge of waste administration have three basic functions: regulation, collection and disposal. Waste disposal authorities are to award waste disposal contracts through competitive tendering and are to make contracts with waste disposal contractors who may be private sector companies or companies set up by the local authority which must be at arm's length from the waste authority. The Waste regulation authority is responsible for issuing a waste management license. Under the regime, controlled waste may not be deposited, treated, kept or disposed of without a license. The licensing method issued as a means of controlling waste.

Malcolm (2005) identified lack of modem technology/lethargy in implementing efficient waste management methods as one of the challenges whereas different efficient ways of domestic waste management had long been in use in many developed countries. Recycling waste is one of the commonest ways of managing waste in developed countries. It involves the production of a useful material from waste garbage almost always has enough value to justify recycling parts of it. Financial instruments are used to encourage recycling and this is supported by environmentalists. In UK for instance, in keeping with the philosophy of introducing market forces into environmental regulation a system of financial credits was introduced by Section 52 of the EPA. It involves the waste disposal authority (the body responsible for disposing of the waste), making payments to the waste collection authority (the body responsible for collecting the waste), in respect of waste which they have collected for recycling. This means that they would have less waste to take to the landfill site or to the incinerator. If a third party, e.g. a charity association collects waste for recycling they should be appreciated.

Landfill is currently the most common method of disposing of waste in many developed countries. It accounts for the bulk (90 per cent) of waste disposal in the UK (Mowoe, 1990). At its most basic, this involves digging a hole in the ground and filling it with rubbish. The practice usually is to bury different types of waste in the same landfill site (Malcolm, 2005). Usually domestic waste is disposed of with industrial waste; the latter serves to reduce the concentrations of components leached from the former-diluting the industrial leachate. In particular domestic refuse can serve to neutralize acid wastes which arise in considerable amounts in many countries including Nigeria. In the UK, legislation makes it possible for waste regulation authorities to grant licenses subject to conditions relating to the care of the site after it has been filled (Malcolm, 2005).

The other major method of waste disposal is incineration. This means burning waste in an incinerator. In many areas of Japan, France, Germany, Italy and Scotland, such low value recyclable waste (mostly paper and plastics) are incinerated (Mowoe, 1990). The reality is that much domestic waste in these forms i.e. paper and plastics (packaging waste) is a major contributor to the waste stream and to the problem of litter. Incineration could reduce the domestic waste volume by 95% (Atsegbua et al., 2003). When waste is burned, there are two consequences: gases will be emitted into the air and residues in the form of ash and sludge will be left behind. Until recently, disposal of this incinerator waste has been a continuing problem. In the mid-1990's successful experiments in France and Germany used electric plasma touches to melt incinerator waste into rounded glassy pebbles, valuable as concrete filler and they do not dissolve in water (Atsegbua et al., 2003).

Added to the above methods of waste disposal is a new technology for domestic waste collection called pneumatic collection system for domestic waste (Mowoe, 1990). This system conveys waste without the need for trucks driving through towns and is operational 24 hours per day every day of the year. The system was especially suited to the development of new urban areas and for renovation of historic centres. Pneumatic collection is a break away from conventional forms of collection in that it avoids the need to place waste on the public highway and does away with movement of trucks and all the associated nuisances. Running entirely underground, the system contributes to protection of the environment by creating cleaner urban areas that function better and are more environmentally friendly. It is an innovative service with a simple operating principle. Users deposit their waste boxes on the streets on building land or in the garbage disposal areas of residential building and hotels. Each box has an associated "waste value" allowing intermediate storage before transport of the bags to a central collection point.

The bags are then dropped automatically into tanks where the waste is compacted. The air needed to propel the bags is provided by high-power blowers and the system is entirely controlled from a computerized cock pit. Access to the drop boxes is available at any time, every day of the year and without restriction. Pneumatic collection has many economic advantages: designed to last for 50 years, the installation and operating costs are optimized by a high level of automation and energy -efficient processes (Ita, 2000).

THE STUDY AREA

Akure, the study area, became the capital of Ondo State in 1976. Since then, it has been influenced by the influx of people into the town. Akure is located at the centre of the state, approximately within Latitudes $7^0$15'N and $7^0$28'N North of the Equator and longitudes $5^0$6'E and $5^0$21' E East of the Greenwich Meridian. It is bounded in the north by Akure North Local Government in Iju Itaogbolu; in the west, by Ile-Oluji Local Government; and in the South, by Idanre Local Government.

According to the provisional figure of the 1991 national census, Akure had a population of 239,124 people and in 1996, the population increased to 269,207. NPC (2006) puts the population as 353,211 and now over 380,000 people by projection. However, this figure has increased immensely owing to the influx of the people into Akure from other parts of the country due to the various activities in the area.

Trading and civil service are the dominant occupation in Akure. Markets are built by the present administration and this has caused increase in solid waste in the area. There are also some commercial activities and industrial companies. As Akure grows commercially, it is abundantly endowed with well-developed and service oriented industries, insurance, banking, printing, advertising and public relations. These cause increase in solid waste generation in Akure.

RESEARCH METHODS

Survey research design was engaged in this study. The target population were residents of Akure and the officials of Ondo State Waste Management Authority. Structured questionnaires were administered on the sampled residents while interviews were conducted on the top management and actual workers that move from house to house to collect the wastes.

For the purpose of this research, the stratified random sampling method was used. Using this method, Akure, the study area was classified into three strata with each stratum having sub-division. The bases for this classification were location and population density which to a great extent determines the amount of waste generated in any neighbourhood (Agboola, 1999). The pattern of development in Akure is linear along its main roads which are Adesida Road, Arakale Road, Ondo Road and Oda Road. The three developmental strata and their sub-divisions arising from this pattern are:

1. Peripheral suburb: Alagbaka, Ala Quarters, Ijapo Estate and FUTA Area
2. Newer inner suburb: Hospital Road, Oluwatuyi Quarters, Oshinle Quarters, Ijoka Road, Ilesha Garage, Oke Aro, Oke Jebu
3. City centre: Oja Oba, Isolo, Oja Oshodi, Eyinke, Ijemikin, Odopetu, Araromi and Odo lkoyi.

A sample size of five hundred was used for this study. This was selected on the basis of administering 25%, 35% and 40% questionnaires in each of the three strata that is, Peripheral suburb, Newer inner suburb and City centre respectively. Using the stratified random sampling method, 125, 175 and 200 respondents from each of the three developmental strata to which Akure was classified were randomly selected. However, 368 returned and well completed were found useful for this study. The data collected were analysed with simple descriptive statistics of frequencies, percentage and 5-point Likert scale.

DATA ANALYSIS AND RESULTS

Table 6 shows the various types of solid wastes generated within Akure, the study area. Respondents were asked to tick the types of wastes generated within their household or business place.

Table 1: Types of Solid Wastes Generated by Residents

Type of Waste	Frequency	Percentage
Food waste	368	100
Nylon	368	100
Tin	299	81.25
Old Appliances	238	64.67
Cartons	226	61.41
Glass	205	55.70
Paper	180	48.91
Plastic	180	48.91
Plank	131	35.59

Source: Field Survey, 2015

Table 1 shows the type of solid waste generated by respondents. All the respondents i.e 100% confirmed that they generate food waste and nylon, 81.25% of them generates tin as wastes, 64. 67% generates old appliances as wastes while 61.41% generates carton as waste. 48.1% of the respondents generate paper and plastic as wastes, while 35.5% of the respondents generate planks as wastes. The findings conform with the conclusion of Akaninyere and Atser (2001) that the major components of waste are degradable materials (food remnants, paper, and rags) and non-biodegradable plastics, tins, metals, bottles, glass, and bones. The study asserted that in several Nigerian cities, garbage contributes substantially more than other components. This could be explained by the fact that most activities which affect the environment stem from the need for food; its production, processing and preparation. Moreover, the findings of this study also confirm that of Benneh *et al* (1993) in Accra, Ghana and Adewumi *et al* (2005) in Akure.

Table 2: Waste Disposal Strategies

Method	Frequency	Percentage
Road side (expecting truck)	293	79.61
Dumping in bushes	198	53.80
Controlled dump sites	201	54.61
WMA containers	162	44.02
Burning	122	33.15
Gutters / Streams	72	19.56
Bury within compounds	45	12.22
Cart pusher	89	24.18

Source: Field Survey, 2015

Table 2 shows the waste disposal strategies adopted by the residents in the study area. Most of the respondents 79.61% drop their solid wastes by the road side waiting for the Waste Management Authority's truck for evacuation. This method is followed by dumping wastes to controlled dump sites as attested by 54.61% of the respondents. Burning of wastes, dumping in gutters and streams and burying some within the compound are not very common among the residents. Only 33.15%, 19.56% and 12.22% respectively do these. The results of this study show the new orientation of the residents towards a better environmental sanitation. Moreover, the State Government through the Waste Management Authority monitors and penalise offenders of environmental sanitation.

Table 3:Frequency of WMA Collection System

System	Frequency	Percentage
Once in a week	208	56.52
Once in two weeks	102	27.72
Once in a month	35	9.51
No presence	23	6.25

Source: Field Survey, 2015

Table 3 shows the frequency of the Waste Management Authority in collecting the solid wastes generated. From the Table, 208 representing 56.52% of the respondents indicate that WMA van comes to their neighbourhood to evacuate wastes, another 27.72% confirms that the van comes once in two weeks. Only 35 of the respondents (9.51%) say the van only come not more than once in a month while 6.25% say they have never seen any government refuse collection truck in their neighbourhood. This result shows that the Authority in charge covers more than half of the city in a week and much more (84.24%) in two weeks. Perhaps the few areas not covered are due to location and inaccessibility owing to poor roads.

Table 4: Perception of Respondents to Waste Collection Management

	VS	**S**	**N**	**LS**	**NS**
Adequacy of dump sites	42 (11.41)	63 (17.12)	11 (2.99)	122 (33.15)	130(35.33)
Adequacy of containers	43(11.68)	51 (13.86)	42 (11.41)	120 (32.61)	112(30.44)
Regularity of Waste Collection	117 (31.79)	144 (39.13)	29 (7.88)	52 (14.13)	26(7.07)
Service charge	126 (34.24)	163 (44.29)	2 (0.54)	62 (16.85)	15(4.08)
Attitude of personnel	113 (30.71)	171 (46.47)	47 (12.77)	23 (6.25)	14 (3.80)
Final management of wasters	87 (23.64)	89 (24.19)	59 (16.03)	71 (19.29)	62 (16.85)

Source: Field survey, 2015

Note: VS- very satisfactory; S- satisfactory; N- neutral; LS- less satisfactory; NS- not satisfactory.

Table 4 shows the feelings and thoughts of the respondents towards the general management of solid wastes in the study area. 68.48 per cent of the respondents are not well satisfied with the provision of dump sites. Moreover, 63.05% have the same poor feelings to the adequacy of waste containers located at some points in the town. However, from the Table, 31.79% are very satisfied and 39.13% satisfied with the regularity of waste collection by the Management Authority. In other words, a total of 70.92% of the respondents are satisfied in this regard. The respondents, are also satisfied with the amount being charged for the service rendered; 78.53% of them affirms this. The attitudes of the personnel are also rated high as 30.71% of them show that they are very satisfied while 46.47% are satisfied. The perception of respondents to final management of waste show a sort of dissatisfaction as only 47.83% indicates satisfaction.

Outcome of Interview of Key Staff

The interview conducted on Ondo State Waste Management Authority indicated that the activities of the authority are mainly the collection, disposal and management of waste in the study area. Though there are several factors militating against the management of solid waste by the authority in the study area among them are lack of non-governmental organizations' participation in waste management, low political will to strengthen environmental management agencies and bodies, poor information management, non-compliance by the general public and adequacy of equipment for waste management.

It was further revealed that the state government has taken a step further in the management of solid waste by establishing an integrated waste management plant at Igbatoro road, Akure. It has production capacities of 25 tons of organo-mineral fertilizer per day, 5 tons of scrap metal recycling per day and 50 tons of nylon/plastic recycling per day.

CONCLUSION AND RECOMMENDATION

Generation of domestic solid wastes is a daily affair, though its management ought not to be a problem if correct approaches are employed. Waste management should be given adequate attention by both state and local governments. The study established the important role being played by ODSWMA in solid waste management. The authority is efficient in its services delivery in terms of waste collection and disposal and also the frequency with which the service is carried out in Akure. The authority is adjudged to be living up to its responsibilities according to the findings of this study especially in the regularity of waste collection, pocket friendly service charge and the courteous attitude of the personnel to their customers. However, it is hereby recommended that the state government should increase the annual budget of environmental management in order to carry out mass repairs, overhaul and maintenance of the Authority's equipment for effective waste collection, disposal and management. For better efficiency, modern equipment for recycling, processing and reuse of wastes should be provided. In addition, more refuse dump containers should be placed on streets within the city to discourage people from indiscriminate refuse disposal.

REFERENCES

Adewumi I. K., Ogedengbe M. O., Adepetu J. A and Fabiyi, Y. L. (2005). Planning Organic Fertilizer Industries for Municipal Solid Waste Management. *Journal of applied Sciences Research* 1(3), 285-291.

Aibor M. S and Olorunda J. O. (2006). *A Technical Handbook of Envirometnal Health in the 21st Century for Professional Students.* His Mercy Publishers, Akure

Ajadike J. C. (2001). Urban Solid Waste: problems and management in Nigeria. In GEK Ofometa and P. O. Phil Eze eds. *Geographical perspective on Environmental Problems and Management in Nigeria.* Department of Geography, University of Nigeria, Nsukka,

Akinwale A. (2005). Waste Management in Nigerian Local Governments. *International conference on Energy, Environment and Disasters,* Charlottee, N. C; USA-July 24-30.

Atsegbua L. A. (2003). *Environmental Law in Nigeria, Theory and Practice.* Ababa Publishers, Lagos.

Bello V. A. (2009). *The Effect of Waste Dumpsites on Proximate property values in Lagos, Nigeria.* Unpublished PhD Thesis, Department of Estate Management, Federal University of Technology, Akure.

Benneh G., Songsore J., Nabila S. J., Amuzu A. T., and Tutu K. A. (1993). *Environmental problem and Urban Household in Greater Accra Metropolitan Area.* M.AC. Stokholm, Ghana.

Emeribe A. C. (2000). *Environmental Issues on Urban and Rural Development.* Gross Hill Press, Enugu.

Ita M. (2000). "Waste: is the developing World ready'. *Science in Africa.* http://wwww.scienceafrica.co.za/index.htm.

Mowoe K. M. (1990). Quality of life and Environmental Pollution and Protection. In Omotola J. A. (ed.), *Environmental Law in Nigeria.* Faculty of Law, University of Lagos.

Ogedengbe P. S. and Oyedele J. B. (2006). Effect of Waste Management on Property Vlues in Ibadan, Nigeria. *Journal of Land Use and development Studies* 2(1), 14-21.

Ojolowo S. K. (2007). *The Impact of Excreta Disposal into Lagos Lagoon on the Lagoon Ecosystem at Iddo Discharge Point in Apapa L. G. A. of Lagos State, Nigeria.* An unpublished M.Sc Thesis, University of Ibadan.

Olanrewaju O. O and Ilemobade A. A. (2009). Waste to Wealth: A case study of the Ondo State Integrated Waste Recycling and Treatment Project, Nigeria. *European Journal of Social Sciences*, 8(1), 7-16.

Onibokun A. G., Adedipe N. O., and Sridhar M. K. C (2000). Centre for African settlement studies and Development *Monograph Series* No 13, Ibadan. CASSAD Publication.

Ossai R. M. (2006). *Moving Solid Waste Management into the 21st century in Nigeria.* Seminar paper presented at National Council on Environmental Management, Katsina 13th – 17th November.

Sridhar M. K. C and Ojediran O. J. (1989). *Environmental Health.* 46, 28

UNEP (2008). *"Pollution of West Africa's Coastal and Marine Environment*" www.grids.no/geo/123.htm

World Bank (2003). *Thailand Environmental Monitor 2003*, Pollution Control Department, Royal Thai Government, The world Bank, US, Asia Environmental Partnership.

Yusuf S. A. and Ojo O. T. (2007). Household Willingness to pay for improved solid waste management in Ibadan North L. G. A. of Oyo State, Nigeria. *Journal of Environmental Extension,* University of Ibadan. Vol. 6

ASSESSMENT OF SOLID WASTE MANAGEMENT PRACTICES IN MAKERA WARD OF MINNA. NIGER STATE

SALIHU Suleiman[1], SULEIMAN Aisha Nana[2] & SHUAIB Iklimah[3]
1 Centre for Human Settlement and Urban Development, Federal University of Technology Minna,
2 Department of Building Technology, Federal Polytechnic Bida,
3 Department of Architecture, Federal University of Technology Minna

As a result of industrialisation and rapid population growth (urbanisation) in many cities and towns, solid wastes are generated faster than they are collected, transported and disposed. Solid Waste Management remains one of the most pervasive environmental sanitation challenges facing contemporary cities in the country today and it has continually remained at its lowest capacity despite huge Government investments in the sector. Many cities in the country today, are suffering from sudden increase in solid wastes and their poor disposal. The volume of wastes resulting from plastic materials being littered in the streets, open spaces and public premises are becoming alarming. These wastes are often discarded without due regard to environmental sanitation. The concomitant effect of poorly controlled open dumps, drainage lines and illegal roadside dumping spoils the scenic resources of the city, pollutes soil and water resources and produce potential health hazards to the residents. This paper seeks to examine the waste management practices in Makera Ward of Minna Local Government Area. This is done through mapping out of the solid waste dump sites in the ward, identification of sources of generation, collection and composition of solid waste, amount of waste generated, methods of household solid waste transportation and solid waste disposal.

Keywords: Solid Waste, Waste Management, Waste Disposal, Open Dumps, Environmental Sanitation.

solleee2x@yahoo.com

Salihu et. al. (2016). **ASSESSMENT OF SOLID WASTE MANAGEMENT PRACTICES IN MAKERA WARD OF MINNA NIGER STATE** Sustainable Built Environment and Climate change; The challenges of Post 2015 Development Agenda. School of Environmental Technology Conference, SETIC, 2016

INTRODUCTION

Ayo, 2010, stated that, Nigerian cities are witnessing high rate of environmental deterioration and are rated among urban areas with the lowest liveability index in the world. It is estimated that between 20 percent and 30 percent of the urban population enjoy decent urban life in the country. Although studies have identified various environmental problems, among them is solid waste management, little attention has been given to their implications for sustainable development in literature.

The growth of human population coupled with increased economic activities in towns and cities result in high rate of solid waste generation. A fundamental attribute of solid waste is that it is inevitable as almost every human activity involves the generation of waste in solid, liquid and gaseous forms. Social dynamics such as modernisation and economic development influence waste generation. This calls for careful planning and adequate resource allocation to forestall a mismatch between the rates of waste generation, rate of collection and disposal.

Solid Waste Management remains one of the most daunting environmental sanitation challenges facing the country today and it has continually remained at its lowest ebb despite huge investments in the sector. Currently, as a result of industrialisation and rapid population growth in many cities and towns, wastes are generated faster than they are collected, transported and disposed (Adebayo, 2006). The management of solid waste is far from being satisfactory in Nigeria. Many parts of our cities and towns do not benefit from any organised waste management services and therefore wastes are unattended to, buried, burnt or disposed haphazardly. In areas where the authorities do the collection, it is often irregular and sporadic. Recycling of waste is negligible while the methods used for collection, transportation and final disposal are very unsatisfactory. Waste when left unattended for a long time constitutes serious health hazard, causes offensive odour, pollutes underground water sources and decreases environmental aesthetics and quality. The waste burden has indeed become critical with waste products often containing materials that are toxic and not readily biodegradable. Such materials include various types of industrial chemical wastes, which can contaminate soil and underground water sources indefinitely if not properly disposed. Biomedical wastes from health care institutions also contain infectious/hazardous materials that can pose potential hazards to the environment and human health, when not properly disposed. The improper handling and disposal of medical wastes is a major threat to refuse collectors and scavengers and can result in infections such as Tetanus and Hepatitis. This in turn undermines productivity and reduces national income, thereby perpetuating a vicious cycle of poverty. (Akwa Ibom, 2000).

Effective and efficient Solid Waste Management is based on a hierarchy of management options: the reduction of waste, its reuse wherever possible, recycling, composting and energy recovery, and final disposal. However, there will always be certain wastes for which incineration is the most reasonable environmental and economic option. (Adebayo, 2006).

The National Environmental Sanitation Policy sets out to achieve a clean and healthy environment for all Nigerians (FEPA, 1991). In tackling the underlying problems of solid waste management, this Policy Guidelines on solid waste management by Federal Ministry of Environment in 2005 has recommended effective, efficient and sustainable waste management strategies. Such strategies include, waste minimisation at source through re-use, recycle and energy recovery before final disposal. Due emphasis has also been given to the use of locally available, appropriate and easily affordable technologies. Criteria for standardisation of the technologies have also been put in place (Nest, 1991).

This paper seeks to examine the waste management practices in Makera Ward of Minna. This is done through mapping out of the solid waste dump sites in the ward, identification of sources of generation, collection and composition of solid waste, amount of waste generated, methods of household solid waste transportation and methods of solid waste disposal.

LITERATURE REVIEW

Omran (2007) refers to solid waste as 'solid material which is discarded. This definition ignores the relevant issue of the usefulness, value, or desirability of the matter in question, but in as much as discarding is an intentional act, it implies that the discarded judges the material to be of relatively little current value to him. He contends that waste management is a systematic control of generation, storage, collection, transportation, separation, processing, recovery and disposal of solid waste. In the smallest of places, solid waste management is accepted as a major aspect of the indigenous community organization and traditional home management; hence every house/compound has a designed area for solid waste collection/disposal and or incineration. In Nigeria, wastes are generated in homes, commercial, industrial sites, hospitals, schools, on streets and even religious activities.

Solid Waste Management-Etymological Discourse:

Miller, 1979, argues that the amount of waste generated by human population was very insignificant. This was due to the size of the population and the spread of population around the world, coupled with the fact that there was very little exploitation of natural resources. Common wastes produced during the early ages were mainly ashes and human wastes; these were released back into the ground, which did not cause any harm to the environment. Before the invention of metals, wood was widely used for most purposes. However, the reuse of wood has been well documented. Best example being the reuse of timbers for shipbuilding purposes. With the invention of metals namely: bronze and iron, their use became common in most applications. With the advent of industrial revolution, waste management became a critical issue. This is owing to the increase in population and massive shifts in population from rural areas to industrial towns and cities during mid-18th century. There was a consequent increase in industrial and domestic wastes posing threat to human health and environment. By mid-19th century, considerable efforts had begun towards managing wastes. Incinerators were first used during late 19th century in United Kingdom, but they were opposed on the grounds of emissions, which fell unto the surrounding residential areas. Further to this, a series of legislations were passed in response to concern over human health and environment (Schwarz, 2005).

In United States, the Environmental Protection Agency (EPA) is the national agency that works to protect human and the natural environment. Environmental Protection Agency (EPA) established and enforces national environmental protection standards, conducts research on environmental problems, and assists other organizations in protecting the environment through grants, technical assistance and other programmers.

RESEARCH METHODOLOGY

Purposive sampling technique was adopted for this research. It involves the following: mapping out of the solid waste dump sites in the ward, identification of sources of generation, collection and composition of solid waste, amount of waste generated, methods of household solid waste transportation and methods of solid waste disposal. Data collected for this Research were through Primary and Secondary Sources. The primary Data collected are through direct field survey while the secondary data were collected from published materials which are relevant to this research.

THE STATE OF WASTE MANAGEMENT IN MINNA

Minna, the capital city of Niger State, Nigeria is not spared the menace of un-evacuated solid waste. The creation of Niger State in 1976 had led to the upgrading of Minna to a state capital. Since then, the city has experienced a great influx of people accompanied by a high demand for both residential and commercial accommodation. These have resulted in urban environmental problems of which the management of solid waste is clearly the most serious. Many areas of the city have become health risk owing to the accumulation of solid waste.

A close examination of municipal solid waste management in many developing cities including Nigeria shows that the present strategies are deficient and need to be re-addressed. Rapid urbanization in the developing world, if ignored, can be a threat to health, the environment and urban productivity. Cities are known to be engines of economic growth, but the environmental implications of such growth need a proper assessment, particularly in terms of environmental quality.

Schiopu *et al.* 2007 have agreed that there is the need to develop master plan and implement a simple but reliable tool that will help decision makers in the analysis process. In the same vein, Schwarz *et al.* 2005 also agrees that goals and time frames need to be established, duties of national and local governments and industries clarified, in addition to the allocation of funds in order to produce effective waste management framework in both developing and developed countries in the world Indiscriminate solid waste disposal is actually a menace and embarrassment to Minna city where heaps of refuse litter most parts of the city (Isu, 2005). Considerable percentage of solid wastes generated in Minna city are either deposited on the roads, or road sides, unapproved dump sites, in water ways (drainage system), or in open sites which adversely affect the environment friendliness. In fact, solid waste poses various threats to public health and adversely affects flora and fauna as well as the environment especially when it is not appropriately collected and disposed (Geraldu, 1995). The poor state of solid waste management in Minna city is caused by inadequate facilities, poor funding, and poor implementation of policies as well as wrong lifestyle (consumption pattern) (NISEPA. 2009). According to Egunjobi (1986), the problem of effective solid waste management has to do with poor social services delivery efforts which cause unnecessary delays in solid waste clearance. It is either broken down machinery, non-maintenance of dumpsters, poorly maintained urban streets and roads and irregularities in the designation of sanitary landfill sites. Studies have revealed that household account for about half of the solid wastes generated, that is, by weight in the third world cities, which includes Minna (UNDP, 2012). It has also been noted that solid waste management has received considerable attention not only in Niger State but Nigeria generally. (NISEPA. 2009)

SOLID WASTE MANAGEMENT IN MAKERA WARD

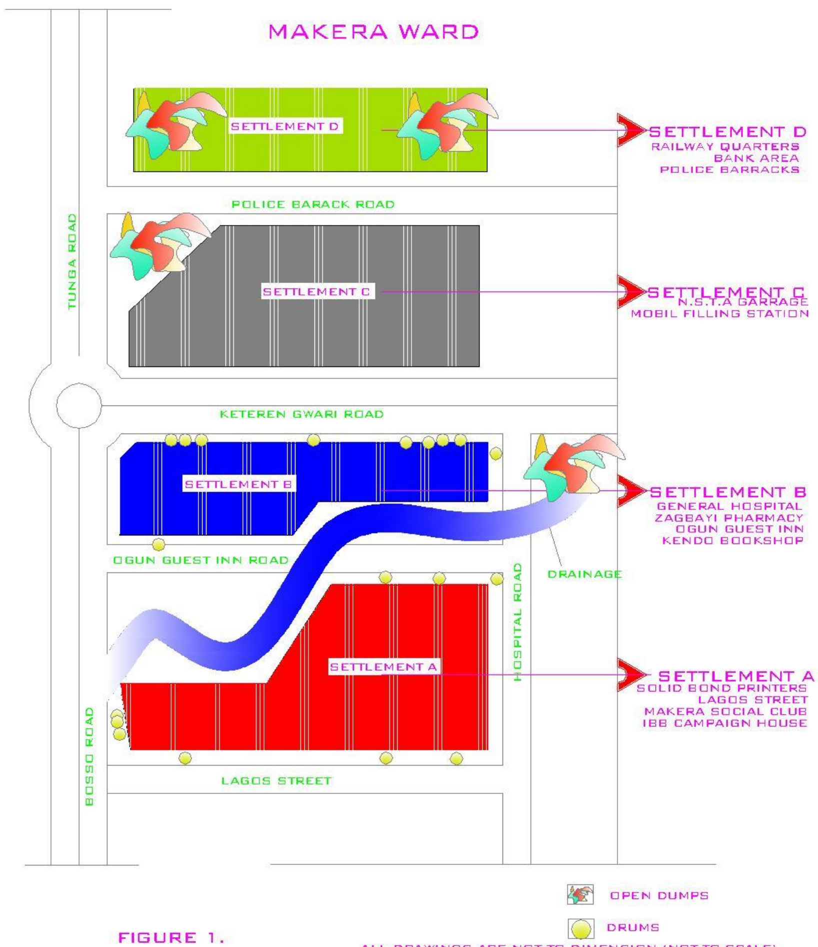


Fig 1: Grouping of Makera Ward into settlements A, B, C and D
Source: Researchers field work (2015).

Makera is one of the eleven wards in Minna. It comprises of a section of Central Minna from Lagos Street, to hospital road, down to Railway Quarters to police barracks as shown in Fig 1. The areas are classified into four groups; they are settlement A, B, C, and D. The groupings of the areas into individual settlements are as follows:-

Settlement A (Solid Bond Printing Press, Lagos Street, Makera Social Club, IBB Campaign Office), **Settlement B (**General Hospital, Zagbayi Pharmacy, Ogun Guest Inn**,** Kendo Bookshop), **Settlement C (**N.S.T.A Garage, Mobil Filling Station)**, Settlement D** (Railway Quarters, Banks Area, Police Barracks)

ANALYSIS OF WASTE MANAGEMENT FOR SETTLEMENTS A AND B

The analysis of solid waste management for settlement A and B is as follows:-

i. Mapping out the solid waste dump sites

- Eleven (11) numbers of 200kg metallic drums/bins (2200kg) positioned between Mobil roundabout and Hospital junction to Zagbayi Pharmacy area (opposite Mudos Pharmacy), all filled up with waste. (As shown in plate 1.)

Plate 1: A drum filled with solid waste. Source: Researchers field work (2015).

- A dump site in drainage was located around Ogun Guest Inn area; with an approximated quantity of 5000kg of solid wastes (approximations are made using load carrying capacity of the smallest NISEPA trucks which is 5000kg). (As shown in plates 2 & 3). (Researchers field work, 2015).


Plate 2 and 3: A drainage line with deposits of solid wastes.
Source: Researchers field work (2015).

Eight (8) 200kg (1300kg) metallic bin/drums were positioned between Lagos Street and Mobil roundabout. Three (3) of the bins were half empty at the time of visit.

ii. Sources of Waste Generation and Collection

Most of the waste generated are Household and commercial wastes and collected through dustbins, cartons, used plastic and metal buckets

iii. Composition of Solid Waste

Garbage, vegetable, paper/glass, wood/bone, cans, plastics, food wastes, polymers, Household waste and packaging materials.

iv. Amount of Solid Waste Generated or Collected

Approximately 8500kg of solid waste is generated in every three (3) days. Making a total of approximately 16000kg/week. (Researchers field work, 2015).

v. Methods of Solid Waste Transportation

Solid wastes are generally conveyed from homes to dump sites either by cart pushers or children carrying bins on their heads. (As shown in plate 4)

Plate 4: A cart pusher transporting solid wastes to dump sites.
Source: Researchers field work (2015).

Methods of Solid Waste Disposal

In settlements A and B the method of solid waste disposal is through evacuation by NISEPA's (Niger State Environmental Protection Agency) trucks. (As shown in plate 5).

Plate 5: NISEPA's truck evacuating solid wastes from dump sites.

Source: Researchers field work (2015).

Table 1: Quantity and Percentage (kg) of Composition of Solid Waste for Settlements A and B

Waste Type	Quantity (Kg)	Percentage (%)
Garbage	5280	33
Vegetables	800	5
Paper/Glass	2178	15
Wood/Bone	480	3
Cans	320	2
Plastics	640	4
Food wastages	800	5
Polymers	3540	22
Household wastages	1440	9
Packaging materials	320	2
Total	16000	100

Source: (field work, 2015)

Table 1, shows the percentages and the quantities of the compositions of solid wastes in the settlements as follows: Garbage 33% (5280kg), Vegetable 5% (800kg), Paper/Glass 15% (2178kg), Wood/Bone 3% (480kg) Cans 2% (320kg), Plastics 4% (640kg), Food Wastages

5% (800kg) Polymers 22% (3540kg), Household Wastes 9% (1440kg) and Packaging Materials 2% (320kg).

ANALYSIS OF WASTE MANAGEMENT FOR SETTLEMENTS C AND D

The analysis of solid waste management for settlement C and D is as follows:-

i. Mapping out the solid waste dump sites

Three (3) uncontrolled open dump sites are located in this category of settlements. These are:-

a. A 32m^2 (approximately 10000kg) open dump beneath the Mobil Bridge, behind N.S.T.A garage, servicing the activities around the garage, sugar cane, fruits market and Railway Quarters as shown in plates 6, 7 and 8. (Researchers field work, 2015).

Plate 6: The aerial views of the open dump Source: Researchers field work (2015).

Plate 7: The left side views of the open dump Source: Researchers field work (2015).

Plate 8: The right side views of the open dump Source: Researchers field work (2015).

b. Two (2) open dump sites of different sizes at the extremes of the barracks servicing the whole neighbourhood. The larger one, which is at western part of the barracks, is approximately 60m^2 (approximately 12000kg). (As shown in plate 9).

Plate 9: An open dump servicing Police Barracks Source: Researchers field work (2015).

The second open dump servicing the other extreme part of the eastern barracks is smaller in size. This is approximately 42m^2 (7800kg) mostly encroached by grasses during the time of visit. (As shown in plate 10).

Plate 10: An open dump in Police Barracks being encroached by grasses.

Source: Researchers field work (2015).

ii. Sources of Waste Generation and Collection

Most of the waste generated are commercial wastes from the market and collected through used sacks, dustbins, cartons, used plastic and metal buckets

iii. Composition of Solid Waste

Garbage, vegetable, paper/glass, wood/bone, cans, plastics, rotten fruits, polymers and packaging materials.

iv. Amount of Solid Waste Generated or Collected

Approximately 19800kg of solid waste is generated. (Researchers field work, 2015).

v. Methods of Solid Waste Transportation

Solid wastes are generally conveyed to dump sites by cart pushers. (As shown in plate 11)

Plate 11: A cart pusher transporting solid wastes to dump sites.
Source: Researchers field work (2015).

Methods of Solid Waste Disposal

In settlements C and D the method of solid waste disposal is through **burning**. (As shown in plate 12).

Plate 12: A segment of the dump site being burnt. Source: Researchers field work (2015).

Table 2: Quantity and Percentage of Composition of Solid Waste for Settlements C and D

Waste Type	Quantity (Kg)	Percentage (%)
Garbage	5544	28
Vegetables	1386	7
Paper/Glass	2178	11
Wood/Bone	198	1
Cans	594	3
Rotten Fruits	4851	24.5
Polymers	4356	22
Packaging materials	99	0.5
Total	19800	100

Source: Researchers field work (2015).

Table 2, shows the percentages and the quantities of the compositions of solid wastes in the settlements as follows: Garbage 28% (5544kg), Vegetable 7% (1386kg), Paper/Glass 11% (2178kg), Wood/Bone 1% (198kg) Cans 3% (594kg), Rotten Fruits 24.5% (4851kg), Polymers 22% (4356kg) and Packaging Materials 0.5% (99kg).

Table 3: Total Percentage and Quantity of Composition of Solid Waste for Settlements A to D

Waste Type	Quantity (Kg)	Percentage (%)
Garbage	10820	32.23
Vegetables	2186	6
Paper/Glass	4578	13
Wood/Bone	678	2
Cans	914	2.6
Plastics	640	1.4
Food wastages	800	1.6
Polymers	7876	22
Household wastages	1440	4
Packaging materials	419	1.17
Rotten Fruits	485	14
Total		

Source: Researchers field work (2015).

The following are the total percentages and the quantities of the compositions of solid wastes in all the settlements as shown in table 3: Garbage 32.23% 10820kg), Vegetable 6% (2186kg), Paper/Glass 13% (4578kg), Wood/Bone 2% (678kg) Cans 2.6% (914kg), Plastics 1.8% (640kg), Food Wastages 0.2% (800kg) Polymers 22% (7876kg), Household Wastes 4% (1440kg) Packaging Materials 1.17% (419kg) and Rotten Fruits 14% (4851kg).

WAYS TO MITIGATE WASTE MANAGEMENT IN MAKERA WARD

Inclusiveness and Environmental Education

For effective waste management, the citizens must be mobilized through sensitization and environmental education. Sensitization will bring about adequate citizen participation and private sector partnership. The public agency such as NIGER STATE ENVIRONMENTAL PROTECTION AGENCY (NISEPA) cannot alone achieve success in waste management without corresponding positive collaboration of the private sector. Through sensitization and environmental education, the attitude of the people towards improving and maintaining the neighbourhood, quality will be achieved.

Fortifying Waste Management Agency

Strengthening a public waste management agency requires a responsible government that will be committed to the cleanliness of the cities by beefing up the personnel strength of the agency, improving the infrastructure and logistics. These will enable the agency to operate at a high level of efficiency. Administration in Niger State led by Governor should mount an aggressive attack on urban filth by reinforcing and equipping NIGER STATE ENVIRONMENTAL PROTECTION AGENCY (NISEPA), the agency responsible for waste management in Niger State. There is need to apply the "polluter-must-pay" principle as well as upward review of sanitation fees so as to generate revenue and ensure' adequate funding of the agency. And also, there is need for the re-introduction of sanitary inspectors to enforce hygienic occupancy in our cities as well as in the rural areas.

Effective Government Support

Government should pursue vigorously the program of poverty reduction as a way of addressing urban waste management problems and to ensure its sustainability.

Provision of Waste Management Legislation

Government should put in place elaborate and comprehensive legislation to guide the waste management behaviour of the people. Observation shows that household waste disposal involves children, house helps and maids whose attitude to waste disposal is lackadaisical. Waste legislation should ban such class of people and make it mandatory that only the adults should be involved in household waste disposal. Similarly, general sanitation exercise should be done fortnightly rather than monthly. Every house should also by law possess a waste dustbin and landlords of filthy yards should be prosecuted.

Infrastructural and Management Improvements

The management of waste management agency such as NISEPA should be headed by a professional environmental manager who is a well-trained environmental practitioner rather than a politically appointed individual who is not knowledgeable about the intricacies of the environment. This will assist in right decisions being taken on waste management. As well, road infrastructure such as route-ways should be improved and properly maintained so as to facilitate routine waste collection from neighbourhoods.

Effective Monitoring and Surveillance

Two variables loaded high on this factor. Women are known to be very committed and thorough in the areas of environmental cleanliness and clean up. Again, they are more at home than their male counterparts. Women need to be organized and empowered to constitute waste management "marshals" to mount surveillance within the neighbourhood. If they are properly organized and re-orientated they can provide the much needed sanitary watchdogs and controllers. The existing women's organizations such as Christian Women Organization (CWO) and Christian Mothers' Union (CMU) and FOMWAN could be of help in this direction since they abound in all neighbourhoods.

CONCLUSION

The analysis of the study mapped out four (4) designated locations of the solid waste dumpsites, nineteen (19) metallic drums/bins spread within the study area containing various constituents of waste such as garbage, vegetable, paper/glass, wood/bone, cans, plastics, food wastages, polymers, household wastes and packaging materials. The study covers the quantity of solid waste generation in the area, which is 35800Kg comprising of 76.2% biodegradable, 23.8% non-biodegradable and also, being transported to the dumpsites by cart pushers, then to the landfills by NISEPA trucks. It was also observed that, there were many bottlenecks to the management of solid waste in Makera Ward ranging from ineffective and inefficient management to attitude of the people in the waste management practice in the Ward. There is need for implementation of Public Private Partnership in the solid waste handling and management in the Ward to provide proper collection and disposal of waste to forestall the outbreak of epidemics which can place burden on health of people in the Ward.

REFERENCES

Adebayo, W.O., Bamisaye, J.A., Akintan, O.B. & Ogunleye, O.S. (2006). Waste Generation, Disposal and Management Techniques in an Urbanizing Environment: A case Study of Ado-Ekiti, Nigeria. *Research Journal of Applied Sciences.* 1(4), 63-66.

Akwa Ibom State. (2000). *Environmental Protection and Waste Management Laws, 47,* Laws of Akwa, Ibom State of Nigeria.

Ayo, B., Ibrahim, B., & Mohammed, R.M. (2010). The Practice and Challenges of Solid WasteManagement in Damaturu, Yobe State, Nigeria. *Journal of Environmental Protection*. 1, 384-388.

Al-khatib I, Arafat HA, Basheer T, Shawahneh H, Salahat A, Eid J & Ali W. (2007). Trends and problems of solid waste management in developing countries: A case study in seven Pakistani Districts. *Waste Management*, 27(12): 1910-1919.

Babayemi J.O & Dauda KT. (2009). Evaluation of solid waste generation categories and disposal. *Journal of Applied Sciences and Environmental Management,* 13(3): 83-88.

Chattopadhyaya S, Duttad A & Ray. (2011). Municipal solid waste management in Kolkata India: A Review. *Waste Management,* 29(4): 1449-1458.

Federal Environmental Protection Agency (1991). Sustainable Development in Nigeria. *National Reports for the United Nations Conferences on Environment and Development,* Rio de Janeiro, Brazil.

Miller G.T. (1979). *Living in the Environment.* 2nd Edition. California: Wadsworth Publishing Company,

NISEPA. (2009). Niger State Framework for Integrated Sustainable Waste Management. Niger State Strategic Waste Management Framework.

Nwachukwu M.U. (2009). Solid waste generation and disposal in a Nigerian City: An empirical analysis in Onitsha Metropolis. *Journal of Environmental Management and Safety,* 1(1): 180-191.

Nigerian Environmental Study Action Team. (1991). *Nigeria's Threatened Environment.* A National Profile, Nigerian Environmental Study and Action Team. Ibadan: Intec. Printers.

Ogwueleka T.C., (2009). Municipal solid waste characteristics and management in Nigeria. 6(3): 173- 180.

Ogboi KC, & Okosun A.E., (2003). The role of scavengers in urban solid waste management in Nigeria. *Environment Studies and Resources Journal*, 2: 65-92.

Omran, A & Read, A.D., (2008). Waste not, want not: A study of household attitude towards recycling of solid waste. *Environmental Engineering and Management Journal,* 7: 1-8.

Schwarz H.O, Omran A, & Rapp P., (2005). A case study on successful municipal solid waste management in industrialized country by the example of Korlsrune City, Germany. *Journal of Engineering*, Tome VI: 1564-2673.

Schiopu AM, Apostol I, Hodoreanu M, & Gavrilescu M., (2007). Solid waste in Romania: Management, treatment and pollution prevention practices. *Environmental Engineering and Management Journal,* 6: 451-465.

UNDP, (2012). Niger State Framework for Integrated Sustainable Waste Management. Niger State Strategic Waste Management Framework.

ASSESSMENT OF HOUSEHOLD SOLID WASTE MANAGEMENT TECHNIQUES IN SOME SELECTED INFORMAL SETTLEMENTS IN MINNA, NIGER STATE, NIGERIA

SHUAIB Iklimah [1], SALIHU Suleiman [2], AISHA, Nana Suleiman [3] & DAUDA, Abubakar Dada [4]

SHUAIB Iklimah[1], SALIHU Suleiman[2], AISHA, Nana Suleiman[3] & DAUDA, Abubakar Dada[4]

1 Department of Architecture, Federal University of Technology Minna, Niger State, Nigeria.
2 Department of Architecture, Federal University Birnin-Kebbi, Kebbi State, Nigeria.
3 Department of Building Technology, Federal Polytechnic Bida, Niger State, Nigeria.
4 Department of Building Technology, Niger State Polytechnic, Zungeru , Niger State, Nigeria.

Waste is easily generated than managed by households in Developing Countries. Despite the measures put in place by Government of various states across the country, waste is still a menace yet to be tackled. This has resulted in pollution of the environment due to the emissions of toxic gases from these wastes. The resulting effect is an endangered human life, an unsafe and defaced environment. The research examined the current household solid waste management in some selected informal settlements in Minna and also finding a suitable solution of handling these generated waste by various households. Data would be collected through Waste Reduction Study Questionnaire Survey of some households that were randomly selected. The research postulated that majority of the residents are concerned and affected by the poor state of their environment currently, due to improper and inappropriate solid waste management. Very few of the residents knew little about recycling and composting. Some locally effective solid waste management strategies have been suggested.

Keywords: *environment, household, informal settlement, pollution, solid waste*

chartwithkily@yahoo.com

iklymahshuaib@gmail.com

Shuaib, I. et. al. (2016). **ASSESSMENT OF HOUSEHOLD SOLID WASTE MANAGEMENT TECHNIQUES IN SOME SELECTED INFORMAL SETTLEMENTS IN MINNA, NIGER STATE, NIGERIA** Sustainable Built Environment and Climate change; The challenges of Post 2015 Development Agenda. School of Environmental Technology Conference, SETIC, 2016

INTRODUCTION

With the increase in population and related activities, the demand for essential services namely water supply, drainage/sewerage, garbage collection and disposal, transportation; far exceeds supply. Also, land use distribution patterns are unsatisfactory. While taking up developmental activities, the sustaining capacities of the environment are rarely considered. The Master Plans although allocate land for various uses, do not specify the extent and intensity of activities amidst all their contingencies in each of the land uses which would be inconsonance with environmentally satisfactory development. For example, the slums and squatter settlements are scattered in and around the cities. The environmental pollution problems in urban areas are hence becoming complex and are highly risky. The solutions for waste management problems, particularly in slums and squatter settlements areas, are increasingly difficult due to ever-increasing gap between generation, accumulation and removal.

According to UNESCO (2011), its Goal 7 of the 8 Millennium Development Goals is to 'ensure environmental sustainability'. A very important issue that is crucial in realizing this goal is that of the need to develop and adopt effective strategies for solid waste management (SWM) and more especially in densely populated urban areas. The main purpose of SWM is to provide hygienic, efficient and economic collection, transportation, treatment and/or disposal of solid wastes, without polluting the atmosphere, soil or water resources. The environmental and public health risks that arise due to inadequate waste disposal have been well documented: surface and groundwater are contaminated by leachate; the soil by direct waste contact or leachate; the air by burning of waste; the spread of diseases by different vectors such as birds, insects and rodents; and the uncontrolled release of methane from anaerobic waste decomposition (Schertenleib & Meyer, 1992). The research is aim at examining the current household solid waste management in some selected informal settlements in Minna and also finding a suitable solution of handling of these generated wastes by various households, through analysing some of the strengths and deficiencies in the current SWM system in Minna, a fast growing city in North central Nigeria.

The Menace of Solid Waste

Municipal solid waste management (MSWM) will continue to be a major challenge facing countries all over the world, especially for developing countries where the amount of municipal solid waste (MSW) has increased greatly due to rapid increase in urban population (Adebayo *et al*, 2006). Meanwhile, with limited resources, only basic technologies for treatment and disposal, and deficient enforcement of relevant regulations, serious problems remain for MSWM in developing countries, especially in regard to safe disposal. The progress of modern civilization and the associated increase in population worldwide has contributed significantly to the increase in the quantity and variety of waste generated (Anikwe and Nwobodo, 2002). The increase in consumption of resources has resulted in large amounts of solid waste from domestic activities and can lead to significant threats to human health. Improper management of solid waste has serious environmental and health consequences, their environmental effects include pollution of surface and subsurface waters, unpleasant odours, pest infestations, and gas explosions (Ayo and Mohammed, 2010). Due to inadequate waste disposal, surface and groundwater are contaminated by leachate and the air is polluted by burning of waste or uncontrolled release of methane from anaerobic waste decomposition (Sha'Ato *et al*, 2007). The hazards associated with improper solid waste disposal and the associated environmental health impact should therefore be of utmost concern to waste management experts. If waste pollution continues unchecked, it may lead to unprecedented health consequences (Chen and Fujita, 2010).

The Management of Waste

Waste management is a global issue which needs maximum attention. In developing countries, waste management agencies lack the resources and trained staff to provide their rapidly growing populations with the necessary facilities and services for solid waste management to support good quality of life (Pokhrel and Viraraghavan, 2005). Within the framework of sustainable development, developing countries today face the challenge of balancing economic growth with environmental progress. The indiscriminate dumping of MSW is increasing and is compounded by a cycle of poverty, population explosion, decreasing standards of living, poor governance, and the low level of environmental awareness.

Hence, these wastes are illegally disposed of onto any available space, known as Open-dumps (Izugbara and Umoh, 2004). The collected waste is generally dumped on land in a more or less uncontrolled manner. Such uncontrolled waste disposal not only creates serious environmental problems and affects human and animal health, but also causes serious financial and socio-economic losses (Kalu *et al,* 2009). The potentials of residents to generate waste have increased in recent times due largely to accelerated urbanization, and population growth, which have elicited strong international concerns about the possible environmental, health and safety effects of living in the vicinity of these open-dumps. The only way to prevent this is to assess the level of waste generation, its management techniques and available disposal facilities.

The feedback from visitation to the environmental health office clearly showed that the staffs are determined and willing to do their work which they always did. However, there are several challenges that prevent the smooth and effective delivery of these services. These include: insufficient work vehicles; inadequate number of personnel; inadequate Government funds and lack of technical facilities such as ICT. These challenges are in agreement with research reports, for example, Golit (2001) have identified financial and technological constraints as impediments to appropriate and organized SWM. Since these constraints are also peculiar to many other urban centres in Nigeria (see for example, Adedibu, 1983; Egunjobi, 1986, 1992; Akintola, 1987; Ogu, 1987; Ipadeola, 1988; Nwude, 2006; Ukpong, 2006 and Osse, 2006), there is therefore a reasonable need to devise alternative ways of waste disposal and better still, devise effective ways of waste reduction.

Waste Generation and Characteristics in Minna

Solid waste in Minna is broadly classified into three main categories: Domestic refuse (solid waste generated by households, markets, food centers and commercial premises such as hotels, restaurants, etc.). Industrial refuse (not including toxic and hazardous waste) and Institutional refuse (solid waste from various government installations like hospitals, schools and recreational facilities. Figure 1 shows the actual amount of solid waste disposed (in tonnes) in the last two decades (1987-2009) in Minna city (UNDP/NISEPA, 2009).

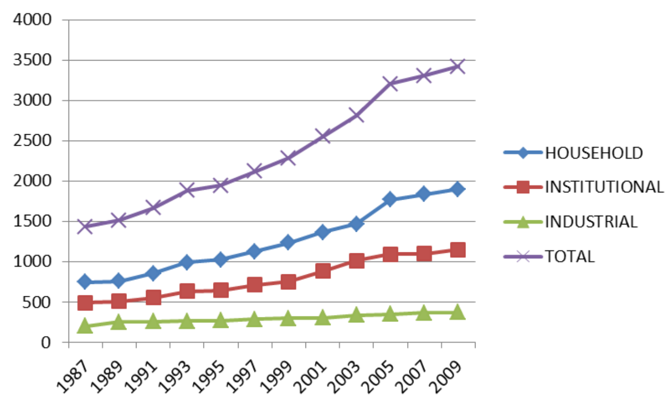


Figure 1: Waste disposed of in Minna for the past two decades Source: UNDP/NISEPA (2009)

RESEARCH METHODOLOGY

The Waste Reduction Study Questionnaire Survey (WRSQS) that was employed for this research was adapted from that of Post (2007). Minna, the capital of Niger State, having a total population of approximately 506,113 is the study area for the research. The town lies on latitude 60.331E and longitude 90.371N. According to UNDP/NISEPA (2009) the average population density in Minna is about 3448 persons per km^2. The study area was selected because the city's population is rapidly growing due to its proximity to Abuja, the country's administrative capital. However, more people means more waste, and more waste means more resources needed for waste management, the rapid population inflow should be considered in designing a waste management plan (Manaf *et al*, 2009). The town is susceptibly vulnerable to infectious diseases outbreak because it is densely populated and having a hot and dry climate. At the same time, rapid population growth continues to contribute to the burden of solid waste disposal. Solid waste management in the town has traditionally been undertaken by the Niger State Environmental Protection Agency (NISEPA).

Minna has a total number of eleven wards. For the purpose of this research, Nassarawa 'A' ward was chosen because it has the highest number of informal settlements. These areas include: Stadium road, Emir's road, Kuta road, Paida junction, Ogbomosho Street, Central mosque road, Sayako area, Unguwar Sarki, Unguwar Gabas, Sokoto Street.

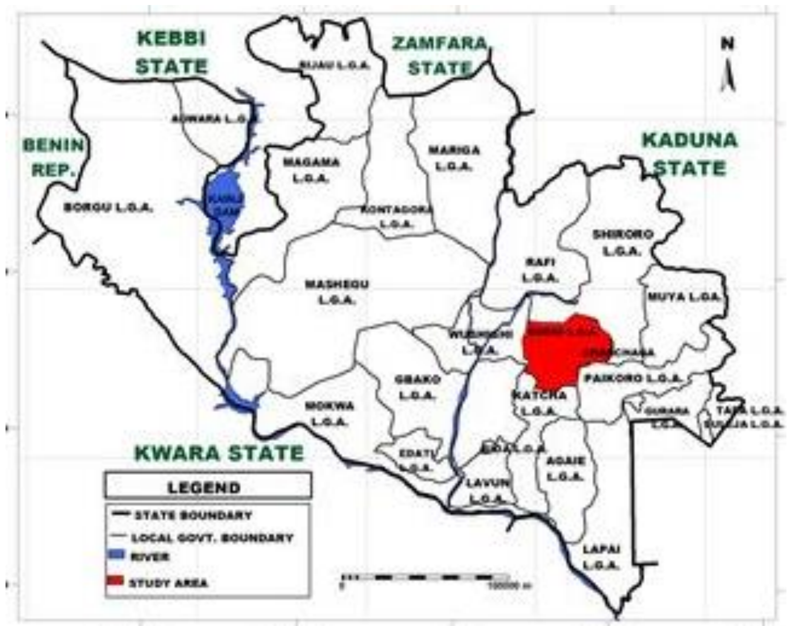


Figure 2: Niger state showing Minna
Source: Department of Urban and Regional Planning, FUT Minna

A total of 150 survey questionnaires were randomly administered among households of the selected informal settlements in Nassarawa 'A' ward, Minna out of which 100 copies were returned. The questionnaire design consists of seven sections: Natural Environment, Household Solid Waste Management, Concerns about Solid Waste Management, Willingness to participate, Solid Waste Management Attitude Scale, Environmental Health and Demography. The data generated and collated were analysed using SPSS. Microsoft Word was used to generate tables and figures from the results obtained for presentation and discussion. Stratified Random Sampling technique was used to analyse data for the research.

FINDINGS AND DISCUSSION OF RESULTS

The results are presented in tables and figures in the order of the respective sections of the WRSQS questionnaire. The different sections are intertwined with each other as they relate to the hazard and menace of solid waste to the environment, as well as possible solution to the problem.

Table 1: Nassarawa 'A' Ward Natural Environment

	Correct definition (%)		**Wrong definition (%)**		**No idea (%)**	
1. Ability to define the term Natural environment	32.7		6.6		60.7	
	Concerned (%)		Not Concerned (%)		No opinion (%)	
2. Concern about the current state of the environment	75		14		11	
	Automobile exhaust (%)	Sewage pollution (%)	Individuals (%)	Institutional (%)	Household garbage (%)	Yard trimmings (%)
3. What is being considered as the major issue that affects the environment	6.7	38.3	6.7	3.1	42.1	6.7
	No effect (%)		Some effect (%)	A lot of effect (%)	No opinion (%)	
4. Individual effect on the environment	3.4		23.3	55.3	18	

Source: Field work (2015)

From Table 1, majority of the respondents (60.7%) from the study area had no idea of the meaning of Natural environment. Even though a greater number of them are concern about their natural environment current situation (75%), it is obvious that their knowledge about the natural environment is shallow. Household waste/garbage is being considered by a great percentage of respondents (42.1%) to be the major issue that affects their environment. The individual person was believed by majority of the respondents (55.3%) to have the most effect on the environment.

Table 2: Household Solid Waste Management in Nassarawa ‘A’ Ward

1. Method of household garbage storage	**Closed container (%)**		**Open container (%)**			**Plastic bags (%)**			**Other (pile in the yard) (%)**		
	26.7		43.3			10.0			20.0		
2. Method of household garbage disposal	**Burn (%)**	**Bury (%)**	**Dump In gutter (%)**	**Dump in yard (%)**	**Dump on road (%)**	**EHO Dumpsite (%)**	**Garbage truck (%)**	**Recycle (%)**	**Reuse (%)**	**Compost (%)**	**Other (%)**
Food waste	16.7	3.3	10.0	3.3	3.3	40.0	6.7	0.0	6.7	10.0	0.0
Yard trimmings	53.4	3.3	3.3	0.0	3.3	23.4	0.0	0.0	13.3	0.0	0.0
Paper/cardboard	73.4	3.3	0.0	0.0	0.0	13.4	3.3	0.0	3.3	0.0	3.3
Plastic	40.0	6.7	3.3	0.0	0.0	26.7	0.0	6.7	13.3	0.0	3.3
Metals	13.4	3.3	3.3	3.3	0.0	26.7	3.3	30.0	0.0	0.0	16.7
Glass	6.7	6.7	10.0	6.7	0.0	43.3	3.3	16.6	0.0	0.0	6.7
% AVERAGE	33.9	4.4	5.0	2.2	1.1	28.9	2.8	8.9	6.1	1.7	5.0

Source: Field work (2015)

Table 2 shows that majority of the residents of Nassarawa ‘A’ ward stored their household garbage in open containers (43.3%). Burning constituted the major method of household garbage disposal by respondents (33.9). Many others (28.9%) make use of the environmental health office (EHO) dumpsite and very few of the respondents made use of other methods such as: composting, recycling, reuse, use of garbage truck.

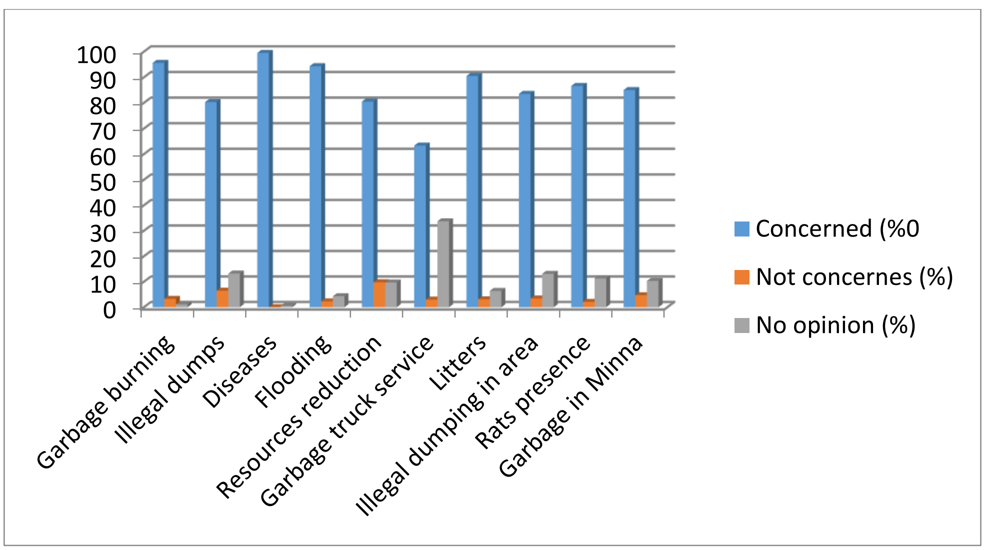


Figure 3: Solid Waste Management Concerns Source: Field work (2015)

Generally, majority of respondents from these informal settlements showed concern about the solid waste management issues, as can be seen in Figure 3. A greater number of them were concerned about the diseases related to improper waste storage and disposal (99.5%). While only few (1.1%) have no opinion regarding the health-risk related to waste burning.

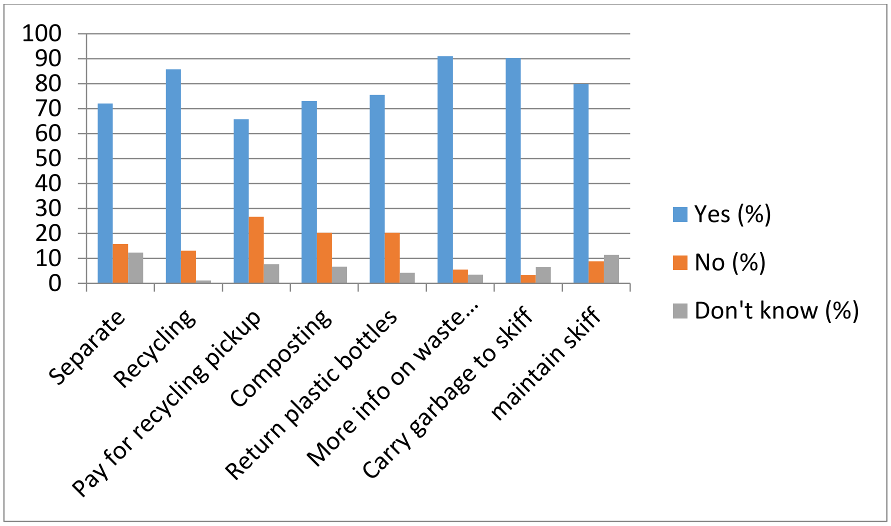


Figure 4: Willingness to Participate Source: Field work (2015)

From Figure 4, it is obvious that majority of Nassarawa 'A' residents are willing to participate in efforts aimed at reducing waste, through recycling and composting of household garbage and were also willing to get more information on how to reduce waste.

Table 3: Solid Waste Management Attitude Scale in Nassarawa 'A' Ward

S/N	Statement	Agree (%)	Disagree (%)	No opinion (%)
1	I play an important role in Minna waste management	66.7	23.3	10
2	Environmental education should be taught in schools	90	10	0.0
3	The Purchase decisions that I make can increase or decrease the amount of waste my household will dispose of	83.3	13.3	3.4
4	I **do not** care that burning waste can be bad for my health and the health of others	13.3	83.3	3.4
5	People throw waste on the streets and in the drains and gullies because they have no other means of disposing them	26.7	66.7	6.6
6	Government is not doing enough to fix the waste problem	93.3	6.7	0.0
7	Correct waste management should **not** be taught in schools	10	90	0.0
8	Other personal issues (like crime, unemployment, and cost of living) are more important to me than a waste-free community	26.7	66.6	6.7
9	Regular collection of waste is the only solution to waste problem	83.3	13.3	3.4
10	Picking up waste around my community is my responsibility	50	43.3	6.7
11	Public education about proper waste management is **one way** to fix the garbage crisis	90	6.7	3.3
12	It is very important that Government put recycling laws and programs in place in Minna	83.3	13.3	3.4

Source: Field work (2015)

From Table 3, while most of the respondents (66.7%) agreed that they individually play important roles in garbage management, a greater percentage of the respondents (93.3%) believed that the local government is not doing enough to fix the garbage problem. A greater number of respondents (83.3%) agreed that: recycling laws and programs should be put in place in Minna: also, that purchase decisions should be controlled and that regular collection of garbage is the only solution to the garbage problem. The majority of the Nassarawa ‘A’ ward residents (90%) also agreed that environmental education should be taught in schools and that public education about proper garbage management is a way to fix the garbage crises. When asked about whether other personal issues were more important than a garbage-free community, a greater percentage (66.6%) disagreed. Majority of the respondents (83.3%) were against the burning of garbage.

Table 4: Environmental Health of Nassarawa ‘A’ Ward

1.Type of toilet facility used	**Water closet linked to sewer main (%)**	**Water closet not linked (%)**	**Pit latrine (%)**	**None (%)**		
	13.3	30.0	50.0	6.7		
	Yes (%)	**No (%)**				
2. Location of toilet facilities on premises	86.7	13.3				
	Exclusive use (%)	**Shared (%)**				
3. Usage of toilet facilities	73.3	26.7				
4. Main source of drinking water	**Public supply (%)**	**Private tank (%)**	**Public stand pipe (%)**	**Way side tank (%)**	**Well (%)**	**Others (%)**
	13.3	26.7	6.7	10.0	23.3	20.0
5. Presence of disease vectors and breeding sites	**Yes (%)**	**No (%)**				
	83.3	16.7				
6. Main material of the house	**Wood (%)**	**Zinc (%)**	**Concrete (%)**	**Concrete and zinc (%)**	**Wood and zinc (%)**	**Others (%)**
	6.7	6.7	13.3	46.7	16.6	10.0
7. Type of tenure	**Owned (%)**	**Rented (%)**	**Rent free (%)**			
	60.0	30.0	10.0			
8. Household-grown food for consumption	**Vegetables (%)**	**Fruits (%)**	**Animals (%)**	**Others (%)**	**No (%)**	
	43.3	13.3	6.7	10.0	26.7	

Source: Field work (2015)

Table 4 shows that most of the respondents use pit latrine facilities (50%). While most of the toilet facilities are privately used by the household members (73.3%), few others are being shared by the Nassarawa ‘A’ ward’s residents. Most of the houses are owned by the household members (60%), which made it possible for them to grow various kind of crop and animal for household consumption, such as; vegetables, fruits, poultry.

Table 5: Nassarawa 'A' Ward Demography

1. Age range (%)						2. Gender (%)		3. Educational level (%)				
18-24	**25-34**	**35-44**	**45-54**	**55-64**	**65-Above**	**Male**	**Female**	**Primary**	**Secondary**	**Tertiary**	**No school**	**Don't know**
20.0	26.7	23.3	16.6	6.7	6.7	33.3	66.7	13.3	36.7	40.0	6.7	3.3

4. Employment (%)						5. Income range per month (%)				
Employed	**Unemployed**	**Student**	**Retired**	**Not of working age**	**Don't know**	**No income**	**Less than ₦ 10000**	**₦ 10000-₦ 30000**	**₦30000 or more**	**No response**
26.7	36.7	20.0	6.7	3.2	6.7	46.7	13.3	6.7	3.3	30.0

Source: Field work (2015)

Most of the respondents from these informal settlements are literate and with a greater percentage (40%) who have received a tertiary education, as shown in Table 5. Majority of the respondents (36.7) were unemployed. A large percentage (30%) did not disclose their income range and majority (46.7%) had no source of income.

CONCLUSION

This survey project has being able to provide an indication of the current household solid waste management in Minna. The residents are generally concerned about their environment but are not doing enough to reduce, recycle and reuse the household waste they generate. It is clear from their responses that they are ready to help fix the problem if given the appropriate support from government as this report had shown. The natural environment requires protection in order to remain healthy for all of its inhabitants. To protect and bring about a healthy and sustainable environment requires the collective efforts of the public, the environmental health authorities and the private sector, as well as the Government.

REFERENCES

Adebayo, W.O., Bamisaye, J.A., Akintan, O.B. & Ogunleye, O.S. (2006). Waste Generation, Disposal and Management Techniques in an Urbanizing Environment: A case Study of Ado-Ekiti, Nigeria. *Research Journal of Applied Sciences.* 1(4), 63-66.

Adedibu, A.A. (1983). Solid Waste Characteristics in Ilorin. *Journal of the Nigeria Institute of Town Planners,* 3(1).

Akintola, F.O. (1987). Prospects of Solid Waste Management in Ibadan City. *Seminar paper, Department of Geography, University of Ibadan.*

Anikwe, M.A.N. & Nwobodo, K.C.A. (2002). Long Term Effect of Municipal Waste Disposal on Soil Properties and Productivity of Sites Used for Urban Agriculture in Abakaliki, Nigeria. *Bio resource Technology*. 83(3), 241-250.

Ayo, B., Ibrahim, B., & Mohammed, R.M. (2010). The Practice and Challenges of Solid Waste Management in Damaturu, Yobe State, Nigeria. *Journal of Environmental Protection*. 1, 384-388.

Chen, X., Geng, Y. & Fujita, T. (2010). An Overview of Municipal Solid Waste Management in China. *Waste Management*. 30(4), 716-724.

Egunjobi, L. (1986). *The Solid Waste Management Problem, Urban Growth and Urban Management in Nigeria with Particular Reference to Public Utilities and Infrastructure.* Ibadan: NISER.

Egunjobi, L. (1992). Perception of Urban Environmental Problems: A pilot Study centered on the City of Ibadan, Nigeria. *African Urban.* 4, (1- 2), 59-69.

Golit (2001). *Sustainable Cities and Benefits. Regional Policy and Development.* London: Mitshire Kingsley publishers.

Ipadeola, S.F. (1988). Solid Waste Generation Management: Towards an Environmental Sanitation Policy. *Environmental Issues and Management in Nigeria Development.* 77-87.

Izugbara, C.O. & Umoh, J.O. (2004). Indigenous Waste Management Practices Among the Ngwa of Southeastern Nigeria: Some Lessons and Policy Implications. *The Environmentalist.* 24(2), 87-92.

Kalu, C., Modugu, W.W. & Ubochi, I. (2009). Evaluation of Solid Waste Management Policy in Benin Metropolis, Edo State, Nigeria. *African Scientist.* 10(1), 117-125.

Manaf, L.A., Samah, M.A.A & Zukki, N.I.M. (2009). Municipal Solid Waste Management in Malaysia: Practices and Challenges. *Waste Management*. 29(11), 2902-2906.

Nwude, M.O. (2006). A Sustainable Option for Solid Waste Management in Kaduna Metropolis. *Unpublished M.Sc Thesis.*

Ogu, B.C. (1987). Solid Waste Management in Imo State Urban Centres: The Case Study of Aba. *Unpublished MURP Dissertation.* Ibadan: Centre for Urban and Regional Planning, University of Ibadan.

Osse, F.O. (2006). Characterization of Abuja Federal Capital City Solid Waste for Appropriate Management Strategy. *Unpublished M.Sc Thesis.*

Pokhrel, D. & Viraraghavan, T. (2005). Municipal Solid Waste Management in Nepal: Practices and Challenges. *Waste Management.* 25, 555-562.

Post, J.L. (2007). Solid Waste Management in Jamaica: An Investigation into Waste Reduction Strategies. *Unpublished MSc Thesis.*

Sha'Ato, R., Aboho, S.Y., Oketunde, F.O., Eneji, I.S., Unazi, G. & Agwa, S. (2007). Survey of Solid Waste Generation and Composition in a Rapidly Growing Urban Area in Nigeria. *Waste Management*. 27, 352-358.

Schertenleib, R., & Meyer, W. (1992). Municipal Solid Waste Management in DC's: Problems and Issues: Need for Future Research. *IRCWD News (No. 26).*

Ukpong, B. (2006). Strategy for Sustainable Solid Waste Management in the Federal Capital Territory (Garki, Wuse, and Karu). *Unpublished M.Sc Thesis.*

UNDP/NISEPA. 2009. Niger State Framework for Integrated Sustainable Waste Management. Niger State Strategic Waste Management Framework.

UNESCO (2011). *UNESCO and Education: "Everyone has the right to education".* Paris: United Nations Educational, Scientific and Cultural Organisation.

EVALUATING THE SPATIAL DISTRIBUTION OF OPEN DUMPSITES AND THEIR EFFECTS ON THE RESIDENTS IN BOSSO-MINNA, NIGERIA

Salamatu Kassah[1], Abdullahi A. Kuta[2], Nanpon Zitta[2], Oluibukun G. Ajayi[2], Semiratu W. Abdullahi[3], Idris M. Kontagora[4]

[1] Centre for Waste Management (CWM), Grenfell-Baines School of Architecture, Construction and Environment, University of Central Lancashire (UCLAN), PR1 2HE, UK

[2,] Department of Surveying & Geoinformatics, Federal University of Technology, Niger State, Nigeria.

[3] Department of Microbiology, Federal University of Technology, Niger State, Nigeria.

[4] Department of Surveying & Geoinformatics, Niger State Polytechnic, Zungeru, Niger State.

Open dumpsites are the most prevailing form of waste disposal in most developing countries like Nigeria – which has been battling with indiscriminate dumping of waste for decades without much success. The failure of waste management system and Sanitary landfill in Nigeria has resulted to an uncontrollable spread of different kind of disease epidemics such as Malaria, Typhoid, Cholera, Dysentery and many others, posing threats to human health and causing the death of many people especially those residing within close proximity and as well as polluting the land, air and water bodies. The problem has been worsened due to lack of spatial data on the location of the dumpsite as well as identifying the households that are more vulnerable to the diseases associated with uncontrolled dumpsites. This study therefore seeks to evaluate the spatial distribution of open dumpsite in Bosso, Minna using Geographical Information System (GIS) and to investigate their likely effects on the residents. The methodology employed in the study involved the collection of waste dumpsites' coordinates using Global Positioning System (GPS) receivers and using Arc GIS 10.0 to digitize the built up areas from the acquired satellite images, creation of attribute tables, buffer analysis, overlay operations and production of maps. Residents living within 100m buffer zone were classified as highly vulnerable to disease spread, those farther away from dumpsites by 200m were classified as being moderately affected while those residents above 300m from dumpsites were classified as having very low vulnerability to disease spread. The research revealed that most of the open dumpsites were located within the high density areas which clearly demonstrated a true characteristics of high density areas and few of these sites are noticeable in the low and medium density areas. About 50% of the entire buildings fell within the 100 to 300m buffer zone generated. It is therefore recommended that immediate evacuation of these open dumpsites be effected and strategic location of waste transfer stations established by the Government and authority concern.

Keywords: Open Dumpsites, Waste management, Buffer, Spatial Analysis and GIS

abdullahi_kuta@yahoo.com

KASSAH et. al. (2016). **EVALUATING THE SPATIAL DISTRIBUTION OF OPEN DUMPSITES AND THEIR EFFECTS ON THE RESIDENTS IN BOSSO-MINNA, NIGERIA** Sustainable Built Environment and Climate change; The challenges of Post 2015 Development Agenda. School of Environmental Technology Conference, SETIC, 2016

INTRODUCTION

Dumpsites can be described as refuse dumps situated either on land or on water where waste materials, such as solids, liquids, semisolids and gaseous are disposed (Abul, 2010). The siting, management and proper handling of dumpsites is essential to public and environmental health. The absence of these measures may cause the waste constituents to enter the environment thus affecting the livelihood of the surrounding communities (Sever, 1997; Daniel and Laura, 1999).

There are basically two options for waste disposal/dumpsites: operate a properly designed, constructed, and managed landfill or open dumpsites in which waste is burned in a controlled or an uncontrolled facility that converts waste to energy (United States Environmental Protection Agency, 2002). Open dumps are the most preferred method of disposing waste in most developing countries regardless of the fact that it is unhygienic and unsafe (Remigios, 2010) which are usually sited on low lying areas of an open land. There have been several occurrences of open and illegal dumping of refuse on the streets and other places that are not legally allocated for the purpose of waste disposal in Bosso, Minna-Niger State. Benedine, Robert & Abbas (2011) stated that open and illegal dumpsites are indiscriminately sited, irrespective of the presence of infrastructural facilities available in those locations. This could be as a result of attitudinal problem from the public especially in developing countries who prefer a place within the shortest distance and the institutional constraint from the government of Niger State that has no standing frame work to address this problem. This makes open dumping of waste the most prevailing form of waste disposal in developing countries especially Nigeria (Saidu, 2011). They are piled up by the road side, in the rivers, drainages and many open spaces in the cities thus posing threats to human health and environment (Cheeseman, Imam, Mohammed, and Wilson, 2007).

Open dumpsites are favourable harbours for mosquitoes, cockroaches, rodents, houseflies etc which serves as hosts or causative agents for malaria, typhoid fever diarrhea, Lassa fever etc. The people living close to open dumpsites are often subject to direct transfer of contamination from hand to mouth or through inhalation of dangerous volatile compounds and aerosols (Aderoju, Salman, Anjoye, Nwadike, Jantiku, Adebowale, Fagbemiro, Agu, 2014). Constant exposure to dumpsite lead to considerable public health consequences such as, cholera, Malaria, Typhoid, Dysentery/Diarrhea and many others, which degrades human health on daily basis (Su, 2005; Nubi, Ajao, and Nubi, 2008). The indiscriminate dumping of waste along the road side, open spaces, drainages and canals poses threats to human health and the environment in many countries (Oluwafemi, 2009; Joseph, Nagendran and Visvanathan nd). This is usually found in urban areas, where several developments have taken place and waste management practice is ineffective, and people suffer widespread of diseases which sometimes lead to premature death especially among children and women since their immune system may be unable to fight those diseases (Bartlett, 1999; Nwaka, 2005). Dumpsites irrespective of the type, (open or closed) should be sited at the outskirts of the city or community, because of the health effect on the residents, through the proliferation of flies, mosquitoes and rodents that transmits diseases which affects the human health (Abul, 2010).

"Effect of Waste Management on Climate Change is a Fact, not a Myth" (Oresanya, 2010) which caused air pollution with impact on climate through methane emission in which dumpsites have been identified as major sources (Aljaradin and Persson, 2012) especially the traditional open dumpsites which do not have a top cover or other preventive measures to reduce methane emission into the atmosphere. Therefore, dumpsites are regarded as the largest source of atmospheric methane in the world, leading to a global warming (Hansen, Nazarenko, Ruedy, Sato, Willis, Del Genio, Koch, Lacis, Lo, Menon, Novakov, Perlwitz, Russell, Schmidt, and Tausnev, 2005) which result in changing the temperature and rainfall patterns and which is expected to bring a variety of pressure upon plant and animal life.

There are a lot of reasons why open dumpsite is still been practiced in Bosso area of Minna despite the health implications This can be attributed to sheer ignorance of the health risks associated with dumping of waste in open areas, inadequate resources as well as lack of legal policies against indecent dumping of refuge. Others are lack of political will to protect and improve public health, high illiteracy rate and lack of collection centres/drums close to the residence especially in highly populated areas of Bosso-Minna. Waste management in Minna is considered to be unsuccessful, because it is affected by unfavourable economic, institutional, legislative, technical and operational constraints (Mohammed and Chukwuma, 2011). Although, Niger State government together with the Federal Government have attempted to implement some tactics to clean up the city but not much is seen to have been attained as most part of the state are surrounded by open refuse dumps. This has resulted to series of complaints by the residents of Minna on the dilapidating condition of their environment with the residents taking to the streets to complain about the level of garbage waste overflowing their roads, streets and drainages systems, stressing that it is becoming a threat to their health and entire well-being (Ebenezer, 2012).

Therefore, due to the health effects of open dumpsites, decision makers and professionals like town planners, engineers, environmentalists etc. require information about the locations (spatial distribution) of the dumpsites that will enable effective planning and identification of illegal dumpsite in Bosso-Minna. Evaluating the spatial distribution of the open dumpsites will help the agencies in locating the locations of the dumpsite which will help to determine if the site are to be evacuated. It will also help in identifying the residence that are at risk due to their proximity to these sites. The major problem is knowing where these dumpsites are located and their relationship/effect with the residence: how far is this dumpsite from the residential areas, and are these dumpsites approved by the authorities or not. Most times the reason why the government is ineffective in waste management is due to the lack of spatial data on the location of dumpsites which can easily be achieved with the use of Geographical Information System (GIS). GIS is a powerful tool which allows for integration of data from numerous sources and the performance of detailed analysis, taking into consideration the locations, social and economic variables (Parker and Campbell, 1998). GIS provides a powerful technology for the spatial analysis of environmental and health data, and the major areas of its application include assessment and mapping of environmental exposure, mapping of health outcome, and the analysis of spatial relationships between environment and health (Briggs and Elliott, 1994). It can also be used as a decision support tool to simplify the search for suitable sites selections for specific purpose because it is capable of extracting and classifying spatial features (Nakakawa and Ogao, 2007). Aderoju, et al. (2014) used Geo-Spatial approach to analyse the spatial patterns of waste dump sites and the health hazards associated with it as well as identifying possible areas at risk of health hazards in Minna, Niger State, Nigeria.

This research is aimed at using GIS based spatial analysis to evaluate the spatial distribution of open dumpsites in Bosso-Minna by creating data base of dumpsite within the study area which will help the waste management agencies to know the location of the dumpsite and plan for proper management of dumpsites. This is important because it will help in analysing the health effect of these wastes on the residence within close proximity to the dumpsites.

METHODOLOGY

Study Area

The study area for this research work is Bosso Town-Minna in Bosso local Government Area of Niger State, Nigeria. Bosso town is the home of Federal University of Technology, Minna Bosso campus. According to 2006 population census in Nigeria, Bosso-Minna is said to have a population of 147, 359, (75,826 males and 71,533 females), while Niger state as a whole maintains a populations of 3,950,249 (National Population Commission, 2007). Niger State is blessed with cultural diversity with the major dominants of Bosso-Minna being Gbagyi and Nupe. Bosso-Minna is located on Latitude 6^{o} 30’E and Longitude 9^{o} 40’N and lies in the southern Guinea Savannah zone of Nigeria. It has a sub-humid, semi-arid tropical climate with mean annual precipitation of 1200 and 1300mm. About 90% of total annual rainfall occurs between the months of June and September (Saidu 2011). The temperature rarely falls below 22^{o}C but peaks at 40^{o}C and 30^{o}C in February/March and November/December respectively while wet season temperature average is about 29^{o}C” (Musa, Oladiran, Ezenwa, Ogbadoyi, and Akanya, 2011; Mohammed and Chukwuma, 2011).

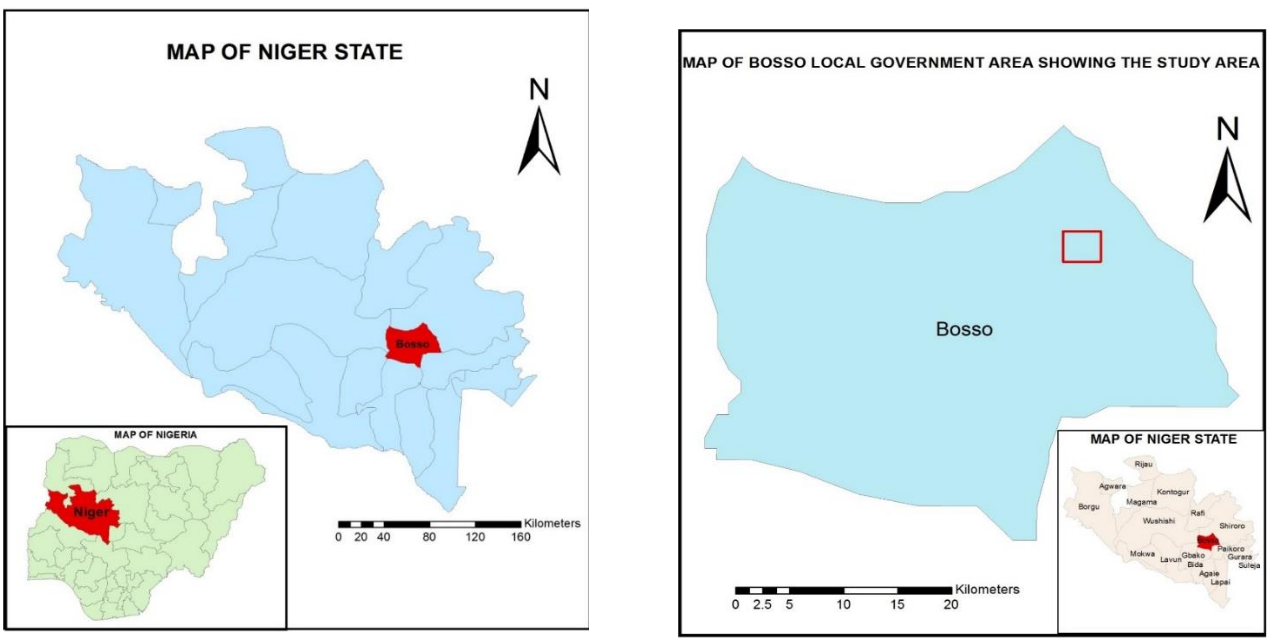


Figure 1: Map of Bosso Local Government Area Showing the Location of the Study Area in Red

MATERIAL/DATA

Two types of data were used for this study; spatial and attribute data. The spatial data are the coordinates of the dump sites as well as the satellite image of minna. QuickBird satellite images of 0.6 metre resolution covering the study area was obtained from Niger State Geographical Information System (NIGNIS). The attribute data includes; name places of open dumpsites, street name, description of waste etc. The satellite image was already georeferenced and projected to Universal Traverse Mercator (UTM) Zone 32N with Minna datum been the origin. The attribute data are textual data like names of road/streets, area etc. which were obtained in the field.

METHODS

Database was created using ArcMap 10.1 software and shapefiles created for the following features such as buildings, rivers, road etc. From the satellite image, features such as roads, buildings, water carnal were digitized on screen. The area was divided into low and high density. The places that are well planned were regarded as low density while areas that are not well planned were digitized as cluster of buildings since it is not possible to digitise them as individual buildings. The coordinates of dumpsite were observed through ground surveying using Garmin 72H GPS hand held receiver.

SPATIAL ANALYSIS AND QUERY

Buffering and proximity operation was carried out to determine the distances between dumpsite and the residential areas. Buffer rings were created in form of polygon around each dumpsite to show the proximity and disease prevalence. Three buffer rings were created using 100, 200 and 300metres respectively. More distances could have been used but the study area is not large enough hence the whole study area would have been covered if distance of 500metres and above were used, therefore covering the whole map and rendering it useless and also losing its meaning for the purpose for which it was created. Those houses that fall within 100m of dumpsites are classified as highly vulnerable to disease spread; within 100 to 200m as moderately vulnerable, while those within 200m to 300m from the dumpsites are less vulnerable to disease spread. The ArcGIS 10.1 software buffering operation was used in the determination of the the residential buildings that are prone to epidemics in the study area. Spatial query (selection by location) was used to select the buildings that falls within various buffers.

RESULTS PRESENTATION

Table 1: Numbers of Dumpsites in Each Location

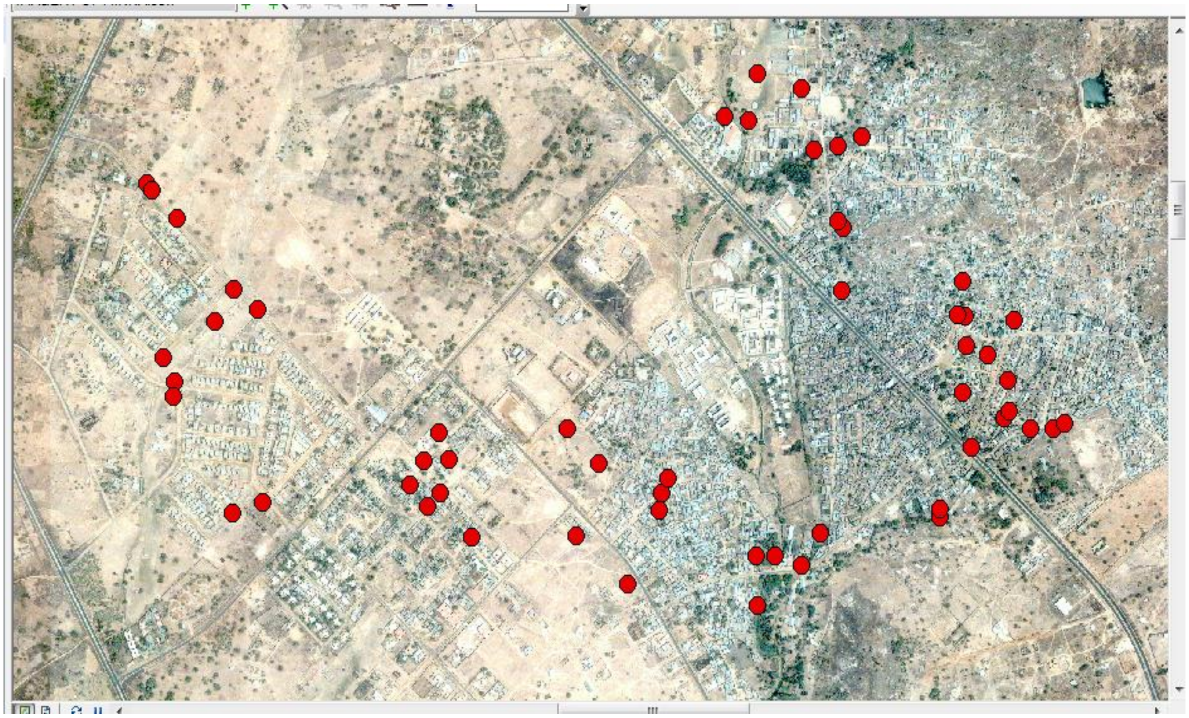
Location of Dumpsites	No. of Dumpsites	Percentage Dumpsites
Bosso Estate	12	21.4
Bosso Lowcost	8	14.2
Front of School	24	42.9
Awwal Ibrahim	12	21.4
FUT Bosso Campus	0	0
TOTAL	56	100

Source: Authors' field work 2016.

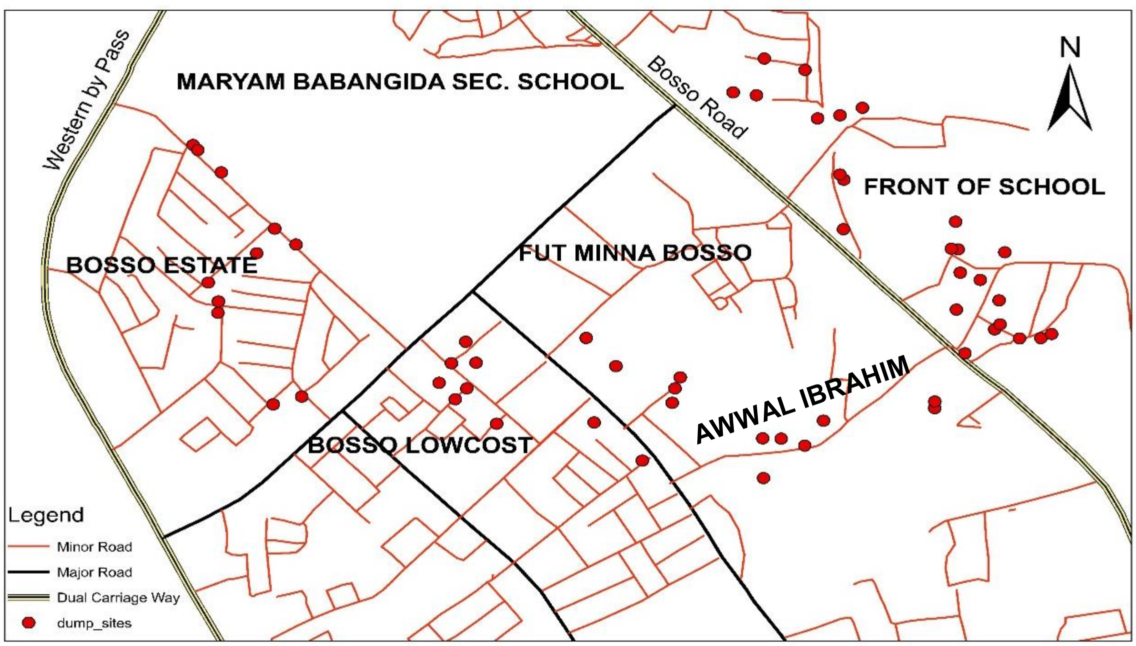
Table 2: Number of Low density Houses vulnerable to deseases due to proximity to the dumpsite

Buffer in Meters	**Number of Houses**	**Vulnerability**	Percentage
Within 100	240	High	13.4
Within 100 to 200	475	Meduim	26.6
Within 200 to 300	369	Low	20.6
Not Within the buffer	703	Not vulnerable	39
Total	1787		100

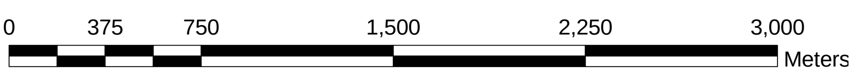
Source: Authors' field work 2016.



A

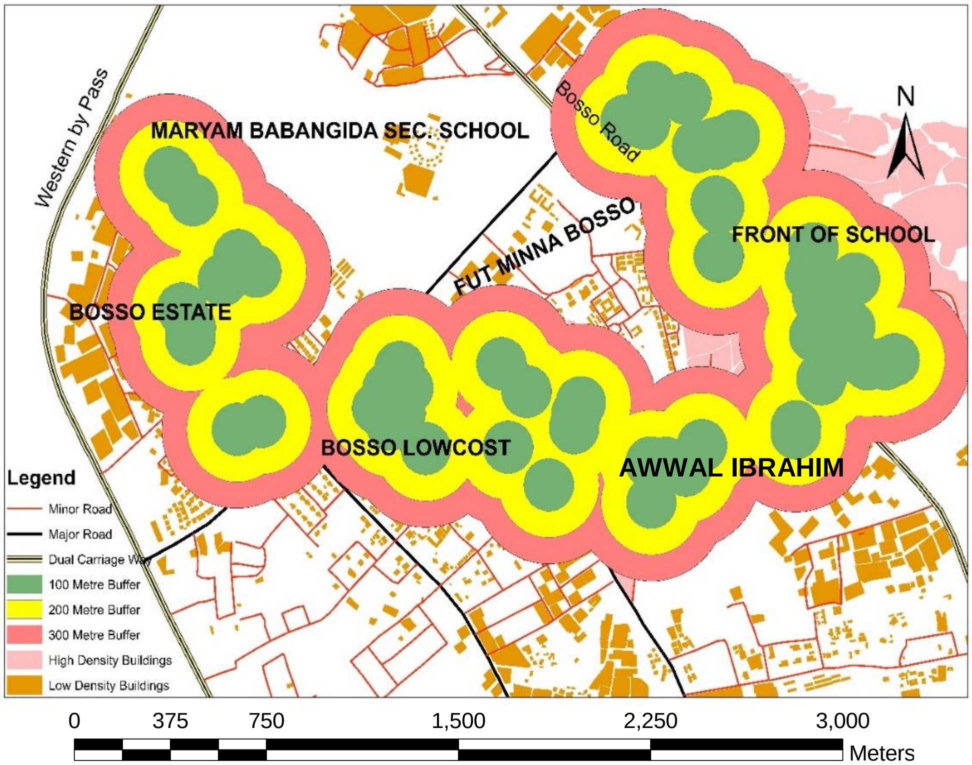


B



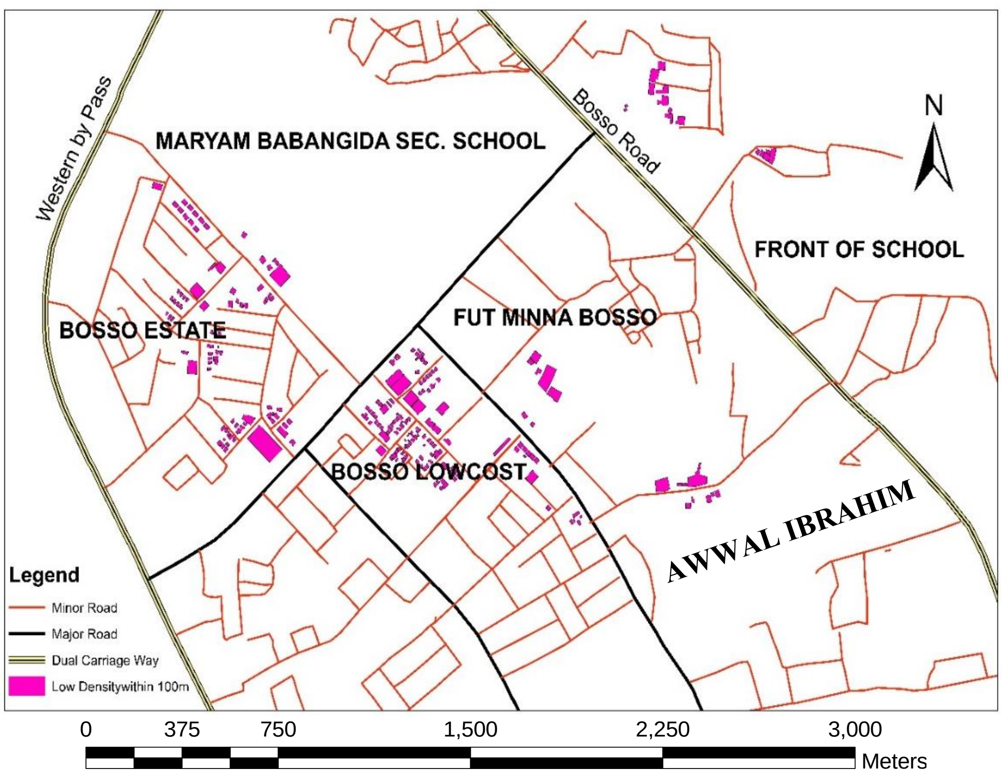
SCALE:-1:10,000

Figure 2: (A): Spatial Distribution of Dumpsites in relation to satellite images. And (B) in relation to the digitize image.



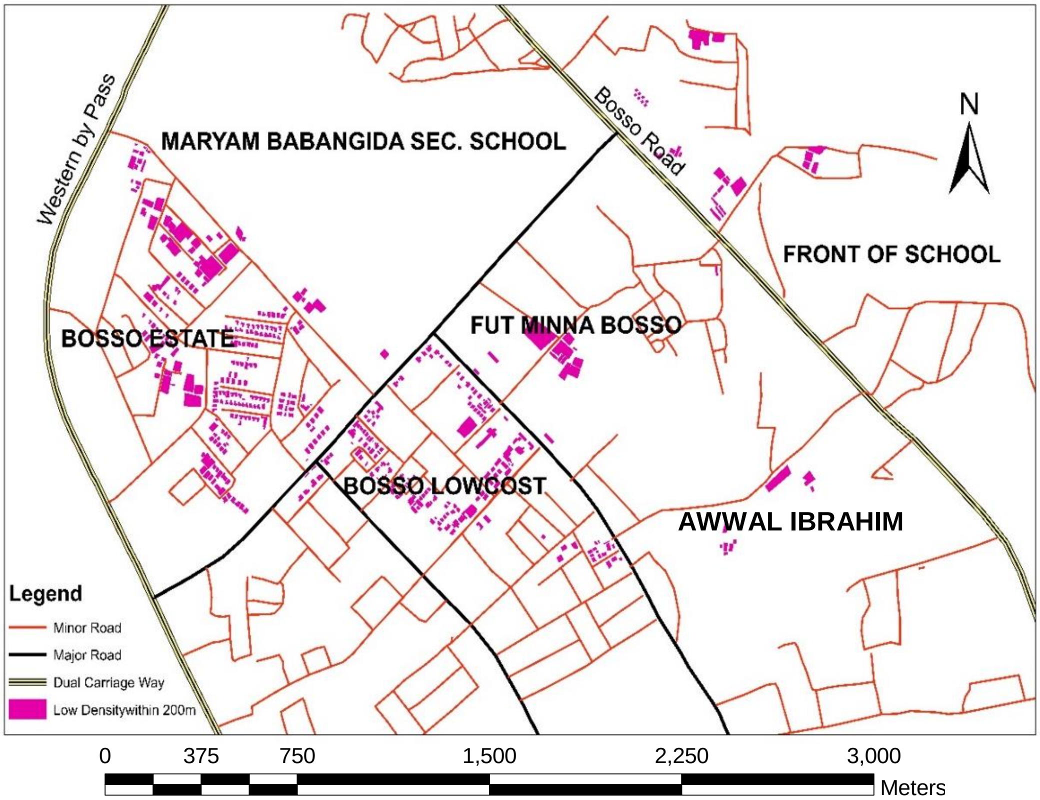
SCALE:-1:10,000

Figure 3: Overlay of buffers rings on Low and high density buildings.



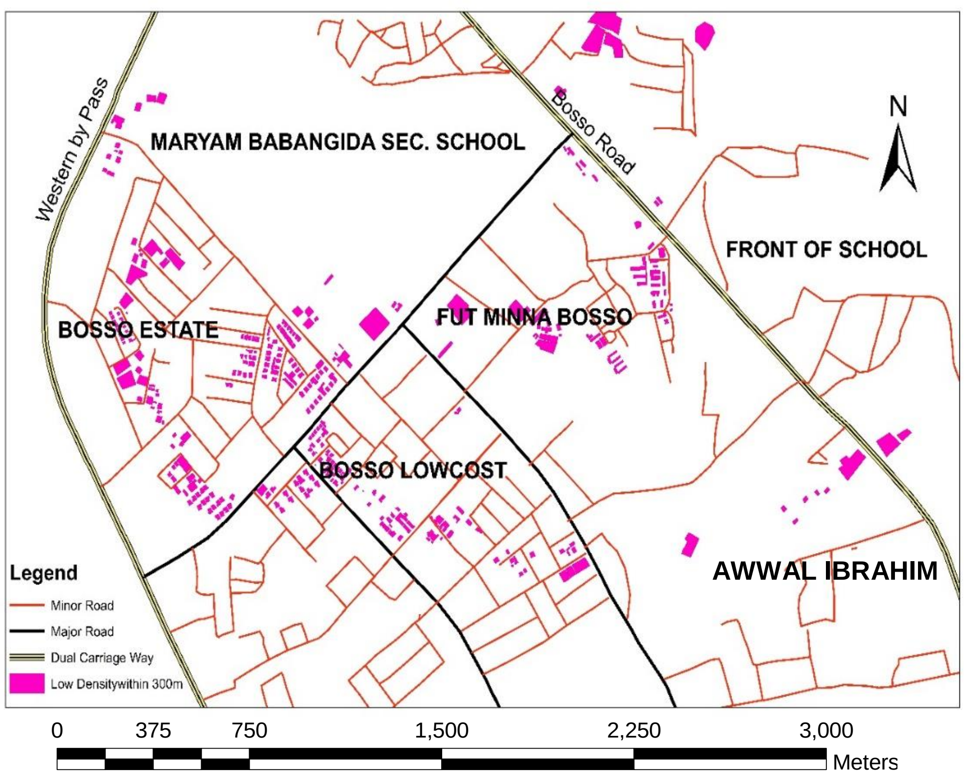
SCALE:-1:10,000

Figure 4: High vulnerability to disease spread buildings within 100metres buffer



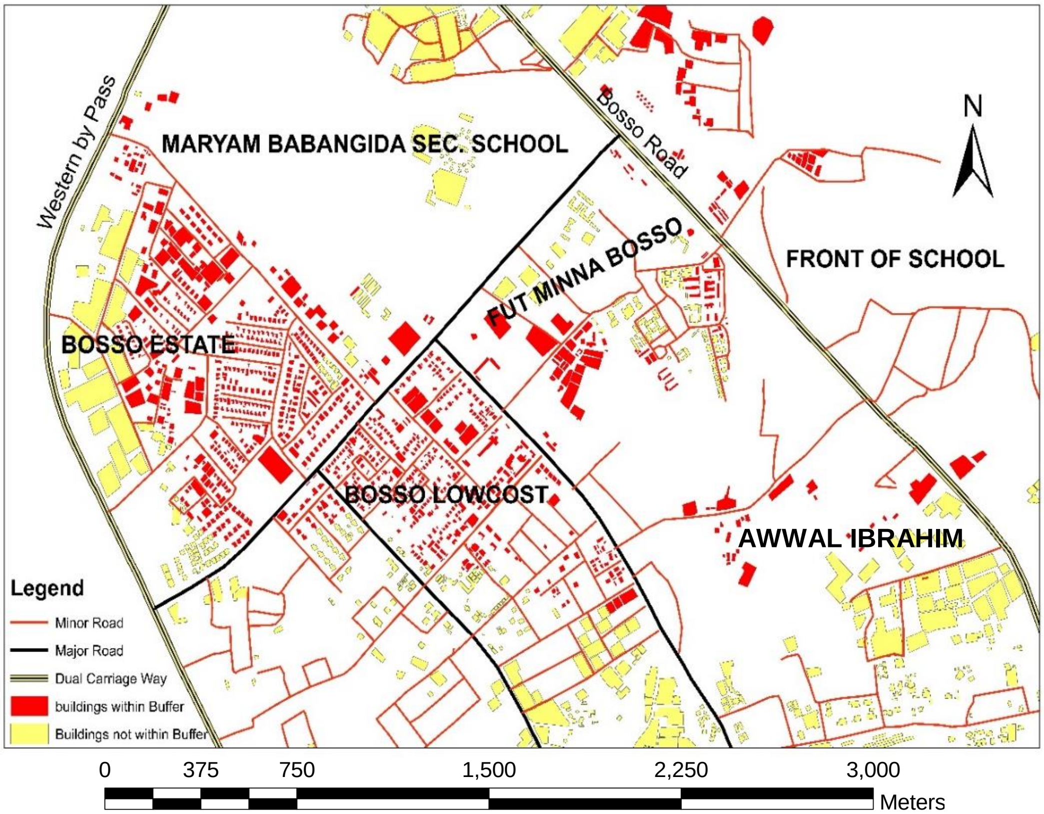
SCALE:-1:10,000

Figure 5: Moderately vulnerable to disease spread buildings within 100 to 200 metres buffer



SCALE:-1:10,000

Figure 6: Low vulnerable to disease spread buildings within 200 to 300 metres buffer



SCALE:-1:10,000

Figure 7: Building within area vulnerable to disease spread in red and building outside areas vulnerable to disease spread in yellow.

DISCUSSION OF RESULTS

The study area for this research work has been subdivided into five segments namely: Bosso Estate, Bosso Lowcost, Front of FUT Bosso campus, Awwal Ibrahim and FUT Bosso campus. A total of 56 dumpsites were located and mapped I the study area as shown in table 1. Front of FUT Bosso campus has the highest number of dumpsites as 24 points while non was recorded in FUT Bosso campus. Bosso Estate and Awwal Ibrahim areas had 12 points each and 9 points were located in Bosso Lowcost. From the satellite image it can be seen that Front of FUT Bosso campus and Awwal Ibrahim are areas of high density buildings with 42.9% and 21.4% of dumpsites respectively.

Table 2 shows the number of low density houses that are vulnerable to diseases as a result of proximity to dumpsites. It was not possible to count the houses in high density areas, therefore, they were digitized as clusters of buildings. As a result, carrying out spatial query of the houses in high density areas was not possible but the result of buffer analysis in Fig 3 clearly pointed out that the high density areas are mostly affected. This is because more than half of the total number of dumpsite exists in the high density region of the study area.

Also, It can be observed from Table 2 that about 61% of the total number of low density houses are within the vulnerable zone. 13.4% with about 240 houses in the high vulnerable zone, 26.6% with 475 houses in the medium zone and 20.6% with 369 houses in the low vulnerable zone. This work also revealed that 703 houses in the low density area are not vulnerable to diseases due to their proximity to dumpsites. That is, they are beyond 300m in all directions to any dumpsites within the study area.

From Figure 2, it was observed that open dumpsites are mostly found within the high density residential area which includes Bosso market, Mypa junction and London street area with a few spread across the medium and low density residential areas namely Bosso estate and Bosso Low-cost. This portrays a true reflection of the characteristics of such settlements. Also it can be seen that the Federal University of Technology, Minna (Bosso campus) and Maryam Babangida Secondary School are free from this menace. This implies that no dumpsite is cited within the school environment. The location of these dumpsites within the Bosso estate and Bosso low-cost residential areas are mostly along the existing streets. This could be as a result of the existence of an approved layout design prior to the construction of the estate and also because they are low density residential areas while from Bosso campus towards the north, east and south axis, It was noted that the dumpsites does not follow any definite or specific pattern. Their locations are based on any available space, probably because these areas lacked proper planning standards as shown in Figures 2 and 3. Figure 3 is an overlay of buffer operation around the dumpsites which shows the extent to which the residential buildings are affected with respect to the spatial distribution of open dumpsites. The result shows that the high density area (buildings) is mostly affected. Spatial query operation on low and medium density residential buildings was performed as shown in Figures 4, 5 and 6 but the query was not possible for high density because the buildings were digitized as blocks. The residential buildings with 100m buffer zone indicates highly vulnerable, the 200m buffer zone and 300m buffer zone are termed moderately and low vulnerable respectively to the spread of diseases such as cholera, typhoid fever, diarrhoea and malaria as a result of proximity to dumpsites. From recent disease outbreak on Lassa fever in Nigeria, open waste dumps in residential areas are also convenient places for the breeding and survival of rodents (Niger State Ministry of Health & Health Services, 2016) especially the Lassa fever proliferating Multi-mamatte rats. In figure 7, the research reveals that over 50% of the residential buildings in the study falls within the 100m, 200m and 300m buffer zone which represents high, moderate and low vulnerability respectively. The central and north eastern region of the study area are mostly affected from the buffer operation while the extreme areas are spotted as safe zones in the study area. This indicates that the existence of open dumpsite around the central and the north east regions is on the high side which was also observed to be increasing sporadically so much that if nothing is done to curb the incessant increase urgently, more than 50% of the areas denoted as safe regions will be affected very soon. This is because major cities and urban centres in the world today are faced with a global challenge (population pressure) and Bosso-Minna is not an exception. Therefore, it is a clear warning to the residents and the government of Niger state together with other relevant authorities to look critically into some of these health related issues that could serve as windows to the breakdown of epidemics since the environment is gradually getting affected.

CONCLUSION

This research was carried out by evaluating the spatial distribution of open dumpsites and their effect on the residents in Bosso-Minna, Niger State, Nigeria. The research looks at the distributions of open dumpsites within urban areas of Bosso-Minna where population pressure is high. The spatial analysis carried out, based on the buffer zones generated shows the proximity of the buildings in Bosso-Minna and how likely they are to be exposed to epidemics related to dumpsites such as Cholera, Malaria, Typhoid, Dysentery and many others. The central and north east zones are the most affected areas while the extremes are still safe as at the time of this research work.

The research proceeds to discuss the usefulness of GIS as an indispensable tool for proper decision making, planning and implementation of policies by the Government or relevant authorities.

RECOMMENDATIONS

1. Awareness campaign on the effect of open dumpsites

As stated in this research, one of the reasons of dumping refuse or waste in open areas in Bosso-Minna might be their Ignorance of the health risk associated with open dumpsites and illiteracy rate. Therefore, in recognition of this problem, it is very important for the residents of Bosso-Minna to be educated on this issue in order to be able to combat the and eradicate the epidemics that is posing great threats to the human health and the environment. This can be achieved by creating an awareness programme for the people, enlighten them of the effects and how it can be eradicated.

2. Sanitary landfill site selection

As it has been discovered and discussed in this research, open dumpsites are the common methods of waste disposal in Nigeria from which Bosso-Minna is not exempted. This study suggest sthat a suitable landfill site for waste disposal in an environmentally friendly area be created, considering the factors and constraints for this selection.

3. Evacuation of the existing open waste dumps

This research also recommends that, the Government through relevant authorities should immediately clear all the open dumpsites in the locality and replace them with waste transfer containers like open drums or trailers in strategic locations considering also the walking distance of users.

REFERENCES

Abul, S. (2010) 'Environmental and Health Impact of Solid Waste Disposal a Mangwaneni Dumpsite in Manzini: Swaziland'. *Journal of Sustainable Development in Africa* 12 (7), 64-78

Aderoju, O. M., Salman, S. K, Anjoye, S., Nwadike, B., Jantiku, J., Adebowale, R. K., Fagbemiro, O. A., Agu, N. V. (2014). A Geo-Spatial Approach for Solid Waste Dumpsites for Sustainable Development in Minna, Niger State, Nigeria, *IOSR Journal of Environmental Science, Toxicology and Food Technology (IOSR-JESTFT) e-ISSN: 2319-2402,p- ISSN: 2319-2399.Volume 8, Issue 10 Ver. I (Oct. 2014), PP 16-28 www.iosrjournals.org* www.iosrjournals.org

Aljaradin, M and Persson, K. M. 2012. Environmental Impact of Municipal Solid Waste Landfills in Semi-Arid Climates - Case Study – Jordan, The Open Waste Management Journal, 2012, 5, 28-39

Bartlett, S. (1999) 'Children's experience of the physical environment in poor urban settlements and the implications for policy, planning and practice'. *Environment and Urbanization*, *11*(2), 63-74.

Benedine, A., Robert, T., and Abbas, I. (2011) 'The Impact of Spatial Distribution of Soild W Aste D Umps On Infrastructure in Samaru, Zaria, Kaduna State, Nigeria, U Sing G Eographic Information Systems (GIS)'. *Research Journal of Information Technology* 3 (3), 113-117

Briggs, D. J. and Elliott, P. (1994) 'The use of Geographical Information Systems in Studies on Environment and Health.'. *World Health Statistics Quarterly.Rapport Trimestriel De Statistiques Sanitaires Mondiales* 48 (2), 85-94

Cheeseman, C.R., Imam, A., Mohammed, B., Wilson, D.C., (2007) 'Solid waste management in Abuja, Nigeria'. *Waste Management*, 28(2008) 468-472

Daniel, H. and Laura, T. (1999) 'What a Waste: Solid Waste Management in Asia'. *Washington DC*

Ebenezer A. (2012) 'Minna Communities Dare Epidemic Outbreak Live Amid Stench From Pigs' Dung, Pile Of Refuse'. *Saturday tribune newspaper* [online] 18 August. Available from <http://tribune.com.ng/sat/index.php/environment-watch/8281-minna-communities-dare-epidemic-outbreak-live-amid-stench-from-pigs-dung-piles-of-refuse.html> [26 December 2015]

Hansen, J., Nazarenko, Larissa., Ruedy, R., Sato, M., Willis, J., Del Genio, A., Koch, D., Lacis, A., Lo, K., Menon, S., Novakov, T., Perlwitz, J., Russell, G., Schmidt, G. A. and Tausnev, N (2005). A slippery slope: How much global warming constitutes "dangerous anthropogenic interference"? Climatic Change 68(3): 269-279.

Joseph, K., Nagendran, R. and Visvanathan, C. 'Sustainable Approach for Management of Dumpsites in Asia'

Mohammed , A.S. and Chukwuma, G.O. (2011) 'Strategy for Remediating the Impacts of Solid Wastes on soil and Groundwater Quality in Minna, Nigeria'. *Journal of Innovative Research in Engineering and Science,* 2(3), 173-184

Musa, A., Oladiran, J. A., Ezenwa, M. I., Ogbadoyi, E. O., & Akanya, H. O. (2011) 'Effect of fruiting on some micronutrients, antinutrients and toxic substances in Corchorus olitorius grown in Minna, Niger State, Nigeria'. *African journal of food science*, *5*(5), 411-416.

Nakakawa, A. and Ogao, P. (2007) 'A Spatial Decision Support Tool for Landfill Site Selection'

Nubi, O., Ajao, E. and Nubi, A. (2008) 'Pollution Assessment of the Impact of Coastal Activities on Lagos Lagoon, Nigeria'. *Science World Journal* 3 (2)

Nwaka, G. (2005). 'Planning sustainable cities in Africa'. *Canadian Journal of Urban Research*, *5,* 119-136.

Oluwafemi A, O. (2009) 'GIS-Based Assessment of the Potential Risk of Landfill Sites on their Surrounding Environment using Aba-Eku Landfill Site-Ibadan as a Case Study'. *Roczniki Geomatyki [Annals of Geomatics] Selected Full Texts* 7 (2), 113-119

Oresanya, O. (2010). 2nd Summit on Climate Change (2010) Expo Hall, Eko Hotel And Suites, Victoria Island 5th – 7th May 2010

Parker, E. and Campbell, J. (1998) 'Measuring Access to Primary Medical Care: Some Examples of the use of Geographical Information Systems'. *Health & Place* 4 (2), 183-193

Remigios, M. V. (2010) 'An Overview of the Management Practices at Solid Waste Disposal Sites in African Cities and Towns'. *J.Sustain.Dev.Afr* 12 (7), 233-239

Saidu, M. (2011) 'Effect of Refuse Dumps on Ground Water Quality'. *Advances in Applied Science Research* 2 (6), 595-599

Sever, L. E. (1997). Environmental contamination and health effects: what is the evidence?. *Toxicology and industrial health*, *13*(2-3), 145-161.

Su, G. S. (2005) 'Water-Borne Illness from Contaminated Drinking Water Sources in Close Proximity to a Dumpsite in Payatas, the Philippines.'. *Jrtph* 4, 43-48

United States Environmental Protection Agency (2002), Solid Waste and Emergency Response, May, 2002, www.epa.gov/globalwarming.

ASSESSMENT OF STORM WATER DRAINAGE SYSTEM IN SELECTED HOUSING ESTATES IN MINNA NIGER STATE.

Dauda Abubakar Dada[1], Shuaib Iklimah[2], Makun Christopher Sunday[1], Nasiru Salihu[3]
1 Department of Building Technology. Niger State Polytechnic, Zungeru[1].
2 Department of Architecture. Federal University of Technology Minna Niger State[2].
3 Department of Estate Management and Valuation. Niger State Polytechnic, Zungeru[3]

Housing estate is the agglomeration of residential buildings with recreational facilities and services like good roads and storm water drainages. Therefore the role of storm water drainage system in the design and construction of housing estate cannot be under estimated, because poor storm water drainage system leads to destruction of building and discomfort to human movement. This paper examined the effect of storm water drainage systems in selected housing estate in Minna. Data were collected through Questionnaire administration and observation schedule to ascertain the effect of poor storm water drainage in the selected housing estate. Analysed data revealed that destruction caused by poor storm water drainage systems include flash flooding, soil erosion which exposes building foundation, destroyed road that discomfort movement of occupants. It is therefore recommended that storm water drainage and road should be constructed before building construction and in the design and construction of drainage system, the professionals involve should consider the relief of the land and also the slope of the drainage.

Keywords: *Drainage Systems, Housing Estate, Minna, Storm Water.*

abudada4real@gmail.com
chartwithkily@yahoo.com
makunkris@yahoo.com

Dauda et. al. (2016 **ASSESSMENT OF STORM WATER DRAINAGE SYSTEM IN SELECTED HOUSIN G ESTATES IN MINNA NIGER STATE** Sustainable Built Environment and Climate change; The challenges of P ost 2015 Development Agenda. School of Environmental Technology Conference, SETIC, 2016

INTRODUCTION

Surface storm water runoff has being a major problem for housing developers and Government regulatory bodies, and good management practices will enable the drainage systems to allow the flow of storm water which will avoid flooding, damages to external building walls, improve the quality of life of the inhabitant and prevent the soil erosions .The climate across the country aids the deterioration of building materials particularly those used in the facades as there is need to extend the lifespan of these external building finishes because of the economic, health, aesthetic and structural problems being experienced by the occupants of the buildings (Aluko**,** and Olanipeku, 2013).Urban drainage systems, for the control of impermeable surface storm water runoff, represent a particular issue for developers, regulatory agencies, and water service companies given the increasing pressure to achieve sustainable drainage solutions. Brook (2008) outlined some solutions to home moisture problems and they included: adequate drainage around the house; repair and redesign of rain water downpipes; checking and replacing all leaking pipes; ceasing all moisture generation activities in buildings like cooking without lids, drying of wet clothing indoors, etc. Most of these methods proved to be effective in addressing some dampness problems like condensation and water penetration, however, where the problem originated from other sources such as rising dampness, other methods were needed to assist in the remediation action (Brook, 2008).Flood is essentially attributable to two major causes, namely: climatological and anthropogenic factors. The climatological aspect has to do with heavy and prolonged rainfall. The anthropogenic causes of flooding are Traceable to man's interaction with his environment in the form of urbanization, agricultural activity and deforestation. In most urban areas, the major cause of flooding is anthropogenic. (Gabriel Fadairo. 2013) The disruption, damage to properties, loss of possessions, as well as financial worries and other stresses from living in damp houses mean that flood events can place a considerable strain on households'. In a nutshell therefore, flooding can lead to a variety of problems including loss of lives, properties and livelihood. Flood victims, after being rendered homeless, assume the status of environmental refugees, and resides in squalid or makeshift accommodation. (Parkinson (2003)

STORM WATER AND EXTERNAL BUILDING WALLS

External building walls finishing may not function the way it should, therefore it will not provide the required functions for the probable time due to exposure to harsh environmental conditions, poor management, and insufficient quality of finish material, biological agents, wind and soil erosion and with time, external wall finishing and building foundations will be experiencing deterioration and will destroy their aesthetics and functionality of the building. With time, the deteriorating effects will increase and begin to show on the paint, texture and conditions of external finishes. .Biological mechanisms, many different biological factors have been found to be important. Growths of lichens, mosses, algae, mould, fungi and bacteria are capable of promoting surface deterioration. Some bacteria can synthesize sulphuric (or nitric) acid from airborne sulphur dioxide (or nitrogen oxides), dissolves the unstable formations of a material through further mineralization. Various chemical materials make new, weaker and easily washable products, which after the evaporation of water form deposit crystals of various volumes, form and origin (Aluko and Olanipeku, 2013). These crystals enter the walls through pores and capillaries and destroy the surface of enclosures and spoil its appearance. Material degradation and loss of characteristic properties, as described by the performance of function, in the course of time in most cases occurs due to chemical or physical deterioration (Haneef and johnson, 1999). Natural weathering is essentially a cyclic phenomenon also involving the wetting and drying of the surface. The detrimental effect of air pollutants on building materials has been recognized for a long time and still causes major concern (Johannson, 1990).

STUDY AREA

The research was conducted in Minna town, the capital of Niger state, Nigeria. The town is in the North central part of Nigeria. Which lies on longitude 9^o 33 North of the Equator and latitude 6^o 33 East Greenwich Meridian. On geographical bed of undifferentiated basement. Minna town is an ancient Gbagyi town that has witnessed a rapid growth of urbanization as it's the state capital, local government headquarter , presence of Federal University of Technology, National Examination Council headquarters which aid in increase in population, in recent years. Poverty in Niger state is high with most people living in congested and unhealthy conditions, where sewage and refuse management are lacking. The roads that lead to the town are narrow and in some cases the roads are bad. Which also lack drainage channels and refuse disposals. This makes the town prone to high level of flooding in the town.

The study areas were selected housing low-cost housing estate build by Niger state government, which are mostly 3 bedroom and 2 bedroom bungalow build with sand create block to solve housing problem to civil servant in Niger state.

Map showing Minna.

RESEARCH METHODOLOGY

Information or data was obtained from both primary and secondary source. Primary data was obtain by personal observations, camera and questionnaire administration for collecting basic data from selected housing estate in Minna. Further relevant data and information related to the study were obtained from secondary sources such as government agencies providing additional information different from the field study, books, maps, theses, texts, journals, libraries and visits to websites. The research was carried out during the raining season between the month of July and august, because that is the critical time were most of the buildings are been affected by storm water.

DISCUSSION OF RESULT AND ANALYSIS

Securely said, based on observation one of the major problems facing minna metropolis is storm water runoff as a result of poor storm water drainage systems. Even the so called government reserve area (GRA) has no proper drainage systems, so there is no distinctive deference between the urban areas and the slum areas in terms of drainage facilities. Most of the areas lack drainages or the drainages are not proper maintain or manage, as it is either blocked by refuse disposals or vegetation growth. The table below shows the effect of damages Couse by storm water runoff in the study areas.

Table 1: damages caused by storm water on buildings in study areas.

Housing Estate	Exposure Of Fundation	Decay Of Wooding Material	Micro Growth	Stain	Peeling & Flaking	Paint Fading
Wushishi Estate	80%	75%	70%	70%	85%	65%
Talba Estate	70%	70%	65%	60%	70%	60%
Bosso Lowcost	50%	55%	50%	50%	55%	50%

Source: Authors field work (2015)

The table above shows the percentages of major effect caused by storm water due to lack of storm water drainage system or poor maintenance of the drainage systems.

Exposure of Foundation: this is one of the major problems observed during the field survey at all the study areas, about 60 to 80 per cent of the study areas have the issue of exposed foundations. Storm water runoff washes away the top soil gradually, the water runoff moving at the edge of the walls wash away the soil which overtime exposed the foundation. And also the topography of the soil were some of the buildings are situated makes it difficult for storm water to flow into the drainage system, which settle around the buildings and could gradually exposes the foundations.

Fading And Peeling Of Paint. It was revealed that storm water destroy paints, paints cannot stay and dry for long period of time when the walls are damp or moist. The moisture stick on the walls makes it impossible for the paint to last for a long time, the moisture in the walls keep weakening the adhesive chemical properties of the paints to fade or peel in the case of oil paints.

Flaking or Peeling Of Walls. 70 to 80 per cent of the walls in the study areas, due to the excessive dampness of the walls which leads to the peeling of walls. The storm water courses dampness which gradually destroy the chemical properties of the cement and makes the walls to flakes. These become more severe when the blocks are being exposed, as it may lead to cracks of walls and destructions of aesthetic of the building.

Algae Growth. Algae developed in about 70 to 75 per cent of the walls in the study areas, this is cause by storm water as a result of lack of drainage systems. Because of improper drainage systems the storm water creates its route and may settle at the surrounding of the building. This leads to the growth of algae on the walls which also the aesthetic qualities of the building.

Stains. Stains are one of the most common features found in the walls of the study areas, which is either caused by the intensity of sunlight duration that surface walls receive could affect the walls. Stains can also be caused by storm water, Storm water runoff moves with some particles and diet which could stain the walls.

Decay of Woods. Some part of the building made of woods like the celling noggin, facial board etc, easily get destroy or decay by storm water, these happen when there is dampness on the walls the dry woods attach to the damp walls get wet most times.

Table2.: Users Perception On Day Light In Some Office Spaces In Minna.

Study Areas	Refuse Disposals	Presence Of Drainage	Type Of Drainage	Conditions Of The Drainage
WUSHISHI ESTATE	Drums	Insufficient	Rumbles	Blocked By Vegetation
TALBA ESTATE	Drums	Insufficient	Rumbles & Block	Blocked By Vegetation
BOSSO LOWCOST	Drums	Insufficient	Block	Blocked By Vegetation

Source: Authors Field Work (2015)

Drainage systems made of rumbles which is mostly used in the study areas has more disadvanges than that of the concrete drainage, Rumble drainage allow for the growth of grasses or vegetation that prevent the storm water from flowing in the drainage. These are as a result of the rumbles which are used in constructing the drainages may have seeds, through which it can easily germinate as storm water flown.

In some cases the rumble and block drainages are not smooth like the concrete drainage when water flows with some sand particles which serves as a bed for grass to grow in it, these vegetation makes storm water not to flow very well. The rough surface of block and rumble drainages has a lot of issues concerning easy flow of storm water, storm water find in difficult to move domestic waste if dump in drainage.

It was gathered from my observation that the major factor that causes of flooding in this study areas are poor drainage and management. It was also that in most parts of the study areas, drainage channels were either not sufficiently provided, or were blocked by domestic refuse dump. Water from residential areas could not flow to drainage channels because of blockage.

Table3. Users Perception On The Problem Of Storm Water Runoff In The Study Area.

.

HAVE YOU EVER ENCOUNTER PROBLEM(S) DUE TO STORM WATER RUNOFF IN YOUR BUILDINGS.			
RESPONDANT 100	YES	NO	NOT RESPONDENT
MI WUSHISHI ESTATE	40	10	3
TALBA ESTATE	30	15	2
TOTAL	70 (70%)	25 (25%)	5 (5%)
DO STORM WATER RUNOFF DISRUPT ANY CIVIC ACTIVITIES IN YOUR AREA			
RESPONDANT 100	YES	NO	NOT RESPONDENT
TALBA ESTATE	55	0	6
MI WUSHISHI ESTATE	45	0	4
TOTAL	90 (90%)	21	10 (10%)

Source: Authors Field Work (2015)

The table above shows responses to questionnaire administered from household at the study areas. The civic activities include movement of residents by leg or by vehicle to work, market or school. The finding indicated that storm water runoff obstructed vehicular movement more significantly; individual residents find a way of gaining accessibility to major roads in and out of the estate.70% respondents agreed that storm water runoff disrupt their activities. However 25% respondents who disagree with the fact that storm water disrupt their activities, while 5% respondents refuses to answer the questions.

The table also show questions and responses by the resident on their buildings, due to the storm water runoff as a result of insufficient drainages in their area. These problems may ranges from collapse of buildings to exposure of foundations, flake and peeling, paint fading and cracks. 80% of the respondents claimed that they were suffering structural fitness of their building. In this questions none of the respondent claim not to have any issue with their building at a result of storm water runoff, while 10% refuses to responds to the question.

CONCLUSIONS

The need for the creation of good conducive and functional environment required in the production of Action Plans in the improvement of housing characteristic in minna. It is expected that all professionals in building industries should work together in other to actualize the aim of a projects. This would help in preventing further deterioration of the building settlements and making the area conducive and hygienic.

RECOMMENDATIONS

The report in this paper shows that there is insufficient drainage facilities are either blocked by refuse or vegetation, and also some of these drainages are not constructed properly. Therefore some recommendations were made to drastically reduce to the level of destruction made by storm water in buildings.

I. Proper maintenance of the drainage should be made, and also sanction to be imposed on anybody found dumping refuse illegally.
II. There should be proper checking of the relief, topography and nature of the soil in the construction of drainages.
III. The professional should not considered only the storm water but also domestic water in the design of drainages. of the drainages like cleaning of the drainage
IV. Drainage should be constructed with reinforced concrete, because it has more advantages than others and grasses hardly grown in it.
V. Estate developers to encourage in developing site and services before construction of the buildings, there is usually problems of levels between the road, drainage and the floor level of the building. Most times the street and drainage are higher than the d floor of a building and its surrounding, this makes it difficult for water to flow into the drainage.

REFERENCE

Aluko, O. & Olanipekun, O. (2013)**.** Assessment of External Building Finishes: A Case Study of Selected Buildings in Akure, Ondo State, Nigeria. *International Journal of Engineering and Technology*. 3, 5.

Brook, D.M. (2008), "Home moisture problems", Minnesota Extension Service, University of Minnesota. Retrieved from http://extension. oregonstate.edu/catalog/.

Gabriel, F. (2013). An Empirical Evidence to the Urban Storm Water Crisis and the Way out in Akure, Nigeria. *European International Journal of Science and Technology*. 2, 5.

Haneef, S. Dickinson, C. & Johnson, J (1999). Effects of Air Pollution on Historic Buildings and Monuments and the Scientific Basis for Conservation, Corrosion and Protection Centre, University of Manchester. Report on a Research Project Supported by the Commission of the European Community.

Johannson, L (1990). Synergistic Effects of Air Pollutants on the Atmospheric Corrosion of Metals and Calcareous Stones. *Marine Chemistry.* 30(1), 13 – 122.

Parkinson, J. (2003). Drainage and Stormwater Management Strategies for Low-Income Urban Communities. *Environment and Urbanization.*.15(2) 115-126.

INTEGRATION OF ORGANIC SOLID WASTE RECYCLING FOR IMPROVING THE ENVIRONMENTAL SUSTAINABILITY OF HOTELS IN MINNA, NIGER STATE, NIGERIA.

OTOMI Peter
Department of Architecture, Federal University of Technology, Minna, Niger State, Nigeria.

Organic solid wastes are wastes that are generally biodegradable and decompose in the process that emits offensive and irritating smell when left unattended. The production of organic solid waste in vast quantities has become a major challenge on environmental sustainability as it is mostly used for landfill purposes. The decomposition of these wastes generates greenhouse gas and increases the production of leachate which causes environmental pollution. Therefore, the aim of this research is to assess the impact of organic solid waste on the environment. In achieving the aim of this research, data was collected randomly from hotels in the three senatorial district of the state with the use of observation schedule as well as close ended questionnaires. The results obtained show how indiscriminate dumping of solid organic wastes contaminates the environment. The findings explore the weak system of management by concerned bodies however; adequate proposals will be made to diminish the impact of greenhouse gases and improve the sustainability of the environment.

Keywords: *Organic, Solid Waste, Environment, Sustainability.*

tuk2pita@gmail.com

OTOMI Peter (2016). **INTEGRATION OF ORGANIC SLOID WASTE RECYCLING FOR IMPROVING THE ENVIRONMENTAL SUSTAINABILITY OF HOTELS IN MINNA, NIGER STATE, NIGERIA.** Sustainable Built Environment and Climate change; The challenges of Post 2015 Development Agenda. School of Environmental Technology Conference, SETIC, 2016

INTRODUCTION

Environmental sustainability means the ecologically beneficial actions such as waste reduction which contributes to using resources in more prudent ways thereby minimizing ecological footprints. The volume of solid waste being generated is on a faster rate than the resources to contain it. The volume of organic solid waste generation varies in terms of places and different times annually. According to Oresanya (1998), waste is any unwanted material intentionally thrown away for disposal. Gordon (2005) stated that organic wastes generated from hotels (commercial source) and can be categorised into two;

1. Biodegradable (Food, Kitchen wastes like meat trimmings, vegetable peelings, yard or green waste, paper).
2. Recyclable materials (Glass, plastic bottles, metals, aluminium can)

According to Cointreau-Levin (1997), the dense and humid nature of organic solid waste is due to the extensive consumption of unpacked foods as well as fresh fruits and vegetable. The generation of waste has grown steadily and is expected to increase as time goes by especially in the developing nations because of growth in population size and GDP (IPCC, 2000 cited in Nabegu, 2011). For environmentalists, waste is a kind of object that can have negative impact on the environment (Alam & Ahmade, 2013). Solid organic waste is recognized as an important organic matter resource and has numerous beneficial attributes. However, when sent to landfills, it generates greenhouse gas emissions and can create huge nuisance (Municipal organic waste processing, 2013). Organic solid waste management has posed series of challenges to development across the state. Inadequate expertise, equipment, weaknesses of waste management policies are some of the reasons for poor waste management (Olukanni, 2014). On the other hand, Adewole (2009) argues that poor management and indiscriminate waste dumping is due to poverty and poor level of orientation on environmental awareness. It is unfortunate that despite the various strategies employed and investments by concerned bodies on managing these wastes, little or no quality improvement have been made; however, inadequate orientation is also a contributive factor to this challenge. Hence, frequent dumping of waste on open fields drainages, and roadsides has become the means in which rodents, insects and flies are attracted thus, posing serious environmental hazards to residents. Abila and Kantola (2013) acknowledge that this indiscriminate dumping of waste is a threat to environmental sustainability as it causes pollution. According to Medina (2002) the major models of disposal of solid waste are landfilling or dumping and incineration. It can be said that management of waste in most parts of the state is not a top priority which is a major challenge with the growing population of the state; it is therefore imminent that the volume of waste to be produced will increase with limited infrastructure to contain it. According to Babayemi and Dauda (2009) the challenge of waste management is as a result of the poor collection technique adopted by concerned bodies and the limited coverage area. Afcon (2003) went further to state that the waste collection system is dependent upon the people in an area, the method with which they store their wastes and placing them in strategic location for collection.

IMPACT OF ORGANIC SOLID WASTE ON THE ENVIRONMENT

The environmental impact of organic waste is contamination. When organic wastes which are used for landfills are compressed and breaks down without oxygen, it produces acid which when mixed with plastic items creates a toxic mix which contaminates the lands. Wastes generated in developing countries contain a large percentage of organic materials usually three times more than industrialized nations (Oyelola and Babatunde, 2008). This results to higher volume of wastes. Commercial waste for this study will be defined as waste generated by the activities of hotel employees. Indiscriminate dumping of refuse contaminates surface and ground water supply (Alam & Ahmade, 2013). Greenhouse gases generate as a result of decomposition of organic wastes in landfills, and untreated leachate pollutes surrounding soil and water bodies (Alam & Ahmade, 2013). The term disposal means the discharge, deposit, injection, dumping, spilling, leaking or placing of any solid waste on land or water that such wastes may enter the environment or be emitted into the air or discharged into any waters including ground water (US law-solid waste Act 2, 1999). The current situations of waste decomposition along the streets of Suleja, in open fields and other parts of the state will most likely cause danger either on the short or long term to the environment in one or more of the following ways; Land pollution, air pollution and water pollution.

ENVIRONMENTAL BENEFITS OF RECYCLING ORGANIC SOLID WASTE

1. Greenhouse gas reduction. This is achieved when waste used as landfills are diverted into composting and undergoes controlled processing. (Municipal solid waste organic processing, 2013)
2. Composting. It is the harnessing the natural process of decomposition to transform organic materials (Paz, 2006). Materials that can be compost are vegetable and food scraps, papers etc.

The objective of this study is to;

a. Determine the influence of indiscriminate dumping of wastes.
b. Ascertain the causes of poor waste management plan.
c. Make adequate proposals for improved waste management policies.

RESEARCH METHOD

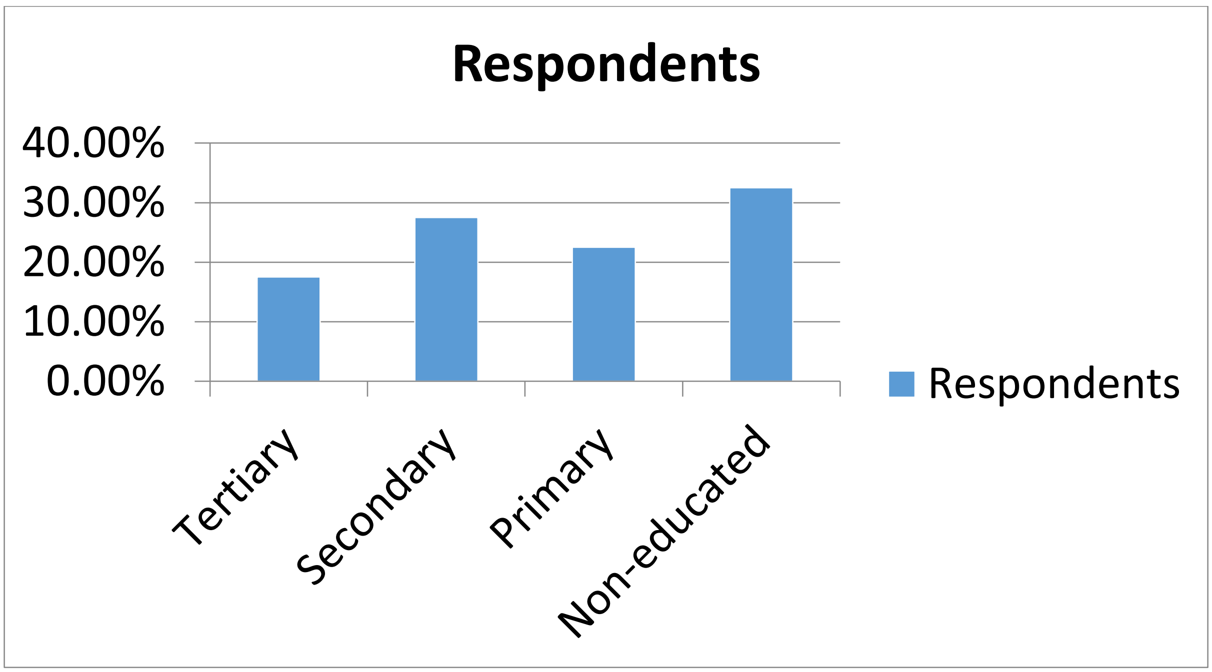
The study area for this research covers the three senatorial districts of Niger state. Data obtained were from primary and secondary sources. The primary data collection method employed to solicit information included the closed ended questionnaires, observation schedule in which dumpsites were visited, and personal interviews with staffs of the hotels and selected residents where these wastes affects. However, Secondary data used for this research includes published sources such as academic journals, books, educational websites and research conducted by others most of which are recent articles. Eight hotels were visited and the data was analysed with the use of bar charts in Microsoft excel.

SAMPLING TECHNIQUE

For the purpose of this research, the stratified random sampling was adopted as the research cuts across the state. Since the hotels visited are in different locations with different population size, this sampling method provides small margin of error with strong elements of validity in the data collected.

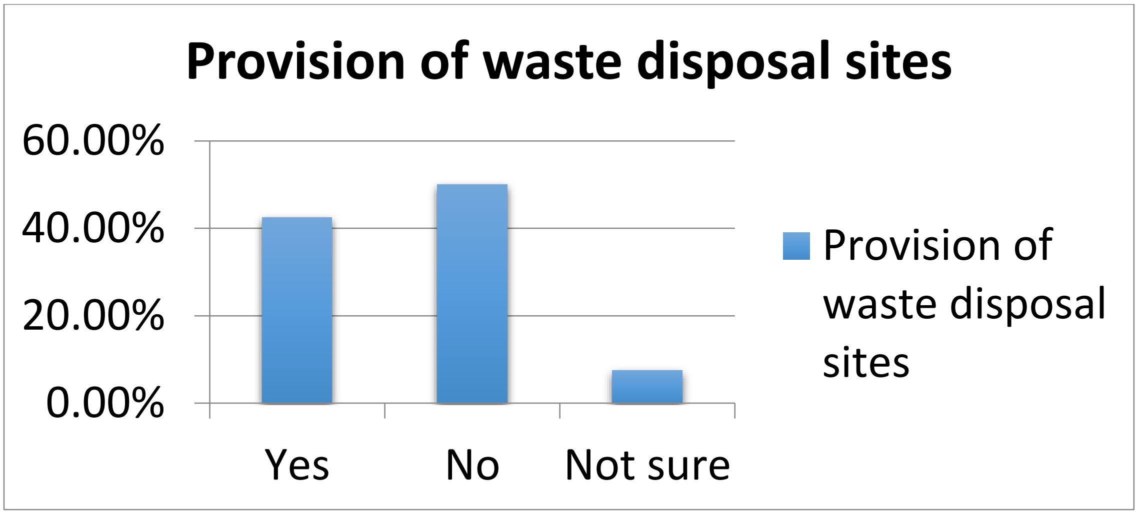
DISCUSSION AND RESULTS

In the course of the field work, the following hotels and its environs were visited; Alovera hotels, Agaie; Desert prince hotels, Bida; Gold touch garden hotels, Suleja; Had resource, Hotels; Hamson international hotel, Kontagora; Hydro hotel, Minna; Mac hotels and resorts, Suleja; Nothing pass God hotel, Shango.



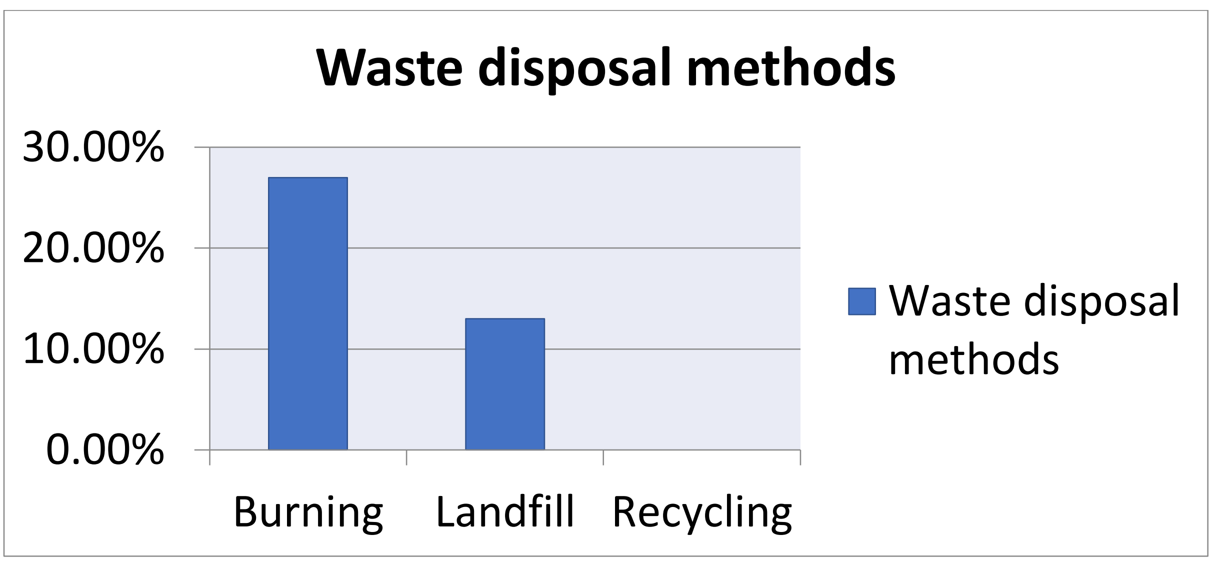
From 47 questionnaires that was administered, 40 was returned and from the chart above, it can be seen that about 18% attained tertiary education, secondary school leavers made up 28% of the population while those with primary school qualification is 5% less however, the uneducated dominates with over 30%.

Provision of Disposal Sites



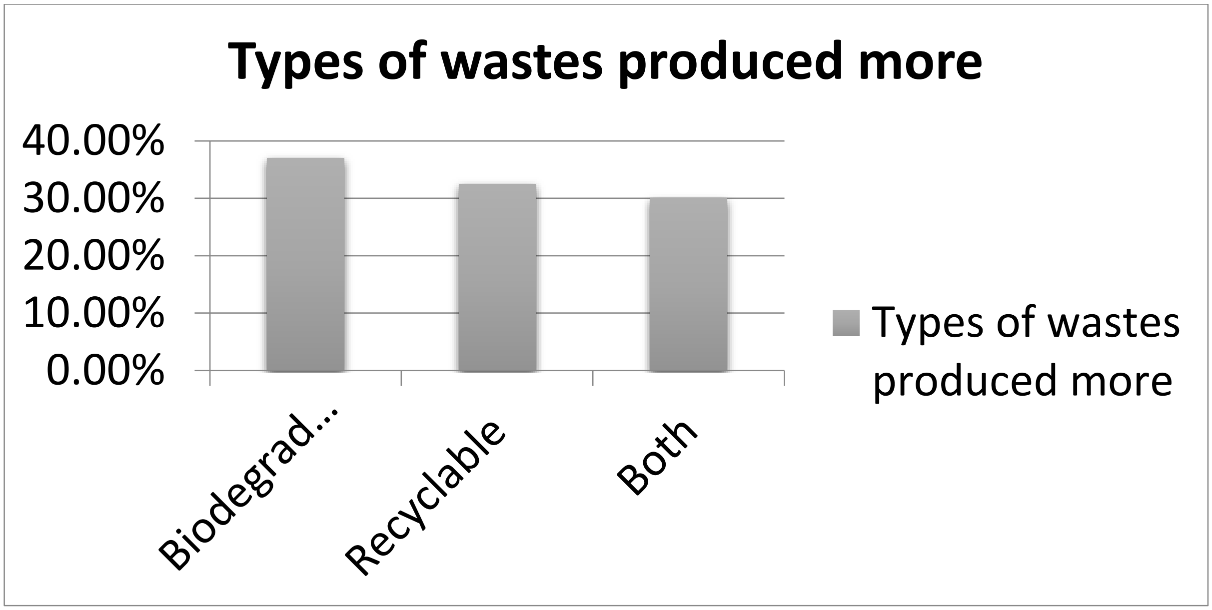
As reported in the chart, just over 40% agrees that spaces are provided which is contrary to half the entire respondents who believe that there are no dump sites, and less than 5% are not sure. From this findings, it can be argued that disposal sites exists however, reasons why they are not adequately used may be as a result of long distance to the sites, or poor orientation on the importance of dumping wastes at spaces provided and the negative impact it can have on the environment.

Waste Disposal Methods



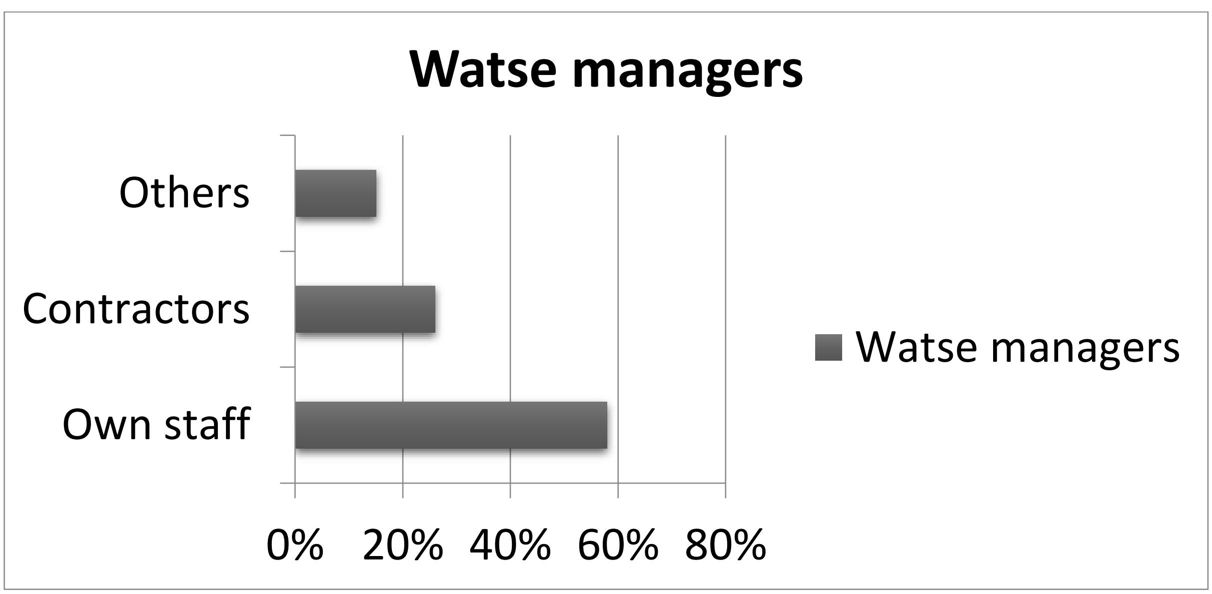
According to the reports in the charts, it indicates that over 25% of hotels engage in burning its wastes while less that 15% uses it for landfill purposes. However, none of the hotels visited practice waste recycling. It can be deduced from this result that contamination of the environment stems from the unhealthy disposal methods adopted by these hotels.

Types of Wastes Produced More



As reported in the Charts, It can be seen that the difference between the types of waste produced is roughly equal, as the biodegradable wastes is within the region of 35%, the recyclable is just over 30%. Another 30% of the respondents believe the both waste are produced at the same level. With the findings that organic wastes generated in developing regions like this is three times more than industrialized nations, one can understand the high level of impact these waste generated will have on the surroundings as they are not properly managed.

Waste Managers



Based on the result findings, it is obvious that Majority of the hotels are responsible for managing their own waste. Perhaps it is the reason behind the mismanagement. Nearly 60% of the hotels engage their own staffs for disposing wastes, about 25% make use of waste disposers on contract basis however, a few of them use other means. These findings automatically raises questions about the effectiveness of the environmental protection agency, or limited funds allocated to them may be responsible.

CONCLUSION

The research focus was on the environment. Considering the growth and development of the state, it is only reasonable to expect the extent of waste generation to increase and preventing it is almost impossible however, better waste management plan to reduce the impact of contamination can only be realised if there is a better understanding of the type of wastes hotels generate in order to strategize on appropriate collection and disposal methods. With the understanding that organic solid waste can undergo composting and recycling provides the opportunity to reduce or eliminate the environmental hazards that emanates from indiscriminate dumping. From the field results, it can be concluded that the state environmental protection agency does far less than expected as it is the hotels that are basically responsible for managing the wastes they generate.

RECOMMENDATIONS FOR BETTER WASTE MANAGEMENT PLAN FOR HOTELS IN NIGER STATE

1. Rather than providing a couple of drop off zones, several smaller drop-off zones within the reach of the hotels for collection provides convenience and discourages the use of waste for landfill purposes.
2. Comprehensive waste management system whereby, these wastes generated could either be composted or recycled should be implemented.
3. There is need for orientation of all stakeholders on the negative influence improper waste management can be to the surrounding environment.
4. The state government should make waste management a top priority by supporting the environmental protection agency (NISEPA) with adequate funding to curb this challenge.

REFERENCE

Olukanni et al..(2014). Appraisal for municipal solid waste management, its effect and resource potential in semi-urban city: a case study. *Journal of South Africa business research*, 2014(2014), 1-13.

Babatunde A.I. & Oyelola, O.T.(2008). Characterization of domestic and solid market wastes at source in Lagos metropolis, Lagos, Nigeria. *African journal of environmental science and technology*. 3 (12). 430-437.

Morelli, J (2010). Environmental sustainability: A definition for environmental professionals. *Journal of environmental sustainability*. 1 (2011). 20-27.

Ahmade, K. & Alam, P.(2013). Impact of solid waste on health and environment. *Special issue of international journal of sustainable development and green economics*. 1 (2). 165-168.

Koulidiati et al..(2013). Environmental impact of waste management deficiencies and health issues: A case study in the city of kaya, Burkina Faso. *Journal of environmental protection*. 4. 1080-1087.

Babalola et al (2010). The practice and challenge of solid waste management in Damature, Yobe state, Nigeria. *Journal of environmental protection*. 1. 384-388.

Nabegu, A.B. (2011). Solid waste and its Implications for climate change in Nigeria. *Journal of human ecology*. 34(2). 67-73.

Mshelia, S.S. & Butu, A.W. (2014). Municipal solid waste disposal and environmental issues in Kano metropolis, Nigeria. *British journal of environmental sciences*. 2(2). 10-26.

Paz E.B, (2006). Sustainable sorting, recycling and disposal of solid waste. *AU journal of technology*. 9(3). 133-138.

Bogner, et al (2007). Waste management, in climate change. Cambridge university press, Cambridge, United Kingdom.

Environment Canada (2013). Municipal solid waste organics processing.

ASSESSMENT ON REFUSE DISPOSAL TECHNIQUES IN HOUSING ESTATES OF MINNA, NIGER STATE

MORENIKEJI Fisayo Teniola, SALIHU Usman Tyabo,
NDAWASHI Bello Mohammed & OTIJELE Godwin Omachoko
Department of Architecture, Federal University of Technology, Minna, Niger State

The generation and handling of refuse from housing estates determines the sanitary and wellbeing of dwellers. The improper disposal of refuse in such environment increases the rate of outbreak of deadly diseases which also negatively contribute to climate change. Refuse burnt by fire pollutes the environment with toxic gases. These toxic gases are not only harmful to human but to the entire ecosystem. Greenhouse gases (GHG) from landfills, smokes from combustion of refuse contributes to the wearing away of the ozone layer which exposes the earth to direct ray of the sunlight. This direct ray of the sun heats up the earth and give adverse effects on the earth and its contents which causes rapid change in climatic conditions. The improper disposal of refuse also results in the fast degradation of buildings in both the rural and the urban environment. This study examines the efficiency of refuse disposal techniques and the short comings in housing estates of Minna metropolis. Observations, interviews and the use of questionnaires were used to obtain necessary information form the people in the environment. Four housing estate was randomly selected through picking from the hat method of sampling. Data analysis was carried out using the SPSS statistical software while Microsoft excel spreadsheet was used for the final output. The paper concludes by providing the best method of disposing refuse without intoxicating the environment. It also recommends the proper refuse disposal system and encourages the government to provide NISEPA with adequate facilities to enhance the efficiency of the agency.

Keywords *- Environment, Housing Estate, Pollution, Refuse Disposal, Waste Management*

fisayomore@gmail.com

MORENIKEJI et. al.(2016 **ASSESSMENT ON REFUSE DISPOSAL TECHNIQUES IN HOUSING ESTATES OF MINNA, NIGER STATE** Sustainable Built Environment and Climate change; The challenges of Post 2015 Development Agenda. School of Environmental Technology Conference, SETIC, 2016

INTRODUCTION

Refuse is any unwanted solid material usually ejected from man and animal habitation. Cambridge dictionary (2014) defines refuse as unwanted waste materials especially materials that is regularly thrown away from a house or factory. It is also seen as the collection items or materials that have been discarded. It could also be called discards, garbage, rubbish, trash or waste. The generation of refuse, disposal and management in Nigeria have constituted various environmental hazards in residential houses in urban centres in Nigeria. Improper disposal of refuse gives room for various diseases harmful enough to destroy the eco-system which consists of human, animals, plant and micro-organisms. The well-being of the terrestrial, aerial and the aquatic habitats are dependent on how well we get refuse disposed. Human endeavours are reasons why refuse is produced in most areas of human lives. Essential human activities such as agriculture, industrialization, construction, transportation, mining, household, medical, technology, are reasons for the production of waste products. The increase in the Nigerian population has contributed greatly to the increase of various human activities that leads to waste generation. (Olarinoye, Sharifat & Kolo, 2012). This increase of population gives rise to the construction of more residential buildings in which people live and carry out various activities that lead to the generation of refuse. The disposal of refuse in urban residential areas in Nigeria is very poor. Refuse is seen on the streets, rivers, illegal dump site and in drainages. The improper management of refuse block drainages and makes flowing water find its way to the roads and wash away the top soil to cause erosion. The blockage of drainages by refuse could also lead to flooding which results to loss of lives and properties. Chukuemeka, Ugwu & Igwegbe (2012). Refuse disposal in Nigerian cities as deteriorated such that waste management is one of the major environmental problems faced by the nation.

Terada (2012), Nigeria, like other third world countries has become a dumping ground for electronic wastes (e-waste), which are; used computers, electronics and other electrical appliances, cars, cell phones and machines. Ofudje, Alayande, Oladipo, Williams & Akiode (2014), Most of these used items, most especially electrical appliances are dangerous to human and the environment as a whole due to the content of heavy metals like lead (Pb) and mercury (Hg) in them. The disposal of the spoilt items has become a big problem in the immediate environment and the city at large. Urbanization and the day-by-day development of science and technology have also contributed to the accumulation of refuse in homes, offices and market places. This is because people want to be relevant in terms of technological advancement and need to be computer literate. They therefore look for a means of getting fairly used materials from other advanced countries because they are cheap and affordable and at the long run contribute to e-waste in their environment. In the quest of getting rid of refuse in residential houses, refuse is being burnt thereby causing air pollution which is harmful to living things in the environment, the ozone layer and also enhance global warming and climate change. Aguwa (2008), Hazardous gases like this in the atmosphere when inhaled by human into the lungs automatically blocks the lungs and could cause deadly illness. It also has adverse effect on buildings in such environment.

The study aims at enhancing sustainable urban development and climate change to make cities livable by getting rid of all the environmental hazards that could emanate from household refuse.

REFUSE DISPOSAL TECHNIQUES

Akindutire & Alebiosu (2013), refuse is any unwanted solid material usually ejected from human habitations. Refuse disposal is the process of getting rid of unwanted solid materials in the environment. The refuse disposal techniques are the method employed to take away refuse from other immediate environment.

To get rid of waste materials in the immediate environment, there are various method that can be employed, these are:

(1) Reduction from the main source.

(2)Recycling.

(3)Combustion\Burning.

(4)Landfill.

(5)Composting.

REDUCTION FROM THE SOURCE

The maximal usage of every material to reduce wastage is a good habit to cultivate. Philip & Walsh (1995), reduction from source reduces refuse products from the homes and it maximizes the use of money spent to purchase such item and at the same time minimizes unnecessary excesses. Ekanem, Ekanem, Eyenaka & Isaiah (2013), reduction from the source does not just reduce wastage but also reduces the amount of landfills and dangers that could emanate from such sites which is also a means of reducing toxic GHG (Greenhouse gas) emission. Tylor & Allen (2004), any unwanted material with a usable life span may therefore be given or sold to the needy or other people in need of such item. Organic wastes such as food, vegetables, from kitchens, restaurant and farms may be given out freely to avoid wastage and may also be used to feed animals. It is also advisable to buy good and long lasting materials such that when they are outdated, they can be reusable product and stand the taste of time.

RECYCLING OF WASTE (WASTE-TO-WEALTH)

The left over household refuse after being reduced to the barest minimum can be sorted out. The recyclable materials such as plastics and polythene, glasses, papers and metals can be separated from other forms of refuse. These materials are thereby used as raw materials in a recycling factories to produce new materials. Recycling of wastes employs people such as the refuse collectors, who sorts out waste products from house to house and convey the recyclable and reusable waste to the recycling factory. Sridhar & Hammed (2014), the recycling of waste to produce new product is referred to as ‘waste to wealth”. The amount of income generated by the refuse collectors is dependent on their negotiation power with the waste traders and the price offered by the waste generators in a situation where the refuse collectors purchase the waste product. (Egun 2012). In a situation when the waste product is free from the waste generator, the waste picker generates more income. This is the reason why the waste collectors prefer to patronize dump sites in search of free reusable and recyclable waste materials. The adverse effect of this is that, in the quest of earning a lot of profit, the waste pickers go out of their ways to steal properties from private premises.

COMBUSTION OF REFUSE

Johari, Mat, Hasim, Hassim, Zakaria & Rozainee (2014), refers to combustion of refuse to as burning or incinerating of refuse. In most African countries, burning of refuse is the order of the day. Once a material is useless and there is need to get rid of it, it is being burnt. Combustible materials such as papers, wood, textile are the most common household refuse materials being burnt. The combustion of refuse takes place on bare ground, near houses, dump sites or incinerators. The combustion of refuse material gives off smoke to the atmosphere. The common air pollutants that may be released to the atmosphere during refuse combustion include: particulate matter, sulphur dioxide, nitrogen oxide, acidic compound, carbon monoxide, metals and organic compounds such as chlorofluorocarbons (CFC). (British Columbia, Ministry of Environment's Fact Sheet on Air Emission, 2011). Poisonous gases like these have serious hazards on human health. They are also dangerous to the eco-system by wearing away the ozone layer, and enhancing global warming. They also accumulate in the atmosphere and come down through what is known as acid rain. The burning of waste materials could also take place in an incinerator which is a designated structure built for the purpose of burning combustible refuse

LANDFILL WASTE DISPOSAL SYSTEM

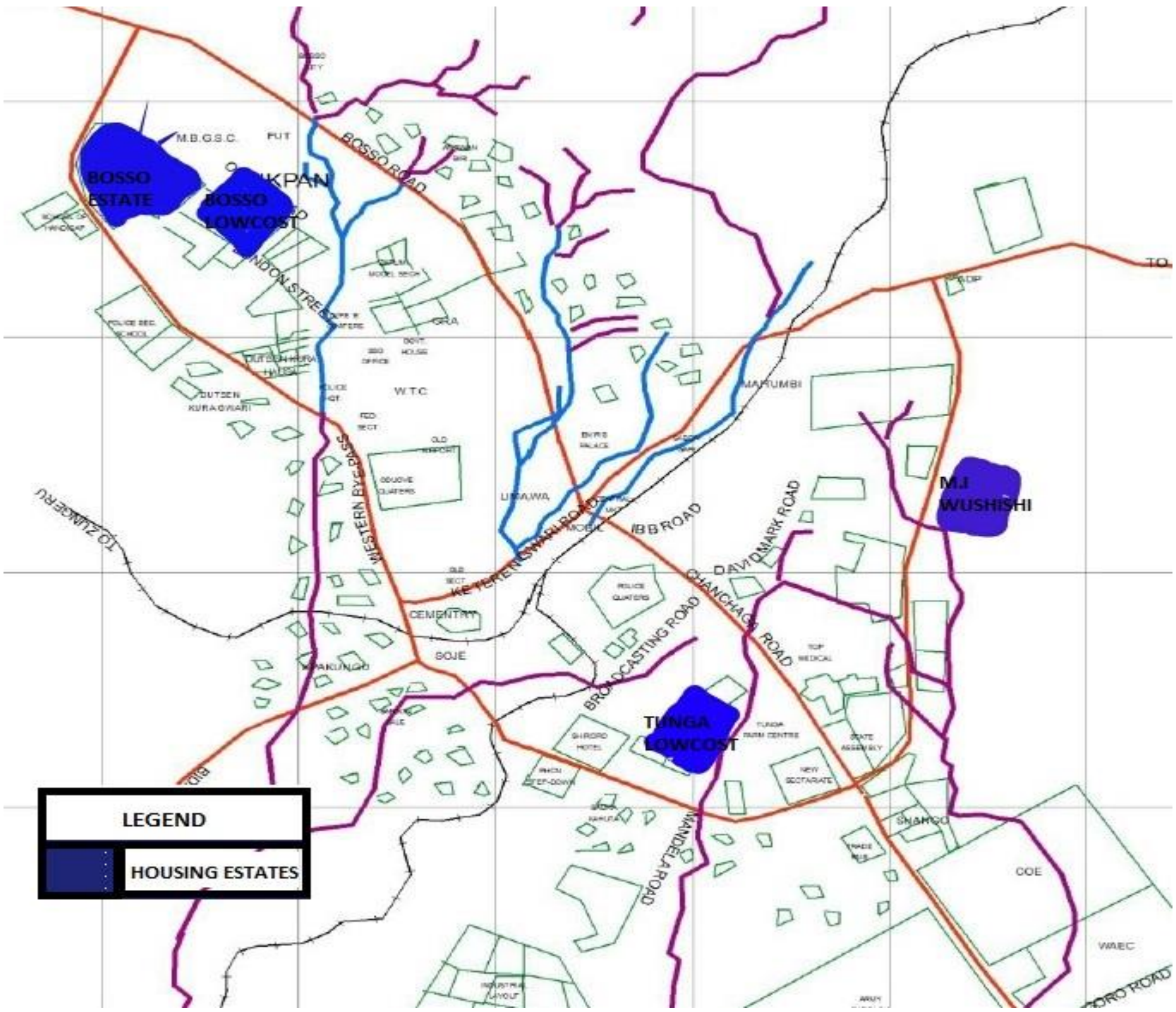
This is a method of refuse disposal which is carried out on a vast land mostly at the outskirt of the human settlement by burial. Johannessen & Boyer (1999), this method of refuse disposal remains predominantly the most common in developing countries throughout the world. Basel convention (2002), the landfill site is usually a designated land by the government for the purpose of proper refuse disposal with the proper consideration of land morphology, water table and geographical proximity to human settlement. Refuse collectors from either the government or private organizations in some cases move round to collect refuse from various homes and convey them to the landfill site. The use of bulldozers is then employed to compact and spread the waste materials they decompose easily and react with the soil. The landfill can be hazardous and pollute the air, soil, and water. In some areas, ashes after combustion are disposed of to the landfill. Composting for soil fertilization is another economical method of refuse disposal. Suleiman (2014), the decomposition of green waste such as food, vegetables and plant waste decompose easily in the humus to produce microorganisms such as fungi and bacteria after a period of weeks or months. These wastes are also known as biodegradable wastes. After decomposition, they are used as natural fertilizers by farmers on their plantations. This may also be referred to as reuse of waste. That is reuse of waste for another purpose which is the fertilization of the farmland. This is a very cheap way to nourish the soil instead of purchasing fertilizers.

RESEARCH METHODOLOGY

The Study Area

The study area covers four major housing estates within Minna metropolies. These housing estates include Bosso estate and Bosso low cost in Bosso area (Bosso local government) Tunga low cost, Tunga area and general M.I Wushishi housing estate, Eastern Bye-pass, also in (Chanchaga local government) Minna.

Map 1.0 Map of Minna, Showing the Housing Estate Samples



SOURCE: Dalil, Mohammad, Yamman, Husaini, Sanni (2015)

These mass housing units were built by both the state government and the federal government for the civil servants of the state. The benefactors will thereby pay back the government at a subsidized rate after a number of years through the deduction from their salaries. During the course of study, it was made known that most of the dweller in the estates are the house owners. Over the years, they have completed the installmental payment of the use to the government except that of the new M.I Wushishi Estate. This study is assessing the techniques of waste disposal within these estates and to note the possible problems facing the estate in terms of waste disposal. The research method was based on field investigation through the use of questionnaire survey method. The questionnaires were administered by the researcher and some research assistants in the areas of study. The questions asked were based on refuse disposal techniques, duration of disposal, organization responsible for the disposal and the rating of the present method of disposal within the study areas. The total numbers of houses were not visited due to the time frame for this research work. The random sampling method of data collection was used in a systematic unbiased manner. The data collected is a good representation of the study area. The analysis of data collected through the questionnaires was carried out with the use of SPSS statistics software version 17.0 and Microsoft Excel for the final graphical output.

Table 1.0; *Study areas with the percentages of the questionnaires administered*

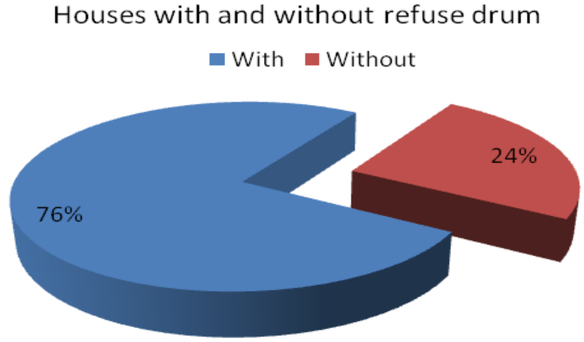
Study Areas	**Frequency**	**Percent**
Bosso Estate	11	26.8
Bosso Lowcost	10	24.4
MI Wushishi Estate	10	24.4
Tunga Lowcost	10	24.4
Total	41	100.0

Author's Fieldwork 2014

FINDNGS AND DISCUSSIONS

In the course of the research work, it was noticed that 76% of the houses in the housing estates have refuse drums as shown in plate 2.0. In 14% of the houses in the study areas, when the drum placed in front of the house is full, they tried to add one more drum to avoid spillage of refuse from the drum. In a situation where both drums are filled up, they tend to burn the spillover refuse to ensure clean and serene environment as shown in plate 1.0. The 24% of the houses without refuse drums either burn their refuse near their houses or dump it at the illegal dump site situated in the estate. Refuse dumpsites within the estates visited were majorly along the roads or close to a main drainage. These refuse dump sites disfigure the image of the estate and make it unhealthy to people leaving nearby.

Figure 1.0; showing the percentage of houses with and without refuse drums



Source: Author's Fieldwork 2014

Plate 1.0 Additional refuse drum and ashes of burnt spillover refuse.

Source: Author's Fieldwork 2014

Plate 2.0 Refuse drum in front of each house within the study area

Source: Author's Fieldwork 2014

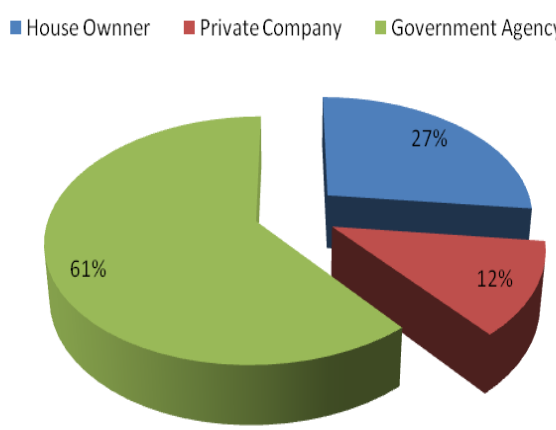
The government agencies responsible for the waste collection in the state, Niger State Environmental Protection Agency (NISEPA) have not being able to reach out to collect waste in all the residential buildings within the state. The collection of refuse in the areas they can cover is not frequent enough. Private refuse collectors in the state have being given the right to operate maximally to help in the disposal of refuse but they are yet to be able to cover the whole state effectively. Refuse spend more time in the refuse drum and take more time than the weekly stipulated time for the collection. As a result of this, it takes a longer time for the drum to be emptied. The degradable garbage there in begins to decompose and produce unpleasant odors which interrupt the comfort and wellbeing of the population within the estate.

Table 2.0; Showing who is responsible for refuse disposal and collection

	Frequency	Percent
House Ownner	11	26.8
Private Company	5	12.2
Government Agency	25	61.0
Total	41	100.0

Sourse: Author's Fieldwork 2014

Figure 2.0; showing who is responsible for refuse collection



Source: Author's Fieldwork 2014

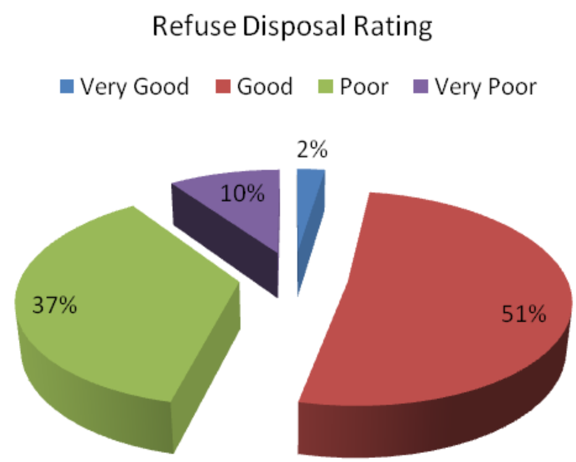
It can be said that 25.5% which is the average number of houses without refuse drum (24%) and the houses where the owners are in charge of their refuse (27%) are responsible for the dumping and burning of refuse in the illegal dump sites as shown in plate 3.0.

Plate 3.0 Refuse dumpsite within the study area.
Sourse: Author's Fieldwork 2014

Plate 4.0 NISEPA officials during refuse collection
Sourse: Author's Fieldwork 2014

Generally, the ratings of the refuse disposal techniques in the study areas shown in figure 3.0 below reveals that the disposal techniques in the estates are good based on the assessment of the respondents. With the present situation of refuse disposal and collection within the study areas, there is need for improvement. Plate 3.0 shows how untidy the environment is around the dumpsite.

Figure 3.0; showing the rating of waste disposal techniques from the respondents



Source: Author's Fieldwork 2014

EFFECTS OF POORLY DISPOSED REFUSE IN THE BUILT ENVIRONMENT

The accumulation of refuse in the environment leads to various environmental pollution which are; air, land/soil and water pollution. Pollution is the contamination of the human environment with materials that interferes with human health, the wellbeing or the natural living thing community. Pollution in the environment leads to the various ailment. It negatively affects the state of wellbeing of the affected population and takes away their comfort through the odour and germs emanating from such refuse. An unclean building with refuse littering the ground creates an impression that such building is dirty and not secure to either live in or visit. It reduces the aesthetic value of such building and gives room for quick dilapidation and deterioration. Cleaning and disposal of refuse as a regular form of building maintenance prolongs the life span of the finishes and the building at large. In the study area, it is noticed that there is some refuse dump site which disfigures the image of the estates. These dump sites block drainages and causes erosion, it also results to the deterioration of infrastructural facilities. It causes air pollution, water pollution and the harboring of microorganism which transmits diseases easily with speed.

CONCLUSION AND RECOMMENDATIONS

The Niger State Environmental Protection Agencies (NISEPA) are trying to make the state clean at all cost but the manpower to carry it out is not sufficient enough to go round the state at the regular one-week interval. They have also encouraged the private bodies to assist but yet, they need more hands. The study areas are known to be organized in terms of planning and the set of people living there. If such area could have dumpsites, then the slum areas where proper planning is a problem without or with little elite is in serious danger. Waste disposal system is still a problem that needs proper attention from both the government and the entire populace to create a sustainable and livable environment.

It is hereby recommended that:

- The recycling of refuse should be encouraged such that income can be generated from waste products which will lead to the employment of people and also minimize the non-degradable waste in the environment.
- Composting system of waste disposal should be employed. This will make the degradable waste useful as manure for the purpose of farming. The composting site should be located at the outskirt of the city such that it does not contaminate the human environment.
- In terms of landfill refuse disposal system, the butane gas generated from it can be used as fuel and other biogases as source of electricity.
- Awareness should be created to educate people about the reuse of waste materials. Any unwanted materials in good condition should either be given out or sold to the interested people. Food items should be given to the needy or should be given to animals to feed on.
- Refuse should be reduced from the source by making good use of every item such that there will not be much waste to dispose.

REFERENCES

Aguwa J.I. (2008) 'Effect of Construction Activities on the Environment'' A paper presented at the School of Environmental Technology, Federal University of Technology, Minna 2nd Annual Conference.

Akindutire I.O and Alebiosu E.O (2013) Waste Management Strategies in Ado-Ekiti Metropolis of Ekiti State, Nigeria. *European Scientific Journal* 9(29) 269-276. ISSN: 18857-7431.

Basel Convention (2002), Technical Guideline on Specially Engineered Landfill (D5). Basel Convension Series/ SBC No.02/03. ISSN 1020-8364

British Columbia Ministry of Environment (2011), 'Combustion of Municipal Solid Waste' Fact Sheet on Air Emission. http://www.env.gov.bc.ca/epd/mun-waste/. Retrieved on 15 September, 2014.

Cambridge Advanced Learners Dictionary (2014), Cambridge University Press. dictionary.cambridge.org/dictionary/british/refuse retrieved on 14 Sept, 2014 by 11am.

Chukwuemeka E., Ugwu J. and Igwegbe D. (2012) 'Management and Development Implication of Solid Waste Management in Nigeria'. *Asian Journal of Business Management.* 4(4).

Dalil M, Mohammad N.H, Yamman U.M., Husaini A, Sanni L.M. (2015), An Assessment of Floodvulnerability on Physical Development along Drainage Channels in Minna, Niger State, Nigeria. Academic Journal 9(1) 38-46 ISSN1996-0786

Egun N.K (2012) 'The Waste-To-Wealth Concept: Waste Market in Delta State, Nigeria'. *Greener Journal of Social Sciences* 2 (6).

Ekanem C.H, Ekanem H.E, Eyenaka F.D, Isaiah E.A (2013), Zero Waste: An Innovation for Less Polution Emission Processes Resource Management Practices and Policies. *Mediterranean Journal of Social Science*. 4(8) ISSN 2039-2117

Johannessen L.M and Boyer G. (1999), Observation of Solid Landfills in Developing Countries: Africa,Asia and Latin America. Urban Development Division, Waste Management Anchor Team.

Johari A, Mat R, Hasim A.H, Hassim M.H, Zakaria Z.Y and Rozainee M. (2014), Combustion Characteristics of Refuse Derived Fuel (RDF) in a Fluidized Bed Combustor. Sain Malaysiana 43(1): 103-109.

Ofudje E.A, Alayande, G.O, Oladipo G.O, Williams D.O and Akiode O.K (2014). Heavey Metals Concentration at Electronic Waste Dismantling Site and Dumpsites in Lagos, Nigeria. *International Research Journal of Pure and Applied Chemistry* 4(6): 678-690. ISSN 2231-3443.

Olarinoye I.O. Sharifat I. and Kolo, M.T (2012) 'Heavy Metal Content of Solid Samples from two major Dump Sites in Minna'. *Natural and Applied Science Journal*. 11 (1).

Philip R.O and Walsh P.W (1995), Decision Makers Guide to Solid Waste Management. 11 EPA 530-R95-023. Solid and Hazardous Waste Education Centre, University of Wisconsin- Madison/Extension.

Sridhar M.K and Hammed T.B (2014), Turning Waste to Wealth in Nigeria: An Overview. J Hum Ecol, 46(2): 195-203

Suleiman I.L (2014), Composting as a Sustainable Waste Management Method in Katsina Metropolis, Northern Nigeria. *International Journal of Bioscience, Biochemistry, Bioformatics* 4(1).

Taylor R. and Allen A. (2006), Waste Disposal and Landfill: Information Needs. Protecting Ground Water for Health: Managing the Qualities of Drinking Water Source. ISBN: 1843390795 12(1)

Terada C. (2012) Recycling Electronic wastes in Nigeria: Putting Environmental and Human Right at Risk. *Northwestern Journal of International Human Right.* 10NW, J INT'L HUM RTS 154.

EFFECT OF SOLID WASTE MANAGEMENT ON RESIDENTIAL QUARTERS IN AKURE, NIGERIA.

Victor Olufemi Adegbehingbe and Sunday Adeluyi Bobadoye
Department of Architecture, Federal University of Technology, Akure, Ondo state, Nigeria**.**

Most of the residential areas in Nigeria are today grappling with the problems caused by mounting heaps of solid wastes from their environments. Several Nigerians have considered a cheap way of disposing off their solid waste by setting the mixed waste on fire in a little corner in their backyard or in a open place resulting in release of air pollution which is harmful to urban climate. Therefore this paper assessed the effects of the study of the solid waste build up phenomenon with a view toward finding ameliorative measures that would help reduce negative effect on residential beautification and sanitation and to provide insights into ensuring, reducing, minimizing and avoiding the evolving solid waste encroachment of city streets and roads. Closed and open ended questionnaires were administered on randomly sampled residents of some residential quarters in Akure, Ondo state, Nigeria and analyzed using simple descriptive analysis. The waste management generated lead to flooding, increased nuisance and visual environmental quality degradation of building open spaces , clogging of draining and traffic routes. The finding shows that there is variation in waste items, this shows a reflection of the income levels. Waste littering is common in some zones, while collection of wastes are not regular. The study shows that there are open burning of waste, irregular and in-frequent waste collection, dumping of waste in drains/gutters, absence of waste separation at source and waste sorting at dump sites by scavengers. The study concludes that greater investment should be made in the area of refuse storage, sorting, collection and disposal. Greater awareness of the need for cleaner environment is needed among the residents. This study recommends vigorous public enlightenments, re-introduction of hygiene studies from primary education, enforcement of environmental and waste disposal protection laws with policy statements to help achieve the healthy city concept of the United Nations.

Keyword: *Solid Waste, Solid Waste Management, Residential Environment, Residential Building, Environmental degradation.*

victoradegbehin22@gmail.com,
voadegbehingbe@futa.edu.ng

Victor Olufemi Adegbehingbe and Sunday Adeluyi Bobadoye (2016). **EFFECT OF SOLID WASTE MANAGE MENT ON RESIDENTIAL QUARTERS IN AKURE, NIGERIA** Sustainable Built Environment and Climate ch ange; The challenges of Post 2015 Development Agenda. School of Environmental Technology Conference, SETIC, 2 016

INTRODUCTION

The problem of solid waste is a universal one as waste exists in every society. Waste management problems only appear more serious in developing economies because of poor management framework. However, one of the major problems confronting medium to large urban centers in Nigeria is that of how to effectively manage the solid wastes generated by residents. Evidence of this is mirrored in the presence of refuse heaps expecting evacuation in the different residential densities (Wahab, 1991; Afon, 2003,; Ibekwe, 2003); Odocha (1994) affirm the incidence of the generation of tremendous quality of solid wastes in Nigeria estimated at 0.95 ton per person per year. A greater proportion of which are inefficiently disposed on the ground, in drains and water bodies. Hence, waste are said to be transferred rather than disposed in Nigeria. Previous studies by Mabogunje (1980) and Filani (1987) have shown that severe insanitary conditions characterize the urban centers, which lack adequate provision for waste evacuation, and are consequently exposed to hazards of air and water pollution.

In most Nigerian cities, the volume of solid wastes generated daily overwhelms urban administrators' capacity to plan for collection and disposal. The tasks of waste collection and disposal have thus become an almost intractable problem. It is therefore not uncommon to find urban streets, drainage and roads practically blocked by solid wastes and these contributes in no small measure to the problem of urban degradation , depreciation of housing quality and flood disasters in cities like Lagos, Ibadan, Kano, Port Harcourt and Akure (Denito, 1980; Ondo State Ministry of Works & Housing, 1998; Popoola, 2001; Fadamiro,2003)

Solid waste management in residential areas is an aspect of housing often neglected by the urban administrators and residents of most developing nations. In Nigeria, there are usually no land use provisions for solid waste management both in the individual plots, structure and that of the general layouts of the city sectors. Nations with acute housing problems such as prevalence of slums, squatter settlements, urban squalor and so on, often experience the menace of indiscriminate dumping of refuse in the residential areas.

The problem of poor planning and insufficient provision for proper storage, evacuation and disposal of solid waste (widely known as refuse) in Akure municipality reflects in the way and manner in which indiscriminately dumped heaps of refuse have taken over virtually every available open space in residential neighborhoods of the city. This problem of poor solid waste management impinges on the livability of the different residential densities of Akure. It is also a cause of further devaluation of the urban environment. This aforementioned problem also aids the perennial flooding in some areas of Akure like Isolo and Oke-Ijebu, especially along the River Ala flood plain, and causes the non-performance of public infrastructure such as roads and drains. Furthermore, the poor state of solid waste management in the residential areas of Akure is indeed apparent in the volume of unsightly mounts of refuse that are generally ubiquitous, and which not only constitute nuisance such as litters, offensive odor, eyesore, blight etc, but also impair the aesthetic quality of the Akure cityscape.

Poor solid waste management, which is contributing in no small measure to the increasing rate of despoliation of the environment in residential neighborhoods of Akure metropolis, hinders effective housing; pleasant urban aesthetic; sustainable urban development and is a potent threat to the physical wellbeing of the resident population. If not given the required priority attention, the sordid state of solid waste management could degenerate further and lead to the outbreak of diseases, flooding, increased nuisance and visual intrusion. Concurrently, further diminishing of housing and environmental quality might occur in the form of further degradation of buildings and open spaces; clogging of drains and traffic routes.

The monthly environmental sanitation program by the Ondo state Government which holds every last Saturday of the month and the weekly market sanitation which holds every Thursday of the week, underscores the unbearable state which the environment, especially that of Akure, has degenerated into, and are therefore laudable.
Previous studies have focused on urban residential area solid waste management mainly on a general urban scale. Preponderance of evidence however shows the existence of intra-city disparities in the provision for solid waste collection as a housing service (Salawu, 1990; Afon, 2007). It is thus necessary to find out why some areas of our cities enjoy better solid waste management SWM services than other areas and to investigate the extent to which the physical characteristics of layouts and infrastructure affects SWM in urban residential areas.

In the light of the foregoing and bearing in mind the invaluable role of effective solid waste management in the achievement of qualitative housing and livable neighborhoods, there is a need for a proper analysis of the factors, which facilitate or hinder effective solid waste management especially within the different residential densities of Akure metropolis. This should be done with a view to identifying factors that are pivotal to the actualization of effective solid waste management for this will help to offer suggestions on the functional approaches for strategic planning. This paper investigated effects of Solid Waste Management residential quarters in Akure, Nigeria. The city of Akure was demarcated into three Zones A, B and C respectively: high, medium and low income residential areas.

LITERATURE REVIEW

In Nigeria, a major feature of the urban environment, particularly from the beginning of the oil boom in the 1970’s was the rapid takeover of cities by all kinds of solid waste. As cities become larger, waste generation becomes more intense and the volume increases greatly. Also, a greater demand is placed on available manpower, equipment and infrastructure that facilities refuse disposal. The problem of ineffective waste management has heightened over the years in Nigeria due to poorly managed urbanization among other factors. The country has experienced rapid urbanization characterized by poor physical planning and haphazard development culminating into severe degradation of the housing environment in the urban centers. Researchers (Filani, 1987; Mabogunje, 1980) have shown that acute insanitary conditions characterize the urban centers, which do not have adequate provision for waste storage, evacuation and disposal, and are consequently exposed to hazards of air, water pollution and visual intrusion in the residential areas. An estimated 0.95 ton of solid waste is generated per person per year in Nigeria. As urban populations continues to grow and as the pace of urbanization and modern living increases in Nigeria, the quantum of solid wastes increases as well, thereby constituting a much greater burden that is presently the case.

Population growth intensifies the pressure on urban infrastructure that support waste management (Odocha, 1994).

SOLID WASTE MANAGEMENT AND IMPLICATIONS FOR HOUSING AND ENVIRONMENT IN NIGERIA

Salawu (1990) observed that the problem of environmental sanitation is one of the most intractable problems facing Nigerian cities. He further identified the collection and disposal of solid wastes as major public health issues, which are also vital factors affecting the quality of urban environment. It is also a major variable in the residents; perception of the quality of urban neighbourhood, which also affects the value of property. While some areas in major Nigerian cities are receiving more attention in terms of refuse collection and disposal services, others are served intermittently or not all. There has been a phenomenal increase in the volume and range of solid wastes generated daily in the country within the past few decades and this is due largely, to the increasing rate of population growth, rapid urbanization, industrialization, increased usage of non-biodegradable materials, from bye products of agricultural practices and food production and general increase in economic activities (Adewumi, 2000). Though proper sanitation is seen as closely related to good housing conditions,70% of the existing housing stock in Nigerian cities lacks basic infrastructure facilities. Nevertheless, the volume of waste generated in these cities amounted to well over 15 million tones in 1999 and the insanitary conditions in which solid wastes are collected, processed and disposed of contributes greatly to urban environmental degradation (Arayela and Falaye,2000). Popoola (2001) observed that urban administrators that have the responsibility for the management of solid waste within their jurisdiction lack the necessary institutional and revenue capacities to effectively do so. It is therefore not common to find urban streets, roads and drains practically blocked by refuse and this contributes to the problem of flood disasters in cities like Ibadan and Akure (NEST, 1991).

It was essentially the problem of mounting; and potentially hazardous and spread of solid wastes in our cities and the need to curtail the malaise, which led to the formal launching of a National Environmental Sanitation Program in August 1985 by the Federal Military Government. The program was aimed at ridding the environment of filth and to inculcate in Nigerians, basic environmental sanitation habits. Consequently, state governments passed Environmental Sanitation Edicts and the last Saturday of the month was declared Environmental Sanitation day. This was a day when the populace is required to clean up their homes and surroundings from 7 a.m. to 10 a.m. Obviously, the war against filth failed to achieve the desired objectives and the Environmental Sanitation day soon turn into a half-hearted monthly ritual. Also, the program exposed the fact that municipal authorities lack sufficient manpower, money and machinery to effectively evacuate solid waste collected together along streets and open spaces. It soon became difficult to get people to clean their environment when heaps of refuse collected the previous month remained unpacked. That the program failed to make the desired sustainable impact on the environment soon became too obvious. The reason for its failure apparently lay in the fact that operational strategies for the program were misconstrued while measures adopted were highly superficial and amounted to scratching on the surface. The inability of the Environmental Sanitation

Program to make the desired impact apparently informed the decision of the Obasanjo regime to scrap the program at the inception of its tenure in 1999.

Olotuah (2000a) affirmed the importance of the mode of solid waste disposal in residential neighborhoods in the determination of housing quality. His study posited that since wastes are generated in the cause of man's daily living; its disposal must be thorough to ensure a healthy living environment. However, Sanusi (1997) observed that the planning and provision for efficient waste management systems in urban centers in Nigeria meet with great difficulty, the fact that sanitation is seen as closely related to housing notwithstanding. Ikurekong and Jacob (2000) claimed that poor housing conditions in most residential neighbourhoods. In Nigeria, cities are characterized by environmental problems of lack of basic infrastructure and service including lack of provision for proper storage and prompt evacuation and disposal of solid waste. Ineffective and insufficient arrangement for Waste Disposal, in many of the urban centers throughout Nigeria, have been ineffective and grossly insufficient. Hence, wastes are often indiscriminately dumped on open spaces and on the street. Some of the affected streets may be rendered impassible for several weeks.

IMPACT OF IMPROPER SOLID WASTE DISPOSAL ON URBAN HOUSING IN AKURE, NIGERIA.

As countries become richer and more urbanized, their waste composition changes (Freeman,1979 and Lietman, 1995). A study carried out by Ogedengbe and Oyedele, (2006) showed that the rate of change in municipal solid waste quantities and composition in developing and developed countries is unprecedented. In further opined that generally the greater the economic prosperity and the higher percentage of urban population, the greater the amount the solid waste generated and as lifestyles rapidly change, the related conveniences and product mobile phones, electronics, polyvinyl chloride plastics (PVC plastics), disposable diapers post special waste disposal challenges. Even more problematic is the fact that in most low and middle income countries, development of waste management systems woefully lags behind the realities of a quickly changing waste streams. In addition, it observed that newly mobilized consumers and their market-survey suppliers rarely consider the potential waste management problems that go hand in hand with changing lifestyles.

Waste management in any city is of paramount importance due to the risk posed to human beings and to the environment. Encarta Dictionary, 2008 describes it as the activities that deal with waste before and after it is produced, including its minimization, transfer storage, separation, recovery, recycling, and final disposal. Knowledge of the sources of waste and type in an area is required in order to design and operate appropriate solid waste management systems (Gumbo1996, Famuyigbo 1998). Waste management is a labor and capital-intensive function that often consumes 20 to 50 percent of municipal operating budget (Oyinlola, 1998 and Thomas 2000).

Residential waste, which is the major type of waste concerned in this paper, has a direct bearing on housing standard of an urban area. It is different from other types of waste because it is directly related to households. The contents of household waste are majorly food materials. Others are papers, broken furniture, plastic materials, disposable diapers, worn-out fabrics, etc. Most household wastes are biodegradable, hence attract organisms, insect and rodents that can transmit diseases to human and this spread very fast when in close proximity to residences. (Ogedengbe and Oyedele, 2006). When residents dump wastes behind their houses, as is the case with some residents in the study area, the organism contaminate with such refuse and act as agents of degradation. This will make the residential environment to be of poor quality, hence, the building will require renovation and maintenance more frequently. The quality of man's environment is an integral contributor to the overall quality of families and individual quality of life (Adedeji, 2005). It is expected that when the environmental sanitation standards of a city improves, there will be an upliftment in the living condition and health security for the inhabitants as well as improvement in the quality and aesthetics of the environment at large. Although trends of solid waste have been examined, much has not been done in the area of housing quality. This paper therefore attempts to examine the effect of waste disposal on the housing and health condition of urban dwellers in Nigeria with a particular reference to the study area.

RESEARCH METHOD

The study entails analysis of solid waste management practice in some residential areas of Akure metropolis. For the purpose of this analysis, comparisons were made between planned, quasi-planned, and unplanned residential areas. These are three distinct types of residential areas in Akure. Examples of planned residential layouts are the Government Residential Areas (GRAs) and estates, which were designed and developed with tangible physical planning and development control measures. The planned Government residential layouts are sited over the periphery of Akure and these include Ijapo and Oba-ile Housing Estates, Ala quarters, Alagbaka, Awule, and Ilesha Road Government Residential areas and Marked A and classified as high income residential areas. On the other hand, unplanned residential areas are residential neighborhoods that constitute the urban core. These areas are the traditional areas located mostly within a three kilometer radius from the AAfin Deji [the palace of the King of Akure]. The traditional areas are as old as the city itself and have evolved over the years without formal or guided physical planning and development control. They are therefore located as the Akure inner-city neighborhood namely: Erekesan, Idiagba-Ijemikin and Obanla and are Marked C and classified as low income residential areas . The quasi-planned residential areas are privately owned layouts which, in theory, are expected to have substantial physical planning inputs, developmental control and infrastructure but which lack such in their implementation. The quasi-planned residential layouts are mostly located as the transitional neighborhoods (Olotuah, 2000; Akinbamijo, 2004) located between the unplanned inner-city neighborhoods and the planned peripheral neighborhoods of Akure and compare of areas such as Adegbola-Ayedun, Gbogi, Isikan, Oke Aro Titun, Oke-Aro and Isolo and Marked B and classified as middle income residential areas.

A Structured Interview Was Adopted In This Research.

Structured interview was conducted in the month of July, August & September 2014 and with the engagement of twenty research Assistants who were 500 leve students of the Federal University of Technology, Akure, Ondo State.

Primary data for the research were obtained in a field survey conducted in the study areas in Akure, Nigeria. The research instrument used is a well structured questionnaire to elicit required information relating to socioeconomic and environmental condition of the household as well as the characteristics of dwellings in which the people live. Additional primary data was sourced by means of structured interviews with the relevant officials of the Ondo Waste Management Authourity and Environmental Health officials of Akure south Local Government Authourity. A sampling frame of 1041 was considered and a sample size of 300 cases representing 30% spread over the study area through random sampling in order to ensure that it was fully representative of the population of the audience of the study. Secondary data includes; records obtained from available health institutions within the area, analogue base maps of the study area, population data, household data and direct observation of the buildings and the environment. The neighborhoods were sampled through the base maps by the use of stratified sampling method. The analysis focused on the physical conditions as well as the general environmental conditions of the dwelling units.

Figure 1a: Map of Nigeria Showing Ondo State

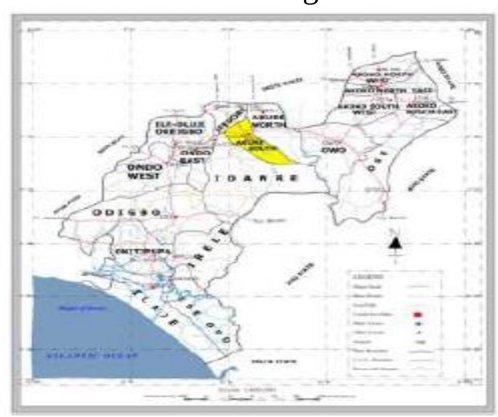


Figure 1b: Ondo State showing the study area

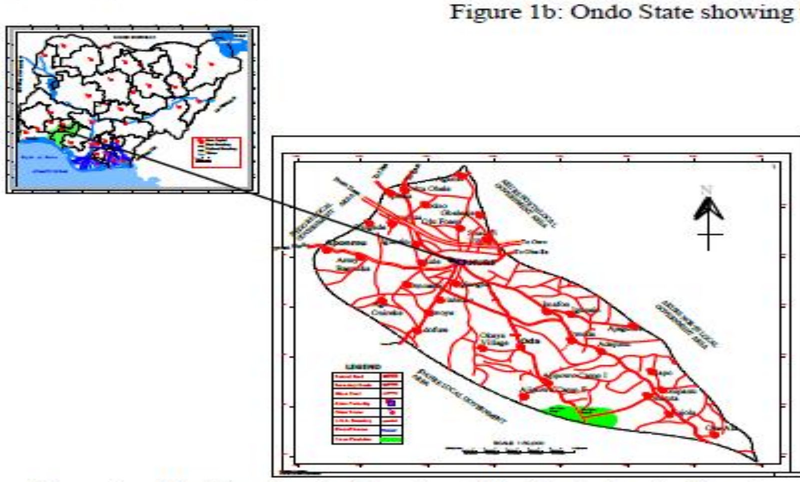


Figure 1c: Map Showing the Location of the Study Area in Nigeria

RESEARCH FINDINGS AND DISCUSSION OF RESULT.

This study investigates residential waste management practices in Akure, an emerging city in Nigeria, with a view to determining the types of waste generated, storage, sorting, transportation,disposal and impacts on environmental quality.
The city of Akure was demarcated into three zones A, B and C representing Planned, quasi-planned and unplanned residential areas or high, medium and low income residential areas respectively. Using a table of random numbers, five wards were selected in each zone for sampling. The sample size for the study was determined using the formula:

$$n = \frac{N}{1+N(e)^2}$$

Where

n = present population

N = finite population

e = the level of significance (0.05)

The 2014 population of Akure City was projected from the 2006 National Population Commission (NPC) figure of 556, 964 using the formula

Where:

Po = projected population

Pt = population of the base year r = rate of growth (2.3)

n = 4 years.

Applying the formula Po = 556, 964 (1 + 2.3)4

100

gave a projected population of 490, 947 persons for the study area. This value was then substituted in the Yamane formula as:

$$n = \frac{556,964}{1 + 556,964\,(0.0025)}$$

This gave the sample size of 500 respondents for the study.

Five hundred people were interviewed from the five wards in the three zones. Questionnaires were use to capture information on: (i) Waste storage

(ii) Frequency of solid waste collection

Plate 3: insufficient to cater for the volume of waste produced.
Source: researchers field survey, 2014

Plate 4: accumulation of refuse on a vacant plot
Source: researchers field survey, 2014

Plate 5: accumulation of refuse on street
Source: researchers field survey, 2014

Plate 6: accumulation of refuse cleared from street drain & open dump
Source: researchers field survey, 2014

Plate 7: accumulation of refuse within residential area

Plate 8: accumulation of refuse within residential area

(iii) Method of solid waste disposal
(iv) Evidence of waste separation either by individuals, government agents, private agents and informal agents such as scavengers.

To determine the composition of waste by volume/day for every home, a systematic approach was adopted with households sampled at intervals of five along the streets. At each sampling point, five baskets were placed in the morning and emptied in the evening. Wastes obtained were then sorted into different classes and weighed using a Griffin and George spring balance. The duration of sampling was two weeks in each sampling zone. The total weight of the waste streams was obtained by simple addition of all weights in the study areas.

Information related to personnel, number and state of vehicle, funding, and involvement or otherwise in waste recycling activities, type of equipment and waste generation data were obtained directly from the authorities of Ondo state Waste Management Authority, Akure, Ondo state and Environmental Sanitation section of Akure South Local Government Authority.

DISCUSSION OF RESULTS

Table 1 shows classes of waste and their weight in Akure . In the three zones, vegetables, metals/can and glass form the bulk of the waste generated. In Zone A, metals/can, paper and plastic are dominant. In Zone B textiles, paper and metal/cans are dominant while in Zone C vegetables, metals/cans, plastic and ceramics are most common. The variation in waste is apparently a reflection of the income levels. For example glass, food remnants, ceramics and metal /can predominate in Zone A. These are waste items often associated with affluence in Nigeria. Commercial waste, for example, paper and metal/can, vegetable dominate in Zone B which is a commercial zone of the town containing several offices and a central market. Zone C is a low income zone with less of food remnants and the dominance of polythene products. The highest total weights are found in the commercial Zone (B) while the lowest values occur in the low income zone (C).

Table 2 shows that waste storage in plastic and paper bags is most common in the low income area (Zone C) with 71.4% and less popular in the high income area. Waste storage in wheeled dustbins is the common practice in Zone A with 53.7% while waste storage in galvanized dustbins predominates among residents of Zone B.

From Table 3, 69% of the residence of Zone A confirmed daily collection of waste. This dropped to only 11% in Zone C. Only 16.6% of the respondent in Zone A acknowledged weekly collection of waste, although this increased to 36% in Zone C. About 20.3% of the inhabitants of Zone C reported twice weekly collection of waste while 10% reported in Zone A. In Zone B, 21% had irregular waste collection while only 5% experienced such in Zone A. Waste littering is most common in zones A and B, characterized by overfilled receptacles. About 15.7% of the respondents in Zone C were not sure of the frequency of waste collection in their zone.

Table 1: Volume per weight and classes of domestic solid waste generated in Akure ,Ondo state

	Zone A				*Zone B*				*Zone C*			
	1 (ka	*2 (ka*	*3 (ka*	*4 (ka*	*1 (ka*	*2 (ka*	*3 (ka*	*4 (ka*	*1 (ka*	*2 (ka*	*3 (ka*	*4 (ka*
1 Textiles	1.4	2.1	2.4	1.8	4.5	1.6	2.0	1.6	0.9	1.2	1.1	0.9
2 Vegetables	3.0	1.6	1.9	1.8	2.9	1.8	1.4	1.8	2.6	2.1	2.0	1.9
3 Leather	0.96	0.7	0.7	0.87	0.7	0.7	0.6	0.74	0.4	0.4	0.1	0.20
4 Paper	3.3	3.6	3.1	2.9	4.1	3.7	3.2	2.9	0.4	0.1	0.1	0.19
5 Ceramics	3.92	2.9	1.0	4.9	1.7	2.8	2.9	1.0	0.9	1.3	1.1	0.11
6 Glass/Bottles	3.5	1.9	2.6	2.7	1.7	2.0	1.1	1.4	1.8	2.00	1.9	2.00
7 Food/Remnants	4.9	3.4	2.5	2.8	1.6	2.8	1.9	1.5	1.1	2.0	1.2	1.23
8 Plastic/Polythen	0.6	0.9	0.9	0.7	0.6	0.8	0.7	0.8	3.8	1.6	2.1	2.9
9 Metals/Cans	5.4	4.2	4.9	5.0	4.2	3.9	5.4	4.0	1.3	0.9	2.1	1.4
Total	22.12	21.3	20.0	25.3	22.0	20.1	19.2	15.4	13.0	12.0	11.7	10.8

Table 2: Response on domestic waste storage

	Zone A	*Percentage*	*Zone B*	*Percentage*	*Zone C*	*Percentage*
Plastic/Paper bags	26	19.4	78	58.7	95	71.4
Galvanized dustbins	36	26.9	45	33.8	34	25.6
Wheeled dustbins	72	53.7	10	7.5	4	3.0
Total	134	100.0	133	100.0	133	100.0

Table 3 : Response on frequency of domestic solid waste collection

S. No.	*Location*	*Zone A*	*Percentage*	*Zone B*	*Percentage*	*Zone C*	*Percentage*
1	Daily	92	69.0	48	36.0	15	11.0
2	Weekly	22	16.0	21	16.0	48	36..0
3	Twice Weekly	10	7.5	23	17.0	27	20.3
4	Irregular	5 5	3.7	28	21.0	22	16.0
	Total	134	99.9	134	99.8	193	100.0

Table 4: Response on method of solid waste disposal

S. No.	*Location*	*Zone A*	*Percentage*	*Zone B*	*Percentage*	*Zone C*	*Percentage*
1	Open burning	06	4.4	04	3.0	25	18.8
2	Open dumping	10	7.0	30	22.6	32	24.0
3	Dumping in drains	01	0.7	20	15.0	18	13.5
4	Dumping in receptacles	117	88	79	59.4	58	43.6
	Total	134	100.1	133	100.0	133	99.9

Table 5: Evidence of waste separation

S.	*Agency*	*Zone A*	*Percentag*	*Zone B*	*Percentage*	*Zone C*	*Percenta*
1	At point of collection	00	0	00	00	00	0
2	Government	00	0	00	00	00	0
3	Private involvement	00	0	00	00	00	0
4	Scavengers (regular)	100	75	78	58.6	50	37.6
5	Scavengers (irregular)	33	25	55	41.4	83	62.4
6	Scavengers (non-existent)	00	00	00	00	00	00
	Total	134	100	133	100.0	133	100.0

Table 4 shows that open burning of waste was most popular in Zone C with 18.8% of the respondents involved but less so in Zone A and B where there are few open spaces. As expected, open dumping was reported more in the same Zone C with 24% of the respondents involved. This is a Zone of inefficient waste collection with pockets of surrounding bushes and underdeveloped plots. Dumping of waste in drains/gutters was also reported in the two zones with 15% for Zone B and 13.5% for Zone C. The wide and inviting open drainage channels in Zone B seems to encourage this practice in this zone.

As evidenced in Table 5, respondents across the three zones reported the absence of waste separation at source. They also indicated that neither government nor any organized private sector was involved in waste sorting. However, waste sorting at dump sites by scavengers is reported across the three zones. These scavengers are more regular in Zone A with 75%, followed by Zone B with 58.6%. Their involvement in waste sorting, however, dropped to 37.6% in Zone C. The reason is that more re-useable waste is generated in the high income zones of A and B. Scavengers were noticed in all the Zones.

FURTHER FINDINGS AND DISCUSSION OF RESULTS

The management of solid waste in Akure as evident from this study indicates some major problems. There is a general paucity of data on key waste variables such as generation rates, composition, densities, storage and transportation. Availability of accurate information on these attributes is a prerequisite for effective waste management in any environment. There is also a lack of specialized waste collection and disposal vehicles such as till trucks for conveying waste to disposal sites. Wastes are rather conveyed using inappropriate vehicles such as sand tippers and trailer trucks. In fact, on investigation, it was discovered that the waste management authority of the state as a whole has only six functional waste trucks in its inventory. It has eight monitoring vehicles, no bulldozer nor grader. This does not only make waste collection and disposal very ineffective but goes to betray the complete apathy on the part of the waste management authority.

Standard refuse bins for the collection of domestic waste was just introduced few month ago, this makes it, somewhat difficult to estimate the waste generated in the city. Also, waste collection is so irregular and in-frequent, those refuse bins at the receptacle points spill over for weeks, particularly in Zone C, before they are emptied/ evacuated.

The issue of technical and administrative manpower is very crucial yet this is grossly lacking in Akure . The city's waste management authority is composed mainly of inexperienced staff with very little or no formal training whatsoever in waste handling issues.

The enforcement of environmental standards and the persecution of defaulters are made difficult because of the non-enforcement of the existing comprehensive legal framework provided in the OSWMA (2000) for dealing with the problem. Many residents, for instance, dump their waste directly into the urban drainage system and walk away unpunished. Also, the complete lack of waste recycling and reuse arrangements either by government or private agencies indicates clearly that a greater part are still useful materials like paper, plastic and polythene, bottles and metals are being thrown away. The Ondo State waste management authority has since inception suffered from poor funding, lack of motivation and incentives in the form of allowances to staff who face all sorts of hazards in the collection, transportation as well as disposal of waste generated in the city. Considering the rising quantity of waste as the city population continues to grow, there is an urgent need for a waste management policy in Akure, the Ondo state capital.

CONCLUSION

Due to rapid urbanization in Akure, waste management has become a major problem. Often, previous unguided development and ineffective solid waste management programme had resulted in environmental degradation, with serious health implications. An environmental management plan with clearly defined objectives needs to be articulated into one holistic approach aimed to achieve a cleaner urban area. This means that greater investment should be made in the area of refuse storage, sorting, collection and disposal. Greater awareness of the need for cleaner environment is needed among the urban population since it will reduce indiscriminate disposal. It is believed that the involvement of both government and private agencies and even individuals in waste sorting at the source will go a long way in helping the recovery of reusable materials from domestic waste in the study area.

RECOMMENDATIONS

The following recommendations flow from this study:

(i) Establishing Data Base of Waste Generation in the City: This is necessary for the proper planning of waste collection and disposal and in deciding the type and capacity of waste management equipment to procure. Analysis of spatial data such as transport network, collection network, distribution of receptacles and population distribution along with information related to quantity and quality of waste generated will enable waste management authorities to properly plan their waste management strategies on fact rather than on assumption.

(ii) Monitoring and Enforcement of Existing Legal Framework: The purpose of the monitoring units is to enforce the laws promulgated OSWMA (2000) so as to prevent disposal of domestic waste into city drains and ensure efficient waste management practice.

(iii) Manpower Training, Development and Improved Funding: This is a prominent issue in any establishment. Training of man- power will ensure that the city's waste management system is entrusted to able hands who are capable of running it according to international standards.

(iv) Improve Funding of Waste Management Unit and Provision of Appropriate Waste Collection and Disposal Equipment:

Manpower training without improved fund- ing would amount to nothing since it is improved funding that will enable the unit to procure the right equipment such as till trucks, towing locomotives, machine compactors, crawler dozen, tracked mechanical shovels, mechanical excavators etc.

(v) Encouragement of Waste Re-cycling and Re- use: Resource recovery from solid waste management has become an important method of solid waste management. It involves the recovery of waste such as plastic, metals, glass, paper etc. These are then washed and sold to scrap dealers or primary manufacturers. Establishing more collection receptacles and regular waste collection. At present, the number of receptacles provided are grossly inadequate and even then, they are not emptied until the waste has completely spilled over them becoming a hazard as a result of the stench they produced.

Private agencies need to be encouraged to participate both in reusable waste recovery and in general waste management efforts.

(vi) Discourage the Construction of Open Drains in the City: Constructing open drains in cities have become completely outdated and should be totally discouraged. In a city like Akure, the open drains provide an easy dumping opportunity for city dwellers, a practice which results in the blocking of these drains. This would not be possible where drains are covered.

(vii) Provision of Sanitary Landfill Facilities: For a proper deposition of solid waste in a fast growing city such as Akure, a sanitary land- fill is unavoidable. This is because it minimizes pests, disease, air pollution, ground and surface waste pollution in addition to improving aesthetic values. Sanitary land- fills truly offer a final resting place for solid waste unlike incineration which results in residue and fly ash, which must eventually be disposed off.

POLICY GUIDELINES

Based on the major findings in this research, it has become imperative to put up some recommendations that are necessary to improve the environmental and health conditions of the people. The first thing that needs urgent attention is in the area of public enlightenment and environmental and health education. Residents of this area should be educated on the effect of improper dumping of refuse. Without grassroots environmental education and enlightenment, enforcement of environmental sanitation and waste disposal laws has a very little prospect of success. There is therefore a need to educate the people about the danger of living in disheveled environment, particularly in the study area. This appears to be a possible solution as a preventive measure against the preventing environmental hazards in the country, as education promotes health. Also, the existing laws and education guiding environmental sanitation and health should be reviewed and enforce with stiffer actions in order to make them more effective. Meanwhile, the reintroduction of the old sanitary inspectors, locally called ‘wole-wole’ would be of help to sustain this idea. Also, more attention should be given to waste disposal management through adequate funding. Likewise, poverty has been identified as the major underlying cause of poor environmental and good health because the poor are incapable of paying for the required amenities for healthy living. As a result, the ongoing national policy on sustainable minimum wage should be extended to all and sundry. Government should be alive to their responsibilities of making basic amenities that would enable families and individuals have access and maintain good healthy environment

REFERENCES

Adedeji, Y. M.D.(2005). Outdoor Space Planning and Landscape Qualities of Religious Center in Akure, Nigeria. Inter-World Journal of Science and Technology, R. Durson Associates, Owerri, 2 (1): 40-51

Adewunmi, B.A. (2000).Generation, disposal and management of agricultural waste in Ondo and Ekiti States of Nigeria. Journal of Urban and Environmental Research. 2 (1) 1-10.

Afon, A.O. (2003). Issues in urban residential area solid waste management sustainability. *Challenges of Environmental Sustainability in a Democratic Government.* Proceedings of the 11th National Conference of the Environment and Behaviour Association of Nigeria held in Akure, Nov. 289-296.

Afon, A (2007), An Analysis of Solid Waste Generation in a Traditional African City, the example of Ogbomosho, Nigeria. *Environment & Urbanization*. London: sage Publication. 19(2). 527-537.

Akinbamijo, O.B. (2004). Environmental health Hazards and Intra-urban Disparites- A focus on Akure. An unpublished PhD Thesis submitted o the School of Post-Graduate Studies, F.U.T. Akure.

Akinola. S & Salami. R. (2001). An assessment of the effectiveness of private sector Participation Initiatives In Solid Waste Management In Mushin Local Government Area, Lagos State. Nigerian Journal of Social and Educational Research,University of Ado- Ekiti.

Arayela, O & Falaye, T.A. (2000). Urban development challenges in the new century- the recurring problem of inadequate housing supply in Nigeria. Aarches J, I (5), 42 47.

Denito Associates(1980). *Akure Mater Plan* 1980-2000, I.

Encarta, 2008. Microsoft Encarta Dictionary. Redmond, WA, United State of America

Fadamiro, J.A. (2003). Urban aesthetics and environmental quality: the challenges for the architectural profession in Nigeria. Celebration of Cities, A World Architecture Day Workshop organized by The Nigerian Institute of Architects held at the Theodore Francis Idibiye Auditorium, FUTA. October 6, 2003.

Fadamiro, J.A., Bobadoye, S.A & Adelowo W. (2005). Urban poverty and environmental quality in a Nigerian city: The challenges for architectural profession in Nigeria. Urbanization in Africa, Proceedings of the African Union of architects. Held 23rd 25th may 2005 at Nicon Hiltn Hotel, Abuja, Nigeria. 106-121.

Famuyigbo. M.F. (1998). Solid Waste Management In perspective and Policy Overview. Paper presented at the National Seminar, society of Health Nigeria, Kaduna. May 28-31 1998

Filani, M.O (1987). Accessibility and urban poverty in Nigeria. In P.K. Makinwa & O.A Ozo (Eds). The urban poor in Nigeria. 128-138 Ibadan: Evans Brothers (Nigerian) Publishers Ltd.

Freeman 3, A.M. (1979). The Benefits Of Environment Improvement. Baltimore: Resources for the Future. John Hopkins Press.

Gumbo. B. (1996). Aspects of Solid Waste Management. Workshop on Water And Environmental Management organized by the Department of Civil Engineering, University of Zimbabwe.

Ibekwe, O.D (2003, June 23) War against indiscriminate disposal of refuse. Tell, tell Communications Limited. No 25, 46-47.

Ikurekong, E.E.A and Jacob A (2000) Public housing and environmental quality: Perspective on housing estates development in Uyo, Akwa- Ibom State. Effective Housing in 21st Century Nigeria. Akure: Environmental Forum. 123.

Lewin, A. (1981). Housing Co-Operatives in Developing Countries. International Technology Publication Ltd.

Lietman. J. (1995). Urban Environmental Issues. The Agricultural and Forestry Systems Division (AGRAF) The World Bank

Mabogunje A. (1980). The development process: A spatial perspective (2nd ed). London: urban Harman Ltd. 189-193, 217-218.

Odocha, V.N.K. (1994). *Waste generation and management in a depressed economy.* Lecture delivered to students of Law and Environmental Faculties, University of Nigeria, Enugu Campus (UNEC).

Ogedengbe, P.S & Oyedele, J.B. (2006).Effect of waste management on property values in Ibadan, Nigeria, Journal of land use and development studies, vol2, No1.

Olotuah, A.O (2000a). A critical appraisal of the livability of public housing scheme in Ado Ekiti, Nigeria. International Journal of Environment and Development. 4(1),15 23.

Olotuah, A.O.(2006). Housing quality in suburban areas: An empirical study of Oba-Ile, Nigeria.Dimensi Teknik Arsitektur Vol. 34, no. 2. 133-137

Ondo State Ministry of works and Housing(1998). Akure Master Plan Review 1998-2010. Akure: Ondo State Ministry of Works and Housing. 1-2

Oyinlola A.K. (1998). Waste reuse and Recycling. A paper presented at the petroleum (Special) Trust Fund Stakeholders Technical workshop, Abuja.

Popoola, S (2001). Waste management in Lagos State: Myths and Reality. Environmental News Quarterly Publication of the Nigerian Environmental Society. October-December. 16-18, 22

Salawu, A.T. (1990) the environmental context of urban housing: public services and infractructural facilities in Nigerian urban areas. In Onibokun Poju (Ed), urban Housing in Nigeria. Ibadan : NISER. 69.

Thomas. L. (2002). Brief History of Solid waste Management. Written for The California Department of Health Services.

Sanusi, Y.A (1997). The 1991 National Housing Policy of Nigeria: an Analysis. Kaduna.

FACTORS INFLUENCING HOUSEHOLDS' WASTE SEPARATION BEHAVIOUR IN LAGOS METROPOLIS

Ilechukwu Victor & Chukwukaora Ebere

Dept of Urban and Regional Planning, University of Lagos

Numerous studies on Municipal Solid Waste Management are hinged on the technical, administrative and institutional dimensions which failed to develop the kind of Waste Management strategies needed to encourage households to understand and participate efficiently in sustainable waste management practices. The aim of this study is to examine the extent to which the factors such as technological factors, economic motivations, socio-cultural factors and government policy, determine households' participation in separation and non-separation of solid wastes before collection and disposal. Using a multi-stage sampling technique, the residential neighbourhoods in the three selected local government areas of Lagos Metropolis were classified into low, medium and high residential zones for data collection. A structured questionnaire was administered on households of 388 residential housing units and data were analysed using descriptive and stepwise multiple regression tools. The findings revealed that the households (14.70%) that separate wastes before disposal are highly insignificant and the reasons or factors for non separation of wastes are determined by time consuming ($R^2 = 0.517$, $p < 0.05$), payment of collection fees ($R^2 = 0.118$, $p < 0.05$) and no incentive ($R^2 = 0.025$, $p < 0.05$). The conclusion is that households in Lagos Metropolis do not segregate their wastes before disposal because they considered it time consuming and no incentives as they also pay for the wastes collected. Therefore, there is need to adopt a sustainable wastes management strategy whereby adequate provision of wastes recycling banks is made to ensure reduction in time for wastes sorting, reuse of wastes materials to reduce environmental degradation; and proper enlightenment of wastes segregation for wealth creation and economic support for households' livelihoods.

Key words: Solid wastes, Wastes separation, Waste recycling, Wealth creation, Lagos Metropolis

vicilechuks124@yahoo.com

Ilechukwu, Victor and Chukwukaora, Ebere (2016). **FACTORS INFLUENCING HOUSEHOLDS' WASTE SEPARATION BEHAVIOUR IN LAGOS METROPOLIS** Sustainable Built Environment and Climate c hange; The challenges of Post 2015 Development Agenda. School of Environmental Technology Conference, SETIC, 2016

INTRODUCTION

Municipal household solid waste management has become a major problem in developing countries of the world due to rapid urbanization with its attendant adverse environmental effects. This is particularly true as the growth in urban population is accompanied by an increase in the production of municipal wastes (Uchegbu, 2002; Adejobi and Olorunnimbe, 2012). Senkwe and Mwale (2001) as cited in Ogwuche & Yusufu (2011) defined household municipal wastes as those wastes from human, animal and economic activities in the household, which could be biodegradables such as cash crops, peels, grasses, vegetables, etc, or non-biodegradable like the plastics, bottles, metals, etc.

The consequences of inappropriate disposal of household solid wastes are enormous. According to the World Resources Institute, one to two thirds of these wastes generated in developing countries are dumped indiscriminately on streets or in drains, thus causing floods, insect and rodent breeding ground and the spread of diseases (UNEP, 1996). This scenario not only creates serious environmental problems as well as affect human health but also causes serious financial and socio-economic losses. Ogwuche and Yusufu (2011) identified inefficiency of the collecting systems and lack of political will as factors contributing to the problem of generation and disposal of household solid waste. This was confirmed by Adejobi and Olorunnimbe (2012) by stating that the volume of waste generated does not actually constitute major environmental problems, but it is the inability of governments, waste disposal agencies and individuals to keep up with the task of proper and efficient management of waste that are also the problems.

Attempts to improve on solid waste management in most developing countries have focused on the technical aspects which include procurement of waste collection vehicles, privatizing of waste collection services and the maintenance of the landfill sites. However, Matter, Dietschi, Zurbrugg (2013) argued that most of these approaches to waste management system are conventional in the sense that they are "end of pipe solution". Their emphasis is on collection and disposal and not on reuse and reduction. This has led to an attitude of 'we dump, they collect' among residents, institutions, as well as industries, and is therefore not regarded as a sustainable system of solid waste management. These technical-financial approaches have failed to develop the kind of Waste Management strategies needed to encourage citizens to understand and participate efficiently in sustainable waste management practices (Oduwaye & Ilechukwu, 2012). With the current population dynamics in Lagos, Nigeria, the volume of solid waste being generated will continue to increase at a faster rate than the ability of the agencies to improve on the financial and technical resources needed to parallel this growth (UN-Habitat, 2008).

One of the problems of the households' waste management practices in Lagos which revolves around waste collection and disposal, is the absence of a culture of sorting waste by type at the generation stage. Longe, Longe, Ukpebor (2009) in a study carried out in Lagos, noted that household waste of varying components and sizes are collectively disposed without any form of segregation or sorting. Against this background, the study will assess the solid waste management practices of households in Lagos metropolis as it relates to waste segregation. In doing this, effort will be made to identify the factors that influence the wastes segregation behaviour of households. Therefore the research problem is to examine the extent to which the factors such as technological factors, economic motivations, socio-cultural factors and government policy, determine households' participation in separation and non-separation of solid wastes before collection and disposal.

To address this problem, the study is aimed at assessing the relative importance of factors influencing the level of households' involvement in waste segregation and non-segregation behaviour. The objectives are to examine the characteristics of households and nature of waste generated; determine the conventional waste management practices adopted by households; ascertain whether households segregate their waste before disposal and for what reasons; and determine the factors responsible for non-segregation of waste by households for a sustainable solid waste management.

Challenges of Waste Management and Conceptual Issues

Household waste forms a significant constituent of municipal solid waste and its disposal is therefore one of the biggest challenges facing towns and cities all over the world, especially the developing countries. Past studies which focused on top-down approaches to waste management have failed to develop the kinds of organizational and institutional strategies needed to empower citizens to comprehend and participate effectively in waste management activities and are therefore regarded as being unsustainable. So the focus on waste management has shifted to tackling the problem from the grassroots, that is, at the source by way of sorting or minimizing the waste generated.

One of the problems in waste management is the absence of a culture of sorting waste by type at the generation points. This, according to Longe, Longe, Ukpebor (2009), Ayuba, Manaf, Sabrina and Azmin (2013) and Oyeniyi (2011) is due to the fact that waste components are mixed and heterogeneous in nature. Schultz, Oskamp and Mainieri (1995), Beall (1997), Ekere and Drake (2009) and Banga (2011) noted that households' socio-economic attributes such as gender, income, education and age play vital roles in influencing the waste segregation practices. They observed for instance, that women are more likely to separate waste probably because they are more involved in waste handling. However, Gamba and Oskamp (1994), Mosler et al (2008) did not see gender as an important factor in explaining separation behaviour. They argued that those with higher income and mostly educated participate actively in waste separation for environmental reasons. Age, according to Gamba and Oskamp, 1994; Scott, 1999; has a significant influence in separation behaviour but in some cases, a non-significant relationship was found (Valle, Reis, Menezes, Rebelo, 2004; Werner and Makela, 1998).

Insufficient storage space and non-availability of separate storage containers have also been identified as important factors in influencing segregation behaviour (Banga, 2011; Chu, 2012; Afroz, Hanaki and Kurisu, 2008). They reported that a greater percentage of the households are willing to separate their waste if they are facilitated by giving them separate containers for separate wastes. Waste separation brings some financial earnings that cannot be over looked. According to World Resource Institute (1989), one major problem with recycling is lack of incentives for households to sort and segregate recyclable materials. However, Chu (2012) contested that economic incentive is unimportant in influencing segregation behaviour because of the small monetary value of recyclables receive from selling them.

Studies have shown that lack of information and knowledge of benefits of waste segregation are factors that influence the segregation behaviour of households (Afroz, Hanaki, Kurisu, 2008; Gamba and Oskamp, 1994; Simmons and Widmar, 1990). The benefits of segregating solid waste at source by households are large. Apart from the fact that it has been identified as one of the measures for reducing amounts of discarded materials (Figueroa, 1998; Enayetullah et al, 2006), and improving the quality of materials for reuse and recycling including organics for composting (Klundert and Anschutz (2001), Matter, Dietschi, Zurbrugg (2013) noted that reducing the organic content of solid waste by means of composting or any other organic waste treatment technology would not only have a strong impact on reducing the volume of waste to be collected and disposed but it would also reduce the sources of attraction for vermin and rodents, as well as air pollution in terms of smell and greenhouse gas emissions caused by decomposition in transfer points and on uncontrolled dumpsites. Klundert and Anschutz (2001) further stated that segregating recyclables at the household level, and thus ensuring their cleanliness and quality, can provide an interesting opportunity to enhance waste recycling, provide more resources to the recycling industry and augment incomes of the recyclable dealers and waste collectors.

This brief overview demonstrates the complex nature of segregation behaviour and suggests an inconsistent relationship between the above factors and segregation behaviour of households at different locations. Given the above discrepancies, it would be generally wrong to use the results of the above studies to make a generalization or explain the same situation in a different location. The main purpose of this study therefore is to examine these factors and their relative importance in influencing solid waste separation behaviour of households in Lagos Metropolis.

The conceptual frameworks in which the identified issues are examined in this study include the Sustainable solid waste management, Integrated solid waste management and the Three Rs concepts. Sustainable waste management (SWM) involves using material resources efficiently to cut down on the amount of waste produced, and where waste is generated, dealing with it in a way that actively contributes to the social, economic and environmental goals of sustainable development (De Montfort University, 2012). This sustainability involves the recovery, recycling, and reuse of resources, as well as the reduction of waste streams. The overall objective is to protect human health and the environment by producing less waste and by using it as a resource wherever possible.

Due to the complexity, costs and coordination of waste management, integrated solid waste management approach is to cover all sources and aspects such as generation, segregation, transfer, sorting, treatment, recovery and disposal in an integrated manner, with an emphasis on maximizing resource use efficiency. This is a multi stakeholders approach and hence the need to adopt public-private partnership initiatives; designate land space for construction of engineered sanitary landfills; create enabling environment and provision of policies, guidelines and frame-work which would promote individual, households, community, local, National and foreign investment in SWM. It is the belief of this approach that money and equipment alone cannot solve the waste management problems but the attitude and behaviour of stakeholders in waste management. Therefore, separation at source takes an important place in this concept as well as the sustainable waste management concept.

The Three Rs means Reduce, Reuse and Recycle, indicating hierarchy of waste management. The concept points out that priority be given to reduction, reuse and recycling in that order instead of the usual practice of blindly relying on disposal of all solid waste in landfills. The application of the 3Rs in waste management is to make substantial contributions in meeting all the pillars of sustainability by achieving important reductions in the quantities and types of materials requiring final disposal and thus contribute to approaching zero waste discharge. Reduction is a process of using fewer resources in the first place while Reuse is the process of reusing an item or material that has been discarded and Recycle is the process by which materials are recovered and processed so as to convert them into new products.

The Case Study Area

The study is set in Lagos metropolis, Lagos state, south west Nigeria, on the narrow coastal plain of the Bight of Benin. Lagos metropolis occupies the heart of Lagos State with the Atlantic seaboard as the southern boundary. The metropolitan area comprises of sixteen out of the twenty Local Government Areas which make up the State. These include: Lagos Island, Eti-Osa, Lagos Mainland, Surulere, Ikeja, Ajeromi- Ifelodun, Amuwo-Odofin, Alimosho, Ifako-Ijaye,Apapa, Ojo, Somolu, Kosofe, Mushin, Oshodi-Isolo, and Agege (Figure 1: The LGAs of Lagos Metropolis).

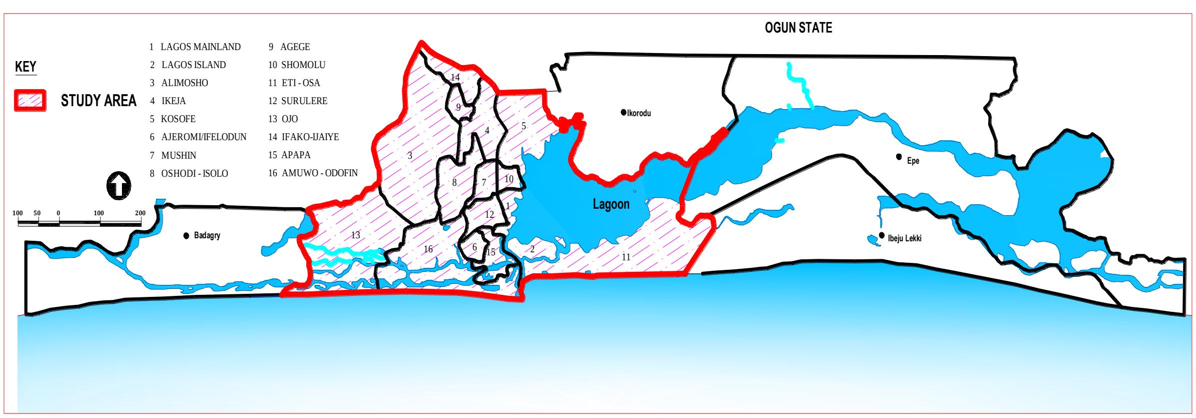


Figure 1: The LGAs of Lagos Metropolis

Lagos Metropolis is presently estimated by UN-HABITAT to have a population of 17 million persons out of a national estimate of 150 million. By the year 2015, the population of Lagos Metropolis is projected to be 24.4 million, becoming the third largest city in the world.

The rapid population growth in Lagos Metropolis poses a number of problems in the urban area. One of the daunting challenges arising from the rapid urbanization of Lagos metropolis is municipal solid waste management (George, 2010). Lagos share of the country's urban population is 30.8% (World Bank, 1996). Hence, Lagos is managing over 30% of the country's municipal solid waste. The constant influx of people into Lagos state and her commercial status make it imperative for high rate of waste generation of all kinds. With the concentration of national socio-economic activities and the presence of over 60% of the country's total industrial and commercial activities; the state is faced with grave urban crisis that is closely associated with municipal solid waste management (Oresanya, 2007).

The agency in charge of waste management in Lagos state is the Lagos State Waste Management Agency (LAWMA). The Private Sector Participants (PSPs) are private companies registered with LAWMA/ Lagos State Ministry of Environment to partake in the collection, disposal and clearance of waste in the city. Household, Industrial, Commercial and Medical waste collection and disposal are handled by the accredited PSP operators all over the state. The house to house method of waste collection is the major method employed in the collection of household wastes in the metropolitan Lagos. Though the Cart system has been abolished, a good number of them are still in operation and constitutes largely the informal sector in solid waste management.

Recently, the waste to wealth approach to waste management has been adopted in Lagos state as a sustainable means of waste management. It involves the recycling of solid waste into various new products. One of the initiatives made towards achieving this programme is the location of recycling banks at designated places in some neighbourhoods. Households are expected to separate their solid wastes into various components before disposing them into the banks. However, from what can be observed, the level of compliance is still low. This is particularly true as household wastes of varying components are still seen lying along major roads, streets and in drains particularly in the densely populated areas. This therefore qualifies Lagos metropolis as a suitable location for this study.

Research Methodology

The factors influencing households' wastes separation behaviour in Lagos metropolis were assessed through a sample survey research approach. Households considered were those in the selected LGA (high, medium and low density areas). Data were collected on the households' characteristics, nature/characteristics of waste generated by households, conventional waste management practices and segregation behaviour of households from which the reasons for solid waste separation and factors responsible for non-separation of solid waste were ascertained. The sample frame is 767,530 households population of the selected local governments (Eti Osa, Surulere and Munshin) in Lagos Metropolis as provided by the Lagos State Bureau of Statistics (2011). A breakdown of this population is shown in Table 1.

Table 1 : Targeted Household Population of the Selected Local Government Areas

S/No	Density Type	Selected LGAs	2006 Population	2014 Population Projection	Estimated 2014 Households
1	Low	Eti Osa	983,515	1,265,373	210,895
2	Medium	Surulere	1,274,362	1,639,572	273,262
3	High	Mushin	1,321,517	1,700,240	283,373
	Total		3,579,394	4,605,185	767,530

Source: Lagos State Bureau of Statistics, 2011.

Using Cochran (1997) formula as cited in Bartlett et al (2001), the sample size for the study is 388 households, representing 0.05% of the total households' population, which is distributed as shown in Table 2.

Table 2: Sample Size for the Selected Local Government Areas

S/No	Density Type	Local Government	Estimated 2014 Household Population	Sample Ratio	Sample Size
1	Low	Eti Osa	210,895	0.05	109
2	Medium	Surulere	273,262	0.05	137
3	High	Mushin	283,373	0.05	142
TOTAL			767,530	0.05	388

Source: Lagos Bureau of Statistics, 2011 and Field Survey, 2014

This study was carried out using a multi-stage random sampling technique. In the first stage, Lagos Metropolis which is made up of sixteen Local government areas was classified into 3 categories of residential neighbourhoods based on the residential density classification. The residential densities identified are High, Medium and Low residential density neighbourhoods. This was done according to residential density grouping by Ashiyanbi (2005). Based on this classification, one local government was selected from each of high, medium, and low residential densities, making it a total of three local government areas. In this case, Mushin was selected to represent the high density residential areas while Surulere and Eti-Osa represented the medium and low density areas respectively.

In the second stage, political wards were randomly selected from each of the chosen local government areas. Four (4) wards were randomly selected from Eti Osa consisting of 20 wards, while five (5) and four (4) wards were randomly selected from each of Surulere and Mushin consisting of 23 and 19 wards respectively. A total number of 13 wards were selected for sampling. Streets in the chosen wards were selected in the third stage based on the intensity of development of houses and thus 43, 47 and 22 streets were chosen in Eti Osa, Surulere and Munshin respectively.

Finally, an average of 2 or 3 houses were selected in the chosen streets by simple random for questionnaire administration on the households. Only one household was sampled in each selected house. The respondents were household members which are 18 years old and above. A total number of 388 questionnaires were administered. Detailed distribution is shown in the Table 3 below

Table 3: Questionnaire Distribution

S/No	Local Government	Selected Political Wards	No of Streets in Each Ward	No of Selected Streets	Apportioned Sample Size
1	Eti Osa	Ikate Lekki	69	14	42
		Ilasan Orile	41	8	16
		Ajiran Osapa	62	12	24
		Maroko/Okun Alfa	45	9	27
	Total	**4**	**217**	**43**	**109**
2	Surulere	Adeniran Ogunsanya	46	9	27
		Iponri/Eric Moore	26	5	15
		Akinhami Cole	39	8	24
		Mosafejo Ojuelegba	38	8	24
		Ararile	84	17	47
	Total	**5**	**233**	**47**	**137**
3	Mushin	Papa Ajao	31	6	42
		Idi Araba	27	5	30
		Babalosa	19	4	28
		Onitire	33	7	42
	Total	**4**	**110**	**22**	**142**
	Grand Total	**13**	**560**	**112**	**388**

Source: Field Survey, 2014

Statistical tools such as means, percentages were used for the descriptive analysis of data collected from the survey while the relative important of factors/reasons for non separation of wastes by the households were analysed using regression analysis.

Findings and Discussion of Results

In order to examine the factors influencing households' wastes separation behaviour, data on households characteristics, types of wastes generated, wastes management practices and wastes segregation behaviour were analysized. The summary statistics of the data collected are presented in Table 4. The characteristics of the households sampled showed that both those that segregate and do not segregate wastes are mostly males (53.60%) whose average age is between 28 – 37 years (35.30%) that attained tertiary education (44.80%) and self employed (24.40%) with average income of between N20,000 – N39,000 per month (27.80%) and with average household size of 4 – 6 persons(63.90%). These characteristics will have effect on the nature of wastes generated and management practices. For instance, studies have shown that that women are more likely to separate waste probably because they are more involved in waste handling (Banga ,2011, Ekere and Drake ,2009 and Schultz, Oskamp, Mainieri ,1995), while others did not see gender as an important factor(Gamba and Oskamp, 1994, Mosler et al, 2008). Households with high income are less likely to engage in waste separation (Banga, 2011) but those with higher education leads to an active participation in waste separation for environmental reasons (Gamba and Oskamp, 1994).

The nature of wastes generated revealed that households mostly generate one 10 litre bucket of wastes per day and with contents mostly consist of metals, glass and ash & sand which has implication on whether the households should segregate or not before disposal. Oyeniyi (2011) studies pointed out those waste components are mixed and heterogeneous as observed in the areas studied and there is no culture of sorting waste by households due to this composition.

The waste management practices revealed that the dominant method of collection and disposal is by LAWMA/PSP (95.40%) in all the study areas and this is not surprising due to high commitment of Lagos State Government to issue of environmental sanitation. However, other households use central refuse dump site (3.10%), by burning (1.30%) and street/drainage channels (0.30%) to dispose their wastes. There is no evidence of use of canals/river/bush for refuse disposal during the survey. Since the dominant method of disposal is by LAWMA/PSP, the study seeks to know how often they operate and if the households separate or do not separate their wastes before collection and disposal. The frequency of wastes collection showed that it is mostly once a week (81.10%) whiles other responses indicated twice a week (13.70%), thrice a week (0.50%) and irregularity (4.70%) in the collection of the wastes by LAWMA/PSP.

Table 4: Descriptive summary statistics of data collected (n = 388)

Variables	Eti Osa		Surulere		Munshin		Total	
	No	%	No	%	No	%	No	%
1 Households characteristics								
- Sex (male)	67	17.30	70	18.00	71	18.30	208	53.60
- Age (28 - 37yrs)	35	9.00	47	12.10	55	14.10	137	35.30
- Education (Tertiary)	86	22.20	41	10.60	47	12.10	174	44.80
- Employment (self)	44	11.30	23	5.90	28	7.20	95	24.40
- Income (20,000-39,000)	12	3.10	46	11.90	50	12.90	108	27.80
- Household size (4 – 6)	75	19.30	75	19.30	98	25.30	248	63.90
2 Waste Disposal Methods								
- LAWMA/PPP	108	27.80	120	30.90	142	36.60	370	95.40
- Central dump	0	0.00	12	3.10	0	0.00	12	3.10
- Drainage channel	0	0.00	1	0.30	0	0.00	1	0.30
- River/bush	0	0.00	0	0.00	0	0.00	0	0.00
- Burning	1	0.30	4	1.00	0	0.00	5	1.30
3 Frequency of waste collection								
- Once a week	102	26.60	112	29.50	95	25.00	308	81.10
- Twice a week	2	0.50	14	3.70	36	9.50	52	13.70
- Thrice a week	0	0.00	1	0.30	1	0.30	2	0.50
- Irregular	6	1.60	2	0.50	10	2.60	18	4.70
4 Households' Waste segregation practices								
- Segregation of wastes	8	2.10	29	7.50	20	5.20	57	14.70
- Non-segregation of wastes	101	26.00	108	27.80	122	31.40	331	85.30
5 Items Segregated								
- Organic	1	1.80	0	0.00	0	0.00	1	1.80
- Paper	0	0.00	1	1.80	2	3.50	3	5.30
- Bottles	2	3.50	3	5.30	0	0.00	5	8.80
- Polythene	0	0.00	1	1.80	0	0.00	1	1.80
- Plastics	4	7.00	9	15.70	8	14.00	21	36.80
- Metals	1	1.80	15	26.50	10	17.50	26	45.60
6 Reasons for waste segregation								
- Earn money	1	1.80	20	35.10	12	21.10	33	57.90
- Manure	0	0.00	0	0.00	0	0.00	0	0.00
- Reuse	1	1.80	2	3.50	0	0.00	3	5.30
- Efficient disposal	6	10.50	7	12.50	8	14.00	21	36.80
7 Reasons for non segregation								
- Lack of space	0	0.00	7	2.00	6	1.70	13	3.80
- Unaffordable bins	3	0.90	6	1.70	1	0.30	10	2.90
- Time consuming	54	15.70	55	16.00	63	18.30	172	50.00
- No incentives	5	1.50	11	3.20	12	3.50	28	8.10
- Collection fees paid	42	12.20	39	11.30	40	11.60	121	35.20

Source: Field Survey, 2014

The segregation of wastes by the households is measured by the types of items sorted or not sorted. This revealed that only 14.70% of the households separate their wastes and the items sorted out are metals (45.60%), plastics (36.80%), bottles (8.80%), paper (5.30%) and polythene & organic materials is 1.80% each. The dominant reasons are to earn money (57.90%), dispose wastes efficiently (36.80%) and reuse (5.30%). A close examination of wastes items segregated and reasons for the segregation shows that metals and plastics are segregated to either earn money or dispose efficiently. However, 85.30% of the households do not separate their wastes before disposal and this is of significant effect on the collection and disposal of wastes. The reasons or factors given for the non separation of wastes revealed that the practice of separation is time consuming (50.0%) and the collection fees paid (35.20%) should be part of the services of LAWMA/PSP to separate the wastes. Other factors identified include no incentives (8.10%) due to the little earnings obtained and absence of sorting containers, lack of space (3.80%) and unaffordable bins (2.90%). These factors corroborated the studies of Chu (2012) and Afroz, Hanaki, Kurisu (2008) that insufficient storage space and non-availability of separate storage containers have also been identified as important factors in influencing segregation behaviour. Also World Resource Institute (1989), identified lack of incentives as one major problem for households to sort and segregate recyclable materials.

In order to determine the level of influence of these factors on why households do not separate their wastes, data on number of households that do not segregate wastes and reasons for such practices were subjected to regression analysis. The dependent variable is the number of households that do not segregate wastes (HNS) and the independent variables are the factors or reasons for the non segregation such as lack of space (LOS), unaffordable bins (UAB), time consuming (TIC), no incentive (NIN) and payment of collection fees (PCF).

Table 5: Definitions of variables in the analysis of the reasons for Non segregation of Wastes.

S/N	Variables	Definition
1	Households non segregation wastes, (HNS)	Number of households that do not segregate wastes before disposal
2	Lack of space, (LOS)	= 1 if respondent is lack of space*
3	Unaffordable bins,(UAB)	= 1 if respondent is unaffordability of refuse bins*
4	Time consuming, (TIC)	Number of hours taken to separate wastes
5	No incentive, (NIN)	= 1 if respondent is no incentive*
6	Payment of collection fees, (PCF)	Amount of money paid as collection fees in Naira

*0 otherwise

The regression model for the variables used is given by:

$$HNS = a + b_1LOS + b_2UAB + b_3TIC + b_4NIN + b_5PCF + e$$

Where $b_1 \ldots\ldots\ldots b_5$ = regression coefficients, e = error term, a = constants and the variables as defined in Table 5

The contribution of the factors to the explanation of the non segregation of wastes before disposal by the households were first determined by non stepwise multiple regression analysis and later by stepwise regression analysis. The results of the multiple regression analysis are presented in Table 6. The overall performance of the multiple regression analysis is good as indicated by R^2 statistics of .607 and F – value of 59.291. The R^2 value means that 60.7% of the overall explanations to the variations in the reasons for non segregation wastes in the study areas are provided by the variables entered in Table 6.

Table 6: Multiple Regression Analysis: Households Non Segregation of Wastes

Variables	Regression coeff	Standard error	t-value	Sign. level
LOS	.033	.147	.626	.532
TIC	-.371	.108	-5.495	.000
UAB	.029	.158	1.096	.273
PCF	-.146	.111	-2.187	.029
NIN	.099	.049	3.312	.001
Constant	5.084	.556	9.146	.000
R^2 = .607	SEE = .882	F – Value = 59.291		

However, the coefficients of the variables and their t – values show that some variables are not significantly important in the overall explanation to the variations in the reasons for non segregation of wastes.

In order to determine the order of importance and quantitatively obtain the contributions of the various variables to the overall explanation of reasons for non segregation, the stepwise regression model is utilized. The stepwise model proceeds by selecting variable with the highest correlation with the dependent variable. The variable is entered in the first step, and is that which makes the greatest reduction in the error sum of squares. This procedure continues until all meaningful independent variables with successively smaller partial correlations have been entered. That is, the most important variables are first entered into the model followed by the least important variables as shown in Table 7.

Table 7: Stepwise Regression Analysis: Households Non Segregation of Wastes

step	Variables entered	Multiple R	R^2	R^2 Change	Regression coefficient	t - value	Sign. level
1	TIC	.692	.517	.517	-.371	-5.495	.000
2	PCF	.736	.635	.118	-.146	-2.187	.000
3	NIN	.754	.660	.025	.099	3.312	.001
4	LOS	.770	.663	.003	.033	.626	.433
5	UAB	.774	.665	.002	.029	1.096	.254
F – value = 131.515							

The most important reason or factor explaining the variations in the number of households that do not separate wastes is time consuming (TIC). The TIC is fairly significant and accounts for 51.7% of variations in the number of households. The TIC coefficient indicates that an increase in the number of hours in separating wastes would result to a 0.371 decrease in the number of households that do not segregate wastes before disposal. This is true as confirmed in the data collected, where 50% of the households do not segregate wastes because it is time consuming. This implies that the number of the households would increase if less time is spent in sorting the wastes.

The second most important variable is the payment of collection fees (PCF), which accounts for 11.8% of the variations in the number of households that do not separate wastes. The PCF coefficient means that an increase in the amount of money paid for wastes collection would bring about a .146 decrease in the number of households that would not separate wastes before disposal. This is because the survey shows that 35.20% of the households would not separate wastes due to the fact that they also paid fees to collect wastes by LAWMA and do not need separation before disposal.

The next variable in order of importance is no incentive (NIN). This variable accounts for 2.5% of the variations in the number of households that do not separate wastes. The NIN coefficient has a positive association with the number of households and which shows that household would increase if there are encouragements such as ready market for the sorted items as well as sorting containers, for them to separate their wastes before disposal. This is why responses show that 8.10% of the households are unwilling to separate their wastes before disposal because of no incentives.

After the third step, the two other variables are not too significant because each of the variables accounts for less than 1% of the variations in the number of households that do not separate wastes before disposal.

The conclusion is that the significant factors that deter households not to separate wastes before disposal are time consuming, payment of collection fees and no incentive, in that order.

Conclusion

In this study, the factors influencing households' waste separation behaviour have been examined and it was discovered that time consuming, collection fees payment and no incentives were important factors responsible for the households' non separation of wastes. This is because the R^2 change in the regression analysis showed that the factors contributed 51.70% (time consuming), 11.80% (collection fees payment) and 2.50% (no incentives) to the variations in the reasons why households do not separate wastes before disposal in Lagos metropolis.

Therefore, it is recommended that the households be encouraged to see the need for wastes segregation by the provision of wastes recycling banks in order to ensure reduction in time for wastes sorting, reuse of wastes materials to reduce environmental degradation; and proper enlightenment of wastes segregation for wealth creation and economic support for households' livelihoods. This means that LAWMA, the Local governments and households should see wastes segregation as business opportunity and source of revenue by extracting valuable resources that can still be used and safely processing and disposing wastes with minimum impact on the environment

References

Adejobi, O. S., &Olorunnimbe, R. O. (2012). Challenges of Waste Management and Climate Change In Nigeria: Lagos State Metropolis Experience. *African Journal of Scientific Research*, 7 (1).

Afroz, R., Hanaki, K., Kurisu, K. (2008). Factors Affecting Waste Generation and Willingness to Recycle: A Study in a Waste Management Program in Dhaka City, Bangladesh. Universiti Malaysia Sarawak (UNIMAS), WPS. No 0803.

Ashiyanbi, J. (2005). Review of the Lagos State Regional Master Plan (1980-2000). Lagos State Ministry of Physical Planning, Alausa, Ikeja.

Ayuba, K. A., Manaf, L.A., Sabrina, A. H., Azmin, S. W. (2013). Current Status of Municipal Solid Waste Management Practice in FCT Abuja.*Research Journal of Environmental and Earth Sciences,* 5(6): 295 -304.

Banga, M. (2011). Household Knowledge, Attitudes, and Practices in Solid Waste Segregation and Recycling: The Case of Urban Kampala.*Zambia Social Science Journal*, 2 (1).

Bartlett, J.E. Kotrlik. K.L. and Higgen J.W. 2001. Organizational research: Determining appropriate sample size in survey research. *Information Technology Learning and Performance Journal.* 19.1: pp 43 - 50.

Beall, J. (1997). Thoughts on Poverty from a South Asian Rubbish Dump: Gender, Inequality and Household Waste.*IDS Bulletin,* 28(3): 73 -90.

Chu, Z., (2012). Factors Influencing Residents' Recycling Behaviour about Municipal Household Solid Waste: A China Case Study. *Journal of Food, Agriculture, and Environment,* 10(3&4): 1427-1432.

De Montfort University (2012). Transforming De Montfort University into a Living Example of Sustainability: Sustainable Waste/Sustainable Waste Management. Retrieved on March 13, 2014 From http://www.thelivinglabiesd.wordpress.com

Ekere, W., Mugisha, J., Drake, L. (2009). Factors Influencing Waste Separation and Utilization among Households in the Lake Victoria Crescent, Uganda.

Gamba, R. J. &Oskamp, S. (1994). Factors Influencing Community Residents' Participation in Comingled Curbside Recycling Programs.*Environment and Behaviour*, 26 (5): 587-612.

George, C. K. (2010). Challenges of Lagos as a Mega City. Retrieved from http//:www.allafrica.com on 14/03/13.

Klundert, A., Anschutz, J.(2001) Integrated Sustainable Waste Management – The Concept, Tools For Decision makers: Experiences from the Urban Waste Expertise Programs (1995-2001).

LAWMA (2010). Waste to Wealth: LAWMA, Extending Frontiers to Neighboring Countries. Retrieved From http//:www.vanguardngr.com on 14/03/13.

Longe, E. O., Longe, O.O., Ukpebor, E. F. (2009). People's Perception on Household Solid Waste Management in Ojo Local Government Area in Nigeria.*Iran. J. Environ. Health. Sci. Eng,*6(3): 201-208.

Matter, A., Dietschi, M., Zurbrügg, C. (2013).Improving the informal recycling sector Through Segregation of Waste in the Household – The Case of Dhaka Bangladesh. *Habitat International,* 38: 150-156.

Mosler, H. J., Drescher, S., Zurbrugg, C., Rodriguez, T. C.,Miranda, O. G. (2006). Formulating Waste Management Strategies based on Waste Management Practices of Households in Santiago De Cuba. *Habitat International*, 30:849-862.

Oduwaye, L. & Ilechukwu, V. U. (2012). Assessment of Waste Management and Urban Governance in Lagos Metropolis. Regional Development Studies Journal, United Nations Centre for Regional Development /University of Nairobi, Kenya, Vol. 16 pp 40 – 52.

Ogwuche, J. &Yusufu, F. A. (2011). Assessment of Factors Influencing the Generation and Disposal of Urban Household Solid Waste in Africa: The Nigerian Perspective. *Journal of Environmental Sciences and Resource Management*, vol 3.

Oresanya, O. (2007). Solid Waste Management for Sustainable Human Settlement Development: The Case of Lagos Metropolis. Paper Presented at the Monthly Meeting of NITP, Lagos state Chapter on 21st Aug, 2007.

Oyeniyi, B. A. (2011). Waste Management in Contemporary Nigeria: The Abuja Example. International *Journal of Politics and Good Governace,* 2(2.2): Quarter II.

Senkwe, B. k., & Mwale, A. H. (2001). Solid Waste in Kitwe, Solid Waste Characterization Study for the City of Kitwe, Zambia: Phase 1 IHS SINPA PAPERS, SINPA NUMBER 28/2001.

Schultz, P. W., Oskamp, S., Mainieri, T. (1995). Who Recycles and When? A review of Personal and Situational Factors. *Journal of Environmental Psychology,* 15(2):105-121.

Scott, D. (1999). Equal Opportunity, Unequal Results: Determinants of Household Recycling Intensity. *Environment and Behaviour*, 31(2): 267-290.

Simmons, D. A., &Widmar, R. (1990). Participation in Household Solid Waste ReductionActivities: The Need for Public Education.*Journal of Environmental Systems*, 19, 4, 323-330.

Uchegbu, S. N. (2002). Environmental Management and Protection. Spotlite Publishers, Enugu, Nigeria.

UNEP (1996). International Source Book on Environmentally Sound Technologies for Municipal Solid Waste Management. Osaka, UNEP International Environmental Technology Centre.

UN-Habitat (2008). The State of African Cities 2008: A Framework for addressing Urban Challenges in Africa. Retrieved from http//:www.stanford.edu on 14/03/13.

Valle, P., Reis, E., Menezes, J., Rebelo, E. (2004). Behavioural Determinants of Household Recycling Participation.*Environment and Behaviour,* 36(4): 505-540.

Werner, C. N., &Makela, E. (1998).Motivations and Behaviours that support Recycling.*Journal of Environmental Psychology*, 18(4): 373-386.

World Bank (1996). Nigeria, Poverty in the Midst of Plenty: The Challenge of Growth with Inclusion. A world Bank Poverty Assessment.

HEALTH AND SAFETY ISSUES

EFFECTIVENESS OF FROTH FLOTATION METHOD FOR THE BENEFICIATION OF BABAN TSAUNI (NIGERIA) LEAD-GOLD ORE

E.A.P. EGBE[1,*], E. MUDIARE[1], O.K.ABUBAKRE[1], M.I. OGUNBAJO[2]
[1]Mechanial Engineering Department, Federal University of Technology, Minna.
[2] Department of Geology, Federal University of Technology, Minna.

The response of Baban Tsauni (Nigeria) lead-gold ore to froth flotation method was investigated in this research work. Value addition to run-off mines is always necessary in order to reduce downstream metal extraction costs. The work investigated the response of the ore to varying alkaline conditions, the presence of depressant and amount of collectors. Sodium ethyl xanthate was used as collector while the traditional frother (pine oil) was used. The work established that a pH level of 8.5 was best suited for froth flotation beneficiation of the ore. The work established the effectiveness of froth flotation for beneficiation of Baban Tsauni lead-gold ore. Flotation of the raw samples gave a lead recovery of 90.25% at a lead grade of 66.88% while flotation of pre-concentrated sample gave a recovery of 96% at a grade of 66%.

Key Words: Metals, Flotation, beneficiation, reagent, recovery, grade.

evus.egbe@gmail.com

Egbe et.al (2016). **EFFECTIVENESS OF FROTH FLOTATION METHOD FOR THE BENEFICIATION OF BABAN TSAUNI (NIGERIA) LEAD-GOLD ORE** Sustainable Built Environment and Climate change; The challenges of Post 2015 Development Agenda. School of Environmental Technology Conference, SETIC, 2016

INTRODUCTION

Production of metals from their ores usually requires some form of energy (heat, electrical or chemical) and the energy consumption depends on the mass of feed (valuable mineral plus gangue). This implies that feeds of higher grades cost less to extract (Wills and Napier-Munn, 2006). Thus grades of ores required for metallic extraction by the known metallurgical routes are much higher than their cut-off grades (Gupta, 2003). Lead extraction by pyrometallurgical process requires feed grades of 40% to 70% while copper extraction requires 20% to 30% (Davenport *et al*., 2002; Bulatovic, 2007). Moreover the cost of transportation decreases with increase in ore grade (Wills and Napier-Munn, 2006). Thus the mineral grade must be increased above that of the run-off-mine to the value required by extraction plants. Egbe et al (2013) indicated that the lead and gold grades of Baban Tsauni run-off-mine are 27.79% and 0.02938% respectively.

Beneficiation is the process by which the concentration of the valuable constituent in an ore is increased while impurities are removed or reduced to practically acceptable levels. As applied to metallic minerals, it involves upgrading of the valuable metal while reducing the gangue to acceptable level in the ore.

The responses often considered in beneficiation of metallic minerals are recovery and grade of the valuable minerals (Olubambi and Portgieter, 2005; Seke and Pistorius, 2005; Gupta and Yan, 2006; Wills and Napier-Munn 2006; Damisa, 2008; Egbe, 2012). Recovery is the measure of the percentage of metal in the raw ore that is recovered to the concentrate through beneficiation while grade is the assay or concentration of a metal in a sample (Guadin 1992). The X-Ray fluorescence (XRF) test is often used for determination of the elemental composition (assay or grade) of raw ore, concentrates and tailings (Wills and Napier-Munn 2006; Egbe et al., 2013_a; Muriana et al., 2014) . Wills and Napier-Munn (2006) indicated that recovery is calculated by applying Equation 1;

$$R = 100\frac{Cc}{Ff} \qquad 1$$

where R= recovery of valuable metal, C = the mass of the concentrate, c= the concentration of metal in concentrate, F = the mass of feed sample and f = concentration of metal in feed sample.

Egbe et al. (2013_b) indicated that a pre-concentration treatment of the ore by gravity method yielded a lead grade of 55.24 % at a lead recovery of 95.66 %. Thus further beneficiation of this ore by froth flotation is required to improve on the lead grade of the concentrate.

The main objective of this work is to determine the best froth flotation requirements for the treatment of the ore. The focus is the floatability of lead, since copper was only present as trace mineral while zinc was not detected in most samples (Egbe et al., 2013_a). The beneficiation studies involved both raw ore and pre-concentrated ore samples. This is due to the fact that all comminution methods (crushing and grinding) produce some amount of fine particles which cannot be treated economically by gravity separation methods.

Experimental Methods

Sample Preparation

Eighty kilograms (80kg) of ore samples were collected from four mining pits at Baban Tsauni, Gwagwalada, Nigeria. All the samples collected were mixed together before crushing. An initial sample preparation aimed at ensuring a homogeneous feed for subsequent test runs was carried out. The crushed samples from the jaw crusher /roll crusher (in that order) were subjected to the same grinding conditions of mill speed, ore mass to ball mass ratio, ball size and grinding time of 15minutes. The products of this batch milling operations were subjected to particle sizing to generate sets of close sized particles based on ratio $1/\sqrt{2}$ between the consecutive sieve sizes. Each set of close sized particles from all the batch sieving operations were mixed thoroughly and passed through a Jones riffling sampler, until sets of 500g samples were obtained for subsequent tests.

Froth flotation

Four hundred grams (400g) of the ore was put in the flotation cell and about 900g of water was added to make a pulp of about 31% solid by weight. The collector (sodium ethyl xanthate) was added and the machine started with the air valve locked. After a minute the machine was stopped and the pulp pH was checked with a pocket pH meter. Either dilute solutions of sodium hydroxide, lime or sulphuric acid was added with the help of pipettes until the attainment of desired pH. Conditioning of the pulp continued for another 5minutes before 0.8ml of frother (pine oil) was added, followed by release of air into the cell. A scraper was used to collect the froth into trays after every minute.

When froth production ceased, the float (concentrates) and the residue (tailings) were washed and allowed to settle for about 20minutes. They were then decanted and filtered before drying to constant weight in an oven at a temperature of 110^{o}C. Finished products were weighed before samples were taken for assay analysis.

Results and discussion

Assay results of the first set of flotation experiments under varying reagents and conditions are presented in Tables 1 to 9. The XRF analysis results of all the concentrates indicated that lead mineral was the major valuable mineral that reported to the concentrate while the second major valuable mineral, gold reported to the tailings. Cadmium mineral was a minor mineral and most of it reported to the concentrate.

Table 1: Assay analysis of concentrates of bulk flotation (pH: 8.5).

Oxides	Concentration (%)	Elements	Concentration (%)
PbO	76.4	Pb	70.869
CuO	0.17	Cu	0.136
Al2O3	1.6	Al	0.847
SiO2	17	Si	9.520
CaO	0.49	Ca	0.350
TiO2	0	Ti	0.000
Cr2O3	0.1	Cr	0.068
MnO	0.02	Mn	0.015
Fe2O3	1.01	Fe	0.706
NiO	0.058	Ni	0.046
CdO	1.9	Cd	1.662
BaO	1.02	Ba	0.914
WO3	0.25	W	0.198

Note: pH regulator: NaOH; pH value: 8.5; Frother: pine oil; Depressant: NaCN

Collector: Sodium ethyl xanthate; Collector dosage:0.26g/tonne

Total mass of feed sample: 370.1g; Mass of floated fraction: 110.2

Table 2: Assay analysis of residues of bulk flotation (pH: 8.5).

Oxides	Concentration (%)	Elements	Concentration (%)
PbO	13.16	Pb	12.21
CuO	0.091	Cu	0.07
ZnO	0.02	Zn	0.02
Au	0.03	Au	0.03
Al2O3	4.62	Al	2.44
SiO2	48.4	Si	27.10
K2O	0.777	K	0.64
CaO	0.661	Ca	0.47
TiO2	0.058	Ti	0.03
Cr2O3	0.042	Cr	0.03
MnO	0.035	Mn	0.03
Fe2O3	1.4	Fe	0.98
NiO	0.023	Ni	0.02
BaO	1.48	Ba	1.33
WO3	0.23	W	0.18
Re2O7	0.03	Re	0.02
OsO4	0.15	Os	0.11
IrO2	0.02	Ir	0.02
HgO	0.22	Hg	0.20

Note: pH regulator: NaOH. pH value: 8.5; Frother: pine oil; Depressant: NaCN

Collector: Sodium ethyl xanthate; Collector dosage: 0.26g/tonne;

Total mass of feed sample: 370.1g. Mass of residues: 259.9g.

The lead assay for the feed sample was 29.27%. The lead recovery was calculated by applying Equation 1 to the data presented in Table 1.

$$R = 100 * \frac{C * c}{F * f} = 100 * \frac{110.2 * 70.87}{370.1 * 29.27} = 72.09\%.$$

where C=mass of concentrate, c=mineral assay in concentrate, F=mass of feed and f=mineral assay in feed sample.

A careful check through Tables 1 and 2 revealed that all the gold was recovered to the tailings. The gold was upgraded from 0.0266% to 0.03%. This gave an enrichment ratio of 1.12782.

The lead assay and recovery obtained suggested that the ore yielded good beneficiation by froth flotation under these conditions (collector dosage of .26g/tonne, pH value of 8.5, sodium hydroxide as pH regulator and sodium cyanide as depressant). Further cleaning of the tailings would increase lead recovery and the grade of gold. No further cleaning of the concentrate was necessary since a lead assay of 70.869 was regarded as high grade.

Table 3: Assay analysis of floated fraction of bulk flotation (pH: 10.5).

Oxides	Concentration (%)	Elements	Concentration (%)
PbO	56.1	Pb	52.03836
CuO	0.205	Cu	0.1637335
ZnO	0.007	Zn	0.0056224
Al2O3	2.8	Al	1.48148
SiO2	31.2	Si	17.472
SO3	1.4	S	0.56
CaO	0.548	Ca	0.3917104
TiO2	0.02	Ti	0.011984
Cr2O3	0.055	Cr	0.03762
MnO	0.02	Mn	0.01548
Fe2O3	1.75	Fe	1.2229
NiO	0.039	Ni	0.0306618
CdO	4	Cd	3.4996
BaO	1.37	Ba	1.227657
WO3	0.24	W	0.19032
Re2O7	0.13	Re	0.09991735
OsO4	0.1	Os	0.074823

Note: pH regulator: NaOH; pH value: 10.5; Frother: pine oil; Depressant: Non;

Collector: Sodium ethyl xanthate; Collector dosage: 0.26g/tonne

Total mass of feed sample: 343.3g; Mass of concentrates: 147.9g

All the gold in the feed sample was recovered to the tailings. Table 4 shows a gold grade of 0.07%. This implied a gold enrichment (0.07/0.02938) of 2.383. This was higher than the lead enrichment (52.03836/29.27) that was 1.778.

Table 4: Assay analysis of residues of bulk flotation (pH: 10.5).

Oxides	Concentration (%)	Elements	Concentration (%)
PbO	14.24	Pb	13.209024
CuO	0.109	Cu	0.0870583
Au	0.07	Au	0.07
Al2O3	4.11	Al	2.174601
SiO2	75.54	Si	42.3024
SO3	1.6	S	0.64
K2O	0.51	K	0.423249
CaO	0.531	Ca	0.3795588
TiO2	0.1	Ti	0.05992
Cr2O3	0.034	Cr	0.023256
MnO	0.033	Mn	0.025542
Fe2O3	1.27	Fe	0.887476
NiO	0.016	Ni	0.0125792
CdO	0.46	Cd	0.402454
BaO	1.05	Ba	0.940905
WO3	0.13	W	0.10309
Re2O7	0.11	Re	0.08454545
OsO4	0.085	Os	0.06359955

Note: pH regulator: NaOH. pH value: 10.5. Frother: pine oil. Depressant: Non

Collector: Sodium ethyl xanthate. Collector dosage: 0.26g/tonne

Total mass of feed sample: 343.3g. Mass of residues: 195.4g

The major difference between the cell condition that yielded the results (Tables 1 and 2) discussed above and the data in Tables 3 and 4 was the change from a pH value of 8.5 to 10.5. By a similar calculation the lead recovery was 76.5941% and a lead grade of 52.038%. The 4.5% increase in lead recovery did not justify the drastic drop in lead grade. Thus the effect of increasing the pH value from 8.5 to 10.5 was reduction in flotation of lead.

The flotation test run which produced the data presented in Tables 5 to 7 only differ from the first set of data above by introduction of a second stage flotation of what could have been the residue and the use of lime as pH regulator instead of sodium hydroxide. In addition, no depressant was used. Upward adjustment of the pH value to 9.5 with no further addition of collector produced the second floated fraction (Table 6).

Table 5: Assay of first float of bulk flotation at pH of 8.5 ($Ca(OH)_2$ used as pH regulator).

Oxides	Concentration (%)	Elements	Concentration (%)
PbO	72.1	Pb	66.880
CuO	0.223	Cu	0.178
Al2O3	1.4	Al	0.741
SiO2	15.2	Si	8.512
SO3	3	S	1.200
CaO	0.41	Ca	0.293
Cr2O3	0.06	Cr	0.041
MnO	0.02	Mn	0.015
Fe2O3	1.25	Fe	0.874
NiO	0.055	Ni	0.043
CdO	4.1	Cd	3.587
BaO	1.88	Ba	1.685
WO3	0.29	W	0.230

Note: pH regulator: Lime ($Ca(OH)_2$); Frother: Pine oil; Collector: Xanthate (0.26g/tonne); Depressant: Non; Mass of concentrate =158g; Mass of feed= 400g.

A similar application of Equation 1 to the data on the first floated fraction yielded a lead recovery of 90.25% at a lead grade of 66.88%. This result gave a better combination of lead grade and recovery than the result obtained above when sodium hydroxide was used as pH regulator even though the former produced higher grade. Economic considerations showed that the net smelter return (NSR) on the latter was higher than that on the former. The results presented above indicated that a better flotation of galena was achieved by using lime as pH regulator than by using sodium hydroxide.

In order to calculate the lead recovery from the second float, the mass of the sample remaining in the cell at the beginning of this unit operation must be estimated by applying mass balance. Since the dry mass of the material removed was 158g and the mass of feed was 400g, the mass of feed at the beginning of this operation was 242g. Substituting this and the relevant data given in Table 5 into Equation 1 yielded,

$$R = 100 * \frac{C * c}{F * f} = 100 * \frac{14.6 * 52.595}{242 * 29.27} = 10.84\%.$$

This recovery was very small and indicated that changing pH value alone could not yield reasonable recovery even though some more materials were floated.

Table .6: Assay of second float of the bulk flotation at a pH of 9.5.

Oxides	Concentration (%)	Elements	Concentration (%)
PbO	56.7	Pb	52.595
CuO	0.212	Cu	0.169
Al2O3	2.9	Al	1.534
SiO2	29.3	Si	16.408
SO3	0.95	S	0.38
CaO	0.72	Ca	0.515
TiO2	0.064	Ti	0.038
Cr2O3	0.063	Cr	0.043
Fe2O3	2.53	Fe	1.768
NiO	0.04	Ni	0.031
CdO	4.6	Cd	4.025
BaO	1.41	Ba	1.264
WO3	0.26	W	0.206
OsO4	0.09	Os	0.0673407
Rh2O3	0.22	Rh	0.178425192

Note: pH regulator: Lime ($Ca(OH)_2$);Frother: Pine oil

Mass of concentrate: 14.6g; Total solid mass in cell: 242g.

Table 7: Assay of the tailings of bulk flotation at a pH of 9.5.

Oxides	Concentration (%)	Elements	Concentration (%)
PbO	7.18	Pb	6.660168
CuO	0.059	Cu	0.047
Au	0.085	Au	0.085
Al2O3	7.27	Al	3.847
SiO2	80.7	Si	45.192
SO3	0.34	S	0.136
K2O	0.784	K	0.651
CaO	0.73	Ca	0.522
TiO2	0.088	Ti	0.053
Cr2O3	0.04	Cr	0.027
MnO	0.036	Mn	0.028
Fe2O3	1.46	Fe	1.02
NiO	0.013	Ni	0.01
BaO	0.48	Ba	0.43
WO3	0.073	W	0.058
Re2O7	0.11	Re	0.085
OsO4	0.077	Os	0.058
IrO2	0.02	Ir	0.017
P2O5	0.4	P	0.175

Note: pH regulator: Lime ($Ca(OH)_2$); pH = 9.5; Frother: Pine oil

Mass of lead tailings: 211.2g; Mass of feed: 400g.

A careful check through Tables 5 to 7 revealed that all the gold was recovered to the tailings. The gold was upgraded from 0.02938% to 0.085%. This gave an enrichment ratio of 2.893. This was higher than the enrichment ratio of lead, which was (66.88/29.27) = 2.284933. The only by-product of this ore was cadmium and it was completely recovered to the concentrate in the case under review. A perusal of all the flotation results showed that cadmium exhibited very high recovery to the concentrate.

Pine oil was traditionally used as frother in flotation treatment of ores. Several other frothers have been developed over the years (Bulatovic, 2007). A good frother stabilises the froth. The pine oil was replaced with coolant oil and the results presented in Tables 8 and 9 show an increase in concentration ratio when compared to the previous results with the use of pine oil. The total lead recovery was found to be 95.33% and a mean grade of 53.078%.

Table 8: Assay analysis of first float from bulk flotation (pH: 8.5).

Oxides	Concentration (%)	Elements	Concentration (%)
PbO	58.1	Pb	53.894
CuO	0.184	Cu	0.147
Au	0.03	Au	0.030
Al2O3	2.6	Al	1.376
SiO2	30.1	Si	16.856
SO3	1.3	S	0.520
CaO	0.844	Ca	0.603
TiO2	0.04	Ti	0.024
Cr2O3	0.12	Cr	0.082
MnO	0.034	Mn	0.026
Fe2O3	1.54	Fe	1.076
NiO	0.052	Ni	0.041
CdO	3.3	Cd	2.887
BaO	1.53	Ba	1.371
WO3	0.25	W	0.198
IrO2	0.02	Ir	0.017

Note: pH regulator: Ca(OH)2; pH value: 8.5; Frother: coolant oil; Depressant: none;

Collector: Sodium ethyl xanthate; Collector dosage: 0.26g/tonne;

Mass of feed sample: 500g; Mass of concentrates: 216.6g

Table 9: Assay analysis of second float from bulk flotation (pH = 9.5).

Oxides	*Concentration (%)*	*Elements*	*Concentration (%)*
PbO	55.6	Pb	51.575
CuO	0.188	Cu	0.150
Al2O3	2.6	Al	1.376
SiO2	27.9	Si	15.624
SO3	1.9	S	0.760
CaO	1.37	Ca	0.979
TiO2	0.03	Ti	0.018
Cr2O3	0.064	Cr	0.044
MnO	0.024	Mn	0.019
Fe2O3	1.7	Fe	1.188
NiO	0.039	Ni	0.031
CdO	6.5	Cd	5.687
BaO	1.55	Ba	1.389
WO3	0.22	W	0.174
Re2O7	0.14	Re	0.108
OsO4	0.09	Os	0.067

Note: pH regulator: $Ca(OH)_2$. pH value: 9.5. Frother: coolant oil;

Collector: Sodium ethyl xanthate; Collector dosage: 0.26g/tone.

Mass of feed sample: 500g; Mass of concentrates: 117.2g

The major valuable mineral recovered to the concentrates was galena (PbS). The gold reported to the tailings in all cases. Lead recovery was highest at a pH value of 8.5 when the same pH regulator was used at different pH values. It was observed that the use of lime as pH regulator produced higher lead recoveries than when sodium hydroxide was used.

Conclusion

The work established the effectiveness of sodium xanthate as collector, lime as pH regulator, and pine oil (or coolant oil) as froth enhancer for treatment of this ore. The reagents demands for the beneficiation of Baban Tsauni lead –gold ore were established. The work revealed that lime (Ca(OH)2) served as a better pH regulator than sodium hydroxide. A good combination of lead recovery and grade of 90.25% and 66.88% respectively, at an optimum pH of 8.5 and collector consumption of 0.26g/tonne was achieved in this work. Froth flotation also enriched the value of gold from 0.02938% to 0.085%. This work has established the effectiveness of froth flotation method for beneficiation of Baban Tsauni (Nigeria) lead gold ore,

References

Bulatovic, S.M. (2007). *Handbook of Flotation Reagents, Chemistry, Theory and Practice: Flotation of Sulphide Ore*. Amsterdam: Elsevier Science and Technology Book. P448.

Damisa, E.O.A. (2008). *Beneficiation Potentials of Nahuta Lead Deposit, Bauchi State, Nigeria*, Thesis Submitted in Partial Fulfilment for the Award of the Degree of Doctor of Philosophy, Department of Metallurgical Engineering, Faculty of Engineering, Ahmadu Bello University, Zaria, Nigeria.

Davenport, W.G., King, M., Schlesinger, M. and Biswas, A.K. (2002). *Extractive Metallurgy of Copper*. Oxford, UK: Pergamon, Elsevier Science Limited, P460.

Egbe, E.A.P., (2012). *Characterization and Beneficiation of Baban Tsauni, Gwagwalada Ore, Nigeria,* **T**hesis Submitted in Partial Fulfilment for the Award of the Degree of Doctor of Philosophy, Department of Mechanical Engineering, School of Engineering and Engineering Technology, Federal University of Technology, Minna, Nigeria.

Egbe, E.A.P. Mudiare, E., Abubakre, O.K. and Ogunbajo M.I. (2013_a). *Characterization Study of Baban Tsauni (Nigeria) Lead-Gold Ore*, International Journal of Management, IT and Engineering, vol. 3(7), 669-686.

Egbe, E.A.P. Mudiare, E., Abubakre, O.K. and Ogunbajo M.I. (2013_b). *Effectiveness of Gravity Separation Methods for the Beneficiation of BabanTsauni (Nigeria) Lead-Gold Ore*, International Journal of Scientific and Research Publications, Vol. 3, (5), 1-7.

Gaudin, A.M. (1992). *Principles of Mineral Dressing*. New Delhi: TATA McGraw-Hill Publishing Company Ltd, p 543.

Gupta C.K. (2003). *Chemical Metallurgy: Principles and Practice*. Weinheim: Wiley-VCH Verlag GmbH and Company, 1-222.

Gupta, A. and Yan, D.S. (2006). *Mineral Processing Design and Operation- An Introduction*. Amsterdam, Elsevier B.V., P693.

Muriana, R. A., Muzenda, E. and Abubakre O. K. (2014). *Carbothermic Reduction Kinetics of Ka'oje (Nigeria) Manganese Ore,* Journal of Minerals and Materials Characterization and Engineering, 2, 392-403.

Olubambi, P.A, and Potgieter, J.H. (2005). *Effectiveness of gravity concentration for the beneficiation of Itakpe (Nigeria) iron ore achieved through jigging operation*. Journal of Minerals and Materials Characterization and Engineering, 4(1), 21-30.

Seke, M.D. and Pistorius P.C. (2005). *The effect of mode of occurrence of galena and sphalerite on the selective flotation of ore samples from the Rosh Pinah mine*. The South African Institute of Mining and Metallurgy. The Third Southern African Conference on Base Metals, 161-184.

Wills, B.A. and Napier-Munn, T. (2006). *Wills' Mineral Processing Technology-An Introduction to the Practical Aspects of Ore Treatment and Mineral Recovery.* Seventh Edition. Amsterdam: Elsevier Science and Technology Books. P450.

ASSESSMENT OF FIRE SAFETY PROVISIONS IN TERTIARY INSTITUTION HOSTEL BUILDINGS IN NIGER STATE.

ALIYU, Waziri Ibrahim, and ABDULRAHMAN, Mukaila El-Hussain
Department Of Architecture, Federal University of Technology Minna, Niger State,

Fire safety measures have become an issue of neglect in most tertiary institution hostel buildings in Niger state and have contributed to the continuous fire outbreak. This has equally become a university management concern in our society today. This paper tends to assess the level of fire safety measures in tertiary institution hostel buildings by identify the problems and attitudes associated with fire outbreak in hostels and proffering solution through research approach that will help to prevent fire outbreak, restricting damage and maximize life safety in in tertiary institution hostels in Niger state. To achieve this, a well-structured questionnaire and observation schedule were used to acquire data in some selected tertiary institution in Niger state. The findings shows that the fire safety equipment is not available or not functional in the hostels also; most of the students in the hostels are not conversant with the usage of such equipment. Means of evacuation of students from the building during any event of fire are discovered to be below requirement. Door and window protectors cause hindrance to escape during fire incidence. Ineffective fire safety equipment management, ignorance of the professional during planning of stage is also a factor affecting the integration of the safety equipment and preventive measures. The research recommends that proper scrutiny of hostel buildings be made by the school management from time to time to ensure that all fire safety precautions are in functional condition, and orientation of students in the hostels about what to do in occurrence of fire outbreak.

Keywords: *Fire, Fire Hazard, safety, Health, Hostel Building,*

aliyu.waziri@yahoo.com

ALIYU, Waziri Ibrahim, and ABDULRAHMAN, Mukaila El-Hussain (2016). **ASSESSMENT OF FIRE SAFETY PROVISIONS IN TERTIARY INSTITUTION HOSTEL BUILDINGS IN NIGER STATE** Sustainable Built Environment and Climate change; The challenges of Post 2015 Development Agenda. School of Environmental Technology Conference, SETIC, 2016

INTRODUCTION

According to Schmerts (1972), tertiary institutions should be designed to accommodate students in hostels within the school environment for effective and optimal of academic activities. These hostels should be comfortable and could be in the form of rooms, halls or apartments. Facilities like toilets, laundry, lounge, etc., are also provided for the convenience of students. The provision of these facilities is usually guided by set standards as well as the number of students expected to reside in the hostels (Ernst and Neufert, 1993).

The little attention paid by Nigerian government and authorities of institutions to housing has led to gross inadequacy in hostel facilities, resulting to overcrowding, over-utilization, deterioration of facilities and higher fire risks. It has increased the number of off-campus students who cannot find spaces in the available hostels. The effect of this situation on academic performance, health and social behaviour of students is negative and cannot be over emphasized (Onwuka, 1990).

Fire Hazards Occurrence In Hostel Buildings

The current trend of frequent fire outbreak in hostels has become a major concern for all. There have been a lot of incidences of fire in hostels, where students lost their lives and properties. According to daily champion newspaper (2011), a fire incident occurrence destroyed one of the students' hostels in government girls' secondary school, rogogo, katsina state. The inferno was caused as a result of electrical fault. Another incident occurred in a hostel at Jos; Plateau State, Nigeria, and killed twenty three students as a result of obstruction from escape by burglary proofs. (Olaitan and Dairo, 2009). Fire in buildings poses serious challenges to fire fighters. The potential combinations of a large number of occupants, numerous ignition sources, high fuel loads and sleeping occupants create several issues that can be difficult to resolve. These issues need to be reconciled with the building codes, fire safety design and cost constraints of the project (Shao-Hoong, 2001).

Fire safety practices have suffered serious neglect among designers and users of buildings. This may be due to indifference and ignorance on the part of the building owner, the designer and/or the users. Flexibility of design of buildings provides greater opportunity to realize efficiencies and effectiveness in fire safety. It is necessary to think of how to avoid the problem than coping with it. This paper intends to identify the problems and attitudes associated with fires in buildings with the view to proffering solution.

CAUSES OF FIRE

Fire occurrence in hostel buildings can be attributed to several factors. According to Hassan (1999) the factors are thus grouped under the following;

- **Accident**

Accident is said to result from an unplanned event which could lead to shock, injury, damage to life and property (Hassan, 1999). Fires which result from accidents are emergency or limitless cause of combustion; fire from this source could be due to faulty electrical equipment and wiring system, and fire spread from neighbouring properties.

- **Faulty Electrical Equipment and Wiring System**

  Fault resulting from electrical equipment such as fan, air-conditioning system, lighting fixtures and power fixtures usually cause fire in hostel buildings if the occupants do not ensure all essential safety precaution in management of electrical equipment. At any event of faulty in wiring system, fire outbreaks become imminent.

- **Fire Spread**

  Fire spreads from neighbouring buildings can affect another and result to outbreak in the building if not appropriately checked. Uncontrolled and careless burning of bushes or rubbish could cause fire outbreak when it is done indiscriminately.

- **Carelessness**

  Recklessness, on the part of an occupant in a hostel building, not following the necessary safety precautions during the use of fire ignitable item may result to an outbreak. Fire from this source usually initiate at a point and spread around the building if not hastily controlled.

  Fire from this source may arise through the following means:

  i. **Careless handling of combustible materials**

     Careless usage of matches and lighters by students; they may drop it without making sure the light is no properly off could come in contact with fire combustible material especially during the dry season, this thus result to fire outbreak.

  ii. **Candle sticks**

     Many students in hostel accommodation use candles as a replacement for electric lights in situation of power outage, mishandling of candle light, placing it on an rickety base, allowing the candles unquenched on its own or allowing candle to drop off at approximate combustible agent will cause fire outbreak.

  iii. **Careless Handling of Inflammable Liquid**

     This is one of the most common causes of fire in hostel building, mishandling of kerosene, fuel; when this liquid come in contact with heat and ample oxygen will result fire in hostel building.

Religious and Ethnic Crisis: In recent times, Nigeria experienced series of religious and ethnic crisis like the Tiv – Jukun crisis (2002), religious crises in the north (2001, 2006), the Boko haram bombings in the north (2011). Many of these crisis often result in fire attacks on their opponent, thereby causing fire outbreak in buildings.

IMPACT OF FIRE TO HEALTH AND SAFETY OF STUDENT IN THE HOSTEL BUILDING

Pollution

The environmental impact of fires is well established, although it is not clear whether any detailed (quantified) studies have been carried out. Fires produce carbon dioxide (CO_2) and other pollutants (H_2S, NO_X, SO_2, etc). Fires hazards, for example in building, are a major source of CO_2 and other pollutants, and it is estimated that the smoke produced from burning PVC can be highly toxic and the presence of dioxins in fire residues has been long recognised. Some fire retardants (PCBs) have been identified as being significantly damaging to the environment. This risk needs to be assessed against the environmental damage from a fire. In addition, the damage caused to a building by a fire can result in the exposure or distribution of hazardous materials, notably asbestos or other toxic chemicals or agents.

Quality of life

The need to protect against death or injury from fire might be expected to be as significant an issue – with regards to quality of life – as that of security. The physical and emotional injuries from fire may require long-term medical care, and can severely affect the victim's quality of life and that of their family. In addition to being traumatic, fire in a hostel building can destroy irreplaceable possessions as well as other material.

THEORY OF FIRE SAFETY DESIGN

Effective fire safety in buildings goes beyond meeting codes. It requires a systematic and diligent approach on the part of the architect for fire prevention, protection and control in all the aspects of building design, construction and use (Malven, 1997). According to Ahiamba (1985), the rate of spread of fire depends on the fuel and available oxygen. Also it depends on the construction of the building. The rate of fire spread depends on the following:-

- **Combustibility**
  This is the rate at which a material burns. For example petrol has much higher combustibility than wood.
- **Flammability**
  Hydrocarbon gases are more flammable than hydrocarbon liquids. In the same way hydrocarbon liquid are more flammable than ordinary combustible. Example, cooking gas is more flammable than petrol or kerosene, and petrol is more flammable than wood.
- **Design and construction**
  A well designed and constructed building will help to reduce the rate of fire spread. For example a hostel building with a badly designed and constructed stairwell and no room compartmentalization will favour fire spread in the building from one floor to another.

- **Contents of building**
  The material of furnishing (fuel) to a great extent determines the rate of fire spread. Timber furnishing and finish will favour fire spreading and its sustenance unlike steel which is considerably, the reverse.

CLASSES OF FIRE AND THEIR EXTINCTION

Hassan (1999) classified fire into four classes:

- **Class A** is a type of fire involving burning materials e.g. wood, paper, textile and other combustible materials. Fire in this class are best extinguished by water agent in form of jet or spray, this blanket (fire blanket) can be used to cover the fire in an enclosure.
- **Class B** fire involves flammable substances e.g. petrol, kerosene, paint and other inflammable solvents. This class of fire is best extinguished with foam or dry powder, carbon dioxide (CO2).
- **Class C** is a type of fire involving combustible gases or liquefied petroleum gases in form of liquid or gas leak e.g. propane, butane, methane. This can be extinguished with foam, dry powder, and CO2 water agent spray to the container.
- **Class D** is a type of fire involving metals e.g. calcium, potassium, aluminium e.t.c.
- Powdered granite, limestone, dry sand and dried powdered extinguisher are best used for this class of fire. Hassan (1999) further reiterates that electrical fire does not constitute a class of fire since any fire involving electricity may involve one of the classes of fire mentioned above.

PRINCIPLES OF FIRE SAFETY

Every fire is somewhat unique. Still, design professionals can do a great deal to enhance their background in fire safety by knowing useful generalizations concerning the requirements of fire-safe buildings (Herbert, 1998). The fire safety principles are adopted primarily to protect life. Herbert (1998) summarized the principles as follows:

1. Management of fire safety;
2. Avoidance of outbreaks of fire;
3. Early detection of fire and early warning to staff and guests to facilitate an adequate response;
4. Compartmentalization of building and provision of escape routes, which are protected from fire and smoke;
5. Limitation of the development and spread of fire;
6. Containment of fire and smoke to the room where the fire originates;
7. Early suppression of fire, where this is feasible;
8. Effective evacuation procedures; and
9. Access and facilities for the fire service.

FIRE SAFETY MEASURES IN HOSTEL BUILDING

Fire prevention measures are a key element in the fire safety management of hostels. This involves the identification and elimination of potential fire hazards both inside and outside the building.

Fire Doors

Fire doors are important part of fire defence system in hostels and should normally be kept closed. The occupants should be made aware of the vital role which such doors play, and of the importance of not propping or wedging they open. This message should be emphasised by appropriate "Fire Door-Keep Shut" signs displayed on each fire door. In situations where it is necessary for operational reasons to hold open such doors, this should be done with electro-magnetic devices linked to an automatic alarm system. Such doors should be closed at night.

Means of Egress

A means of egress is the path available for a person to leave a building, structure, or space. This route must be unobstructed, and doors along this route cannot be subject to locking from the side that people will be leaving. For example, the rear exit door of a building could require use of a key to get in from the outside for security reasons, but the door must always be open able from the inside without a key so that people can get out in an emergency. This is especially important during situations that may involve evacuation by a large number of people at the same time and/or panic-type situations. A means of egress consists of three parts: exit access, exit, and exit discharge. Exit access is the path from any location within a building to an exit. An exit is typically a door leading to the outside, or in a multi-story building, an enclosed exit stairway. Exit discharge is the path from the exit to the public way.

In most buildings, the way in is also the way out. People generally will leave a building the same way they came in since that is the familiar route. However, that is not always possible good for occupants' safety. A fire could occur at any location in a building. The path used for entry into a space may be blocked. Provisions should be made to aid the evacuation of occupant from the building to safety usually in hostel buildings with more than one floor occupants are typically required to use the exit stairways which leads to a safe place.

Persons who cannot use stairways, an alternative mean of egress is to be provided in the design of the building; in cases of mobile impaired occupants. Although most tertiary institution in Niger state lack this design consideration in the initial plan, more so in regards to achieving a well-planned design which consider sustainability as paramount the hostel buildings lack in this aspect as defined. When fire occurs in building, large quantities of smoke and gases are produced. Smoke and hot gases may travel considerable distances within a building and will present a direct threat to life. Visibility also is considerably reduced, thereby affecting the viability of escape routes within and from the building. It is essential that escape routes are available to enable the occupants to reach a place of safety and that they are adequate and capable of being safely and effectively used at all times (Herbert, 1998). Special consideration should be given to accommodating and providing for the safe evacuation of people with disabilities. This may include providing accommodation in appropriate parts of the building, arrangements for giving warning to persons with hearing disabilities and provision of assistance in an emergency to persons with special needs (Herbert, 1998). In addition, security arrangements should not be such as to impede the escape of persons from the building in the event of an outbreak of fire. Basically, alternative escape routes should be available so that a person confronted by fire can escape in a direction which is away from the fire. Each storey of the building should be provided with at least two escape routes, except in the case of small premises which under certain conditions may be served by a single escape stairway. This provision is based on the possibility that, in the event of an outbreak of fire, one of the escape routes may become unavailable for use.

Alternative escape routes from a storey should be remote from, and independent of each other (Herbert, 1999). In addition to a minimum of two escape routes from every storey, the floor layout and occupant capacity will also influence the number of escape routes required for any situation. It is necessary to restrict the distance to be travelled along an escape route. The limitations on travel distance will depend on whether escape is possible in one direction or in more than one direction. The number of escape routes will also be influenced by the capacity of those routes to evacuate each area, taking into account the possibility of an escape route being unavailable for use as a result of the fire. A single escape route from a storey is only acceptable where there is little likelihood of this route being unavailable for use and where an alternative escape route cannot practicably be provided.

Escape Corridors

Corridors which form part of an escape route should be constructed with 30 minutes fire resisting elements (Herbert, 1998). Doors opening onto escape corridors, other than a door from a toilet or bathroom which is not used for the storage of combustible materials, and is separated from the remainder of the building by fire resisting construction, should be fire resisting and self-closing.

Travel Distance

For the purposes of escape, the travel distances along an escape route from any point in a building should be restricted to an extent which is dependent on the availability of alternative escape routes. For this purpose, a distinction is made between:

1. Travel from any point from which escape can be made in one direction only (sometimes referred to as dead-end travel).
2. Travel from any point from which escape can be made in more than one direction, by way of alternative escape routes. (Herbert, 1998).

Fire requires specific conditions to occur through a source of ignition. These conditions are inadvertently present in all buildings, as the by-product of design choices (Patterson, 1993). Hence fire can start at any time in a building depending on what caused it.

A careful study of hostels, private and public, has revealed that not much has been done in the articulation of fire safety in the design of hostel buildings in Niger state. Most hostels have only one entrance and exit in them, while due to security reasons; the burglary proofs in some constitute impediments in cases of fire outbreaks. Compartmentalization in the design of buildings was not employed, to help in the containment of fire spread. Also the number of storeys of some hostels makes evacuation of people difficult during fire incidents. In addition, building materials used in the construction of most of the hostels studied, are not fire resisting enough, rather will aid cases of fire.

The aim of this research is to identify and proffer an architectural design solution that can prevent ignition and spread of fire, and minimize damages in tertiary institution hostels in cases of fire outbreak.

In achieving this aim the following objectives will be pursued:

1. Identification of causes of fire in hostels
2. Identifying the effects of fire on health and safety of students in tertiary institution hostel buildings
3. Identification of best construction techniques proper for checking fire incidents.
4. Proffering solution for health and safety of student against fire outbreak.

RESEARCH METHODOLOGY

The research is based on survey of fire safety measure in tertiary institution hostel buildings. The study thus, focuses on male hostels of public tertiary institution in Niger state. The targeted population were the student, porters, hostel securities, and hostel managers. The data for this study was collected from primary and secondary sources. The primary data was obtained using a well-structured questionnaire and observation schedule which were administered to students and the hostel management within the targeted population. Information were also collected through physical observation of five tertiary institution comprising of male hostels of the public tertiary institutions in Niger state namely; Federal University of Technology Minna male hostels, Ibrahim Badamasi Babangida University Lapai male hostel, Niger State Polytechnic Zungeru male hostel and Bida polytechnic male hostel. Observation schedule was used to check for fire safety precaution in the hostels; this formed a greater part of the research. According to Allen (1973) affirmation that if data cannot be obtained then there is no basis for conducting research.

The secondary data adopted in the study was obtained through literature review from relevant textbooks, journals, lecture notes, and online libraries. The secondary data was utilised to establish criteria and theories against which the primary data was measured. This study relied on structured survey of fire safety measures realised in the hostel buildings in the study area. 950 questionnaires were disseminated, 840 were returned but only 837 which represent 88.1% were viable for analysis. Descriptive statistics were used for questions asked which have stringed variable; frequency and percentage table were used in presenting the data, while data with numerical variable were analysed using mean scores. Statistical package for social science (SPSS) software was used for analysis of the questionnaires. The viable questionnaire were coded in statistical package for social science data editor of which the descriptive statistics, mean score and ranking were performed on the obtained data. The result thus, were displayed in the production viewer, this were used in discussion of results from the various group of questions asked.

DATA PRESENTATION AND RESULT DISCUSSION

Table 2**:** population target in the study area

Category	Frequency	Percentage
Students	**810**	**96.8**
Porters	**7**	**0.84**
Hostel security	**11**	**1.31**
Hostel managers	**9**	**1.08**
Total	**837**	**100%**

Source: field work (2015)

Table 1 shows the population target in the study area, 810 which represent 96.8% of the respondents are students staying within the hostel buildings, 1.31% of the respondent are securities positioned at the hostel buildings while 7 and 9 representing 0.84% and 1.08% respectively of the respondents are porters and hostel managers.

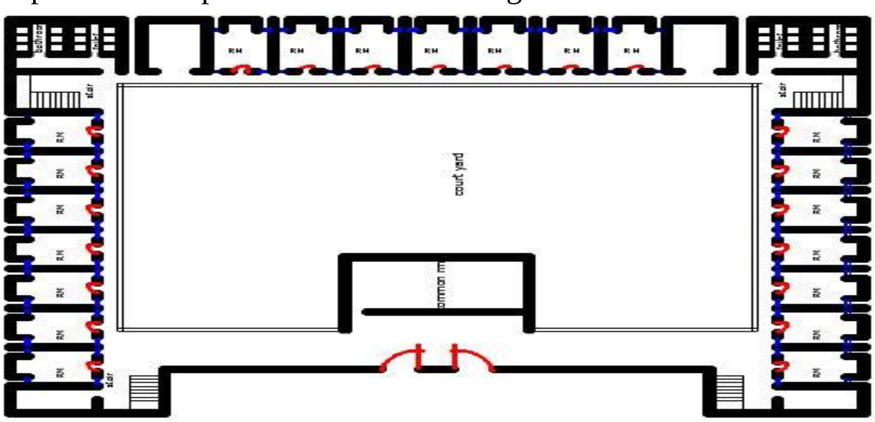


Plate 1: Ground Floor Plan of Male Hostel F.U.T Minna Gidan Kwano Campus.
Source: Field Work 2015

Plate 2: Corridors of Male Hostel F.U.T Minna Gidan Kwano Campus.
Source: field work 2015

Plate 3: emergency stairs way of Male Hostel F.U.T Minna Gidan Kwano Campus
Source: field work (2015)

Plate 4: Bedroom of Male Hostel Niger State Polytechnic Zungeru
Source: Field Work (2015)

Plate 5: Corridor of Male Hostel Bedroom Of Male Hostel Niger State Polytechnic Zungeru.
Source: Field Work (2015)

Plate 6: Fire Safety Equipment At Corridor Of Male Hostel Ibrahim Badamasi Babangida University.
Source: Field Work (2015)

Plate 7: Emergency Stairway of Male Hostel Badamasi Babangida University
Source: Field Work (2015)

Plate 8: Entrance of Male Hostel Federal Polytechnic
Source: Field Work (2015)

Plate 9: Corridor of Male Hostel Federal Polytechnic Bida
Source: Fieldwork (2015)

Category	Frequency	Percentage
Bungalow	**1**	**20**
1-2 floors	**-**	**-**
3-4 floors	**4**	**80**
Above 4 floors	**-**	**-**
Total	**5**	**100%**

Table 2**:** type of hostel building
Source: field work (2015)

Table 2 shows that 80% of the hostel buildings fall within 3-4 floors, while hostel building such as bungalow and 1-2 floors are 20% and 0% respectively.

Category	Frequency	Percentage
1-2 years	**368**	**43.9**
3-4 years	**427**	**51.0**
Above 4 years	**42**	**5.0**
Total	**837**	**100%**

Table 3**:** frequency of years of occupancy in hostels
Source: field work (2015)

The average number of year occupants had stayed in the hostel is presented in table 3, 427 and 368 respondents which represent 51% and 43.9% of the respondent had stayed within the hostel between 3 to 4 years and 1-2 years respectively while 42 respondent representing 5% of the respondents had stayed in the hostel above 4 years. This however, implies that the data is reliable for analysis.

Category	Frequency	Percentage
1-4	**140**	**16.7**
5-8	**627**	**74.9**
8 and above	**70**	**8.3**
Total	**837**	**100%**

Table 4**:** frequency of occupants per room in hostels
Source: field work (2015)

Table 4 shows that 627 of the respondents which represent 74.9% of the total response confirm that, maximum occupancy rate ranges between 5-8 persons in each hostel room while 16.7% and 8.3% represents 1-4 and above 8 persons per room respectively which implies that the number of occupancy in each room result to influx of the hostel building above the capacity it is being built to serve.

Category	Frequency	Percentage
BELOW TERTIARY EDUCATION	**8**	**0.9**
PRE-DEGREE	**81**	**9.7**
OND	**123**	**14.7**
HND	**190**	**22.7**
B.TECH	**430**	**51.3**
M.TECH	**5**	**0.60**
PHD	**-**	**-**
Total	**837**	**100%**

Table 5**:** type of academic study of the occupants
Source: field work (2015)

Table 5 presents the study type of the respondents in the hostels, 51.3% of the respondents are at bachelor degree level, 22.7% and 14.7% of the respondent are at HND and OND level while 9.7% and 0.6% of the respondents are at pre-degree and master's degree level.

Category	Frequency	Percentage
Yes	**88**	**10.5**
No	**749**	**89.5**
Total	**837**	**100%**

Table 6**:** witness of fire incident
Source: field work (2015)

As represented in table 6 above, 749 of the respondents which represent 89.5% of the response have never witnessed any fire incidence while 88 respondents representing 10.5% of the response had witnessed a fire incident.

Category	Frequency	Percentage
Major	**27**	**3.2**
Minor	**810**	**96.8**
Total	**837**	**100%**

Table 6**:** nature of fire occurrence
Source: field work (2015)

As presented in table 6, 810 of the respondents representing 96.8% response confirms that only minor fire incident had occurred in the hostel building which basically involves a particular room or section in the hostel building, while the major incidents are confirmed by 3.2% of the response.

Fire Safety Measures, Functionality and Awareness Occupants

Category	Number	Sum	Mean	Rank
Portable Fire Extinguisher	9	49	5.4	2
Fire Alarm	7	27	3.9	4
Fire Exits	7	20	2.9	5
Emergency Lighting	5	11	2.2	6
Flame Detector	-	-	-	-
Smoke Detector	-	-	-	-
Fire Safety Sign	4	56	14	1
Heat Detector	-	-	-	-
Fire Hose Reel	-	-	-	-
Fire Bucket	9	45	5	3
Dry Riser	-	-	-	-
Fusible Hydrant	-	-	-	-
Wet Riser	-	-	-	-
Dry Riser	-	-	-	-
Halon Gas System	-	-	-	-
Sprinkler System	-	-	-	-
Total	**41**	**155**	**33.4**	**-**

Table 7**:** functional safety equipment
Source: field work (2015)

Category	Number	Sum	Mean	Rank
Destruction Of Properties	9	49	5.4	1
Structural Defect	9	27	3.0	2
Injury	8	20	2.5	3
Death	5	11	2.2	4
Total	31	107	13.1	-

Table 8**:** damages caused by fire
Source: field work (2015)

Table 8 shows the mean score of respondents' response to the degree of damages caused by fire incident. Destruction of properties rank the highest while structural defect ranks second respectively. However, injury and death ranks lowest.

Category	Frequency	Percentage
Yes	83	9.9
No	754	90.0
Total	837	100%

Table 9**:** Awareness of safety practises
Source: field work (2015)

As shown in table 9, 754 respondents which represent 90% of the response are not aware of the fire safety practice, while 83 respondents representing 9.9% are aware of fire safety measures. Thus this shows that a lot of occupant may be at risk when a fire incidence occurs. Furthermore table 10 shows also the awareness of occupant to safety equipment provided in the hostel building, 54.5% of the responses from the respondent are aware while the other 45.5% of the response from the respondent are not aware of the equipment provided.

Category	Frequency	Percentage
Yes	**456**	**54.5**
No	**381**	**45.5**
Total	**837**	**100%**

Table 10**:** fire safety measures and awareness of safety equipment in the hostel buildings
Source: field work (2015)

Category	Number	Sum	Mean	Rank
Size Of Building	3	40	13.3	2
Complexity Of Building	7	205	29.2	3
Type Of Building	8	134	16.8	4
Financial Capability Of Building Management	5	458	91.6	1
Total	23	837	150.9	

Table 11**:** factors affecting incorporation of fire safety devices in hostel buildings
Source: field work (2015)

There are certain factors that affect the Integration of fire safety devices which is presented in table 11 above, financial capability of the building management ranks high in the mean sore while building type ranks the lowest. This thus shows how the presence of fire safety devices in hostel building is being influenced. Furthermore presence of safety measure influences are analyzed in table 12, the mean score of the factors shows that ignorance of building professional ranks the highest. This is because more attention is paid on provision of accommodation while safety is neglected.

Category	Number	Sum	Mean	Rank
Initial cost	7	250	35.7	1
Ignorance of the building professionals	9	498	55.3	3
Attitude of end users	3	22	7.3	4
Maintenance cost	3	67	22.3	2
Total	**22**	**837**	**120.6**	

Table 12**:** factors affecting incorporation of safety in hostel buildings
Source: field work (2015)

Category	Availability	Protectors
Emergency doors	11	6
Doors	**298**	**0**
Window	**596**	**596**

Table 13**:** presence of window and door protectors in the hostel buildings
Source: field work (2015)

As presented in table 13 most of the emergency doors were locked with keys and door protector for security purpose of which in return pose a risk in case of fire incident, while most of the windows are also secured with window protector. But the door at the entrances to the hostel and rooms do not have protect therefore they do not hinder escape from room and main entrance.

Category	Availability	functionality	Remark
Portable Fire Extinguisher	**12**	**5**	**Most are expired and not replaced**
Fire Alarm	**7**	**3**	**Most are not active**
Fire Exits	**11**	**5**	**Most are located at close to an open drainage while other are locked**
Emergency Lighting	**11**	**0**	**Mostly natural lighting from court yard**
Flame Detector	**-**	**-**	**-**
Smoke Detector	**-**	**-**	**-**
Fire Safety Sign	**4**	**3**	**Most are not visible enough**
Heat Detector	**-**	**-**	**-**
Fire Hose Reel	**-**	**-**	**-**
Fire Bucket	**9**	**2**	**Most are still functional**
Dry Riser	**-**	**-**	**-**
Fusible Hydrant	**-**	**-**	**-**
Wet Riser	**-**	**-**	**-**
Dry Riser	**-**	**-**	**-**
Halon Gas System	**-**	**-**	**-**
Sprinkler System	**-**	**-**	**-**
Total	**49**	**16**	**-**

Table 14**:** presence of fire safety measures in hostel buildings
Source: field work (2015)

In other provide sufficient and safe egress from a building, with a minimum of effort and delay, and to present a minimum of obstruction in an exit path. Herbert (1998) stated that an external escape route is acceptable as an alternative means of escape only where:

1. A suitable alternative internal protected escape stairway cannot be practicably provided;
2. The height to the floor of the top storey does not exceed 10 m above ground level. Table 14 shows that fire exit mostly locked with chains while emergency lighting are mostly natural lighting from court-yard but the electrical fitting for emergency light

are non-functional. This implies that most safety measure attention is paid to provision of a security by locking the means of egress and protecting it with lock door protectors. But few hostel building in Niger state provided emergency lighting usually with the use of court-yard and atrium of which can be considered not effective enough most especially at night.

Plate 8: Bedroom Arrangement Of The Male Hostel F.U.T Minna Gidan Kwano Campus.
Source: Field Work (2015)

Plate 9: Emergency Exit Of The Male Hostel F.U.T Minna Gidan Kwano Campus.
Source: Field Work (2015)

The width of escape stairways will depend on the number of persons likely to use them but should not generally is less than 800 mm (Herbert, 1998). A stairway according to Herbert (1998) may be acceptable as an escape stairway where:

1. It is a protected stairway and leads directly to a place of safety at ground floor level;
2. The width of the stairway and dimensions of steps are adequate for the purposes of escape;
3. The stairway is of sound construction and is capable of affording safe passage for the users of the building;
4. The pitch of the stairway does not exceed 38 degrees and is constant throughout its length and the number of treads in a flight is not more than 16 or less than 3.

CONCLUSION AND RECOMMENDATION

Fire is an extremely destructive force that can devastate the environment, people, property and buildings, and its effects can continue for years after the event. There is little doubt that we all need to do everything we can to prevent fire and protect human life and properties. Legislation goes some way to preventing fire and protecting us from the effects. However the use of approved products and design techniques that have been certified and recognised to solve this fire safety issue not only give confidence of safety but also are sustainable in a long run. The current Regulatory Reform (Fire Safety) Order should require planners to make sure that a rigorous risk assessment has been conducted to ensure the safety of the occupants and users of hostel buildings. The use of building materials which are sustainable with respect to fire resistant capacity should be encouraged at the initial stage of a hostel building design, critical fire safety measures also taken into consideration can significantly ease this process. In providing a safer and more fire-free environment will on a long run achieve a safer environment.

Recommendations for safety against fire in the hostel building include;

- Hostel building management of every institution should ensure that the student accommodations within the school are all equipped with the necessary active and passive fire safety equipment for the safety of the students which is paramount. Furthermore, the equipment should be regularly checked to ensure good functional condition.
- Student should be orientated on how to prevent fire from occurring and on what to do in cases of fire incident.
- Government organisation should constantly ensure to supervise hostel buildings during planning, ensuring that they meet up to the fire safety requirements and code.

REFERENCES

Afolayan G.P, (1981); *The Magnitude of Housing Needs among the junior workers of Uni jos*. Unpublised MSc. Thesis, Faculty of environmental Science, Unijos, 1981.

Ahiamba, E. E, (1985); Fire Hazard and its prevention in buildings (A case study of Bendel and Lagos states of Nigeria); B.sc Thesis, Department of Architecture, Bendel state University, Ekpoma. 201

Allen, George R. (1973) *The Graduate Student's Guide to Thesis and Dissertations: A Practical Manual For Writing And Research.* Jossey-Bass, Inc, Publishers, USA

Ernst and peter Neufert (1993); *Architects' data*, third edition, Blackwell science publishers.

Fred Malven(1997); *Time savers standards, for architectural design standards*, seventh edition, McGraw-Hill, Inc.

Ger Herbert (1999), *Fire safety in hostels.* McGraw-Hill, Inc.

Hassan, H (1999); *Fire and safety management in Building*.

James Patterson, (1993); *Simplified design for building fire safety*. John Wiley and sons Inc.

Olaitan P. B, Dairo M. D, (Feb. 2009) Journal of Rescue and Disaster Medicine™ ISSN: 1531-2992, Domestic Fire Accidents In A Developing Country: Reducing Morbidity / Mortality By Modifying The "Burglar Proofs".

Onwuka, E. U. (1990); *Students Housing in University of Nigeria, The Current Status and Direction for Future*. Department of Urban and regional planning, University of Nigeria, Enugu Campus.

Schmerts H.T. (1972); *Institutional Housing Strategies Educational and Realisation.* London: Patrick Wakely.198

Shao-HoongWu, (2001), *fire safety design of apartment buildings*, University of Canterbury.

The Daily champion newspaper, 15 June 2011.

LOCATION-ALLOCATION ANALYSIS OF PUBLIC HEALTH SITE SELECTION USING P-CENTRE MODEL: (CASE STUDY OF CHANCHAGA LOCAL GOVERNMENT AREA, MINNA, NIGER STATE)

Adesina, E. A., Odumosu, J.O, Zitta. N, Ajayi, O.G, Kuta, A.A, and Adamu, G.M
Department of Surveying & Geoinformatics, School of Environmental Technology, Federal University of Technology, Minna, Niger State, Nigeria

Healthcare planning is a challenging field that depends on spatial data such as location and characteristics of health center demand. Chanchaga Local Government Area lack adequate healthcare facilities. So, the need to locate new public healthcare facilities is necessary if distance with population is considered. Garmin 76CSx handheld GPS receiver was used to mapped the existing health facilities and overlaid it on a high resolution Satellite image of 0.5m (GeoEye-1))of the study area. Base on the analysis it was discovered that inadequate healthcare facilities have been the problem of the people in Chanchaga Local Government Area. Thus, there is need to site more new public healthcare facilities in other to solve the problem of uncovered areas in the study area by considering proximity (distance) to the demand (Potential users) using P-Centre algorithm in determining optimal location of public health facilities within study area with the primary goal of minimizing the maximum response time (i.e. Time between a demand site and nearest service location using a given number of service locations).Twenty healthcare facilities were found in the study area which actually shown that the facilities are randomly distributed using Nearest Neighbourhood Analysis in ArcGIS 9.3 Software. Thus, Factor and Constraint maps were produced and overlaid on the buffered of the existing public health facilities using ArcGIS 9.3 software. The study shows that, the health facilities were randomly distributed in the locality with four of them not suitably located affected by the factor criteria which need to be relocated to the proposed suitable site. Similarly, the research showed that the city heart's centre is enjoying more presence of public health facilities than the extreme North-West of the Local Government Council with fewer facilities.

Keywords: Geographical Information System, P-center, Facility, Wards, and Service Area

realsolution007@gmail.com

solutionrealdata@yahoo.co.uk

Background of the study

Public health facilities are social amenities provided by government for good health care delivery for its citizen. The importance of health care to human can never be over-emphasized. Ogundare (1982) linked health to food based on its importance to individual existence and opined that the concern and attention that any government pays to health could lead to the well-being of the people. Adequate supply and optimal allocation of public health facility is important for improving health care delivery system; meanwhile the presence of public health facility is not adequate except when access to these facilities is ascertained.

At the regional scale, the relative location of major population and employment centres in a region influences travel behaviour by making certain modes of travel more or less convenient or 'costly' than the others, and has been shown to be strongly correlated with travel. The location and size of a region's centres is influenced by numerous factors such as housing availability and affordability, school district and neighbourhood quality, private investment and jobs growth, transportation investments and access to other centres. Commute distances are a function of regional growth patterns and associated with per capita sedentary time spent in cars which has been shown to be a predictor of obesity and vehicle emissions. Development that is located within already established urban or suburban areas of a region, preferably in areas well-served by transit, is more likely to become more compact over time and support transit use and reduced auto dependence. Many positive public health outcomes can result from a more compact urban form.

Residential density, land use mix, and street connectivity have all been consistently associated with multiple outcomes related to health: per capita vehicle miles, per capita air pollution emissions, physical activity rates, and obesity and body weights. Climate change impacts such as temperature increase and changes in the frequency, intensity, and duration of extreme events such as floods, high winds, and tropical storms could affect healthcare facilities and practices for managing medical wastes. Health posts, clinics, and hospitals designed to last for decades need to plan for exposure to an altered climate. Plans to build new facilities need to consider projected impacts within the timeframe that the facility is intended to be operational, and ensure that the appropriate materials and locations are selected to reduce vulnerability. This is especially important because health facilities are often key community spaces used as safe havens during and after storms and other emergencies, and need to be fully operational and able to provide services. Health care facilities may also need to be prepared to handle increased visitors as a result of changing disease vectors or injuries from extreme weather events. It is particularly important for healthcare facilities to consider the vulnerability of their electricity source, and build resilient systems that can withstand the projected impacts of climate change.

In designing, building, and operating healthcare facilities and managing medical wastes, steps should be taken, where feasible, to reduce greenhouse gas emissions that contribute to climate change. The activity should aim not only to reduce emissions immediately, but also to support sustained low-emissions development through investments that will lead to reduced emissions in the future.

This study is aimed to solve the problem of location-allocation of site selection of public health facility using P-centre model. A P-center model minimizes the maximum distance (or travel-time) between the demand nodes and the facilities (Hongzhong, et al., 2005). They're often used to optimize the locations of facilities in the public sector such as hospitals, post-offices and fire station etc. The study addressed the following problems:

(i) Investigation of physical accessibility to public health care

(ii) Utilization of health care services

(iii) Analysis of the extent of service areas and identification of gaps in provision

(iv) Modeling of optimal facility locations

(v) Examination of issues of equity and efficiency in health care provision, among others.

The study is necessitated on the fact that Chanchaga Local Government Area of Niger state is one of the highly populated areas among the Local Governments in Niger State. The Local Government Council under study is both residential and commercial in nature in respect to the Land Use with population of more than 57% of people who leave in the heart-center of the metropolitan city of Minna (Census, 2006). Based on Land Mass, Bosso Local Government Area covers 1584.5km² i.e. approximately 96% of the entire area of Minna city (Fig. 1.0). Geographical Information System (GIS) uses various methods in the site selection which includes Network Analysis, Spatial Analysis, Proximity Analysis, Multi-Criteria Analysis (MCA), Analytical Hierarchy Process (AHP), Rank Order Method (ROM), P-centre (minimax), P-median (minisum), etc. The P-center model of location-allocation will be used in this study to address the problem in Chanchaga Local Government Area.

Statement of the Problem

The major challenged people in study area is facing is the problem of inadequate health facilities. Twenty healthcare facilities were found in the study area which actually shown that the facilities are haphazardly distributed. Base on this; it was discovered that inadequate healthcare facilities and accessibility have been the problem of the people in Chanchaga Local Government Area (i.e. in the study area some areas enjoying this service (facility) more than other). Thus, there is need to site more new public healthcare facilities in other to solve the problem of uncovered areas in the study area by considering proximity (distance) to the demand (Potential users) using P-Centre algorithm in determining optimal location of public health facilities within study area with the primary goal of minimizing the maximum response time (i.e. Time between a demand site and nearest service location using a given number of service locations).

The Study Area

The study was carried out in Chanchaga Local Government Area, Minna, Niger State located approximately on Latitude 09^0 36'50'' North of the equator and Longitude 06^0 33' 25'' East of the Greenwich Meridian, covering approximately 72km². The administrative areas of Chanchaga Local Government Area composed of Ten (10) wards. According to the 2006 census, it has a total population of 201,429, which comprises of 105,803 male and 95,626 female.

The land use comprises of both residential and commercial. The major inhabitants of Chanchaga Local Government Area are the Gwari, Nupe and Hausa. Chanchaga Local Government Area possesses a great many world famed places of interest like the Shiroro Palace and the Tunga fall, which attract countless tourists. Besides, Chanchaga is Local Government Area where Innumerable society elites assemble here for school and career, making it matches the name “city centre”. Figure 3.0 shows the map of the study area.

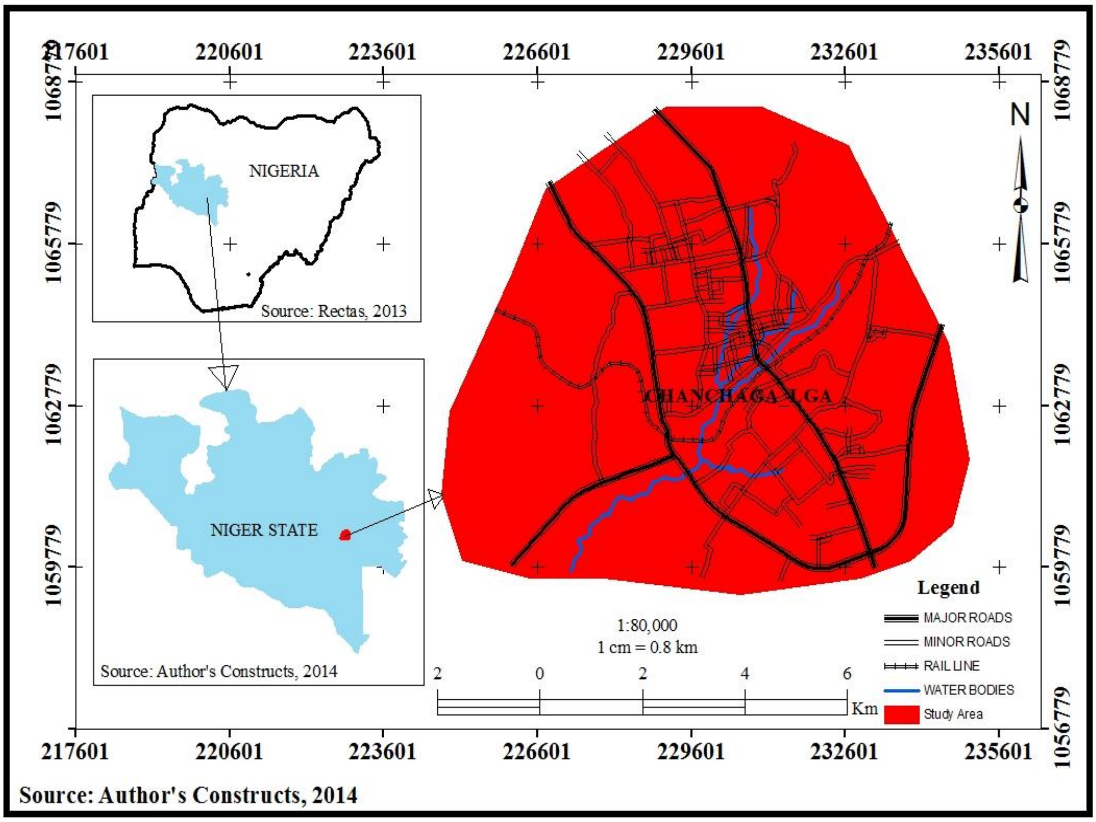


Figure 3.0: Shows the map of the study area

Relevant Conceptual issues and related literature

The location-allocation of equitable distribution of health facilities had been widely studied by researchers over the years. Some of the researchers who had contributed immensely and their findings are highlighted below:

World Bank (2004 and 2006) in its annual development report, gave the following explanation on the need for equity; When personal and property rights are enforced only selectively, when budgetary allocations benefit mainly the politically influential, and when the distribution of public services favours the wealthy, both middle and poorer groups end up with unexploited talent. Society, as a whole, is then likely to be more inefficient and to miss out on opportunities for innovation and investment. Thus, achieving equity in resource allocation and having an equitable development of a society make nations stronger in all ramifications (Tegeret, 2011).

Bagheri et al (2005) also measured accessibility to primary health care services in New Zealand based on World Health Organization (2000) acceptable levels of minimum travel time and distance of 4km for third world countries to the closest facility via a road Network. He used the mean centre of population distribution within each unit and road networks, the best route (shortest path) from residential areas to facilities as well as areas poorly covered was obtained.

Robert (1997) also in his thesis examined the problem of evaluating and improving the potential accessibility of a target population to primary health care services in Central Valley of Costa Rica. Toward this end, he developed a generic mode1 of potential accessibility. He also examined how spatial aggregation of the target population can lead to errors in the evaluation of accessibility, and discussion methods of disaggregating population counts to a grid to reduce this spatial aggregation error. Also, he developed a generic Accessibility Optimization Problem (AOP) that takes a facility-oriented approach to improving accessibility. Two sub-problem formulations are also discussed for the AOP. The Facility Location Sub-problem (FLS) adjusts the facility configuration to improve the efficiency and equity in the distribution of accessibility among the target population while the Resource Allocation Sub-problem (RAS) modifies the allocation of resources to existing facilities. Specific accessibility optimization models for the minimum distance accessibility measure and the Joseph and Bantock (1982) accessibility measure are developed from the generic formulations. These accessibility measures are used to evaluate the current accessibility, and the optimization models are applied in two specific planning scenarios to examine potential strategy of improving accessibility to family planning services in the Central Valley of Costa Rica.

Gustavo (nd) examined case study related to the spatial analysis of Primary Health Care Centers (PHCC) in the city of Lujan, Argentina. In his research, the aptitude of the location-allocation models was exemplified based on the calculus of coverage, mainly applied in the search of efficiency and spatial equity of the Primary Health Care Centers (PHCC) in the city of Lujan. His research answers the question: is there any correspondence between the real localization of the supply points and the ideal localization based on the spatial distribution of the demand population? Which way the spatial efficiency and the spatial equity is modified in accordance to the reallocation of these points and finally where should new installations be settled in order to satisfy the distributed demand?

Oda et al (1987) in his paper used a modeling approach to the problems of the equity-efficiency trade-off relation in the spatial provision of health care in Hokkaido Japan, that is, the relationship between the equalization of access opportunity to health care services and the effective provision of the services in a free-entry and fee-for-service market system was attempted from the perspective of location-allocation analysis. The location-allocation models developed in their paper are composed of a spatial interaction model of demand allocation and another is a resource location model when service provider is private sector. In the resource location model, the amount of potential demand in each region and its capacity (work load) of a human as well as a physical resource are internalized. The demand allocation model consists of a space discount function, attractiveness of the service and potential demand for the service in the region. In the resource location model, revenue maximization was adopted as a criterion of efficiency for private sector as service provider, which is different from the criterion of efficiency usually adopted when public sector is regarded as service provider, that is, minimization of construction and operation costs of public facilities.

Ayoade (2014) in her paper looked into the potential accessibility of women ranged from 15-49 years of age to public maternal health care services by examining the service areas and distributional pattern of public maternal health care facilities in Ibadan, Nigeria. Her findings of the locations of these facilities were collected from the Oyo State Ministry of Health. The distributional pattern was assessed using nearest neighbor analysis and Moran's I statistic. Her research on walking and driving service areas were modeled using the circular buffer method i.e. at a given or defined radius around the supply (Public health facility). Her results showed that facilities are randomly distributed in Ibadan. Thus, there is a need to improve the supply and distribution of facilities to meet present and future needs.

Health care facilities

Health care facilities are hospitals, primary health-care centers, isolation camps, burn patient unit, feeding centers and others (WHO, 2014). In case of emergency situations, health-care facilities are often faced with an exceptionally high number of patients, some of whom may require specific medical care (e.g. treatment of chemical poisoning).

The responsibility of health care is a concurrent in nature among the three tiers of government in Nigeria. However, because Nigeria is a mixed economy, private providers of medical health care have a visible role to play in health care delivery. The federal government is mostly limited to coordinating the affairs of the University teaching hospitals and Federal medical centers which are known as Tertiary Health Care centers whereas the State Government manages various General hospitals i.e. Secondary Health Care centers while the Local Government is responsible for the dispensaries known as Primary Health Care centers (Abbas et al., 2012).

The World Health Organization (1997) specified criteria for health care planning for third world countries and indicated that each service area should cover a 4km catchment area with a population of 60,000 for primary health care in order to have adequate and equity of access to health centers.

Many factors affect a population's ability to access appropriate levels of health care. Oliver and Mossialos (2004) group these factors into three categories:

i. Availability: How suitable or ready for use are those facilities? It is also the degree to which a facility is in a specified operable and committable state at the start of operation. In most cases the facilities are not available for use, even if available they are not suitable for use.

ii. Acceptability and Affordability (Socio-economic)

a) Ethnicity, Religious: How do the people accept the health facilities? In some places their religious beliefs do not allow them to visit hospital. They believe in the traditional ways and self-medication,
b) Gender, Age: Female and young children have more access to health facilities. Even with the status of the facilities they visit those facilities for treatment.
c) Cost: It involves money, which is always a challenge in health. People are not able to fund those facilities.

iii. Geographical Location: The location and terrain in which the facility is located. In areas with rough terrain the geography of the place need to be visited to know where to locate the facility for easy access.

One of the imperatives of the primary health care approach, which is widely adopted in Sub-Saharan Africa, is a concern for social justice. In health terms this means population coverage irrespective of social position. “One main problem with urban health care is not simply that it lacks quality and comprehensiveness but that, because of mal-distribution of facilities, it is not easily accessible to those in need” (WHO, 1993).

Site Selection of Health Care Facilities

Site selection of healthcare facilities have considerable impact on the population of any given area because of the almost universal demand for the services they provide, but there is no definite theory for the location and distribution of healthcare facilities as in the case with other public facilities (Nasri, 2014). World Health Organization (1997) said health facility should be located within 4km of the demand node for the third world countries. Siting a facility into the best place is a decision making problem. Arifin (2010) said the best place depends on criteria such as the optimal distance, the capacity of the facility, population density, optimal cost etc. The term facility is used in location-allocation problem to define an object whose spatial position is optimized through model or algorithm considering interaction with other pre-existing objects (Scapama and Scutella, 2009).

The process of site selection typically involves two main phases: screening in which the identification of a limited number of candidate sites from a broad geographical area given a range of selection factors and the evaluation in-depth examination of alternatives to determine the most suitable site (Chang et al., 2008).

P-Centre Location-Allocation Models

In location literature, the P-center model is referred to as the minima model since it minimizes the maximum distance between any demand point and it nearest facility. The P-center model considers a demand point is served by its nearest facility and therefore full coverage to all demand points is always achieved. However, unlike the full coverage in the set covering models, which may lead to excessive number of facilities, the full coverage in the P-center model requires only a limited number (P) of facilities. The P-center problem was first posed by Sylvester (1857) more than one hundred years ago. The problem asks for the center of a circle that has the smallest radius to cover all desired destinations. In the last several decades, the P-center model and its extensions have been investigated and applied in the context of locating facilities such as Petro Stations, hospitals, fire station, and other public facilities.

Criteria for site selection of public health facility

The factors criteria in table 4.1 were used in this study after due consultations with experts in the health ministry, those responsible for decision making in the health sector and urban regional planners.

Table 4.1: Factor Criteria Siting Health Centre in Chanchaga Local Government Area, Minna, Niger State.

s/n	Factor	Siting (m)
1	Major Road	70
2	Minor Road	30
3	Market	50
4	Motor Park	50
5	Cemetery	200
6	Industrial Areas	100
7	Water Bodies	50
8	Rail Line	150

Source: Authors' study, (2014).

MATERIALS AND METHODOLOGY

The preliminary stage was organized into two aspects: the first involved a reconnaissance visit to the study area for on-the-spot evaluation of the selected existing public health facilities. The second involved the acquisition of the Satellite image (Geo-eye 1) of Minna metropolis for year 2010, the high resolution image and hospitals location information which was obtained from the Ministry of Lands and Survey and Ministry of Health Minna, Niger State. The Shape files (States and Local Government boundaries) shown administrative map of Nigeria was also obtained from Regional Centre for Training in Aerospace Surveys Ile- Ife Osun State, Nigeria. Population data for the Local Government was obtained for both 1991 and 2006 population census (NPC, 2014). Two methods for collecting geometric and attribute data, required for this study are the primary and secondary sources. The primary source of data collection involves direct collection of information, using Garmin *76CSx* Hand Held GPS receiver, oral interview and observations. On screen digitization was also carried out in order to extract the criteria from a high resolution image (0.5m). Various layers were created in order to achieve set objectives. The positions of the existing health facilities mapped by Garmin *76CSx* handheld GPS receiver were modeled into vector during the conceptual designs; a relational database was adopted for the logical modeling and ArcGIS 9.3 software was used in the physical design. Spatial analyses were then carried out on the geodatabase built in ArcGIS 9.3 software.

Workflow Diagram

Figure 5.1 shows the workflow diagram used in achieving the aim of the study Healthcare facilities considerable impact on the population of any given area because of the high demand of the facilities and services provided by the facility, but yet no definite theory for the location and distribution of health facilities as in the case with other public facilities (Oyewo, 2013).

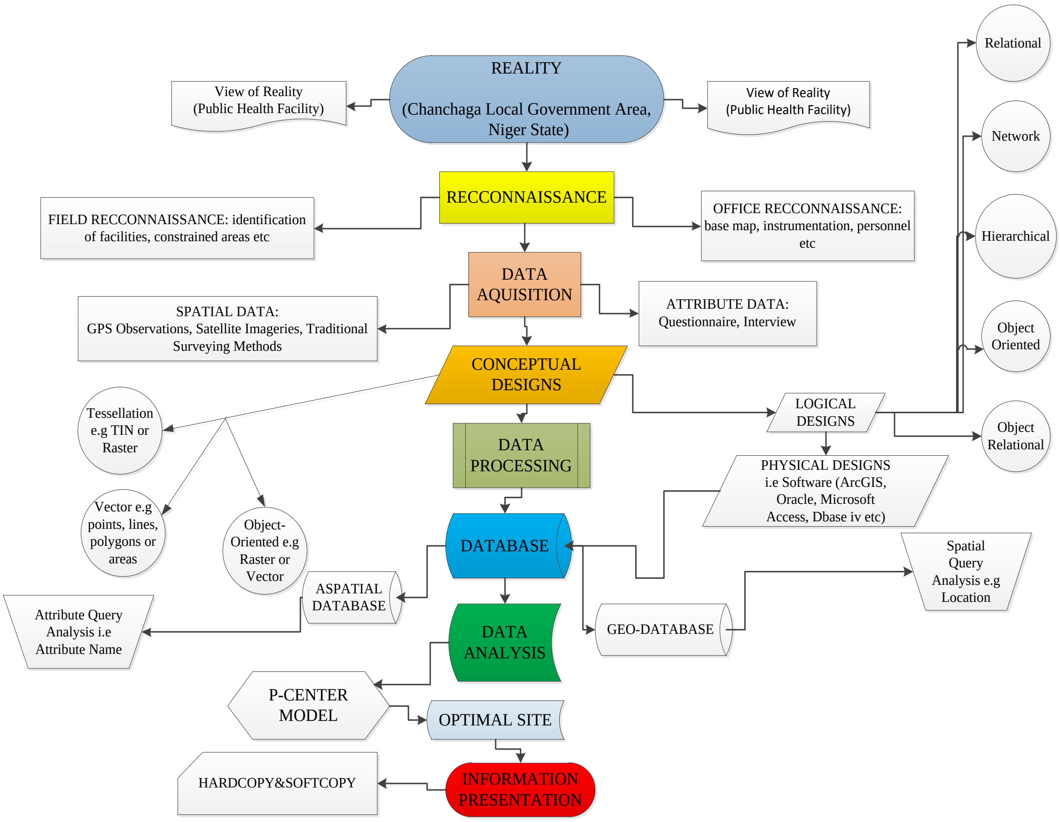


Figure 5.1: Workflow Diagram (Authors', 2014)

Research factor criteria for site selection of public health facility in Chanchaga Local Government Area Niger State

GIS uses various methods in the site selection which includes P-centre model, P-median model, network analysis, spatial analysis, proximity analysis, multi-criteria analysis (MCA), rank order method (ROM), Analytical Hierarchy Process (AHP). Abdullahi et al (2014) used GIS-based network analysis to locate areas of green spaces and also of the deprived socio-economic groups of people of urban green spaces in the city of Leicester, UK.GIS-based P-centre model (PCM) is adopted in this research.In order to carry out site selection successfully, Criteria are needed for the study. The Local Government Area Council has four majorly land-uses: Residential, Commercial, Agricultural and Industrial land-uses. The authors' criteria in table 4.1 section 4.1.3 were used in this study based on the consultations made by the author to experts in the ministry of health, SURE-P and those responsible for decision making in the health sector. Only population density among the criteria is not used based on the fact that; population figures of each ward and household was not given from the National Population Commission (NPC).

In the process of achieving the first objective, criteria were identified and evaluated. Below are the criteria identified for use in this study.

a) **Road networks**: Theoretically, hospitals should be located near the roads, especially the major roads. The noise from motor vehicles passing-by influences the patients in the hospital. Therefore, the roads where categorized into two types i.e. major roads with a quiet distance of 70 meters is set and minor road also with a distance of 30 meters was set beyond the buffer zone, the nearer the better is the hospital being sited.
b) **Existing public health facilities**: New hospital constructions should take this criterion seriously. Keeping the distance from other existing hospitals as well as anticipating impact from each other, is not only relevant to rational resource allocation, but also does matter to the fair competition in the market economy. No set standard for distance from existing healthcare facilities, but after consultation with some experts in the healthcare planning unit, a distance of 300m buffer was agreed and 500m for both optimal and tolerable distances.
c) **Market area:** Hospital is the source of infection, to protect the general public, keep a distance from the market areas. A buffer zone of 50 meters was used.
d) **Water body**: Hospitals cannot be built around the water body, in case the water has been polluted by construction or drainage discharged. A buffer zone of 50 meters was made.
e) **Cemetery**: Hospitals are hardly built inside the cemetery, it is better to protect those areas where dead bodies are disposed from air pollution. A buffer zone of 200 meters was made.
f) **Motor Park**: Siting hospitals close to the motor park is not too good because the volume of noise generated in the park influences the patients in the hospitals. A buffer zone of 50 meters was used.
g) **Industrial Areas**: These areas were also restricted and buffered at 100 meters.
h) **Rail Line**: This factor must also be taken seriously as the noise being generated and vibrations from the train is too high, hospital should not be sited close to it. A buffer of 150 meters was chosen.

Constrained Areas

Constrained areas were also considered. These areas are like Banks, Paramilitary formations, Recreational centers, Religion centers. These areas were considered not because they have adverse effects but their importance to people and as such hospitals cannot be located in such areas.

Database Creation

A database is a large computerized collection of structured data. There are two basic categories of database. These are attribute database (A spatial) and geo-database (spatial). In order to achieve the third objective, a geo-database was created in ArcGIS 9.3 in other to store the acquired existing public health data, factor data and constrained data.

Digitizing the Factor criteria and Constrained Areas

All the shape files created for both factor criteria and constrained areas were digitized in ArcMap. Also, attributes were added in other to perform some queries analysis on the digitized features which have been converted to shape files. Digitizing the features convert it automatically to shape files and as such query by location or attribute can be done on any of the feature class.

Buffering the Factor Criteria and Existing Public Health Facilities

The operation was done based on the set criteria earlier mentioned. All criteria that was set, was buffered so as to know where hospitals can be located. Also, the existing health care was also buffered (300m and 500m for optimal and tolerable distance respectively). This was done in Arc tools box (where analyses are done). Fields were also created to insert the name and type of each facility for easy identification. Two types of facilities were identified: primary healthcare (Clinics) and secondary healthcare (i.e. General hospital) in the study area.

Finally, a map was visualized in ArcMap to show the spatial distribution of existing health facilities in the study area. Average nearest neighbour analysis tool was used to analysis the distribution within the study area.

Wrongly cited public health facilities

Having carried out buffering on the factor criteria and existing health facilities in the study areas, it was shown that four (4) hospitals were wrongly located or sited (Figure 5.2). They were affected by factor criteria chosen. The hospitals that were affected are: Kutilko Clinic in Limawa 'B' Ward which is affected by rail-line, Angwa-kaje in Sabon-Gari Ward is also affected by river, School Clinic in Limawa 'A'- affected by major road and Asibitin in T/Wada South is also affected by minor road.

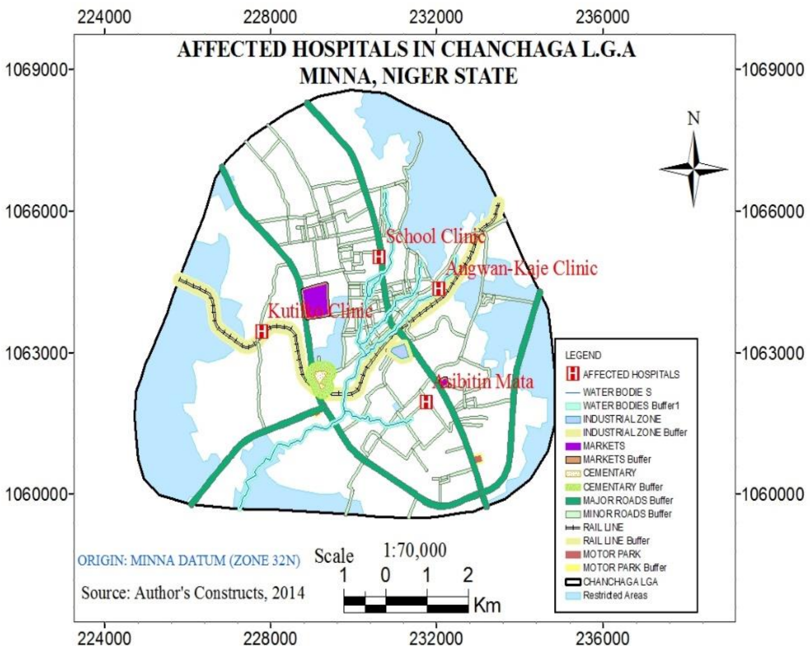


Figure 5.2: Affected hospitals in Chanchaga Local Government Area

Propose Model for the suitable Site Selection of a New Site

This was achieved using model builder, an extension in ArcMap 9.3. Buffer analysis, conversion of feature to raster, union, reclassify, con and plus analysis were done in the model builder through Arc-toolbox. The model builder was used to propose a model that can be used to select all suitable sites for public healthcare facility.

Factor maps are represented as spatial distributions to display the opportunity criteria and the quality of achieving an objective. Constraint maps are limitations or restrictions which prohibit certain elements to be taken into account during the analysis (Malczewski, 1999). The GIS-based P-Centre model uses summations of the factor criteria, criteria for existing facilities and the constrained areas (Yassine and Adel, 2011).

As for the summations procedures, the linear combination of all factors considered is shown as Equation (3.1) and Equation (3.2):

$$\mathbf{U = \Sigma\, fi + ci} \qquad 3.1$$

fi = Factor Criteria

ci = Constrained Areas

ei = Existing facilities Criteria

U = ‘Unsuitable Area’

$$\mathbf{S.S = S - U} \qquad 3.2$$

Where S.S = Site Selection (Suitable Area)

S = Study Area Map

U = ‘Unsuitable Area’

After the factor criteria, constraint criteria and existing facilities have been selected separately, the GIS-based P-centre process integrates them together by subtracting the Unsuitable site (U) from the entire area under study (S) and gets the final result of site selection (S.S). Using the two equations above, the site selection areas was generated.

Figure 5.3 is the composition of the models in order to faction out areas where new hospitals are to be sited.

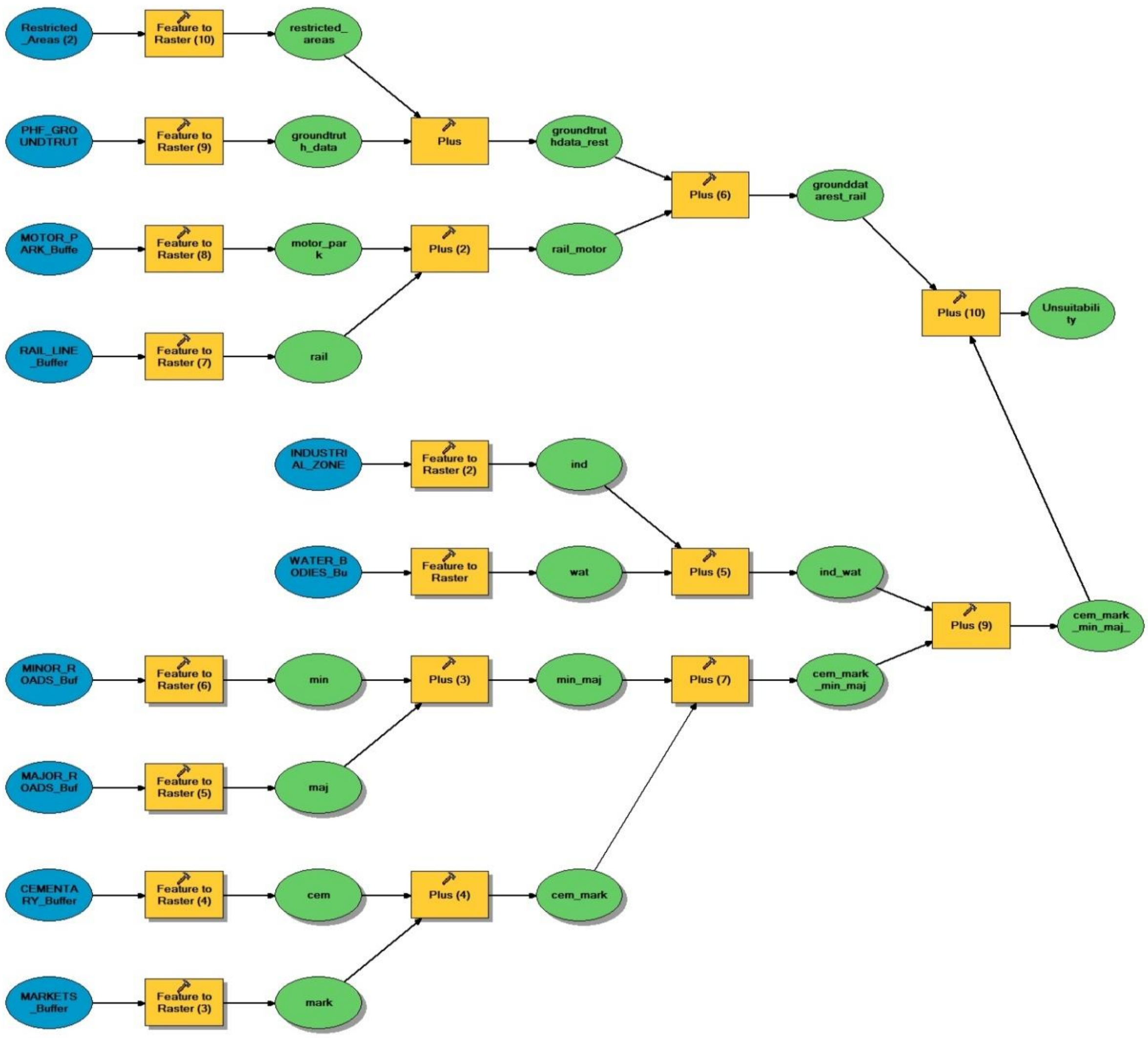


Figure 5.3: Factor model, constrained model with Existing Model used to generate the suitable site selection.

Results and Analysis

Spatial Distribution of Existing Public Health Facility

Figure 6.1 shows the spatial distribution of healthcare facilities in the study area. Twenty (20) healthcare facilities were found in the study area. Only one (1) secondary healthcare facility (General hospital) was found in the study area and nineteen primary healthcare were found.

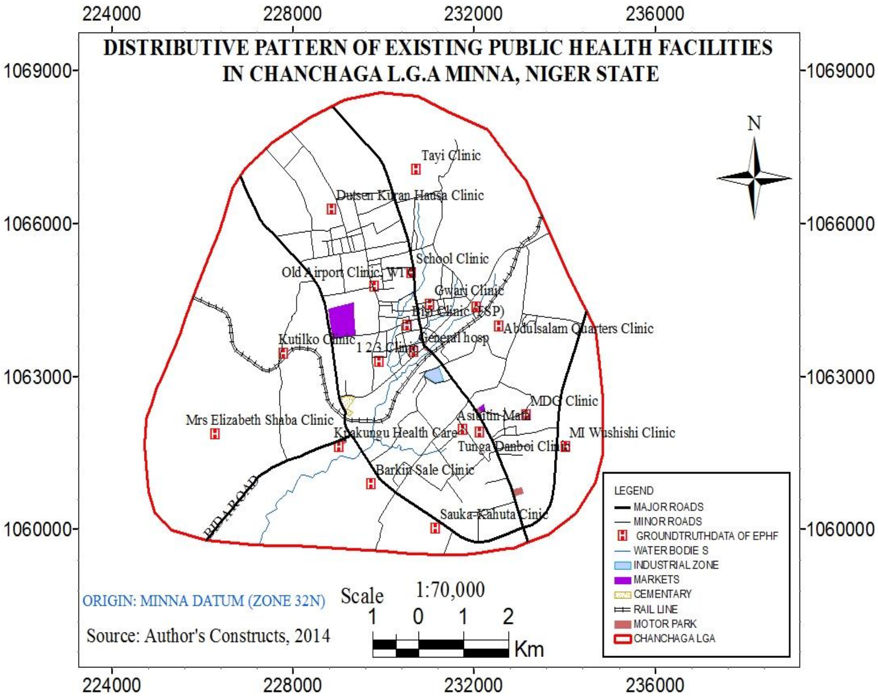


Figure 6.1: Distributive Pattern of Public Health Facilities in Chanchaga L.G.A. Niger State

Further analysis was carried out in the study area to know the distributive pattern of the facilities in the study areas. The nearest neighbourhood analysis was carried out and it was found that the facilities are randomly distributed in the study area (figure 6.2).

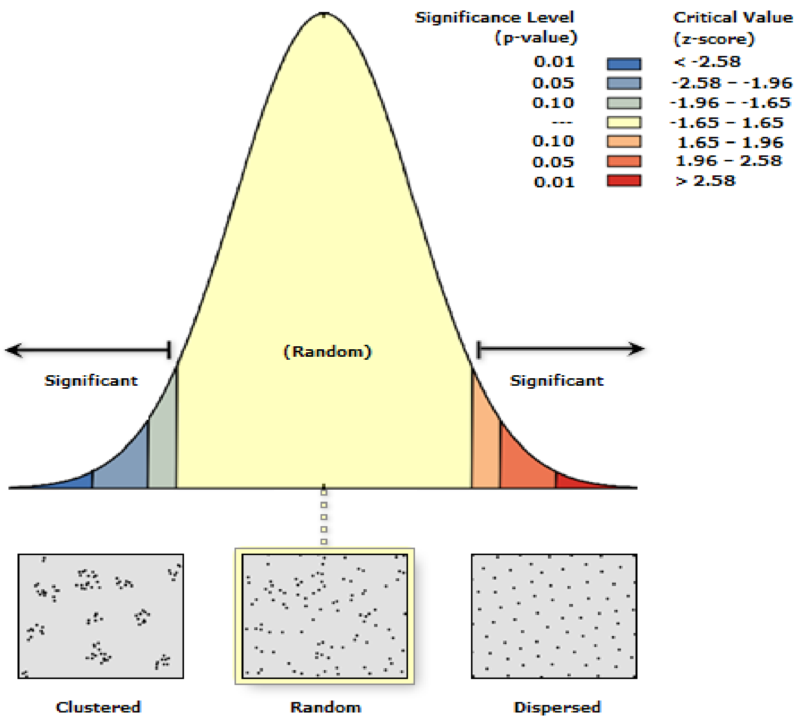


Figure 6.2: Nearest Neighbourhood Analysis. Source: Authors' constructs, 2014

EVALUATION AND MAP PRODUCTION OF CRITERIA

Factor maps were produced; the maps were initially extracted from the high resolution image; constraint maps were also generated from the extracted features.

Factor Maps

They are also referred to as the criteria maps. These maps have been defined in the criteria to be adopted. They are maps that show where hospitals should not be located within a certain distance (figure 6.3). The factors that were considered are: Cemetery, Water Bodies, Major Roads, Minor Roads, Rail-Line, Markets, Motor-Parks, and Industrial Zone.

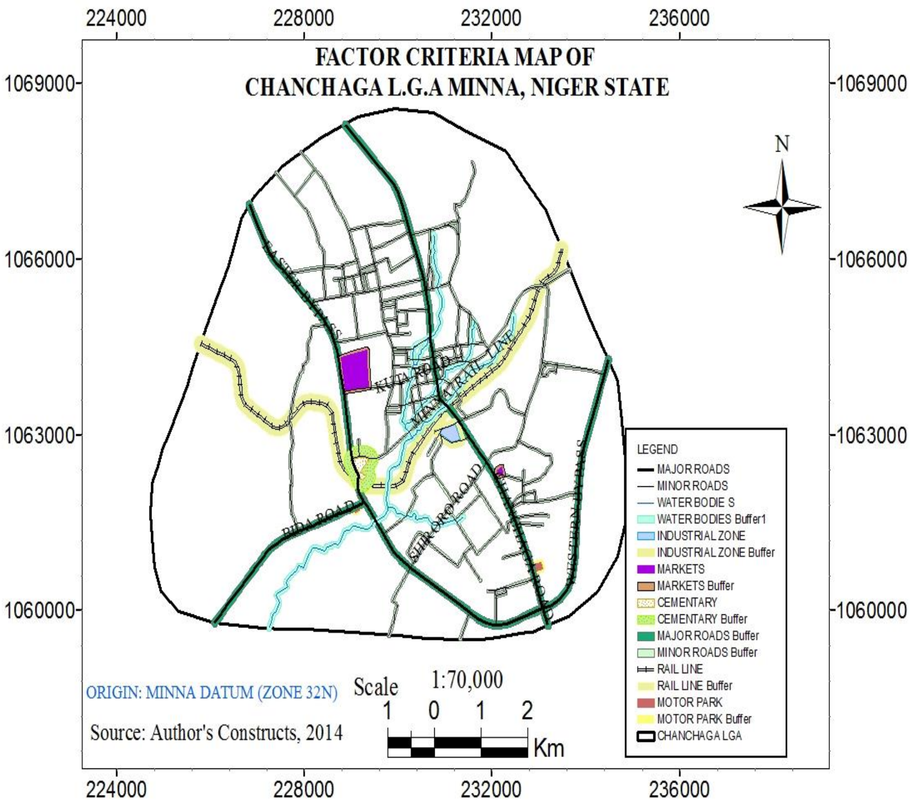


Figure 6.3: Factor Criteria of Chanchaga Local Government Area Minna, Niger State

Constrained/Restricted Areas

These are areas that hospitals should not be located because of some factors which may in the opinion of the people and government are important areas. These areas include but not limited to the following: Banks Areas, Paramilitary Formations, Recreational Centres, Religion Centres, Media Houses, Farmland (Agricultural Land use) and Judiciary Locations. Boolean map was created showing restricted and non-restricted areas (figure 6.4).

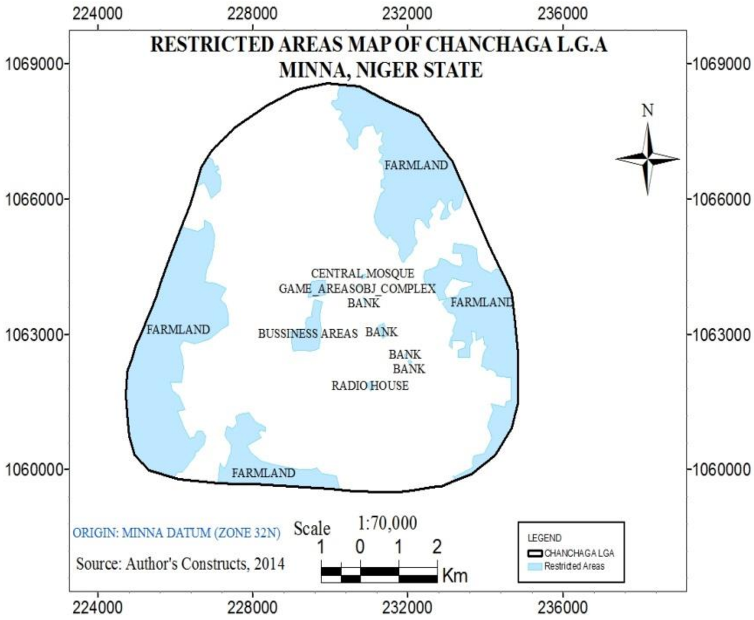


Figure 6.4: Constrained or Restricted Areas of Chanchaga L.G.A. Minna, Niger State

Proposed Site Selection

In the final stage, a suitable site was created by overlaying the factor maps and constrained maps on the buffered existing public health facility map in ArcGIS 9.3 using arithmetic function in ArcGIS 9.3. Based on this, areas that are deprived of the existing public health facilities by author's criteria can be easily identified because of their locations (distance). See figure 6.5a &6.5b.

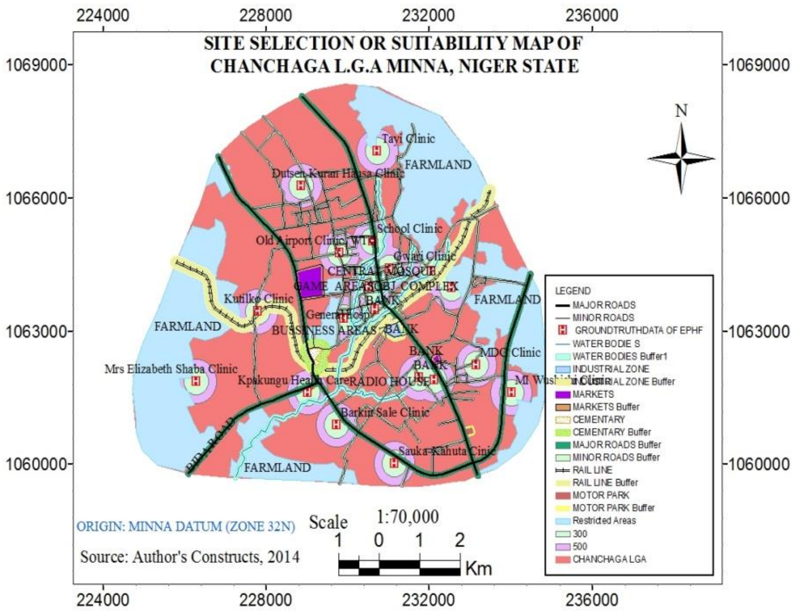


Figure 6.5a: Site Selection of Proposed Public Health Facility

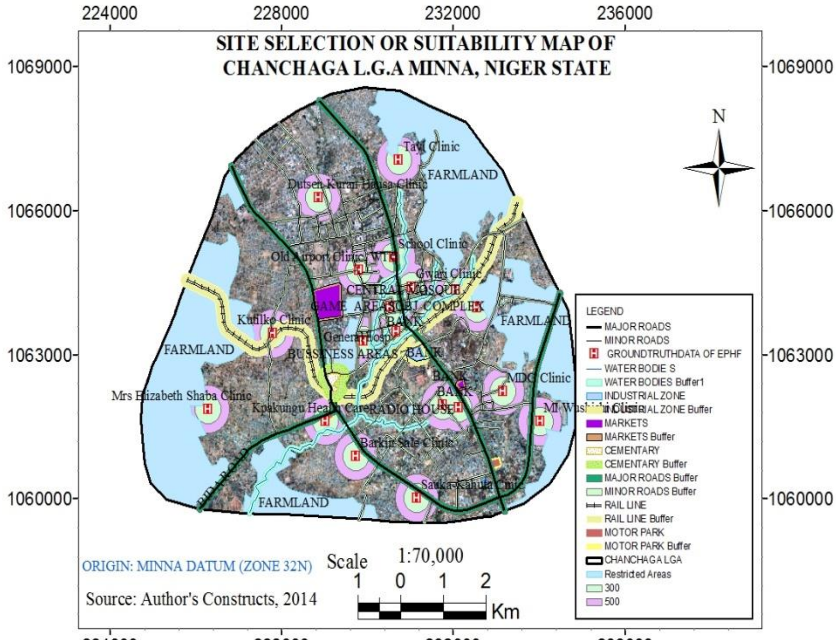


Figure 6.5b: Site Selection of Proposed Public Health Facility

From the results obtained, it can be seen that, the Council's centre enjoys more of the presence of facilities than any other parts. This may be due to the population density in the area. Also, the North-East part of the Council is the areas with low presence of public health facility.

Discussion of Results

Having carried out successful buffering on the factor and existing health facilities in the study areas, it was shown in figure 5.2 that four (4) hospitals were wrongly located or sited. They were affected by factor criteria chosen. The hospitals that were affected are: Kutilko Clinic in Limawa 'B' Ward which is affected by rail-line, Angwa-kaje in Sabon-Gari Ward is affected by river, School Clinic in Limawa 'A'- affected by major road and Asibitin in T/Wada South is affected by minor road. Hence, the health sector needs to be carefully accessed and managed its resources for sustainable development. Health management board may involve in policy making on health. The public (individuals and corporate bodies) also needs information in the distribution, and locating a standard site for public health facilities. Therefore, as a result of the above mentioned issues, the results obtained from this study provide a background for planning and implementation of good management technique and location of public health facilities in Chanchaga Local Government Area, Minna, Niger State. The Niger State Ministry of health can fast run the management and establishment of public health facilities in Minna metropolis based on this study to attend to the areas that are uncovered in the study area. Also, decisions which are related to resource allocation to public health facilities can easily be taken and quick updates could easily be made by the Ministry of Health, Niger State.

Conclusion

The paper presented an experiment based on a real case, in the field of healthcare, where actual positions of basic health units were compared with locations proposed by optimization models. The results showed the effectiveness of the model used, in all criteria considered: P-Centre model. It also revealed that as the population of the study area grows there seems to be a trend of increasing the proportional advantage of the model, when compared to empirical decisions. Further study should be developed in this field to validate this apparent trend, but this may be an indication of the importance of using this model in the health area. In fact, modeling this tendency may represent a powerful tool to support investments decisions. For future studies it would be important to consider other instances of the problem. A new experiment to validate the apparent tendency mentioned above is also, a study that should be done. Moreover, it would be important to consider other types of models, in order to compare their performances. Expanding the study a little more, it could be interesting to explore the field of metaheuristics in order to compare results obtained by different strategies.

Recommendations

For the decision makers of hospital site selection, when making GIS-based P-centre model, reliable and up to date data should be used. For this study, 2010 satellite imagery was used because recent image of the study area could not be accessed and also population figures of wards and if possible that of household should be provided by national population commission.

Also factor criteria should be taken seriously. The need to have defined criteria for hospitals site locations is necessary by those concerned. GIS experts and latest equipment should be acquired by both the Niger State and the Niger State health board in other to enhance the efficiency of GIS. From the study, four hospitals need to be relocated because these hospitals are affected by the chosen criteria of the study.

Finally, GIS technology has the potential to revolutionize health surveillance. It gives health professionals quick and easy access to large volume of data. Moreover, this system provides analytical support for the planning, programming, and evaluation of activities and interventions in the health sector.

References

Abbas, I. Innocent; Auta, S. Z; Naiya and Muhammad, R. (2012).Healthcare facilities mapping and database using GIS in Chikun Local Government, Kaduna State, Nigeria Global Journal of Human Social Science Geography and Environmental Geoscience.

Abdullahi et al. (2014).Using a GIS-Based Network Analysis to Determine Urban Green-spaceAccessibility for Different Socio-Economic Groups; Specifically Related to Deprivation in Leicester, UK. Civil and Environmental Research. Digital Geo-Modelling Laboratory Department of Surveying & Geo-informatics Federal University of Technology, Minna, Niger State, Nigeria.

Arifin, Shamsul (2010). Location allocation problem using genetic algorithm and simulated annealing: A case study based on school in Enschede. Thesis submitted to the faculty of Geo-information science and Earth Observation. The University of Twente.

Ayoade, M. A. (2014). Spatial accessibility to public maternal health. Ibadan. International Journal of Social Sciences.
Bagheri et al. (2005).Measuring spatial accessibility to primary health care. University of Otago, Dunedin, New Zealand.
Chang, N. B., Parvathinathan, G., Breeden, J. B. (2008). Combining GIS with fuzzy multi-criteria decision-making for landfill siting in a fast-growing urban region. Journal of Environmental Management
Doherty, J.; Rispel, L and Webb, N. (1996).Developing a plan for primary health care facilities in Soweto, South Africa. Applying locational criteria. Oxford University Press.
Gustavo, B. (nd). Location–Allocation models applied to urban public services. Spatial analysis of Primary Health Care Centers Luján, Argentina.
Hongzhong, J.; Fernando, O. and Maged, D. (2005). Modeling Framework for Facility Location of Medical Services for Large-Scale Emergencies. Daniel Epstein Department of Industrial and Systems Engineering University of Southern California Los Angeles USA.
Joseph, R. O. (1997). Obstacles to acceptance of location-allocation models in healthcare planning in sub-saharan Africa. North Denton. Uganda Geographical Society and Makerere University.
Lasse, M. J. and Richard, Y. K. (2001). Exploiting Availability Data Sources. Location Allocation Modeling for health service planning in rural Ghana. Danish Journal of Geography.
Law, M. R. and Morris, J. R., (1998). Why is mortality higher in poorer and in more Northern areas of England and Wales? Journal of Epidemiology Community Health.
Lina, Z. and Jie W. (2012).GIS-Based Multi-Criteria Analysis for Hospital Site Selection in Haidian District of Beijing. China.
Malczewski, J., (1999). GIS and multicriteria decision analysis. New York: Wiley.
Nasri, A. M. (2014). Site suitability using multi-criteria analysis of secondary health care facility in Dala and Gwale Local Government Areas, Kano State, Nigeria. Master's thesis project, Department of Photogrammetry and Remote Sensing, Regional Centre for Training in Aerospace Surveys (RECTAS). (Unpublished)
National population commission (1991 and 2006). Abuja.
Nigerian Meteorological Agency (NIMET) 2013.
Oda, T. and Yamamura, E. (1987).A Location-Allocation Model for Health Care Services Planning. Journal of the Graduate School of Environmental Science, Hokkaido University, Sapporo, Japan.
Ogundare, E.I. (1982). Healthcare Delivery is a success in Oyo State. Daily Sketch.
Oliver, A. and E. Mossialos, (2004). Equity of access to health care: outlining the foundations for Action. Journal of Epidemiol Community Health.
Onokerhoraye, (1999).Access and utilization of Modern Health Care facilities in the Petroleum producing region of Nigeria. The case of Bayelsa State. Takemi program in International Health Boston, USA.
Owoola, M. A. (2002). Between Policy and Practice: A Spatial Decision Support System- Based Assessment of Facility Location Planning in Nigeria. Symposium on Geospatial Theory, Processing and Applications.
Oyewo,Y. O. (2013). Geospatial analysis of healthcare facilities in Ile-Ife, Osun State, Nigeria. Unpublished project in RECTAS.
Regional Centre for Training in Aerospace Surveys (2013).Under the Auspices of United Nations Agency. Ile-Ife. Rectas Press.

Robert, L. B. (1997). Evaluating and Improving the Accessibility of Primary Health Care services. Waterloo, Ontario, Canada. A thesis presented to the University of Waterloo in fulfillment of the thesis requirement for the degree of Doctor of Philosophy in Systems Design Engineering.

Sarifah, R. B. S. (2012). Public Healthcare Facility Planning in Malaysia: Using Location- Allocation Models. Institute of Mathematical Sciences faculty of Science University, Malaysia.

Scapama, P. and Scutella, D. (2009). A GIS site-selection process for habitat creation connectivity of habitat patches. Landscape and Urban Planning.

Tegeret, K. K. (2011). Achieving equity in public service delivery. The case study of health-care provisions in Asutifi District. Kwame Nkrumah University of Science and Technology Ghana.

World Bank, (2006). World Development Report: Equity and Development, World Bank and Oxford University Press, New York. www.worldbank.org

World Health Organization, (2000). World malaria report 2010. Retrieved from: www.who.int/malaria/ world_malaria_report_2010.

Yassine, C. and Adel.G, (2011).PV site suitability analysis using GIS-based spatial fuzzy.

PUBLIC TRANSPORT OPERATIONS AND MOBILITY NEEDS OF THE ELDERLY IN LAGOS, NIGERIA

O.O. AGUNLOYE and O.A. ADENIJI
Department of Urban and Regional Planning, University of Lagos

This study assessed the effects of existing public transport operations on mobility demands of the elderly along Mile 12 Bus Stop – CMS Bus stop, Lagos, Nigeria. Sets of structured questionnaire were administered on 85 operators and 137 elders respectively in seventeen major operational bus stops of the study area. Using multi-stage sampling technique, zones of operations, bus stops were identified and drivers and elders were respectively interviewed at each of the bus stops and motor parks for drivers. Data were analysed using descriptive (frequency tables) and inferential (Spearman's Rank Correlation Co-efficient) statistical tools for interpretations and discussion of results. The average elders' trip was 2 round trips per day as elders' travel time from residents to bus stops was 3.8 minutes. Also, the average operators round trips per day was 4 trips as 51.8% of operators perceived the condition of bus terminals in the study area as good. Results showed that most operators 45 (32.8%) rated the conditions of bus stops in the study area as fair as 32.8% of operators perceived the condition of bus stops as fair. It was also found that most respondents 86 (62.8%) observed surface covering from home to bus stops as non slippery in the study area as most respondents experienced tight buses as the most frequent difficulty in the study area while 36 (26.3%) respondents (elders) travel time was between 1-2 hours in the study area. The inferential statistics revealed a positive statistically significant relationship between rating of surface covering and elders' travel frequency ($n=137$, $r_s=0.178$, $p>0.05$). Also, there was a positive statistically significant relationship between curbs and stairs ratings and elders' travel frequency ($n=137$, $r_s=0.186$, $p>0.05$) among others. The study concluded through pragmatic strategies such as the need for assessment and upgrade of available buses to reduce tight and rickety buses, exceptions of elders in terms of stairs to be climbed and provisions of special buses in the study area among others.

Keywords: Public Transportation, Mobility Needs, Elderly

oagunloye@unilag.edu.ng,
oadeniji@unilag.edu.ng

O.O.AGUNLOYE and O.A. ADENIJI (2016). **PUBLIC TRANSPORT OPERATIONS AND MOBILITY NEEDS OF THE ELDERLY IN LAGOS, NIGERIA** Sustainable Built Environment and Climate change; The challenges of Post 2015 Development Agenda. School of Environmental Technology Conference, SETIC, 2016

INTRODUCTION

The past fifty years has been characterised by the explosive growth in urban population and car use as urbanisation is heavily influenced by car use and many households have moved out to the 'green' suburbs and need several cars to satisfy their mobility needs. The resulting consequences of this urban sprawl are well known: the degeneration of social and neighbourhood links, greater car dependence, longer journeys and increased transport costs. Between now and year 2020, it is estimated that urban mobility through cars, buses etc will grow by 50%. Most of these have been estimated to happen in large urban conurbations, especially in less developed cities that already suffered from congestion, alarming number of road accidents and high atmospheric levels of pollution.

In actual fact, decision to embark on a particular trip can be viewed from the costs, quality and availability of required transport system. A good transport system is however expected to support the livelihood activities of growing population. Thus transport system and specifically public transportation of various forms for the elderly play important and pervasive role in enhancing independent livability, access to medical and social services and more interestingly contact with the outside world with a view to reaching all societal groups such as the elderly, children, women among others (Odufuwa, 2006).

Based on the fore-going, the tenet of this paper is to assess effects of existing public transport operations on the mobility demands of elderly in the study area using not more than sixty-five (65) years of age for each of the respondents in the study area.

CONCEPTUAL ISSUES with LITERATURE REVIEW

Global View of Mobility of the Elderly

Of great importance is the observed ageing population in both industrialized and developing countries that demands for a more responsive means of mobility. Based on this, enhanced mobility of the elderly entails having transport service going where and when one wants to travel, provides information about the services, knowing how to use them, being able to use them and having the means to pay for the service. However, providing more responsive public transportation service and friendly transport environment, is partly a result of the increasing ratio of road accidents involving the elderly all over the world (Rodrique 2004, Ogunsanya and Galtima 1993, Adeniji 1987, Oyesiku and Odufuwa 2007 and WBCSD 2002). They have become a high-risk group within the road environment, with the highest rate of severe injuries and deaths (OECD 2002, FHMA 2001, ECMT 2002 and Hakamies-Blomqvist 2003).

Despite this vulnerability frequently witnessed by the elderly, mobility systems currently contributes immensely to various transport externalities - congestion, accidents, pollution and also perpetuate social inequities by offering a very limited range of transport choices to the elderly. Compared with Europe and Japan where public transport remains a vital means of mobility for the elderly, in most developing countries and specifically Nigeria cities, public transport is generally viewed as inadequate to the everyday travel needs of most people (Adeniji 1987 and Oyesiku 2002). For instance, exposure of the elderly to transport externalities- pollution in the process of using available modes of mobility is at extremely high levels and is growing worse.

As emphasized by Metz (2000), mobility in the traditional transport analysis is associated with travel behavior (people travel to access people and places), and this is expressed in terms of supply and demand. This implies that, the concept of mobility of the elderly needs to be understood beyond the analysis of numbers of journeys. According to Alnih and Hensher (2003), the ease with which journey destinations can be reached (accessibility) has increased, while the ease of movement (mobility) has decreased. In other words, high rate of mobility are associated with access, choice, opportunities and freedom. Good accessibility to stations, stops and vehicles for instance is important in lowering resistance to traveling by public transport by the elderly.

Surprisingly, this vulnerable group accounts on average for one in four of the public transport passengers. Thus, given the correlation between age and mobility impairment and prospect of an ageing population, catering for the mobility needs of this group becomes an increasingly important challenge for all transport stakeholders. In comparison, the United States appears to be more proactive with regards to issues that affect the elderly. For instance, the Transportation Research Board identified “an ageing population” as one of fourteen critical issues or challenges facing users or providers of transport services today and in the near future (Scott et al 2005, Pisarski 2003 and TRB 2001). At this point it is pertinent that public transport service most especially in Sub-Saharan Africa cities needs to be affordable, accessible, available, acceptable and safe for the elderly and other users.

Equity and Equality in Provision of Public Transport for the Elderly

The alarming increases of the aged have resultant effects on their mobility needs. In European and some Asian countries, the railway systems and ferry services have reached greater heights in the provision of public transport service for all. Whereas, Nigeria railway and ferry system like some other Sub-Saharan Africa countries is woeful due to their deplorable state of operation that yields no good for all users. In the light of this, public transport service in most Sub-Saharan cities is road based and most carrying units are old and poorly designed, inadequately maintained, dangerously overcrowded, undependable and slow. In Nigeria and notably in Lagos, local buses commonly refers to as “danfos” -flying coffins or “molue”- moving morgues are death traps for users that cannot afford the expensive taxi fare (Odufuwa, 2006).

According to Stahl (1984), problems associated with elderly in buses can be grouped into four:

a) Problems associated with journey from home to the bus stops, which include distance from one’s residence, slippery pavement, high curbs and unexpected steps, which the elderly cannot cope with.
b) Problems related to the bus stop. These are caused by lack of shelter and seats.
c) Problems related to exiting or entering the bus, such as the high steps.

d) Problems related to the bus journey, such as the difficulties when bus stops are not announced by drivers and the bus departure from stops before persons are safely seated.

Odufuwa (2006) emphasized the need to consider the above problems when taking decision on mobility of the elderly.

Public Transportation in Lagos

Bus public transport operation in Lagos is characterized by high levels of fragmentation and indiscipline. There are no fewer than 100,000 different types of buses owned almost exclusively by individuals, one or two each, which they drive themselves or hire out to drivers on a daily rental basis. Before the implementation of the Bus Rapid Transit (BRT) system, the state had witnessed the use of different types of vehicles for public transportation. In the late 1960s and 70s the Bolekajas (wooden lorries used for carrying goods and passengers) were in vogue.

At the twilight of that decade, the Molues (midi buses) became the in-thing. Following the reformation of the bus system, the Lagos State Government established the Lagos State Transport Corporation (LSTC) but soon ran aground due to management challenges. Existing rail corridors are very few and grossly under-utilized. The Nigerian Railway Corporation operates only one train per day in each direction of the Agbado-Agege- Iddo corridor, although efforts are on to resuscitate the services with the recent acquisition of new coaches and wagons by the Federal Government (Fashina, 2011).

The Use of the waterways in Lagos is regulated by the National Inland Waterways Authority, a federal agency. But with the establishment of an agency, Lagos State Waterways Authority (LASWA) to regulate activities on its waterways, the Lagos State Government has signaled its seriousness to promote water transportation. Some ferry operators have been licensed to provide ferry services and have built a number of jetties along the waterways of Lagos. The potential of both rail and water transport remain largely untapped as they carry less than one percent of overall traffic in Lagos.

RESEARCH METHODS

Data for this study were primarily and secondarily sourced. Primary data were sourced through sets of structured questionnaire. These sets of questionnaire were designed to collect data on public transport operations and mobility needs of the elderly. Secondary data were on existing literature. The sample frame took two (2) folds namely the Operators of public transport facilities and the elders as revealed in Table 1. The operators were basically the drivers of the public transport facilities that ply the route of the study area (Mile 12 – CMS). The sample frame for the elders evolved from total average of the elderly at the various bus stops along the study area during the hours of 3pm and 5pm (Afternoon/ evening peak period) on a week day. These bus stops are twenty (20) in general although only seventeen (17) are functional including those designated yellow buses (Danfo and Molue). Thus the sample frame used for this study was One thousand and seventy seven (1,077) elderly passengers at the seventeen (17) functional bus stops/motor parks in the study area (see Table 1). The sample size was in two (2) folds namely eighty-five (85) Operators and One hundred and thirty-seven (137) elders respectively. The eighty-five (85) Operators evolved from five (5) drivers in each of the Seventeen (17) bus stops/motor parks in the study area and this represented the total number of questionnaire administered on the operators. The sample size for the elderly was twelve point seven (12.7%) of the sample frame which translates to One hundred and thirty seven (137) and this represented the total number of questionnaire that were administered on the elderly. The multi-stage sampling technique was used. The sampling procedure for the operators (bus divers) entailed the identification of the study area selection of bus stops and the purposive selection of the five (5) drivers in each of the seventeen (17) bus stops/motor parks that make up the study area for the purpose of questions on public transport operations. The procedure for the elderly covered the identification of bus stops, selection of elderly for survey and the administration of the questionnaire. The selection was done based on facial look and question on age before the conduct of interview through the structured questionnaire. Thus, twelve-point-seven percent (12.7%) of the estimated elders in each bus stop (see Table 2) was used in the administration of the questionnaire. Descriptive (frequency tables) and inferential (spearman's rank correlation co-efficient) statistical tools were used for data analysis after conversion to binary form. The correlation analysis was used to explain the relationship between public transport operations and mobility needs of the elderly through the SPSS data analyses software programme.

RESEARCH RESULTS AND DISCUSSION

Transport Operations

Operators' Travels in a Day

Operators travels per day suggested that the frequency of operators travels in a day were 1-2 round trips per day 13 (9.5%), 3-4 round trips per day 33 (24.1%) and < 4 round trips per day 39 (28.5%). The study suggested that most operators had > 4 round trips per day.

Bus Terminals' Rating

Results revealed in Table 4 that bus terminal rating of operators were good 71 (51.8%), fair 13 (9.5%) and poor 1 (0.7%). The study showed that most operators rated the bus terminals in the study area as good 71 (51.8%).

Rating of Bus Stops

The study revealed in Table 5 that bus stops rating by operators were good 22 (16.1%), fair 45 (32.8%) and poor 18 (13.1%). Results showed that most operators rated the conditions of bus stops in the study area as fair 45 (32.8%).

Rating of Road Condition

Results in table 6 revealed that road condition was rated by operators as good 22 (16.1%), fair 45 (32.8%) and poor 18 (13.1%). Results showed that most operators rated the conditions of bus stops in the study area as fair 45 (32.8%).

Elders’ Mobility Demands

Number of Daily Elderly Trips

It was observed in Table 7 that daily elderly travels were between1-2 round trips 92 (67.2%), between 3-4 round trips 38 (27.7%) while < 4 round trips were 7 (5.1%) respectively. Results showed that most elders’ round trips were 1-2 round trips 92 (67.2%).

Minutes from Residence to Nearest Bus Stops

As shown in table 8, the study revealed that travel time of respondents (elders) from their residents to their nearest bus stops were <1 minute 18 (13.1%), 1 minute (9.5%), 2 minutes 13 minutes (9.5%), 3 minutes 12 (8.8%), 4 minutes 16 (11.7%), 5 minutes 20 (14.6%) and >5 minutes 45 (32.8%) respectively.

Surface Covering from Home to Bus Stops

Results in Table 9 revealed that respondents’ rating of surface covering from home to bus stops were slippery 51 (37.2%) and non slippery 86 (62.8%). The study showed that most respondents 86 (62.8%) observed surface covering from home to bus stops as non slippery in the study area.

Condition of Curbs and Stairs

It was observed through Table 10 that condition of curbs and stairs were rated as available with 60 (43.8%) while unavailable with 77 (56.2%). The study revealed that most respondents (elders) rated the condition of curbs and stairs as unavailable presence in the study area.

Difficulties Encountered on and off Board

As shown in table 11, the study revealed that difficulties encountered on and off board were tight buses 73 (53.3%), rickety buses 36 (26.3%), stairs 20 (14.6%), tight buses, rickety buses and stairs 5 (3.6%), tight buses and rickety buses 2 (1.5%) and tight buses, stairs 1 (0.7%) respectively. Most respondents experienced tight buses as the most frequent difficulty in the study area.

Travel time from Origin to Destinations

Results in table 12 revealed that travel time of respondents (elders) from origin to destinations were < 1 hour 28 (20.4%), between 1-2 hours 36 (26.3%), 3-4 hours 16 (11.7%) and above 4 hours 5 (3.6%) respectively. Most 36 (26.3%) respondents’ (elders) travel time was between 1-2 hours in the study area.

Relationship between Variables of Public Transport Operations and Mobility Demands

Using the spearman's rank correlation co-efficient, the study revealed in Table 13 that there was a positive statistically significant relationship between rating of surface covering and elders' travel frequency ($n=137$, $r=0.178$, $p>0.05$). This suggests that the better the surface covering, the higher the trip frequency of respondents. Also, there was a positive statistically significant relationship between curbs and stairs rating and elders' travel frequency ($n=137$, $r=0.186$, $p>0.05$). This suggests that the better the curbs and stairs, the higher the trip frequency of respondents.

POLICY STATEMENTS AND CONCLUSION

Policy Statements

This study recommends that there should be an upgrade of the bus stops to include covering and seats especially for the elderly. Also announcement of bus stops should be integrated into the transport services for easy identification of stops. There is a need for the assessment of available buses to reduce the tight and rickety buses. Exceptions should be given to elders in terms of stairs to be climbed in order to board the buses. Some of the elders recommended that special buses be introduced into the public transport system, which will include all their mobility needs comfortable buses and seats for smooth travel.

CONCLUSION

This study has examined the correlates of public transport operations and mobility needs of the elderly and found a positive relationship between public transport operations and mobility needs of the elderly. The study revealed that most operators had > 4 round trips per day as 51.8% of operators rated the bus terminals in the study area as good. Results indicated that most operators rated the conditions of bus stops in the study area as fair 45 (32.8%) as 32.8% of operators rated the conditions of bus stops as fair. Results showed that most elders' round trips were 1-2 round trips 92 (67.2%) while most respondents 86 (62.8%) observed surface covering from home to bus stops as non slippery in the study area. Also, most respondents (elders) rated the condition of curbs and stairs as none presence in the study area while most respondents experienced tight buses as the most frequent difficulty in the study area even as 36 (26.3%) respondents' (elders) travel time was between 1-2 hours in the study area.

REFERENCES

Adeniji K. (1987). Para-transit modes in Nigeria: problems and prospects cities. *The international quarterly policy on urban policy*. 4 (4)

Alsnih, A & Hensher, D.A. (2003). The Mobility and Accessibility Expectations of Oseniorsin an Aging Population. *Transportation Research.* Part A, 37

Carlsson G. (2002). Catching the Bus in Old Age: Methodological Aspects of Accessibility Assessments in Public Transport; Lund, Sweden. Lund University

ECMT. (2002). Transport and Ageing of the population. *Conference Paper: European Conference of Ministers of Transport.* www.oecd.org/cem/

Fasina O. M. (2011). Assessment of Mobility Friendliness of Public Transport Facilities on the Elderly in Lagos State. B Sc. Thesis, University of Lagos.
Hakamies-Blomqvist L. (2003). Ageing Europe: the challenges and opportunities for transport safety. *European Transport Safety Council*. http://www.etsc.be/eve
Krumholz, N.A. (1982). Retrospective View of Equity Planning: Cleveland 1969-1979. *The American Planning Association*. 48(2). 163-174
Mandeep Singh, Nitinnagdavane, & Nehasrivastva. (2007). Public Transportation for Elderlyand Disabled
Metz, D.H. (2000). Mobility of Older People and Their Quality Of Life "Transport Policy". 7. 149 -152
Mobereola D. (2009). Lagos Bus Rapid Transit: Africa's first BRT Scheme. SSATP Discussion Paper. No. 9. Urban Transport Series
Odufunwa Olufemi B. (2006). Enhancing Mobility Needs of The Elderly In Sub Saharan African Cities Through Improved Public Transportation; Mobility Needs of The Elderly. *International Association of Traffic and Safety Sciences (IATSS) Research Special Feature Mobility For The Elderly*. 30 (1).
Odufuwa B.O. (2010). Vulnerability and Mobility Stress Coping Measures of the Aged in a Developing City. *European Journal of Social Sciences*. 13 (1)
Ogunsanya A. & Galtima M. (1993). Motorcycle in public passenger transport service in Nigeria. A case of Yola Town; In Ikya, S.G (Ed). Urban passenger transportation in Nigeria. Heinemann. Ibadan
Oyesiku O.K & Odufuwa B.O. (2002). Gender perspectives in travel behavior of motorcycle passengers in Nigeria intermediate cities. In Xavier G. and Innocent (Urban Mobility for All). Balkema. Netherlands World Business Council for Sustainable Development (WBCSD). The Sustainable Mobility project. England. www.sustainablemobility.org
Oyesiku O.K. (2002). The Challenges of Contemporary Road Safety Practices in Africa. *Conferences paper for 3rd International Conference for Road Safety, Abuja*
Pisarski A.E. (2003). Prescriptions for Research: Reviewing the History of TRB'S CriticalIssues in Transportation. TR News 226. 30-35
Rodrique J.P. (2004). Transport Geography on the Web. Hofstra University. http://people.hofstra.edu/geostrans
Scotts D.M, Newbold K. B, Spiney J.E, Mercado R.G, Peaz A. & Kanaroglou P.S. (2005). Changing Mobility of Elderly Urban Canadian 1992 – 1998. CSPA. Canada
Stahl A. (1984). Public Transportation for the Elderly in Sweden: Technical and Behavioral issues in Third International Conference on Mobility and Transport of Elderly and Handicapped Persons; Washington DC. US Department of Transportation Final Report.
TDM. (2010). Travel Models Implementation: Improving methods for evaluating the effects and value of transportation system changes.
Transportation Research Board (TRB). (2001). Critical Issues in Transportation Research News 217. 3-11
U.S. Federal Highway Administration (FHMA). Guidelines and recommendations to Accommodate Older Drivers and Pedestrians European Conference of Ministers of Transport
U. S. Department of Transportation. (1973). The Handicapped and Elderly Market for Urban Mass Transit. Transportation Systems Centre. Cambridge

World Health Organization (2011). Definition of an elderly person. http://www.who.int/healthinfo/survey/ageingdefnolder/en/index.html retrieved 2/3/2011

APPENDIX

Table 1: Average Number of Elderly Passengers at the Seventeen (17) Functional Bus Stops between 3pm and 5pm of A Particular Weekly Travels

Bus stops	Male	Female	Total
Mile 12	16	17	33
Ketu	15	18	33
Ojota	20	25	45
New Garage	5	6	11
Mary Land	10	15	25
Idiroko	5	7	12
Anthony	10	12	22
Town planning	5	7	12
Obanikoro	20	17	37
Palm groove	60	57	117
Onipanu	55	56	111
Fadeyi	60	64	124
Ojuelegba	69	57	126
Barracks	48	74	122
Stadium	40	50	90
Costain	56	52	108
CMS	22	27	49
Total	516	561	1077

Source: Field Survey, 2012

Table 2: Average Distribution of Questionnaire Per-Bus Stop

Bus stops	Population	Selected elders (12.7%)
Mile 12	33	
Ketu	33	
Ojota	45	
New Garage	11	
Mary Land	25	
Idiroko	12	
Anthony	22	
Town planning	12	
Obanikoro	37	
Palm groove	117	
Onipanu	111	
Fadeyi	124	
Ojuelegba	126	
Barracks	122	
Stadium	90	
Costain	108	
CMS	49	
Total	1077	

Source: Field Survey, 2012

TRANSPORT OPERATIONS

Table 3: Frequencies of Operators' Travels in a Day

	Frequency	Percent
1-2	13	15.3
3-4	33	38.8
above 4	39	45.9
Total	85	100

Source: Field Survey, 2012

Table 4: Bus terminals' Rating (BRT)

	Frequency	Percent
good	71	83.5
fair	13	15.3
poor	1	1.2
Total		100

Source: Field Survey, 2012

Table 5: Rating of Bus Stops

	Frequency	Percent
good	23	27.1
fair	34	40.0
poor	28	32.9
Total	85	100

Source: Field Survey, 2012

Table 6: Rating of road condition

	Frequency	Percent
good	22	25.9
fair	45	52.9
poor	18	21.2
Total	85	100

Source: Field Survey, 2012

ATTRIBUTES OF MOBILITY

Table 7: Number of daily elderly trips

	Frequency	Percent
1-2	92	67.2
3-4	38	27.7
above 4	7	5.1
Total	137	100.0

Source: Field Survey, 2012

Table 8: Minutes from residence to bus stop

	Frequency	Percent
less than 1	18	13.1
1	13	9.5
2	13	9.5
3	12	8.8
4	16	11.7
5	20	14.6
above 5	45	32.8
Total	137	100.0

Source: Field Survey, 2012

Table 9: Surface covering from home to bus stops

	Frequency	Percent
slippery	51	37.2
non slippery	86	62.8
Total	137	100.0

Source: Field Survey, 2012

Table 10: Curbs and Stairs

	Frequency	Percent
present	60	43.8
none present	77	56.2
Total	137	100.0

Source: Field Survey, 2012

Table 11: Driving status

	Frequency	Percent
never drove	50	36.5
stopped driving	45	32.8
still drives	42	30.7
Total	137	100.0

Source: Field Survey, 2012

Table 12: Difficulties encountered on and off board

	Frequency	Percent
Tight buses	73	53.3
Rickety buses	36	26.3
Stairs	20	14.6
Tight buses, Rickety buses, Stairs	5	3.6
Tight buses, Rickety buses	2	1.5
Tight buses, Stairs	1	.7
Total	137	100.0

Source: Field Survey, 2012

Table 13: Travel Time from Origin to destinations

	Frequency	Percent
less than 1hr	28	20.4
1-2hrs	36	26.3
3-4hrs	16	11.7
above 4	5	3.6
Total	85	62.0

Source: Field Survey, 2012

Table 14: Correlations of public transport operations and mobility needs of the elderly

		Frequency of Trips (elderly)	Average number of trips in a day (elderly)	Surface covering from home to bus stops	Travel Time from Origin to last bus stop	Curbs and Stairs	Average number of trips in a day (Operators)
Frequency of Trips (elderly)	Pearson Correlation	1					
	Sig. (2-tailed)						
	N	137					
Average number of trips in a day (elderly)	Pearson Correlation	.219*	1				
	Sig. (2-tailed)	.010					
	N	137	137				
Surface covering from home to bus stops	Pearson Correlation	.178*	-.043	1			
	Sig. (2-tailed)	.038	.620				
	N	137	137	137			
Travel Time from Origin to last bus stop	Pearson Correlation	.029	.043	-.077	1		
	Sig. (2-tailed)	.795	.696	.485			
	N	85	85	85	85		
Curbs and Stairs	Pearson Correlation	.186*	-.056	.233**	-.051	1	
	Sig. (2-tailed)	.030	.513	.006	.645		
	N	137	137	137	85	137	
Average number of trips in a day (Operators)	Pearson Correlation	-.089	-.159	.009	-.026	.199	1
	Sig. (2-tailed)	.416	.146	.934	.812	.068	
	N	85	85	85	85	85	85

VIABILITY OF FIRE ESCAPE ROUTES IN THE STUDENT HOSTELS AT SELECTED KATSINA STATE TERTIARY INSTITUTIONS

SHITTU, Abdullateef Adewale[1], IDIAKE, John Ebhohimen[1], OYEWOBI, Luqman Oyekunle[1], TSADO, Abel John[1], BILYAMINU, Badamasi[1], MAC-BARANGO, Dumo O.[2]

[1]Department of Quantity Surveying, Federal University of Technology, Minna, Nigeria.
[2]Department of Quantity Surveying, Rivers State University of Science and Technology, Port Harcourt, Nigeria.

Most of the windows in tertiary institution hostels are usually provided with security bars w hich may help to keep the hostels safe from intruders, but they can also trap students in case of fire outbreak. The tertiary institutions' administration should make windows and doors w ith security bars have quick release devices for easy opening in an emergency. This study a ddressed the problem of the devastating effect of fire which results in loss of lives and prop erties due to the fact that many tertiary institutions in Nigeria have given less attention to th e fire safety programme. To address this problem, the study set out to assess the cost of pro vision of escape routes in the hostels of tertiary institutions in Katsina State in case of fire o ccurrence. Data were collected from the archive of the Works Department of four selected t ertiary institutions in Katsina State and from direct measurement of floor areas, area of esca pe routes and number of escape routes (i.e. doors, corridors and staircases) from three hoste ls from each of the four selected institutions. Analysis of data was done with the use of regr ession analyses. Major findings from the study showed that there exists significant relations hip between: i. the cost of providing escape routes and cost of construction; ii. population o f hostel occupants and number of escape routes; and iii. floor area of hostel and area of esca pe routes. It was concluded that population of hostel occupants, hostel floor area, number of escape routes and area of escape routes have significant influence on the cost of providing e scape routes in tertiary institution buildings. It was recommended that the projected number of hostel occupants and hostel floor area should be considered in estimating the cost and nu mber of escape routes when designing for escape routes in the hostel buildings.

Keywords: *fire escape routes, hostel floor area, population, tertiary institutions*

aishatabdulahi2007@yahoo.com
funsho@futminna.edu.ng

Shittu et. al. (2016). **VIABILITY OF FIRE ESCAPE ROUTES IN THE STUDENT HOSTELS AT SELECT ED KATSINA STATE TERTIARY INSTITUTIONS** Sustainable Built Environment and Climate change; The chal lenges of Post 2015 Development Agenda. School of Environmental Technology Conference, SETIC, 2016

INTRODUCTION

Fire is an important process that affects ecological systems around the globe. The positive effects of fire include stimulating growth and maintenance of various ecological systems. Fire has been used by humans for cooking, generating heat, light, signalling, and propulsion purposes. The negative effects of fire include hazard to life and property, atmospheric pollution, and water contamination. It can result in conflagration, which has the potential to cause physical damage through burning. According to Umar (2014), achieving an acceptable level of fire safety in University Students‟ hostel is one of the greatest responsibilities of the University administration. Students‟ hostel fire can easily cause devastating effect, if appropriate measures are not employed. Even though, the fire occurrence in students‟ hostel is not frequent but if it occurs may result in loss of lives and properties. Hence it requires a full and continuous devotion from both the University community and the administration to provide adequate escape route in case of fire emergency.

An escape route is a continuous and unobstructed path of exit travel from any point within a workplace to a place of safety (OSHA, 2003). An escape route consists of three parts: the first part is called Exit access – portion of an exit route that leads to an exit; the second part is called Exit – portion of an exit route that is generally separated from other areas to provide a protected way of travel to the exit discharge; and the third part is called Exit discharge – part of the exit route that leads directly outside or to a street, walkway, refuge area, public way, or open space with access to the outside. Most of the tertiary institution hostels windows in Nigeria are usually provided with the security bars (burglary) which may help to keep the hostels and offices safe from intruders, but they can also trap people in a deadly fire because the burglary serves as obstructions to windows that are meant to be fire escape routes. Windows and doors with security bars must have quick release devices to allow them to be immediately opened in an emergency. Occupants of such buildings (students) should understand and practice how to properly operate and open locked or barred doors and windows. The population in a hostel should also be considered when designing escape routes. According to Wikipedia Encyclopedia (2012), population is a term referring to the total number of human inhabitants of a specified area. Fire prevention, protection and escape route are subjects of vital importance and are so linked with the design and construction of buildings that it is essential to have an understanding of the factors which influences the nature, the rate of growth, ultimate severity and nature of risks involved in the event of fire. The nature of risks in the event of fire can depend on the use to which the building is put. Example, hostels in tertiary institutions and lecture halls, because of the large number of people accommodated (population) involves a high life risk even though the combustible contents may be low while a large ware house storing a lot of combustible materials involves a considerable risk to extensive damage to structures and contents but a low risk to occupants because their number is likely to be small. Since the hostels in tertiary institutions involve a high life risk, suitable forms of construction, planning of the building internally and satisfactory planning and construction of the means of escape should be highly considered which will allow occupants to escape without difficulty.

Fire is therefore a leading cause of accidental death because a fire can engulf a structure in a matter of minutes and people get trapped due to lack of escape routes, use of security bars on windows and over population of people in a particular floor area. Fire requires specific conditions to occur through a source of ignition. These conditions are inadvertently present in all buildings, as the by-product of design choices (Patterson, 1993).

The current trend of fire in hostel buildings has become a concern in our society today. There has been a lot of incidence of fire in hostels, where student has lost their lives and valuable properties (Nwabueze, 2012). These issues need to be reconciled with the building codes, fire safety design and cost constraints of the project. Fire safety in students" accommodation cannot be over emphasized, although, many institutions in Nigeria have given less attention to the program; despite its importance and the devastating effect of fire, thus may result in loss of lives and properties (Umar, 2014). It is therefore essential that escape routes are available to enable the occupants to reach a place of safety and that they are adequate and capable of being safely and effectively used at all times. In the light of this, the study set out to assess the cost of provision of escape route in the hostels of tertiary institutions in Katsina State in case of fire occurrence. The objectives of the study are:

i. To determine the relationship between construction cost and cost of providing escape routes in hostels of tertiary institutions in Katsina.

ii. To determine the relationship between population and number of escape routes in the hostels of tertiary institutions in Katsina.

iii. To determine the relationship between the floor area of hostel and area of escape routes in tertiary institutions of Katsina State.

The following null hypotheses were used for the study based on the literature findings:

H_0l: There is no significant relationship between construction cost and the cost of provision of escape route in the hostels of tertiary institutions in Katsina

$H_0$2: There is no significant relationship between population and number of escape routes in the hostels of tertiary institutions in Katsina.

$H_0$3: There is no significant relationship between the floor area of hostel and area of escape routes in tertiary institutions of Katsina State.

SURVEY OF PREVIOUS WORKS

An Overview of Fire Incidences

Fire is referred to as the rapid oxidation of combustible material and gases producing heat and light (oxygen, heat and fuel) in the absence of one of these elements there cannot be fire (Oyeyode, 2003). Fire is one of the most destructive hazards which threaten buildings. It has the potential to affect the occupant, the building and its components. Also areas not directly damaged by the flame or heat may be smoked, dirt and falling debris or by the huge volumes of water used in fire fighting. According to Malven (1997), when substantial heat is generated, over 500 – 600 degrees Celsius, flashover occurs and the fire becomes fully developed, engulfing the whole compartment. Decay follows when all the fuel or oxygen within the compartment is totally consumed. An example often quoted is that a wooden log is difficult to ignite but thin sticks can be ignited easily and will burn fiercely when piled together. According to Patterson (1993), building fire safety in its most simplified form is based on three general strategies; first is to prevent ignition; if it occurs, to prevent spread; and if spread occurs, to minimize damages to the lives and properties, occupants and fire-fighters. Mogbo (1998) researched on the environment and fire incidences in Nigeria and the implications on public policies and politics. Using a critical review of literature and interview, Mogbo (1998) discovered that the incidence of fire outbreak has caused damage to lives, property, the economy and the environment at large. Shittu (2001) studied the incidence of fire outbreak in public and residential buildings of Kwara State from 1990 - 1999. Using a quantitative method of research, Shittu (2001) collected archival data and discovered through an empirical statistical analysis that fire outbreak results into serious losses of lives and property in both residential and public buildings with the highest impact felt in residential buildings. Shittu (2007) researched on a comparative analysis of fire outbreak between the military and civilian era in Niger State in domestic and public buildings. Using archival data collected from Niger State Fire Service which were analysed using T – test, Shittu (2007) discovered that cases of fire outbreak are recorded more during the civilian era than the military and therefore fire outbreak remains on the increase in both domestic and public buildings. Shittu (2010) studied the incidence of fire outbreak in North-Central Nigeria and discovered that there was no significant difference in the number of recorded fire cases in both domestic and public buildings of the States in North-Central Nigeria. Shittu (2010) therefore concluded that the incidence of fire outbreak is still on the hike. Shittu *et al.* (2013) carried out an appraisal of fire safety provisions in tertiary institutions buildings in Minna, Niger State and discovered that most of the tertiary institutions do not follow the required standards in providing for fire preventive measures in their buildings. Nwabueze (2012) also researched on the enhancement of Fire Safety in Hostel Designs and concluded that population of occupants and floor area of rooms are very important factors to be considered when designing for the number of escape routes required to enhance fire safety in hostel buildings designs. These studies have, however failed to assess the viability of fire escape routes n the hostels of tertiary institutions in Nigeria. In the light of this, the study reviewed literature to identify the theory of escape route design, factors influencing escape route design and cases of fire outbreak in tertiary institution buildings in Nigeria among other issues in order to clearly identify the gap in previous researches and how to address the problem left unsolved due to this gap.

Student Housing in Nigerian Tertiary Institutions

The Nigerian higher educational institution was established with the aim of giving students a very sound and qualitative education, so as to be able to function effectively in any environment in which they may find themselves, so as to become more productive, self-fulfilling and attain self- actualization (Saint et al, 2004) .This is because in Nigeria, students are the single most important stakeholders in the University/College System. Similarly, Students' accommodation is among the most important facilities that should be provided in a typical Nigeria University Campus. This is because it offers the students the opportunity to interact amongst their colleagues from faculties other than their own in addition to the unique opportunity for night discussions and social interactions which when put together will help in shaping the student's social life, appreciation of their roles and responsibilities in the community and society at large (Esenwa, 2003). In the beginning, Nigerian universities were established with the intention of providing comfortable hostel accommodation for all students on campus. Up till the early 1970s there was no problem of students' accommodation in University campuses (Esenwa, 2003). Some Nigerian Universities at that period were planned and designed to accommodate both staff and students on campus; hence their location on a large expanse of land away from the developed areas or towns. Then, not many females were admitted. Therefore, in the universities, the spaces provided for accommodation were more for the male students. However, with current search for parity; equal opportunity for both sexes; the female students' enrolment has increased (Esenwa, 2003).

Following this development, a committee, popularly referred to as Brigadier T. B. Ogundeko Committee, was set up by the National Universities Commission (NUC) in 1977, to look into funding problems in the Nigerian University System and submits recommendations. Esenwa, (2003), noted that the recommendations of the Committee on students' accommodation are as follows:

a) Government policy that only 75% of university students should be housed on campus should be continued and the need for these students to interact with the public is valid.
b) In order to relieve pressure on government finance in the areas of student housing, the older universities should henceforth finance construction of student living accommodation with loans, while government should finance one third of the student accommodation required by newer universities.
c) The latter recommendation should put the newer universities at par with the older ones which have had at least one third of their student accommodation requirements financed by government. The students should contribute a substantial part of the repayment.
d) The universities should employ the services of an Estate Agent to undertake a feasibility survey of the avenues of raising loans from the many mortgage establishments, insurance companies, the provident fund and banks.
e) Design for students' hostels should be more modest, simple and functional, so that they can be within the means of students.
f) Students should be charged N150.00 per session for lodging the subsidy for additional hostel would come from lodging charged on existing buildings in older Universities would government require to pay a subsidy until it has developed one third of the accommodation required."

When it was however realized that even with this new policy, available hostel spaces were still inadequate, a new accommodation policy that guarantees accommodation for fresh students and final year students was then put in place (Esenwa, 2003),. To create more accommodation space, many universities introduced the concept of double bunking (e.g. University of Benin, University of Nigeria, Nsukka) to increase available bed spaces without a corresponding increase in the number of conveniences (such as toilets). This turned to be a sedative measure because it worked for just a short while only as student's enrolment continued to increase without a corresponding increase in hostel facilities. According to Esenwa, (2003), due to the drop in capital allocation to Universities in 1975, when seven new universities (known as second generation universities) were established, a policy which provides for accommodation of about 33% of the total students enrolment in the universities was formulated and it unfortunately, brought about the problem of squatters in our students' hostels. In the middle of 1980s, the problem became so acute that students had no other choice than to live off campus and grapple with the problem of insecurity, unsteady water and electricity supplies, while some even slept in the classrooms (Esenwa, 2003), thereby, giving rise to so many problems such as female rape cases, abduction of persons, rise in incidences of prostitution and fall in academic quality. This justifies the need for more hostels in Nigerian tertiary institutions which should provide all fire preventive measures.

Theory of Fire Safety Design

Fire safety is defined by Encyclopedia Americana (1993) as the precautions that are taken to prevent or reduce the likelihood of fire that may result in death, injury or loss of property. Passive Fire Protection Federation (2013) viewed fire safety from three perspectives of passive protective measures as given below:

i. Passive fire protection is the primary measure integrated within the constructional fabric of a building to provide inherent fire safety and protection by responding against flame, heat and smoke, to maintain the fundamental requirements of building compartmentation, structural stability, fire separation and safe means of escape.

ii. Passive fire protection measures achieve their intended purpose by raising the fire resistance of the structure, protecting the structure against the effects of fire, reducing fire spread through secondary ignition, limiting the movement of flame and smoke, and minimizing the danger of fire - induced collapse or structural distortion.

iii. Passive fire protection design, incorporating passive fire protection materials, systems and assemblies, serves by fire containment to protect life, safeguard the building structure, protect assets, maintain building serviceability after fire, minimize rebuild costs, and facilitate quick business recovery and continuity.

In the light of the above there is a strong need for the provision of effective fire detection devices in buildings to bring about effective fire protection for occupants of buildings.

Fire Detection and Alarm Systems

The provision of an appropriate fire detection and alarm system is an essential element of the fire safety measures in a hostel (Malven, 1997). It provides early warning of the occurrence of fire and thereby facilitates the activation of appropriate emergency procedures, including evacuation. Early detection also improves the chances of restricting the growth and spread of fire within the building by the use of first aid fire-fighting equipment, where safe to do so, and by early call-out of the fire services (Herbert, 1998). A fire detection and alarm system should be provided in all hostels. The system should incorporate automatic fire detection (heat or smoke type detectors, as appropriate) throughout the premises and suitably located manual activation facilities. Large buildings should be divided into fire alarm zones, as required by the standard, which will facilitate identification of the alarm source.

In order to make fire detection and alarm system to effectively serve its purpose, there is the need for an adequate provision of escape routes in hostel buildings. This enables the occupants exit the building and seek for help immediately.

General Provisions for Means of Escape

Effective fire safety in buildings goes beyond meeting codes. It requires a systematic and diligent approach on the part of the architect for fire prevention, protection and control in all the aspects of building design, construction and use (Malven, 1997). According to McKay (1975), the means of escape in large buildings should form an integral part of the design of the building and should be such that the occupants can make their way to safety along the escape route' by their own unaided efforts. McKay (1975) also stated that long narrow corridors with several turns and an insufficient number of staircases may lead to overcrowding and panic, which can have more disastrous results than the fire itself. McKay (1975) also reported that when escape routes are being planned the type of person likely to be involved must be considered. Occupants of flats will be familiar with the layout of the premises where as customers in a shop may be completely unfamiliar with their surroundings. In schools the fundamental principle is the provision of an alternative means of escape and in hospitals the main concern is with the adequacy of the means of escape from all parts of the building.

When fire occurs in building, large quantities of smoke and gases are produced. Smoke and hot gases may travel considerable distances within a building and will present a direct threat to life. Visibility also is considerably reduced, thereby affecting the viability of escape routes within and from the building. In examining the means of escape, it is necessary to consider the evacuation process. Herbert (1999) asserted that evacuation can be subdivided into such distinct phases as:

- Phase 1: evacuation from the room or area to a common corridor, a protected stairway or to a final exit;
- Phase 2: evacuation via a common corridor to a protected stairway or a final exit; and
- Phase 3: vertical evacuation via a protected stairway to a final exit and a designated assembly point.

Floor Surfaces on Escape Routes

The floors of corridors, lobbies, landings and stairways forming parts of escape routes should have non-slip even surfaces. Where ramps are provided for use by physically handicapped persons, they should comply with Technical Guidance Access for Disabled People (Herbert, 1998).

Height of Escape Routes

Escape routes should have minimum clear headroom of 2 m and should not have an obstructions or projections except any door frame below this height (Herbert, 1998).

Doors on Escape Routes

All doors on escape routes should generally open in the direction of escape. Doors should not open across stairways, or obstruct the width required for escape of corridors, landings, or lobbies when open. However, doors serving rooms which accommodate less than 50 persons may open into the accommodation (Herbert, 1998). A fire resisting vision panel should be provided in fire doors which are located on corridors for the purpose of sub-division.

Principles of Escape Route Design

Herbert (1998) reported that in designing for fire escape routes, horizontal and vertical components should be considered. In bungalows, the means of escape will consist of horizontal escape routes only, while multi-storey buildings will require a combination of these two components. For the purposes of escape, the travel distances along an escape route from any point in a building should be restricted to an extent which is dependent on the availability of alternative escape routes. The horizontal escape routes may be sub-divided into the components for travel within rooms and horizontal travel from rooms to a protected stairway or to a final exit. The protection in vertical escape routes should be provided to the enclosure to the stairway at all storeys and additionally by the provision of protected lobbies, where required, between the stairs enclosure and the accommodation. In some limited situations an external escape stairway may be the only practicable way of providing an alternative means of escape from a building.

Herbert (2008) added that the general principles of escape route design recommend a list of factors required for effective means of escape. These are: number of escape routes and width of escape routes. Basically, alternative escape routes should be available so that a person confronted by fire can escape in a direction which is away from the fire. Each storey of the building should be provided with at least two escape routes, except in the case of small premises which under certain conditions may be served by a single escape stairway. Escape routes should be sufficiently wide to enable evacuation of the occupant capacity of the rooms or areas they serve. The width of escape corridors should generally be not less than 900 mm.

The review of previous works in this study has pointed out that for effective fire escape route systems to be designed in buildings; there is a need to consider the size of the building, the floor area of rooms and the population occupants. This forms a basis for the study to use this parameters to assess the viability of fire escape routes in the hostel buildings of tertiary institutions in Katsina State.

Cases of Fire Outbreak in Nigerian Tertiary Institutions

Mogbo (1999) in his paper work written in the journal of the Nigerian Institute of Quantity Surveyors pointed out that the following government educational institutions had faced the trauma of fire outbreak:

(a) the Institute of Management and Technology Enugu, burning down decades old workshops,

(b) Federal Polytechnic at Idah in Kogi state and Bida in Niger state respectively.

(c) University of Nigeria Nsukka where engineering laboratory complex as well as some staff residential quarters were razed to the ground,

(d) Ahmadu Bello University Zaria where the chapel complex was burnt down by students during religious riots and protests. There were also other cases where protesting students in some secondary schools burnt down their school buildings.

Daily independent, August 26, 2010, reported a fire incident that gutted about eight rooms of the G-block of a male hostel at Usman Danfodio University, Sokoto. Christianity Today Magazine, March 12, 2004, again reported the case of a hostel fire that destroyed twenty six lives in Nigeria, because there was only one entrance and exit to the building. In addition, in 2005, fire incident occurred in the female hostel of the Federal University of Technology, Minna, Niger State which destroyed property and another incidence also occurred in 2009 and at the Bosso campus (temporary site) of the same institution. A recent incidence of fire outbreak was reported by Voice of the Nigerian Tertiary Institutions (2013) that the Community Campus Radio Station of the Federal University of Technology, Minna, popularly referred to as Search FM 92.3 was gutted by a mid-night inferno on Wednesday 16, January, 2013 destroying property worth over =N= 50 million. The fire outbreak which occurred around 12:00 a.m. as a result of electric spark gutted the whole studio and other offices of the station. This is in line with the discoveries of Shittu (2001), Shittu (2007) and Shittu (2009) that the major cause of fire outbreak in Nigeria is electrical faults. All these reports have shown that the incidence of fire outbreak is a problem requiring adequate attention.

It has also been revealed from the previous research reviewed that fire outbreak is a disaster that has being a problem to domestic, public and institutional buildings. Previous studies have researched on the causes of fire, financial loss due to fire (Shittu, 2001; Shittu, 2007; Shittu, 2009), analysis of fire safety provision in tertiary institution buildings (Shittu *et al*, 2013), and relationship between fire incidences and capital expenditure (Shittu *et al*, 2015). These studies have however failed to study the factors influencing the cost of providing fire escape routes in buildings which has been identified as a major way capable of mitigating injuries in the case of fire outbreak by Shittu *et al*. (2013). This study fills this gap by carrying out an assessment of the cost of provision of fire escape routes in the hostels of tertiary institutions in Katsina State.

METHODOLOGY

This study adopted the quantitative research approach using archival data collected from Umar Musa Yar'Adua University, Katsina, Alqalam University, Katsina, Hassan Usman Katsina Polytechnic, Katsina and Federal College of Education, Katsina. The study examined three hostel buildings each from the four purposively selected higher institutions in Katsina State. This gives a population of 12 hostel buildings. The criteria for the selection of the higher institutions were age and population of hostel occupants.

Data collection was from both primary and secondary sources. Primary source of data collection was through direct measurement of floor areas, area of escape routes and number of escape routes (i.e. doors, corridors and staircases) from the hostel buildings sampled. Secondary source of data collection was from the archive of the maintenance/works department of the selected tertiary institutions in Katsina State where data were obtained on the construction cost from ‘as built’ Bills of Quantities and Working Drawings and population of occupants of the hostel buildings sampled. The data were on construction cost, population of hostel occupants, floor area, area of escape routes and number of escape routes. Thus the source of data collection is a "primary source of data collection".

The data collected were analyzed scientifically using simple regression analysis to determine the relationship between the pair of variables for which the research hypotheses were tested. The regressions were subjected to four functional forms (Linear, logarithmic, square and cubic) of analyses. The strength of the relationships between the variables studied was obtained using the coefficient of determination (R^2) value. An R^2 value below 50% is taken to represent a weak relationship while that above 50% is taken to represent a strong relationship. F-Test was used to test for significance. The study assumes a 5% level of significance.

Below is the decision rule for each of the tools of the regression statistics discussed above:

F test:

The decision rule here states that:

- If $F_{calulated} > F_{tabulated}$ then relationship is significant i.e. reject H_o
- If $F_{calulated} < F_{tabulated}$ then relationship is not significant i.e. accept H_o

Coefficient of determination (R^2):

The decision rule here states that:

- If $R^2 \geq 50\%$ then relationship is strong.
- If $R^2 < 50\%$ then relationship is weak.

DATA PRESENTATION, ANALYSIS AND DISCUSSION OF RESULTS

The results of experiments carried out on fire escape routes in hostels of tertiary institutions in Katsina are presented in this section.

Data Presentation

The data collected for the study from the twelve hostels on population, escape routes and construction cost are presented in Table 1.0.

Table 1.0: Data on 12 Hostels in Tertiary Institutions of Katsina State

Hotel No.	Type of Building	Hostel Construction Cost (=N=)	Cost of Escape Route (=N=)	Population	Number of Escape Routes	Hostel Floor Area (M^2)	Area of Escape Routes (M^2)
1	2STOREY	361,396,350.00	72376912	501	178	3441.87	757.21
2	2STOREY	226,141,800.00	44785876	332	178	2380.44	478.96
3	BUNGALOW	122,076,900.00	14549168	236	67	1427.8	269.85
4	BUNGALOW	75,708,000.00	1.00E+08	108	44	757.08	115.08
5	2STOREY	470,862,000.00	70229646	444	122	3139.08	659.21
6	2STOREY	353,667,600.00	56710400	66	76	5441.04	544.1
7	2STOREY	90,787,500.00	28171265	225	84	1815.75	312.31
8	BUNGALOW	29,197,700.00	2926660	106	61	834.22	100.11
9	3STOREY	190,252,320.00	48518100	552	292	5006.64	1251.66
10	3STOREY	80,577,225.00	18219034	265	281	1852.35	244.88
11	2STOREY	201,201,000.00	27960922	201	77	2012.01	325.95
12	2STOREY	82,331,340.00	4378348	102	61	904.74	110.38

Source: Field Survey (2015)

Data Analysis and Discussion of Results

The use of regression analysis was employed to determine the relationship between the variables considered for the study. This was done to achieve the stated objectives and to test the hypothesis of the study. The regression analysis was carried out in four analyses. The results of these analyses are presented and discussed below. Table 2.0 revealed that, from the linear model, there exists a weak, positive and non-significant relationship between the cost of providing escape routes and cost of construction of hostel buildings of tertiary institutions in Katsina State.

Table 2.0: Relationship between Cost of Escape Route and Construction cost

Analysis No.	Variables X	Variables Y	Type of Model	Observations Regression Equation	R/R^2 (%)	F_{cal}	F_{tab}	P_{value}	Strength of Relationship	Remark
1a	Cost of Escape Route	Construction Cost	Linear (Simple)	$Y = 9x10^7 + 2.487x$	54/29	4.106	4.96	0.070	Weak	NS
1b	Cost of Escape Route	Construction Cost	Cubic (Simple)	$Y = 9x10^7 - 6.334x + 3.5x10^{-7}x^2 - 2.9x10^{-15}x^3$	92.5/85.6	15.902	4.07	0.001	Strong	SS

KEY: NS = Not Significant
SS = Statistically Significant

From Table 2.0, it was observed that the coefficient of correlation (R) value was 54% indicating a strong degree of association, while the observed coefficient of determination (R^2) value was 29% indicating a weak relationship between the variables. The positive correlation observed between the variables shows a tendency that increase in the cost of providing escape routes will be accompanied by an increase in the construction cost and vice versa. The F calculated value of 4.106 observed was less than the value of F tabulated value of 4.96. The probability (P) value of 0.07 observed was greater than 0.05. The relationship between Cost of Escape Route and Construction cost was improved in the logarithmic, quadratic and cubic models where the probability (P) values observed were 0.03, 0.013 and 0.001 respectively. The observed coefficient of determination (R^2) value was improved to 85.6% indicating a strong relationship between the variables in the cubic model. These models show strong and significant relationship between Cost of Escape Route and Construction cost. The null hypothesis was therefore rejected based on these models. Table 2 gives a summary of the results of the linear model when the relationship was not significant and the cubic model when the relationship between the variables was most significant.

Table 3.0 revealed from the linear model that there exists a strong, positive and significant relationship between the population of hostel occupants and number of escape routes in hostel buildings of tertiary institutions in Katsina State.

Table 3.0: Relationship between Number of Escape Routes and Population of Hostel Occupants

Analysis No.	Variables		Type of Model	Observations						
	X	**Y**		**Regression Equation**	**R/R^2 (%)**	**F_{cal}**	**F_{tab}**	**P_{value}**	**Strength of Relationship**	**Remark**
2	Population	Number of Escape Routes	Linear (Simple)	Y = 27.29 + 0.38x	72/52	10.924	4.96	0.008	Strong	SS

KEY: SS = Statistically Significant

The observed coefficient of correlation (R) value, from Table 3, was 72% indicating a strong degree of association, while the observed coefficient of determination (R^2) value was 52% indicating a strong relationship between the variables. The positive correlation observed between the variables shows a tendency that increase in the population of hostel occupants will be accompanied by an increase in the number of escape routes and vice versa. The F calculated value of 4.106 observed was greater than the value of F tabulated value of 10.924. The probability (P) value of 0.008 observed was less than 0.05. The null hypothesis was rejected based on this. The logarithmic and quadratic models also show similar results. This agrees with the findings of McKay (1975), Melinek and Brown (1985) and Herbert (1999).

Table 4.0 revealed from the linear model that there exists a strong, positive and significant relationship between the floor area of hostel and area of escape routes in hostel buildings of tertiary institutions in Katsina State.

Table 4.0: Relationship between Hostel Floor Area and Area of Escape Routes

Analysis No.	Variables		Type of Model	Observations						
	X	**Y**		**Regression Equation**	**R/R^2 (%)**	**F_{cal}**	**F_{tab}**	**P_{value}**	**Strength of Relationship**	**Remark**
3	Hostel Floor Area	Area of Escape Routes	Linear (Simple)	Y = -9.168+ 0.182x	84/71	24.815	4.96	0.001	Strong	SS

KEY: SS = Statistically Significant

The observed coefficient of correlation (R) value, from Table 4.0, was 84% indicating a strong degree of association, while the observed coefficient of determination (R^2) value was 71% indicating a strong relationship between the variables. The positive correlation observed between the variables shows a tendency that increase in the floor area of hostel will be followed by an increase in the area of escape routes and vice versa. The F calculated value of 24.815 observed was greater than the value of F tabulated value of 4.96. The probability (P) value of 0.001 observed was less than 0.05. This formed a basis for rejecting the null hypothesis. The quadratic, logarithmic and cubic models show similar results but improved the R^2 value to 86.5%. This agrees with the findings of McKay (1975), Herbert (1999) and Shittu *et al*. (2013).

CONCLUSIONS AND RECOMMENDATIONS

The study concludes that the cost of escape routes has a significant influence on the total cost of construction. Population of hostel occupants has a significant influence on the number of escape routes which invariably has an influence on the cost of providing escape routes in hostel buildings. Hostel floor area has a significant influence on the area of escape routes which invariably has an influence on the cost of providing escape routes in hostel buildings.

Finally, population of hostel occupants, hostel floor area, number of escape routes and area of escape routes have significant influence on the cost of providing escape routes in tertiary institution buildings. It was therefore recommended that the projected number of hostel occupants should be considered in estimating the cost and number of escape routes when designing for escape routes in the hostels of tertiary institutions. Floor area of hostel buildings should also be used as a basis for determining the area of escape routes when designing for the area/space to be provided for escape routes in tertiary institution buildings.

REFERENCES

Encyclopedia Americana (1993). Encyclopedia Americana International Edition. Vol. 11. Danbury, Connecticut.

Esenwa, F. O. (2003). *Proposal on Private Sector Participation in University Hostel Development and Management*; Department of Physical Planning & Development, National Universities Commission, Abuja.

Fire Safety Manager (2015). *User Guide to the Classification of Fires for Extinguishing Purposes.* UCL Fire Technical Note – TN024. London.

Herbert, G. (1999), *Fire safety in hostels.* McGraw-Hill, Inc. U.K.

James Patterson, (1993); *Simplified design for building fire safety*. John Wiley and sons Inc. U.K.

Leadership Newspaper (2011). Nigeria Records 1,000 Deaths, 7,000 Fire Accidents Annually. *Leadership Newspaper Groups*. Y S Media Coy., Abuja. Retrieved from www.leadership.ng/articles on 6/1/2013.

Malven, F. (1997); *Time savers standards, for architectural design standards*, seventh edition, McGraw-Hill, Inc.

Milke, J. (2002); World Trade Center Appendix A: *Overview of fire protection in buildings.*

Mogbo, T.C (1998). Fire Outbreak and the Urban Environment in Nigeria: Implication on Public Policy and Politics. In A. A. Ndanusa (Ed.); *The Quantity Surveyor*. A Journal of the Nigerian Institute of Quantity Surveyors, Lagos. January – March. Pp31-32, 36-38.

Nwabueze, T. M. (2012). *Proposed Nnamdi Azikwe UniversityUniversity Postgraduate Hostel, Awka: Enhancing Fire Safety in Hostel Designs.* An unpublished MSc. Thesis. Department of Architecture, Faculty of Environmental Sciences, School of Postgraduate Studies, Nnamdi Azikwe University, Awka.

OSHA (2003). *Engineering Exit Routes. Occupational Health and Safety Administration.* US Department of Labor.

Passive Fire Protection Federation (2013). *Gateway to UK Fire Protection*. Ganders Business Park, Kingsley House, Bordon, Hampshire, UK. Retrieved from http://www.org/pfpf_definition.htm on 12/03/2013.

Patterson, J. (1993). *Simplified design for building fire safety*. John Wiley and sons Inc.

Saint, W., Hartnett, T. A. and Strassner, E. (2004), *Higher Education in Nigeria:* A Status Report; World Education News and Reviews.

Shittu, A. A. (2007). A comparative analysis of Fire Outbreak in Domestic and Public Buildings in Niger State during the Military and Civilian Era (1993-1998 and 1997-2004 Respectively). In L. M. Ojigi (Ed.): *Environmental Technology and Science Journal*. School of Environmental Technology, Federal University of Technology, Minna, Nigeria. Volume 2(2): 139-146.

Shittu, A. A. (2009). Analysis of Fire Incidences in Domestic and Public Buildings of Some Selected States in North- Central Nigeria. In Z. A. Uji (Ed.): Journal of Environmental Sciences, Faculty of Environmental Sciences, University of Jos, Jos, Nigeria. Vol. 13(I/II): 54-61.

Shittu, A. A., Adamu, A. D., Oke, A. A., Aliyu, S. & Shehu, M. A. (2013). Appraisal of Fire Safety Provisions in Tertiary Institutions Buildings in Minna. In M. Zubairu (Ed.). *Centre for Human Settlement and Urban Development (CHSUD) Journal*. Federal University of Technology, Minna, Nigeria. December, 2013, Volume 4(1): 64 - 72.

Shittu, A. A., Idiake, J. E. and Akanmu, W. P. (2015). Relationship Between Cost of Fire and Capital Expenditure in Kwara State. In A. Nasir, A. S. AbdulRahman and A. S. Kovo (Eds). *Procs: 1st International Engineering Conference (IEC 2015).* School of Engineering and Engineering Technology, Federal University of Technology, Minna, Nigeria. 1st – 3rd September. 243 – 250.

Shittu, A.A (2001). *An Analysis of Losses due to Fire Incidence in Residential and Public Buildings of Kwara State (1990-1999)*. Unpublished B.Tech. Thesis Quantity Surveying Department, Federal University of Technology Minna, Nigeria.

Umar, A., Wakawa, U. B., Abubakar, A. I. and Said, E. A. (2014). Development of Fire Risk Assessment Procedure for the University Students' Hostel Buildings in Nigeria. *The International Journal of Engineering and Science (IJES)*. 3(8): 18-21. ISSN (e): 2319-1813, ISSN (p): 2319-1805.

Voice of the Nigerian Tertiary Institutions (2013). FUTMinna Campus Radio "Search 92.3 FM" Engulfed by Fire on Wednesday. Federal University of Technology, Minna Campus Radio. January, 24. Retrieved from http://nigerianuniversities.com/2013/futminna-campus-radio-search-92-3fm on 12/03/2013.

ASSESSMENT OF WHEELCHAIR ACCESSIBILITY IN FACULTY BUILDINGS AT THE FEDERAL UNIVERSITY OF TECHNOLOGY MINNA

R.E. Olagunju, P. Ayuba, M.E Abdulrahman, S.A Oyetola, D.O Alonge, M.B Ajala
Department of Architecture, Federal University of Technology, Minna

In order to achieve sustainability in any design, there is a need to create an enabling environment for all kinds of people, including the physically challenged. These physically challenged; Mobility impaired or wheelchair users in this case are rarely considered during the design and construction of institutional buildings. This has led to the promulgation of laws by the government of Nigeria on the design of accessible schools for all. Even at that, a lot of institutional buildings still do not cater for these wheelchair users. This paper seeks to assess the level of accessibility for wheel chair users in faculty buildings in the Federal University of Technology in Minna, which has two campuses, the main campus in Gidan kwano and the Bosso campus respectively. The data will be gathered using a descriptive survey method and analyzed using the SPSS software. The result of the analysis will reveal the extent of provision for wheel chair users and suggestions and recommendations will be made to ensure that spaces are designed to cater for the physically challenged.

***KEYWORD**: Accessibility Physically Challenged, Faculty Building, Circulation*.

alonge.olubunmi@yahoo.com

Olaguju et. al. (2016). **ASSESSMENT OF WHEELCHAIR ACCESSIBILITY IN FACULTY BUILDINGS AT THE FEDERAL UNIVERSITY OF TECHNOLOGY MINNA** Sustainable Built Environment and Climate change; The challenges of Post 2015 Development Agenda. School of Environmental Technology Conference, SETIC, 2016

INTRODUCTION

Since 2000 In Nigeria, the Disability Rights Education and Defence Fund have collected country-based laws that protect the rights of individuals with disabilities. Between that period and now there has been a rise in the inclusion of the physically challenged in our public and private buildings, these can be said to be a good and welcome idea in the society, however, much still needs to be done. The idea of having an inclusive design does not mean that we have a section of the building where the physically fit stay at a place and the physically challenged are sectioned elsewhere (Otto, 1998). That is a misconception that needs to be cleared. In building terms, Inclusion is a term used by people with disabilities and other disability rights advocates for the idea that all people should freely, openly and without pity accommodate any person with a disability without restrictions or limitations of any kind (Otto, 1998). Accessibility refers to how available something is to everyone. When something is accessible, everyone has the opportunity to use it or to participate in it. Inclusive building design can then be said to be the design that is accessible to and for every kind of person inspite of their physical, social or economic state (Lacey, 2002). Achieving this on paper will require a deep and critical look at the various types of disabled persons with a focus to take care of their needs within the same building as those who are not physically challenged. Their movements and their activities must not conflict themselves. In other words, there must be a good flow within the people to take care of everyone's needs.

ASSESSIBILITY, INCLUSION AND CIRCULATION

Accessibility means that everyone has equal access to the built environment with no discrimination based on one's level of ability. It can be defined as being the opportunity that an individual, at any given location and of any given ability, possesses to take part in a particular activity or a set of activities within the built environment (Jones, 1975). It implies that the built environment must be truly usable for all.

Accessibility happens when we discover and break down the barriers and create opportunities for everyone to participate fully in their school and community. If everyone cannot use something, such as a door, staircase or hallway, it is considered inaccessible. Something that can be used by everyone, such as an automatic door, a ramp or wide hallway, is considered accessible. People often take for granted how easy it is to enter a room, eat at a restaurant, play in a park, go for a walk or even visit a washroom. For a person with a disability, these daily tasks and outings can be very difficult if there is limited or no accessibility to them.

WHY IS ACCESSIBILITY IMPORTANT?

Out of every 100 people in a community, there could be as many as 15 who have a disability. If this is expanded, it means that a good number of people in the city or country have a form of one disability or the other. Despite this large number, there continues to be a lack of understanding of and concern about accessibility. Without a continued effort to promote full accessibility, the basic rights of too many people will continue to be neglected (Bar, 1999).

Every society is known for its value as well as equality and human rights. It is believed that everyone who obeys the law and plays by the rules of society should be given these equal rights. Having equal rights implies that everyone – no matter what cultural, religious, ethnic or physical differences there are – has an equal opportunity to experience everything society has to offer. This means the opportunity to go to school, enjoy popular forms of entertainment and even something as simple as taking a walk down the street. In other words, everyone has the right to access and to enjoy the same places, events, services and products as everyone else (Richard, 2000). When those basic rights are unavailable, it means that basic human rights are being violated.Accessibility, then, ensures that everyone within a community has access to the same activities and opportunities.

Inclusion is a term used by people with disabilities and other disability rights advocates for the idea that all people should freely, openly and without pity accommodate any person with a disability without restrictions or limitations of any kind (Barnes, Oliver, Barton (2002). Although disability rights has historically existed as a relatively cohesive movement, the movement centered on inclusion has only recently begun to take shape and position itself in the eye of the general public (Jones, 1975).

The Findings Are Explored Under Two Sections:

1. External design features, which will include different elements of the external built environment in schools, and highlights key areas for consideration in relation to accessibility such as Arrival and Departure areas, external circulation routes, car ports and ramps, entrance porch as well as walkways.

2. Internal design features, which includes elements such as doorways and corridors, flooring, ramps, stairs and lift.

EXTERNAL DESIGN FEATURES

Car Parks

- Cars are the only practical method of transport for some disabled people, whether they drive themselves or ride with someone else; therefore it is vital to provide accessible parking with unhindered access to building entrances.
- The car park space for disabled people should be conveniently located and clearly signed.

Walkways and Building Entrances

Wheelchair access to the walkways can be made with a minimum of 1.50m. Two people can sit closed to each other.

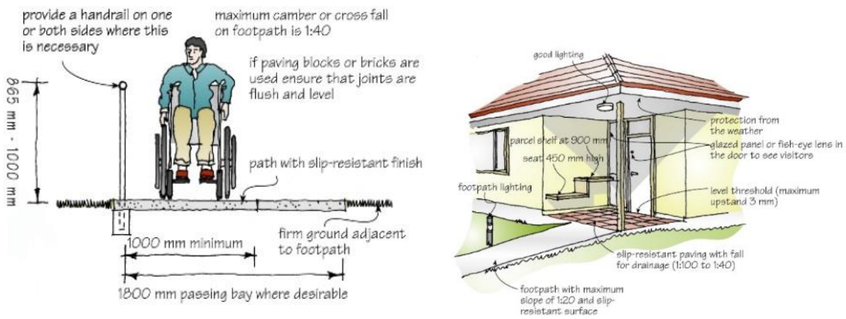


Plate 1. Source: Architecture (AIA); 2004

Access into Building

The elements which make the entrance accessible are: A good lighting, A parcel shelf at 99000, footpath/ with light, protection from the weather, glazed panel or fish-eye lens in the door to see visit, level threshold (maximum up stand 3mm), slip-resistant paving with fall for drainage (1:100 to 1:40), footpath with maximum slope of 1:20 and slip-resistant surface Special me measurement are required to open the door.

INTERNAL DESIGN FEATURES

Lifts

Besides the minimum measurement of 1.10 m (width) x 1.40 m (depth), the lifts shall have control buttons outside and within the lift cage. Control buttons shall be placed approximately 1.0 m above the floor and minimum 0.5 m from the corners. Door(s) shall be placed at the narrow end(s) of the lift. (If the doors are placed at a right angle to each other, the size of the lift shall be minimum 1.8 x 1.8 m.

Doors

If the door opens outwards, there must be an additional 0.2 m along the facade of the building. The area outside external doors must be flush with the internal floor. The area outside external doors must have tactile markings or be of a different colour from the surrounding surface finish. If the door opens towards the person, there must be no less than 0.5 m on the side of the door opposite its hinged side. Doorsteps may be no more than 25 mm high.

Corridors and Shared Access

The dimensions of an offset hinged door that allows room for a wheelchair user to move beside and through the minimum wide of a corridor is 0,90m which permit to someone walking to cross or pass over someone in a wheelchair BUT it is not enough for two people crossing in a wheelchair with a standard size of 75 cm. For more comfort, the wide of the corridors can be 1.40m.It is necessary to make some turning diameter of 1,50m in front of the doors, ends of corridors.

STUDY AREA

Federal university of University is located in Bosso Local Government Area. It is the only Federal university in the Niger State. For the purpose of this research, the term "schools" will be used for "faculty". Just so that your understanding is not lost within this discourse. It has two campuses with a total of 6 schools; the temporary site in Bosso and the permanent site in Gidan Kwano. The Bosso campus has only one faculty building. Other schools represented there are the Pre-Degree and IJMB schools. All these eight (8) schools will be assessed based on the topic. It is expected that at the end of this research, the observations and analysis will aid even other non-academic buildings on how the issue of wheel chair accessibility should be tackled.

The schools studied include;

1. School of Science and Science Education (SSSE)
2. School of Environmental Technology (SET)
3. School of engineering and Engineering Technology (SEET)
4. School of Information and Communication Technology (SICT)
5. School of Agriculture and Agricultural Technology (SAAT)
6. School of Entrepreneurship and Management Technology (SEMT)
7. The Centre for Remedial Study Hall (CRES)
8. The IJMB Hall.

RESEARCH METHOD

Observation schedules were used in gathering the data. The research encountered limitations from some schools which were locked at certain periods of the day, making access very difficult. To analyse these data obtained, SPSS software was used and the results were displayed using charts and tables.

FINDINGS AND DISCUSSION OF RESULTS

Table 1: the table shows the relationship of each of the faculty buildings to the number of physically-challenged (PC) in them.

LOCATION: ARE THERE P.C. PEOPLE THERE?				
		ARE THERE P.C. PEOPLE THERE?		Total
		YES	NO	
LOCATION	SSSE	1	0	1
	CRES HALL	0	1	1
	IJMB HALL	0	1	1
	SET	0	1	1
	SEET	0	1	1
	SICT	0	1	1
	SAAT	0	1	1
	SEMT	0	1	1
Total		1	7	8

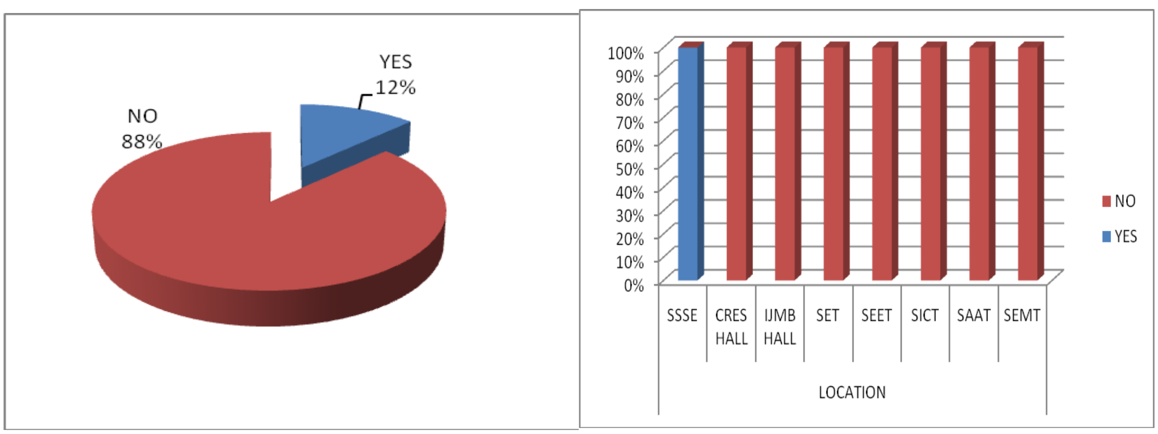


Fig. 1: Number of physically challenged individuals in these faculties.

Table 2: Relationship between the location and the Accessibility of the Entrance.**LOCATION IS THE ENTRANCE ACCESSIBLE?**

		IS THE ENTRANCE ACCESSIBLE?	Total

		YES	NO	
LOCATIO	SSSE	0	1	1
N	CRES HALL	0	1	1
	IJMB HALL	0	1	1
	SET	1	0	1
	SEET	1	0	1
	SICT	1	0	1
	SAAT	0	1	1
	SEMT	0	1	1
Total		3	5	8

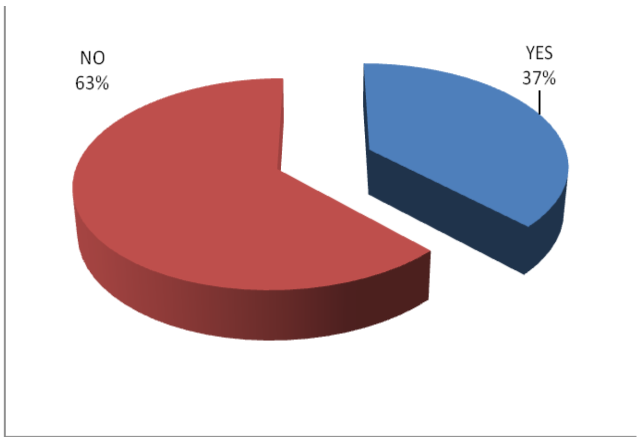


Fig. 2: Picture showing the impact of accessibility on each of the schools.

There is a large percentage of schoolshere which do not have clear entrances for wheel chair users. Only 37% have entranrces that can allow simple assess of wheelchairs. The other 63% will have factors like; high kerbs at entrances, no ramps at entranaces and, inadequatedoor width.

Checking The Availabliliy Of Ramps In Each Of The Schools.

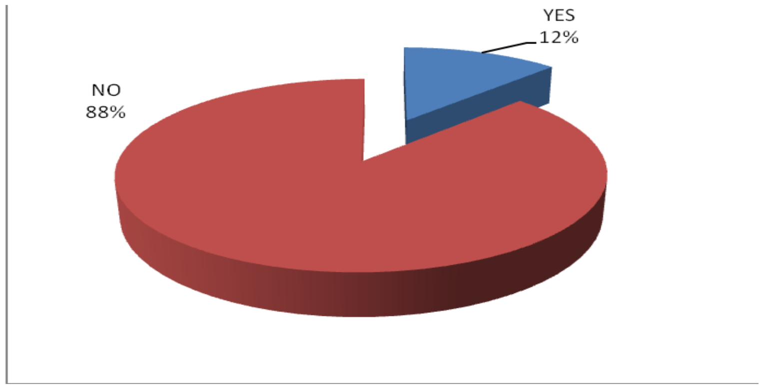


Fig.3: The piechart above represents the analysis of the percentage of ramp availablility in each school buildings.

88% of the schools do not have ramps there. This shows the alarming rate at which we are excluding the physically challenged from our schooling sysytem. If the situation is this way in fut minna where a large number of these school buildings were built more than a decade ago, remains to be seen how other older schools will fare. This analysis has shown that architects are faced with an enormous task of designing and constructing more inclusive school buidings.

Plate 2.School of Environmental Tech.

Plate3.Ramp at the School of Science and Science Tech (Too steep)

Source : Reseacher's fieldwork 2015

Table3: table representing the level of obstructions at the premises.

LOCATION * ARE THERE OBSTRUCTIONS LOCATED IN THE PREMISES?				
		ARE THERE OBSTRUCTIONS LOCATED IN THE PREMISES?		Total
		YES	NO	
LOCATION	SSSE	0	1	1
	CRES HALL	1	0	1
	IJMB HALL	1	0	1
	SET	1	0	1
	SEET	1	0	1
	SICT	0	1	1
	SAAT	1	0	1
	SEMT	0	1	1
Total		5	3	8

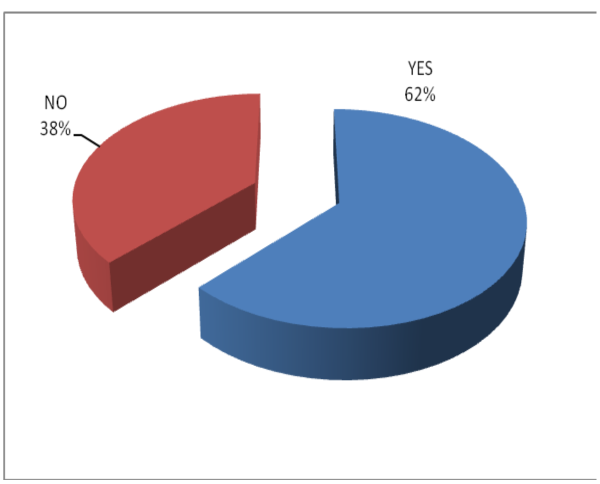


Fig. 4: Chart representing the level of obstructions at the premises.
Soure: Researcher's fieldwork 2015

The analysis carried out has shown that only 38% of the schools assessed do not have obstructions at the premises. This tells us that for the remainning 62%, there will be difficulty for wheelchair users to conveniently move around the building. This means that we must ensure that these schoolbuildibgs atttend to these situation but removing such obstructionns.

CONCLUSION

There is a rising need for all inclusiveness designs. It cuts across farther than just school buildings. The concept of inclusion is to create a medium where the physically challenged can stay in, and get to take part in the same activities as those who are not. Looking into a school setup, the aim is to be able to look into the exterior and internal environments. Looking at how the built environment can support the physically challenged. They must have ability to use similar entrances, use same exits, use same classrooms, same toilets and every other part of that school building. From the Research carried out in all the six (6) schools of FUT Minna as well as the CRES Hall and IJMBhalls,four areas of accessibility were critically assessed. The presence of the physically-challenged in these schools, The availability of clear entrances, the availablity of ramps, obstruction objects at entrances.It was discovered that only one school had physically challenged persons. The entrnaces were not clear for easy access for wheel chair users. Ramps were majorly not in those buildigs. Only one school had ramps at 12%. The other 88%didn't. In general, the physically challenged people will still face alot of obstructions eevn when they move within these buildings.

From the summary of the findings this research conducted, it has shown clearly that only 12% of the faculty buildings was able to achieve inclusion in the design of these buildings. Furthermore, this implies that mobility impaired were not taught of while the construction of these buildings were been done, probably becauses most of these buildings were constructed about 15years ago. The school of Information and Communication Technology (SICT) was seen to consider inclusion as well as assessibility for the mobility impaired within the school and this can be attributed also to the fact that it is a new building constructed recently. All of these implies that awareness on effective design consideration for physically challenged in the society is gradually increasing. For all the existing building assessed, elements that aid easy assess and inclusion can still be adopted, and for new buildings, strict guidelines has to be adhered to to include all physically challenged found with University building and the society at large.

REFERENCES

Bar and Galluzzo. (1999). *The accessible school: Universal design for educational settings, Berkeley.*

Barnes, Oliver, Barton. (2002**) .***Disability Studies Today. Cambridge: Polity Press USA*

Burnette,G.(1996). *Including Students with Disabilities in General Education Classrooms*: Inclusion, Policy to Practice, 4(3). Retrieved 02/02/2014 from: http: / / www. accesseric. org.

Jones, P. (1975). Accessibility, *Mobility and Travel Need: Some Problems of Definition and*

Measurement, I.B.G. Transport Geography Study Group Conference, University of Birmingham.

Jones, P. (1981). *Accessibility Measures*: Transport and Road Research Laboratory, Berkshire.

Lacey, M. (2002). *Centre of Accessible Environments*; *planning your home for safety and convenience.* London: Centre for Accessible Environments.

Moore, and Gilbert. (1998). *Educating Students with Disabilities in General Education Classrooms, Eugene: University of Oregon.*

Otto, M.(1998). Keeping *Compliant with 504, ADA, and I D E A. School Business Affairs*, Vol 64(12), pg 9–12, 14–16.

Richard, Olsen, (2000), *Summary Guidelines for School Design to Include Children with Disabilities, Center for Architecture and Building Science Research. New Jersey Institute of Technology.*

Riley, R. W. (1999). *Schools as Centers of Community.* Department of Education. Washington. Retrieved 02/02/2014 from: http : //ed. gov/ Speeches

Roy, (2006), *Acoustic Classroom Designs Break Learning Barrier, Commercial Building Products*, retrieved from http://www.cbpmagazine.com, on 12th August 2014

Hazel and Bob, (2005). *Water and sanitation for disabled people and other vulnerable groups: designing services to improve accessibility*. Water Engineering and Development Centre, Loughborough University.

REDUCING ACCIDENTS AND HEALTH HAZARDS IN THE NIGERIAN BUILDING INDUSTRY

Eze, Chukwudum J.[1], Ayuba, Philip[1], Shittu, Abdullateef Adewale[2]
[1]Department of Architecture, Federal University of Technology, Minna
[2]Department of Quantity Surveying, Federal University of Technology, Minna

Accidents and health hazards owing to building collapse have been the talk of the day in the Nigerian building industry. The building team such as the architect, quantity surveyor, builder, engineer, and contractor are always blamed as a result of their indiscriminate attitude toward the construction of such building which has led to numerous lives wasted and injuries sustained. A descriptive research method through the conduction of oral interview and observation in some construction sites has shown that source of accidents and health hazards in the Nigerian building industry can be traced down to three main areas such as: design, construction and physical/environmental elements. This paper therefore, discussed the sources of accidents and health hazards in the building industry, and proffered ways to reducing such menace. It finally advocates that the National building code now in place should be enforced so that Developers would avoid the uncaring attitude of developing the Environment.

Keynotes: A*ccidents, Building Industry, Construction, Design, Environment*

ezechucks@yahoo.com

Eze, Chukwudum J.[1], Ayuba, Philip[1], Shittu, Abdullateef Adewale[2] (2016). **REDUCING ACCIDENTS AND HEALTH HAZARDS IN THE NIGERIAN BUILDING INDUSTRY** Sustainable Built Environment and Climate change; The challenges of Post 2015 Development Agenda. School of Environmental Technology Conference, SETIC, 2016

INTRODUCTION

The building construction industry carries with it its fair share of accidents and health hazards. Accidental occurrences continue to show construction in a poor light, and this is understandable. The construction industry as a whole is often considered to be complex and unique. For instance, two buildings are rarely identical and the work on each construction site changes from day to day and this takes place mainly when it is open and exposed to the weather. Safety and health should be a major concern to the whole building team. Building personnel can contribute to safety at work by carrying out building operations correctly. Contracting organizations too, must safeguard the safety, health and welfare of the people who work for them as far as it is reasonably practicable. There should be the incorporation of safety working practices in the process of building. Tudunwada (1987) posited that injuries, industrial hazards and deaths need not be accepted as an inevitable price to be paid for industrial progress. Accidents do not just occur. They are mostly caused by people. Also occupational diseases are caused by unsafe work method and processes.

According to St. Paul’s Steiner School (2013), accident is an unplanned event which has the capacity to cause injury or damage, and is attributed to either damage to plant or product, loss of production; increased cost, pollution of the environment and injury to person, few of which may even lead to death. According to Prokopenko (1981), a health hazard is the risk or danger of occurrences of work related disease, illness or serious discomfort, which could harm the physical or mental well being of a worker or the public.

Sources of accidents in the building industry have been channeled toward abuse of responsibility and error by workers. McCormick and Tiffin (1975) have highlighted the tendency towards error as a pervading human trait. They opined that errors of various kinds can of course, affect the quality of work people do and can also contribute to injuries and fatalities. Not only that, the factory inspector should also sit up to enforce the workplace health and safety standards.

The Factory Inspectorate Department is empowered to enforce workplace health and safety standards, ensuring that all workplaces maintained minimum standards of health and safety prescribed by the Factories Act, 1990 (Chapter 126, Volume VIII of the Laws of the Federation of Nigeria). Apart from carrying out workplace inspections, the department also conducts workplace surveys, investigates accidents, provides some occupational health and safety information, registers factories including construction sites and struggled to proactively promote workplace health and safety through enlightenment programmes, safety awareness, workshops, lectures and seminars.

The sources of errors and accidents are not entirely to be found in the individual in question, however; situational variables such as the nature of the work activities, the design of equipment and structure, the work procedures and the work environment can have a significant bearing upon the frequency and nature of errors and accidents. In the construction industry, however, sources of accidents can be traced generally to the three main areas which this paper shall dwell on: design, construction and physical/environmental elements.

SOURCES OF ACCIDENTS IN THE BUILDING INDUSTRY

Design:

In the conventional process of building industry, the design team directly employed by the client consist of:

i. Project manager (Team leader)
ii. The architect (designer)
iii. The Quantity surveyor (who serves as financial adviser)
iv. The Builder (who serves as a building construction expert)
v. The structural engineer (who serves as specialist consultant to structural works)
vi. The Electrical engineer (who serves as specialist consultant to electrical works)
vii. The Mechanical engineer (who serves as specialist consultant to mechanical works)
viii. The Acoustic engineer (who serves as specialist consultant to Acoustical works)

The architect produces and supervises an architectural plan of a building after generating a design brief from the client, Structural engineer basically produces the structural design; while the builder and/or contractor construct the building with the specification of the designer and specialist consultant and delivers same to the client. According to Ward (1978), building must be well planned, suitably sited and satisfy not only the numerous regulations regarding standards of construction, planning and safety, but also the need of the client in all climatic and environmental conditions. According to Ayininuola and Olalusi, (2004), buildings are structures, which serve as shelter for man, his properties and activities. They must be properly planned, designed and erected to obtain desired satisfaction from the environment. The design team primary concern during the design stage should be structural reliability, risk of consequence of fire, storms, flood, earthquakes and tremors and details, precision and appropriateness of specifications.

Ayodele (2003) asserted that a large number of accidents have occurred in building sites due to failure of temporary or partially complete structures and poor specification. Olalusi (2004) described failure as an unacceptable difference between expected and observed performance. A failure can be considered as occurring in a component when that component can no longer be relied upon to fulfill its principal function and therefore this can cause a health hazard. Bush (1973) noted that safety should be a prime consideration during planning, designing and construction in the building industry.

Construction:

In the construction of buildings, issues to be considered as sources of accidents in the building industry include:

i. Feasibility of Construction Method: Many building failures have been linked to poor unrealistic construction method adopted.

ii. Sufficient technical expertise by contractor: Some buildings have failed as a result of engaging wrong hands who don't have the technical knowledge on how to build. This as a result has endangered many lives and destroyed properties worth billions of naira.

iii. Quality and Availability of Supervisor and craftsmanship: Poor and irregular supervision by the architect or those that stand on the gap has jeopardized the quality of buildings which has led to accident in the site. Supervisors and craftsmanship should be engaged in the building sites.

iv. Satisfactory Construction Materials: Quality materials should be specified and be used for building construction in order to save lives and properties. For instance, use of sub-standard material has led to building collapse as shown in Plate 1.

v. Site Layout: None serious attention to the site layout during the setting- out operation and its construction has caused a lot of accident on the site. To less accident on building sites, contractors should strictly adhere to the ideology of the site layout.

vi. Adoption of realistic safety practices on site: Unconcerned (don't care) attitude toward the use of safety measures has caused more injuries to accident victims on site.

Plate 1.: A collapse building due to use of sub-standard material.
Source: Amadi, Eze, Igwe, Okunlola & Okoye(2012)

Ayodele (2004) observed that many accidents in Nigeria have occurred in building sites due to lack of sufficient technical expertise by the builder. Odumusu (1986) opined that the building industry involves the application on skills in areas of programming and design, construction management and erection, and in the prudent use of materials. He observed that absolute lack of knowledge and improper coordination of the various areas of inputs are responsible for the numerous failures, cracks, vibration and excessive deflection of the structural system. When a construction method is not feasible, this constitutes a accident risk (Perry and Hayes, 1985). A large number of accidents have occurred in building sites due to failure of temporary or partially complete structures and poor specifications. Bush (1973) has noted that safety should be a prime consideration during planning, designing and construction in the building industry.

Odumusu (1986) noted that the building industry involves the application of skill in areas of programming and design, construction management and erections and in the prudent use of materials.

Hazards may be encountered when inexperienced or unqualified personnel are employed in the building process. Bush (1973) opined that safety must be put into the hands of practical men with knowledge of the industry. Usage of unsatisfactory construction materials, especially concrete has been known to cause accident in many building sites. Odumusu (1986), observed that defective workmanship and materials often arise in projects under construction as a result of lack of proper understanding of the nature and properties of a major material like concrete.

According to Ogunjobi (2003), concrete has been responsible for the serious cracks which develop in some structures where it has also been known to have created both hazards to the public, and in some cases risks of instability within the system itself.

On the part of contractor, they should ensure that building site is laid out in the most effective manner is an essential part of a good planning process. Ogunjobi (2003) opined that a contracting organization produces a site layout showing the proper position of such item as site accommodation, materials sheds, compounds and storage areas, temporary roads, mechanical plants and scaffoldings, services, and hoarding. They should ensure that there is ease of movement of labour, materials and some plant items in order to prevent unnecessary accident. Scaffolding should be erected in such a manner as to provide a safe method of working and means of access. A temporary service like electricity should be provided where there will not be a likelihood of electrocution. Hoarding is another safety measure that should help ward off unnecessary interference of work on site by the public, and especially children. Non-adoption of realistic safety practices on site has been a major source of accident in the building construction industry. According to Ogunjobi (2003), under normal circumstances, the contracting organization should have a person specifically in charge of safety; but in Nigeria this aspect is practically non-existent.

The international Labour Office [ILO] (1969) pointed out names of the unsafe practices on site to include:-

a) Non-shop prefabrication of building members earmarked for high-building elevation as an aspect of materials handling.
b) Equipment failure through lack of proper maintenance
c) Use of inappropriate tools
d) Inadequate sharing of trenches
e) Improper use of electric and gas welding equipment (Bush 1973)
f) Improper construction of ladders, scaffolds and guards for floor opening
g) Poor housekeeping like incorrect ways of piling materials, storing combustibles.

Physical/Environmental Factors

Physical/environmental factors that can contribute to accidents at construction sites include:- rain, sun, fumes, ice vapours, unlevel or uneven surfaces, radiation, snow, fog and heat, confined space, noise, gas and humidity (Prokopenko 1981). Perry and Hayes, 1985 also identified fire, earthquake, flood, landslip to be among factors that can cause accidents and health hazards at construction sites.

Mechanical:

Vehicles and/or tractors can as well be a contributing factor to accident in construction industry. According to European Agency for Safety and Health [EASH] (n.d) about one in three fatal accidents at work involve vehicles. The main categories of transport accidents at work include:

(i) People are struck or run over by moving vehicles (e.g. during reversing);

(ii) Falling from vehicles

(iii) Struck by objects falling from vehicles

(iv) Injured because of vehicles overturning.

It follows that by removing or reducing the risk of accidents involving vehicles on construction sites, there can be a significant reduction in the number of fatal accidents in this sector.

RESEARCH METHODOLOGY

A descriptive research method was employed in this research which incorporates conduction of oral interviews and through observation in the building construction site. The choice of study area is based on the fact that there is rampant increase of building construction as well as site accident in Nigeria. A single case study of Abuja was conducted whereby information from the Factory Inspectorate Department was assessed to find out their compliance when accident and/ or health hazard occur in construction industry.

Method of Data Collection

The research scrutinizes the various sources of accidents, ways of reducing accidents and health hazards in Nigeria building industry. This was done through conduction of oral interviews, literature review and observation in order to have firsthand information.

DISCUSSION

A record from the Factory Inspectorate Department has shown that some construction industry do not comply with the obligation of given information to factory inspectorate department when accident and/ or health hazard occur in construction industry. The department is headed by a qualified director who oversees the activities of the department and has various factory inspecting officers (headed by a qualified inspector of factories) who visit sites and on health and safety at workplaces and report directly to the director of factory.

The most frequently undertaken activities of the department are general factory inspections, construction site inspections, and accident and incident investigations as shown in Table 1.

Table 1: Major Activities Undertaken by Factory Inspectorate Department

Activity	**Frequency at which activity is carried out**
General factory inspection	Carries out inspections throughout the country within the limits of resources
Construction site inspection	Carries out inspections of some sites that have been registered with the Factory Inspectorate Department
Scrutiny of factory plans	Examines all factory plans brought to its notice in order to give approval
Safety awareness seminars	Organizes seminars and workshops with health and safety stakeholders and some employers about twice a year or depending on availability of fund and logistics
Accident and incident investigation	Investigates all reportable accidents and dangerous occurrences notified to the department
Occupational Diseases investigation	Investigates all reportable occupational diseases notified to the department

Source: Umeokafor, Evaggelinos, Lundy, Isaac, Allan, Igwegbe, Umeokafor, and Umeadi, (2014).

Reporting of accidents and incidents to Factories Inspectorate Department was low because most employers were ignorant of their duties under the Part IV of the Factories Act 1990 and partly, for the fact that some employers were not aware of the different roles played by the Factory Inspectorate Department and Labour Department (Umeokafor *et. al.*, 2014). Even at the visit of Factory Inspectors to the sites some workers exert fear to give sincere account of the actual severity of accidents or dangerous occurrence because they are afraid of being sacked by their employers. This was evident from the numbers of accidents reported to the Factory Inspectorate Department which is shown in Table 2. Dangerous occurrences, fatal and over three-day accidents are reportable to the Factory Inspectorate Department. Most employers do not report these reportable incidents as also shown in Table 2.

Table 2: Accidents Reported to Factory Inspectorate Department from 2007 to 2012

Year	**Number of Injuries**	**Number of Deaths**	**Number of Near Misses**	**Number of Accidents Reported**
2007	4	1	1	3
2008	8	6	-	2
2009	3	2	-	16
2010	5	1	1	3
2011	8	2	-	7
2012	14	4	1	6

Source: Table structure, partly adopted from Umeokafor *et al.* (2014) and modified by author; content from accident reports collected from the Factory Inspectorate Department (2007-2012).

In Plate 1, owing to nonchalant attitude or lack of knowledge of being in existence, a typical Work Place Accident occurred which would have been preventable through regular Factory and Labour Inspections. This is an evidence of an accident which could have been prevented if there was proper registration of site by the contractor and site inspection by the Factory Inspectorate Department.

Plate 2: A typical Work Place Accident preventable through regular Factory and Labour Inspections.
Source: Wogu (2013)

Figures 1 and 2 present the trend of accidents record of the construction SMEs in terms of severity for a five-year period (2009 - 2013). Figure 1 reveals that over the five-year period accidents resulting to minor injuries of less than one day off work summed to 733 cases; accidents leading to injuries of 1 – 3 days off work summed to 353 cases; accidents resulting to injuries of 4 or more days off work amounted to a total of 181 cases; and accidents leading to permanent disabilities or death summed to 55 cases only.

Figure 2, on the other hand, reveals that over the five-year period accidents resulting to minor injuries of less than one day off work summed to 55.45% of total cases recorded; accidents leading to injuries of 1 – 3 days off work amounted to 26.70% of total cases recorded; accidents resulting to injuries of 4 or more days off work amounted to 13.69% of total cases recorded; and accidents leading to permanent disabilities or death amounted to 4.16% of total cases recorded only. This implies that the construction SMEs incurred more minor accidents than fatal accidents over the five-year period. This shows further that the construction SMEs had very good accidents record.

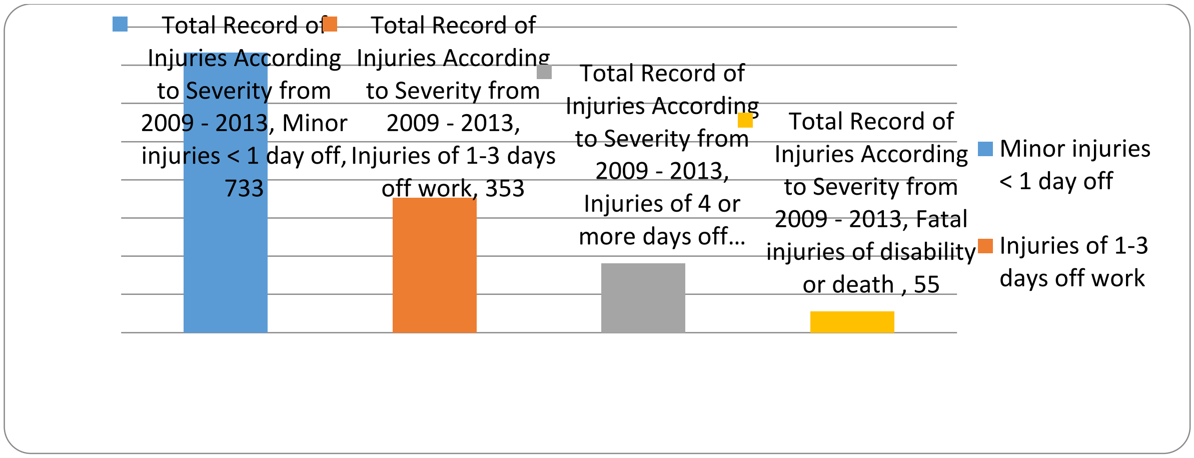


Fig. 1: Total Record of Injuries According to Severity from 2009 – 2013
Source: Authors' Field Work (2014)

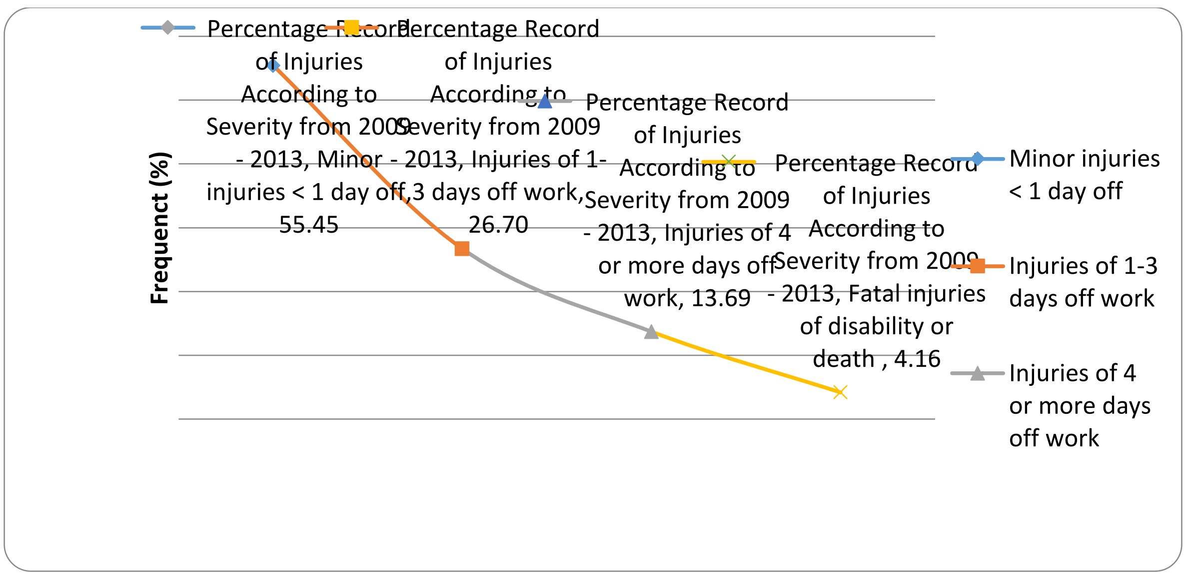


Fig. 2: Percentage Record of Injuries According to Severity from 2009 – 2013
Source: Authors' Field Work (2014)

SOURCES OF HEALTH HAZARDS

Protopenko (1981) identified sources of health hazards in the building industry to include physical hazards, chemical and stress hazards.

i. **Physical hazard includes**: These consist of vibration, noise, heat, cold and ultraviolet in the built environment.

ii. **Chemical hazards include:** Chemical, gases, fumes, vapours, metals/materials, which may damage the eyes, skin, lungs and other internal organs or bones. Ogunjobi (2003) observed that lead which comes from such products as paints and petrol can enter the body through the respiratory tracts, especially when unclean paint-strained hands are used to eat. He observed that over 40% of lead inhaled is absorbed into the blood stream, accumulates in body organs the kidney and the nervous system and damage the brain over time. More so, environmental impact of concrete, its manufacture and application is complex which has harmful effect to the body. For instance, the carbon (iv) oxide (Co_2) emission for the cement factory (Mehta & Monterio n.d.)

iii. **Stress**: According to American Heritage New Dictionary of Cultural Literacy (n.d.) it is a term which denotes the effects of metal and emotional pressure. It stressed that a building worker who is frightened may suffer from headaches palpitation, insomnia, nervous tension, instability or other symptoms. Stress is one health hazard which affects individuals very differently. People vary greatly in their ability to cope with this and very often a small amount of stress at work added to psychological pressure outside work can produce severe symptoms.

RECOMMENDATIONS

The following recommendations are made for the effective management of safety and health in the building industry:-

i. All building should be designed by qualified professionals. There should be no compromise for the structural aspect, since the consequences of exempting any class of qualified member of building team from their specialized field are enormous and the risk must not be contemplated.

ii. All registered building firms should be made to have an officer specifically in charge of safety so that the need for prevention of accidents and health hazards can be more actively appreciated.

iii. The planning authorities of the various local governments should employ professionally qualified personnel to cope with the approval and supervision works within their local government areas. There must always be a follow-up to ascertain compliance of the building execution with architectural impressions, structural design and specification.

iv. There is a great need for the Federal government to promulgate a national construction regulation, governing both building and civil works in the country.

v. Proper soil investigation should always be done, whatever the type of structure to be built. The structural system of any building must not be made to suffer from inappropriate design solution.

The researchers believe that these recommendations as listed above will go a long way in making construction safer in Nigeria. Therefore, there is an urgent and a great need to safeguard the lives and health not only of building workers but also building users.

CONCLUSION

It has been found out that a majority of accidents and health hazards in construction industry is the handwork of human being. The design and construction aspects of building have been the veritable sources of accidents in the building industry in Nigeria, but it seems that serious attention is not being paid to them. Probably, this may be as a result of various mal-practices that have been noted in the construction industry. A situation whereby quacks design buildings and get approvals in local planning authorities is indeed worrisome. The National building code now in place should be enforced so that buildings do not pose any danger to the occupants.

REFERENCES

Amadi, A. N., Eze, C. J., Igwe, C. O., Okunlola, I. A. & Okoye, N. O. (2012). Architect's and Geologist's View on the Causes of Building Failures in Nigeria. Modern Applied Science; 6(6), ISSN 1913-1844 E-ISSN 1913-1852, Published by Canadian Center of Science and Education.

Ayininuola G. M. & Olalusi O.O. (2004). Assessment of Building Failures in Nigeria: Lagos and Ibadan Case study. Retrieved from www.ajol.info>journal 1(5) on 27th January,2016. 3.35pm.

Bush, V. G. (1973). Construction Management: Handwork for Contractors, Architects and Students. Reston Publishing Company, Inc. Reston, Virginia, 22.90, USA.

EASH (n.d). European Agency for Safety and Health at Work - Retrieved from http://osha.europa.eu

Factories Act, (1990).The Laws of the Federation of Nigeria. Chapter 126, (8)

ILO (1999). Safety, health and welfare on construction sites. A training manual. Geneva: International Labour Office. ILO Cataloguing in Publication Data. Retrieved from http://www.undp.ps/en/forms/callforproposals/2012/safetyP4Apump.pdf *on 1st February, 2016, 5.15pm*

McCormick, J. E. & Tiffin, J. (1975). Industrial psychology, 6th Edition. George Allen and Unwin, London.

Mehta, P. k. & Monterio, P. J. M. (n.d.). Concrete: Microstructure, Properties and Materials. Retrieved from www.ce.berkeley.edu/ on 27th January, 2016. 2.45pm.

Odumosu, R. C. (1986). "The Right Mix", African Technical Review sept. edition, pp 94

Ometan, B. O. (1987). "A survey of the collapse of building in Nigeria", Structural engineering 1 (1) 29-31

Perry, J. G. & Hayes, R. W. (1985). "Risk and its management in construction projects", Proc. Institute of Civil Engineering Part 1, 78, pp 72

Prokopenko, J. White J, Bittel L, Eckles. R. (1981). Modular Programme for supervisory development (3) international labour organization, Geneva.

Schenkelbach, L. (1975). Safe Management Primer. Dow Jones-Irwin Icn: Illinois, USA.

St. Paul's Steiner School (2013). Accident/incident/Incident Definition. St. Paul's Steiner School, London. TBR November, 2013. Retrieved from http://www.hse.gov.uk/pubns/edis1.pdf on 24th February, 2016; 1:30 p.m.

The American Heritage New Dictionary of Cultural Literacy (n.d.). Stress. *Third Edition*. Retrieved January 15, 2016 from Dictionary.com website http://dictionary.reference.com/browse/stress

Tudun-wada, L. (1987). Need for industrial safety stressed. An Article in the Daily Times pp 3.

Umeokafor, Nnedinma, Evaggelinos, Kostis, Lundy, Shaun, Isaac, David, Allan, Stuart, Igwegbe, Ogechukwu, Umeokafor, Kosi and Umeadi, Boniface (2014). The Pattern of Occupational Accidents, Injuries, Accident Causal Factors and Intervention in Nigerian Factories. Developing Country Studies, 4: (15). pp. 119-127. ISSN 2224-607X. http://www.iiste.org/Journals/index.php/DCS/article/view/14423.

Wogu, E. (2013). Mid-term Achievement in Commemoration of National Democracy Day and 2nd Anniversary of President Goodluck Ebele Jonathan's Administration. Ministerial Platform: Federal Ministry of Labour and Productivity. 16th June, 2013.

ASSESSMENT OF ERGONOMIC FACTORS AMONG NON-ACADEMIC STAFF OF SCHOOL OF ENVIRONMENTAL TECHNOLOGY, FEDERAL UNIVERSITY OF TECHNOLOGY MINNA

Y.D. MOHAMMED[1] P.O. ALUMBUGU[1] & R.A. JIMOH[2]
[1]Department of Quantity Surveying, Federal University of Technology Minna
[2]Department of Building, Federal University of Technology Minna

Implementing ergonomics in workplace improves health and safety among staff, increase job satisfaction of workers, thereby leading to increase work quality services and productivity. In a related development, ergonomics can also increase overall employees' morale, decrease workers compensation costs and decrease absenteeism and turnover among the workers. However, implementing ergonomic principles at work place has been low; hence this study assessed ergonomic related factors of workers within the School of Environmental Technology using physical measurement and personal observation of 10 non-academic staff. The 3 factors identified for assessment were anthropometric measurement (using measuring tape), light intensity measurement (using Lux meter) and quick exposure check (using checklist). The results of the anthropometric measurement assessment showed that only Hip width was found to match with current furniture for most workers, while other parameters were found to be highly mismatched. The results of quick exposure showed, that most workers have experienced moderate exposure levels for back (static and moving), shoulder/arm, wrist/hand and neck. Based on the lighting level at workstation of workers, there was an indication of inadequate lighting level. It can be concluded that based on the 3 ergonomic factors assessed, implementation level was low. Additional improvement to workers workstation is required coupled with long term planning of new chairs that are customized for workers need, ability to rest or lumber support with additional head support and adjustable table. This will enable the user to adjust the height of the table to ensure that his hand is able to wrest nicely on the table.

Keywords: Ergonomic, Anthropometric, Planning, Intensity, Workplace.

yaksmoves@yahoo.com

Y.D. Mohammed[1] P.O. Alumbugu[1] & R.A. Jimoh[2] (2016). **ASSESSMENT OF ERGONOMIC FACTORS AMONG NON-ACADEMIC STAFF OF SCHOOL OF ENVIRONMENTAL TECHNOLOGY, FEDERAL UNIVERSITY OF TECHNOLOGY MINNA** Sustainable Built Environment and Climate change; The challenges of Post 2015 Development Agenda. School of Environmental Technology Conference, SETIC, 2016

INTRODUCTION

Ergonomics is the scientific study of human work. It considers the physical and mental capabilities and limits of the worker as he or she interacts with tools, equipment, work methods, tasks and the working environment. Ergonomics helps adapt the job to fit the person, rather than forcing the person to fit the job. Adapting the job to fit the worker can help reduce ergonomic stress and eliminate many of the potential ergonomic disorders. The objective of ergonomics is to adapt the job and workplace to the worker by designing tasks, work stations, tools, and equipment that are within the worker's physical capabilities and limitations (Shamsul *et al*., 2014).

According to E-Fact (2010), Office Ergonomics is the branch of ergonomics dealing specifically with the office environment. Historically, the office has been considered a relatively safe and healthy place to work and that the modern office environment presents an array of potential hazards that can be avoided by taking simple precautions (Shamsul *et al*., 2014). This concept according to Shamsul *et al.* (2014) is reflected in complaints of discomfort, anxiety, irritation and general job dissatisfaction and can be measured in terms of sick leave, absenteeism and job turnover. Accidents that occur in offices are frequently due to poorly designed office environments and improper office procedures and the rate of office accidents declines when office workers are informed of potential hazards and safe work practices (Shamsul & Mohammed, 2015). Shamsul and Mohammed (2015) recommended training regarding general safety precautions for work in an office reduces both the number and severity of accidents. Ergonomics: is the science of fitting jobs to people. Ergonomics encompasses the body of knowledge about physical abilities and limitations as well as other human characteristics that are relevant to job design (Office Health and Safety, 2002).

The main goal of office ergonomics is to reduce the incidence of musculoskeletal disorders (MSDs). From 1996 to 2004, the Workplace Safety and Insurance Board (WSIB, 2006) reported that MSDs accounted for nearly 42% of all lost time claims in Ontario. This statistic accounts for only lost time claims, which underestimates the true nature of the problem as many individuals continue to work with pain and discomfort.

By implementing office ergonomic methods, many MSD risk factors present in the office environment may be recognized and controlled, diminishing the risk of MSD injury. According to National Council for Occupational Safety and Health (NCOSH, 2007) Musculoskeletal disorders are major health and safety problems in many workplaces. In a poorly designed job, workers often have to reach or twist some part of their body over and over again. After a while, this can seriously hurt muscles, tendons and ligaments. These types of injuries are called musculoskeletal disorders (MSDs). Sometimes they are called cumulative trauma disorders, repetitive strain injuries, repetitive motion disorders, or overuse syndrome. All of these mean the same thing. They all are caused by poorly designed jobs and equipment (NCOSH, 2007).

Musculoskeletal disorders usually develop over time. They can cause constant pain and sometimes permanent damage. Musculoskeletal disorders can prevent workers from being able to do their jobs. According to Washington State Fund (WSF, 2009) workers' compensation claims that the single largest class of injury claims in the office is Work-related Musculoskeletal Disorders (WMSD's), which account for over 40% of all among office workers. These injuries result in medical and time loss costs of over $12 million per year to State Fund employers, and are responsible for over 70,000 lost work days per year. Due to the nature and severity of WMSD's, they account for more than their share of injury costs - about 60% of overall claim costs (WSF, 2009). The objective of the study is to establish ergonomic related factors of workers within school of environmental technology. Three factors were identified for assessment among the workers; those factors are anthropometric measurement, light intensity measurement and quick exposure check. Anthropometric measurements refer to furniture measurement. Furniture designed using ergonomic principles can improve performance and reduce workplace injury (Laypersons Guide, 2011). As contained in the Office Ergonomic Manual, (2011) the chair must fit you and be appropriate for your tasks, and sitting properly in a well-fitted chair helps to limit back strain and discomfort. The manual provide good features for an ergonomic chair as follow:

1. Adjustability
    a. Seat height range: Seat height should be adjustable to the height recommended for the worker(s) who will use it.
    b. Backrest: The backrest should be adjustable both vertically and in the frontward and backward direction.
2. Seat depth - Seat selection should be based on that which suits the tallest and the shortest users.
3. Adjust the seat height so your feet rest flat on the floor or use a supportive footrest.
    a. Sit upright in the chair with the lower back against the backrest and the shoulders touching the backrest.
    b. Thighs should be parallel to the floor and knees at about the same level as the hips (equal to or slightly lower).
    c. Back of knees should not come in direct contact with the edge of the seat pan. There should be 5.08-10.16 cm (2-3 fingers) between the edge of the seat and the back of the knee.
    d. Use a footrest when attempts to adjust your chair and the rest of the workstation fail to keep your feet on the ground.
    e. Ensure that you have some space (5-7 cm) between the top of your thighs and the underside of your workstation.
    f. Have enough space under your work surface so that you can pull yourself all the way up to the edge of the desk with room for your legs and knees to fit comfortably.
4. Check that the seat pan depth is such that the user can maintain contact with the backrest in the lumbar area and avoid increased pressure on the back of legs and behind the knees.
    a. Sit in the chair and push your hips back as far as they can go against the chair back.
5. Check that the adjustable arm rests do not impede access to the work station or arm movement. The arm rests should be removable and the distance between the arm rests should be adjustable.

a. Adjust the height and/or width of the armrests so they allow the user to rest arms at their sides and relax/drop their shoulders while keyboarding.
b. If the armrests are too high, they will elevate the shoulders which can cause stiffness or pain in the shoulders and neck.
c. Don't use the armrests to slouch.
d. If the armrests are too low, they promote slumping and leaning to one side.
e. Elbows and lower arms should rest lightly on armrests so as not to cause circulatory or nerve problems.
f. If your armrests are in the way, remove them.

6. Adjust the height of the backrest to support the natural inward curve of the lower back (100-119 degree reclined angle). The upper and lower back must be supported.
   a. A chair that maintains the normal alignment of the spine (S-curve) will relieve fatigue and discomfort

ANTHROPOMETRIC MEASUREMENT

Anthropometric measurement consists of measuring of the body part and also measuring the chair component. The matching between the workers and their workstation were assessed using the mismatch calculation. The formulation to determine the mismatch is show in Table 1.

Table 1: Mismatch Formula

Parameter	Measurement Equation
Popliteal height (PH) against seat height (SH)	$(PH + 3) \cos 30^{o} \leq SH \leq (PH + 3) \cos 5^{o}$
Buttock popliteal length (BPL) against seat depth (SD)	$0.8\ BPL \leq SD \leq 0.95\ BPL$
Hip width (HW) against seat width (SW)	$HW < SW$
Shoulder height (SH) against backrest height (BH)	$0.6\ SH \leq BH \leq 0.8\ SH$
Elbow height (EH) against table height (TH)	$EH + (PH + 2) \cos 30^{o} \leq TH < (PH + 3) \cos 5^{o} + 0.8517EH + 0.1483\ SH$

Source: US NIOSH, 2009

In anthropometric measurement two types of description were carried out. They are

1. The anthropometric description.

In anthropometric measurement there are 7 variable measurements in anthropometry which are categorized in to position of sitting. Anthropometric measurements were measured in sitting position. Details are described in Table 2

Table 2: Description of Anthropometric Measurement

Parameter	Method of Measurement
A. Sitting height	Vertical distance from a horizontal sitting surface to the vertex
B. Sitting shoulder	Vertical distance from a horizontal sitting surface to the acromion
C. Shoulder breadth	The lateral borders of the two Deltoid muscles
D. Hip breadth	Breadth of the body measured across the widest portion of the hips
E. Buttock to Popliteal length	Horizontal distance from the hollow of the knee to the rear most point of the buttock
F. Popliteal height	Vertical distance from the foot-rest surface to the lower surface of the thigh immediately behind the knee, bent at the right angles.
G. Sitting elbow height	Vertical distance from a horizontal sitting surface to the lowest bony point of the elbow bent at a right.

Source: US NIOSH, 2009

2. The furniture measurement description

The furniture was measured in four parameter consist of seat height, seat depth, seat width and backrest height using measuring tape. If the level of the furniture is adjustable, the height of the furniture should be levelled into the maximum height.

Details of the description of the furniture measurement are show in the Table 3

Table 3: Description of the Furniture Measurement

Parameter	Method of Measurement
A. Seat height	Measurement as the vertical distance from the highest point of the front of the seat floor.
B. Seat depth	Measure as the horizontal distance from back to front of the seat surface
C. Seat width	Measure as the horizontal distance from the outer left of the seat surface to the outer right.
D. Backrest height	Measure as the vertical distance from the highest point of the front of the back seat of the seat surface.
E. Desk height	Measure as the vertical distance from the floor to the top of the front edge of the desk.

Source: US NIOSH, 2009

LIGHT INTENSITY MEASUREMENT

Glare is a common problem with lighting in offices. It makes it difficult to see the computer screen and strains the eyes. Light intensity is measured in Lux and a good lighting in an office environment enables the staffs to see clearly and perform their work safely. Good lighting should enable employees to easily view their work and environment without the need to strain their eyes. Different activities require different levels and qualities of light (Ergonomic Guidelines, 2013). European Agency for Safety and Health at Work, (2000) stated that medical evidence indicates that using computers is not associated with permanent damage to the eyes but some workers may experience temporary visual fatigue. This can lead to impaired visual performance, headaches, and tired, red or sore eyes. These symptoms may be caused by concentrating on the screen for a long time, poor positioning of the computer, flickering screens, inadequate lighting, glare and refection, or poor legibility of paper or screen documents.

Recommended lightning level based on recommended average luminance level as shown in the Table 4

T**able 4: Recommended lightning level based on average luminance level**

Lightning for working interiors	**Level (Lux) on the working plane**
Infrequent reading and writing	200
General office, shops and stores, reading and writing	300 – 400
Drawing office	300 – 400
Restroom	150
Restaurant and Cafeteria	200
Kitchen	150 – 300
Lounge	150
Bathroom	150
Toilet	100
Bedroom	150
Classroom, Library	300 – 500
Shop, Supermarket, Department store	200 – 750
Museum and Gallery	300

Source: Malaysia Standard MS 1525:2007

Also, colour contour were used to determine the light intensity in each of the departmental office. Table 5 shows the colour contour

Table 5: Colour contour

Light intensity (Lux)	Colour Contour
<300	Yellow
301 – 500	Green
>500	Red

Source: Malaysia Standard MS 1525:2007

Quick Exposure Checklist (QEC)

Quick Exposure Check (QEC) involves conducting an assessment on workers that have direct experiences of the task. The Rubens Centre for Health and Medical Ergonomics (2013) defined QEC as assessing the changes in exposure to musculoskeletal risk factors of the back, shoulders and arms, hand and wrists, and neck before and after an ergonomic intervention. Quick Exposure Checklist is a method used to identify the relationship of posture used by employees with ergonomic problems. QEC assesses the exposure of the four body areas at greatest risk to the most important risk factors for work related musculoskeletal disorder (WMSDs).

Quick Exposure Checklist is based on the Lin and Buckle (1999) methods which require monitoring and feedback by employees in assessing postures performed by employees. This method contains 6 steps to determine the final score which are:

1. Observers Assessment
2. Working Assessment
3. Ergonomic Exposure Score Calculation
4. Determination of Response Category
5. Assessment by Ergonomic Observer
6. Interpreting result QEC score

Ergonomic assessment consists of four (4) assessments of the body areas which are:

a. **Back posture** – the assessment should be made at the moment when the back is most heavily loaded, for example, when lifting a box, the back is under highest loading when the person leans or reaches forward or bends down to pick the load.
b. **Shoulder and Arm** – the assessment should be based upon the position of the hands when the shoulder/arm is most heavily loaded during work. This may not necessarily be at the same time as when the exposure of the back is assessed.

c. **Wrist and Hand posture** – this posture is assessed during the task when the most awkward wrist posture is adopted. This may be the wrist flexion/extension, side bending (ulnar/radial deviation).
d. **Neck** – the neck posture is defined as excessively bent or twisted if the angle is greater than 20^o relative to the torso.

METHODS AND MATERIALS

The study was a criteria based study, the main criteria for the study were:

a. School of Environmental Technology Secretaries (6 from the Department and 4 from the Dean's Office) were the target using purposive sampling method.
b. The staff must be in the current post for at least One (1) year.
c. Every working day the staff must spend at least five (5) hours on his/her duty post.
d. Anthropometric measurement was carried out using measuring tape as stated under section 2.0
e. Lighting was measured using Digital Lux Meter (Model LX-1010BS). The measurement was done at 9am. A light mapping was developed for each workstation at each office in order to determine the lighting changes and compliance.
f. Quick Exposure Checklist was developed and used as stated under section 4.0

RESULT AND DISCUSSION

Table 5 is the average result of the anthropometric measurement of the 10 non-academic staffs selected for the study within the School of Environmental Technology.

Table 5: Average Anthropometric Measurement Result

Parameter	Length (cm)
Sitting Height	82
Sitting shoulder height	54.3
Shoulder breadth	45.6
Hip breadth	38
Buttock to popliteal length	43
Popliteal height	47
Sitting elbow height	69

Source: Researchers Analysis

Table 6 shows the average result of current furniture measurement at the ten (10) staff selected for the study with the non-academic staff of the school of environmental technology workstation.

Table 6: Average Current Furniture Measurement Result

Parameter	Length (cm)
Seat height	53
Seat depth	50
Seat width	52
Backrest height	53
Desk height	75.2

Source: Researchers Analysis

Analysis using Mismatch Formula

Using the Mismatch formula on Table 1 to analyse and determine the relationship between the anthropometric measurement of the staff and the furniture measurement of the staff, the following results in Table 7 were obtained from the mismatch analysis.

Table 7: Overall Mismatch

Parameter	Measurement Equation	Result
Popliteal height (PH) against Seat hight (SH)	$43.3 \leq 53 \leq 49.8$	High mismatch
Buttock popliteal (PHL) against Seat depth (SD)	$34.4 \leq 50 \leq 40.85$	High mismatch
Hip width (HW) against Seat width (SW)	$38 < 50$	Match
Shoulder height (SH) against backrest height (BH)	$32.58 \leq 53 \leq 43.4$	High mismatch
Elbow height (EH) against the table height (TH)	$111.4 \leq 75.2 < 116.6$	High mismatch

Source: Researchers analysis

Based on Table 7 above for overall mismatch, only the Hip width was found to match with current furniture for staffs while other parameters were found to be highly mismatched.

On the lighting at the workstation of the staff, most of their work areas indicated inadequate lighting (less than 300 lux). However, at the positions where the light sources were located in the offices, the areas were found to have adequate lighting. As regard to the Quick Exposure Checklist for the body areas, the problems that most staff faced are the back (when performing their task, their back is almost neutral but the maximum weight handle by them was heavy in between 11 and 20kg), shoulders and arms postures have placed at about chest high, wrist and hand is deviated and bent for 10 times per minute or less, and the neck is occasionally bent and twisted when performing work.

Table 8 refers to exposure category is used in determining the level of exposure of staff's body area

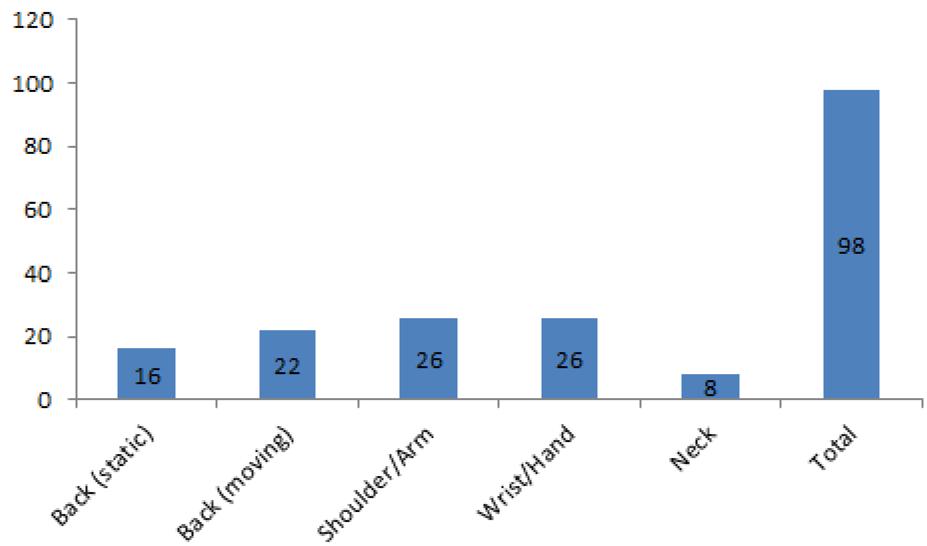
Table 8: Exposure Categories

Score	Exposure level			
	Low	Moderate	High	Very high
Back (static)	8 – 15	16 - 22	23 – 29	29 - 40
Back (moving)	10 – 20	21 - 30	31 – 40	41 – 56
Shoulder/Arm	10 – 20	21 - 30	31 – 40	41 - 48
Wrist/Hand	10 – 20	21 - 30	31 – 46	41 - 46
Neck	4 – 6	8 - 10	12 – 14	16 – 18

Source: US NIOSH, 2009.

The Figure 1 shows the average results of exposure for body area of the staff considered for the study

Figure 1: Average Exposure Score for Body Area.



The average results for exposure score shows that the staffs has experiences moderate exposure level for back (static and moving), shoulder/arm, wrist/hand and neck as indicated in Table 8 and shown in Figure 1.

However, the total average exposure score for body areas for the staffs is 98. Table 9 has to do with interpreting the result of Quick Exposure Checklist (QEC).

Table 9: Interpreting Result of QEC

If manual handling required by workers	
Sum of all scores	**Action suggested**
Less than 70	Acceptable
70 – 80	Investigate
89 – 123	Investigate further and change soon
Greater than 123	Investigate and change immediately
If manual handling is not required by workers	
Sum of all scores	**Action suggested**
Less than 65	Acceptable
65 – 81	Investigate further
82 – 113	Investigate further and change soon
Greater than 113	Investigate and change immediately

Source: US NIOSH, 2009.

Based on Table 9, the action suggested for the staff workstation is needed to be investigated further and change soon because the total exposure score were in range of 89 and 123 if required manual handling and 82 and 113 if manual handling is not required.

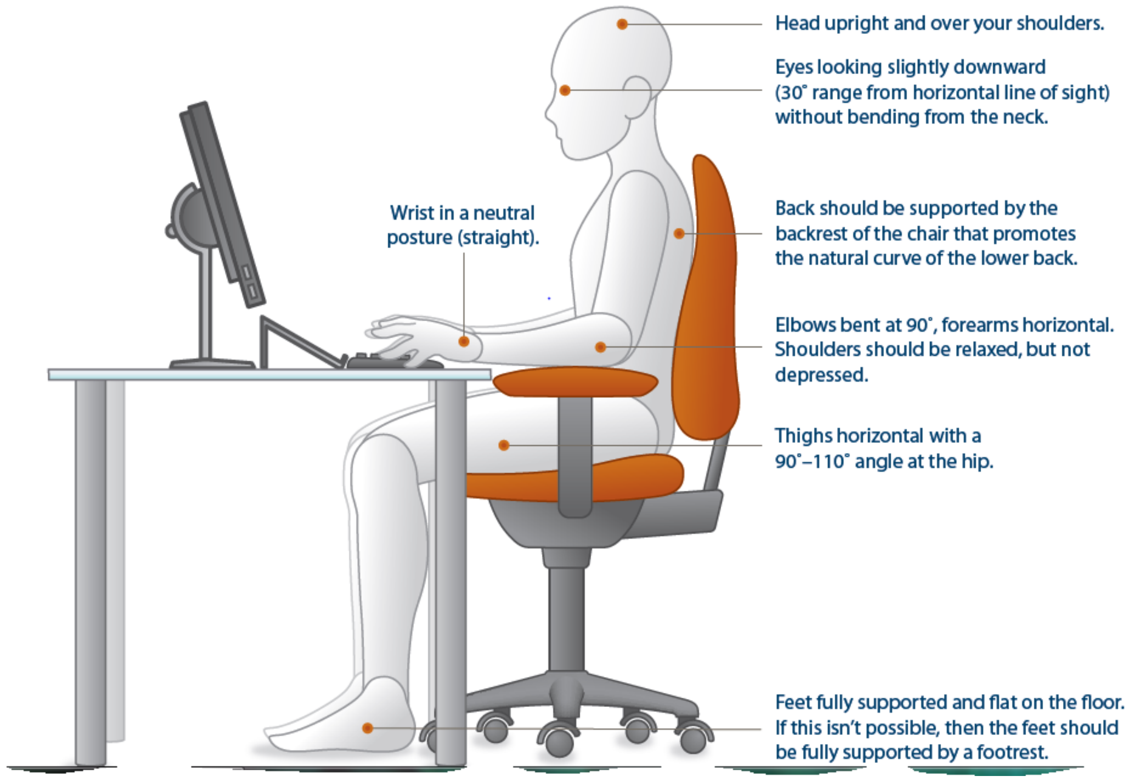
CONCLUSION AND RECOMMENDATIONS

Through assessing and interpreting the results of the three ergonomic factors consider in this study; the anthropometric measurement, the lighting measurement and the quick exposure checklist measurement (QEC), it can be concluded that majority of the staff (non-academic) of the school of environmental technology are at moderate risk of suffering from Musculoskeletal disorder (MSD) at their workstation.

Based on the above conclusion, the recommendation of the study can be divided into short term and long term planning. The short term planning consists of improvement to their workstation as shown in Figure 2.

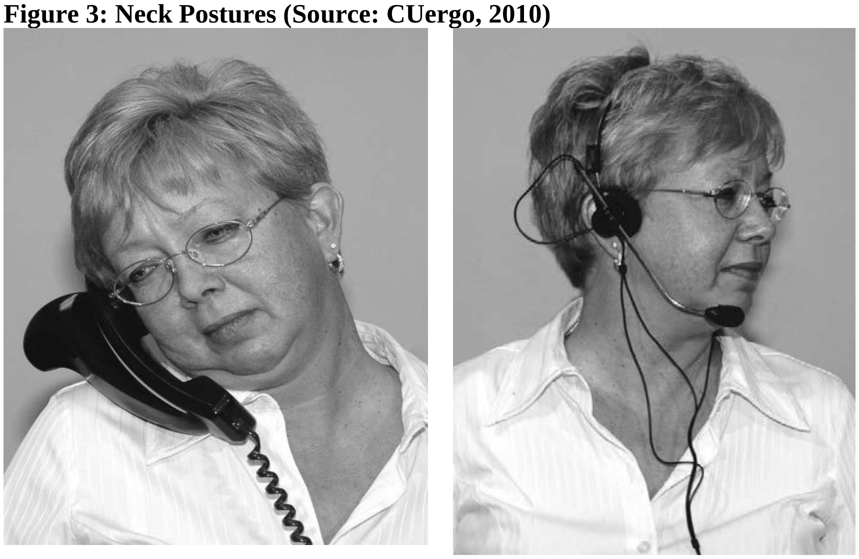
Also, the staff should use headset while working and answering a call, Figure 3 illustrates the best position on how to answer telephone call.

Figure 2: Improvements to workstation



(Source: CUergo, 2010)

Figure 3: Neck Postures (Source: CUergo, 2010)



A. **B.**

Picture A is an example of an awkward neck posture which occurs when multi-tasking while Picture B shows how awkward neck posture can be eliminated through the use of a telephone headset.

Long term recommendations: These include but not limited to:

a. New chair that is customized for their need including ability to rest on lumbar support with additional head support.
b. Adjustable table – this will enable the user to adjust the height of the table to ensure that his hand is able to wrest nicely on the table (without hanging).
c. Head set – this will eliminate the need of side bending of neck while on the telephone.

REFERENCES

CUergo. (2010). Computer workstation ergonomic guidelines http://ergo.human.cornell.edu/ergoguide.html

E-Fact (2010). European Agency for Safety and Health at work. http://osha.europa.eu

Ergonomic Guidelines (2013). Office Ergonomic. Organisational Health Unit Department of Education, Training and Employment

Lin, G & Buckle, P. (1999). Current techniques for assessing physical exposure to work-related to musculoskeletal risks with emphasis on posture-based methods. *Ergonomics*, 42(5) 674 - 695

Malaysia Standard (2007). Guideline on Occupational Safety and Health in the Office, Department of Occupational Safety and Health, Ministry of Human Resources Malaysia.

NCOSH (2007). National Council of Occupational Safety and Health Report on Musculoskeletal Disorder in Office

Office Ergonomic Manual (2011). Office Ergonomic Manual, Concordia University Collaborators: Christine Durant, Lina Filacchione, Rosa Caullo.

Office Health and Safety (2002). www.hse.gov.uk/office/index.htm

Rubens Centre for Health and Medical Ergonomic (2013). Quick Exposure Checklist (QEC). www.survey.ac.uk/rubens/erg

Shamsul, B. & Mohammed, T. (2015). A Ergonomic Report to Pertubuhan Keselamatan Sosial Malaysia.

Shamsul, B.M.T., Mohd Nor Farham, M.B., Mohd, Zahiruddin, Z., Adib Asymawi, M.Y. (2014). Ergonomic Assessment Report Prepared by Makmur Corporate Resources Sdn. Bhd.

United States National Institute of Occupational Safety and Health (2009). Occupational Safety and Health Administration: United State Department of Labor http://www.osha.gov.com

Washington State Fund (2009). Northwest Centre for Occupational Health and Safety, Department of Environmental Health University Washington. http://depts.washington.edu/envhlth/conted/usha/

Workplace Safety and Insurance Board (2006). Occupational Health and Safety Council of Ontario Part 1 MSD Prevention Guideline for Ontario. http://www.wsib.on.ca.

CLIMATE CHANGE AND THREAT TO SUSTAINABILITY OF THE BUILT ENVIRONMENT

REVIEW OF CHANGES IN CLIMATE AND SUSTAINABLE URBAN DEVELOMENT IN AKURE METROPOLIS

AKURE, Josephine. O and ZACCHAEUS, Mayowa. E
Department of Urban and Regional Planning, Federal University of Technology, P.M.B. 65, Minna, Niger State

This paper evaluates the change in climate and urban development sustainability of Akure in Ondo State, Nigeria. Urban development and the consequent change in climate have posed and are posing threat to existence of life. Many states in Nigeria lack the necessary coping capability required for coping with the impact of climate change. It has become necessary to integrate climate change concerns into urban development. This paper contributes to the dialogue on the linkage between changes in climate and the sustainability of man's activities. It examines the following specific issues; the incidence of change in climate in Nigeria, the vulnerability of Nigeria as a nation to climate change, and the consequences of climate change on urban development. Lastly it called for considerable urban activities in the urban area as a result of the consequences of climate change. Suitable measures are recommended in the study.

josrem20002@yahoo.com
mayowazacchaeus@gmail.com

Akure. j AKURE, J and ZACCHAEUS, M (2016). **Review of Changes in Climate and Sustainable Urban Develoment In Akure Metropolis** Sustainable Built Environment and Climate change; The challenges of Post 2015 Development Agenda. School of Environmental Technology Conference, SETIC, 2016

INTRODUCTION

As climate change becomes increasingly acknowledged as a key driver of global, regional and local-scale impacts that exacerbate the vulnerability of human systems, the question of how to conduct climate compatible development within urban systems has become more pressing. This is because the planet is currently mid-way through the second global wave of urbanization, which is proceeding on a scale and at a rate that is historically unprecedented. Moreover, this second wave of urbanization is largely taking place within the slums and informal settlements of developing-world cities in Africa and Asia, where multiple pressures combine with climate change impacts to exacerbate pre-existing vulnerabilities and inequalities (Adefalolu, 2007).

However, African cities are vulnerable to a variety of climate change impacts, ranging from gradual shifts in temperature, intense rainfall, rising sea-levels, coastal erosion and groundwater salinity to changes in the frequency and/or severity of extreme events, such as fires, floods, heat waves and storm surges according to Elisha, (2006). IPCC (2007) report predicted that by 2020 between 75 and 250 million people in Africa will be endangered to increased water level caused by climate change, hence flooding, agricultural production and access to food in many African countries may be further threatened. This will adversely affect food security, worsen malnutrition and increase diseases on the continent. Nigeria is particularly susceptible to climate change. Most agricultural practices in Nigeria especially in south west where Akure is located rely on rainfall and over 70% of the country's population relies directly or indirectly on rain-fed agriculture (IFAD, 2009). Nigerians are highly susceptible to diseases related to the warm and moist climate and occurrence of extreme climatic events. Epidemics of malaria and meningitis are common in Nigeria. As these diseases increase better in warmer climates, any increase in temperature in the country will likely aggravate the epidemics.

Due to increasing anthropogenic activities in Akure, the study area, overexertion in hot weather, sun or bushfire exposure, and exercising or working in hot, poorly ventilated or confined areas, people have been exposed to change of climate which increases the risk of heat stress as observed by Fadairo (2008). These effects of climate pose a great challenge on the well-being of the people, agriculture and health. This reinforces this importance of assessing the impacts of climate change and how to sustain development and human activities without jeopardizing the jeopardizing the chances of posterity in meeting their needs.

Conceptual/ Theoretical Background

Climate change is a global phenomenon including causes of natural climate changes and anthropogenic changes in climate. It hits most seriously the livelihood of the most vulnerable groups, which have generally little capacity to adapt (Adger *et. al*., 2003). Having defined climate change to mean a permanent departure of climatic pattern from mean values of observed climatic indices, Obioh (2001) includes departure in climatic indices to mean change in climate. Indicators for assessing the evidence of climate change in a region are increasing temperature, increasing evapo-transpiration, decreasing rainfall amount in the continental interiors, increasing rainfall in the coastal areas, increasing disruption in climatic patterns and increasing frequencies and intensities of extreme weather (Ahmad and Ahmed 2000; Intergovernmental Panel on Climate Change IPCC 2001a; Hengeveld et al. 2005).

IPCC (2007) states that "Climate change is a change in the state of the climate that can be identified by changes in the mean and or the variability of its properties and that persists for an extended period typically decades or longer". Nigeria's First National Communication on climate change under United Nations Framework Convention on Climate Change (UNFCCC) (2003) noted that climate change is the change of climate which is attributed directly or indirectly to human activities that alter the composition of the global atmosphere and which are in addition to natural climate variability, observed over comparable time period. Another opinion of Okali, (2004) explain climate change by first of all defining climate as the "average weather" together with the variability from the average; it is the synthesis of the weather in a given place over a period of at least 30 years. He listed the main elements of weather to include temperature, rainfall, dew, humidity, wind, sunshine, mist, haze and cloud.

IPCC (2007) explain the complex interaction between the atmosphere and human activities as dictated largely by governance, level of literacy, technology, trade, consumption pattern, socio-cultural preferences and other issues influencing our actions and reactions (see figure 1). The Importance of climate to lives on earth and human possessions have for centuries provoked advances in the studies of the atmosphere.

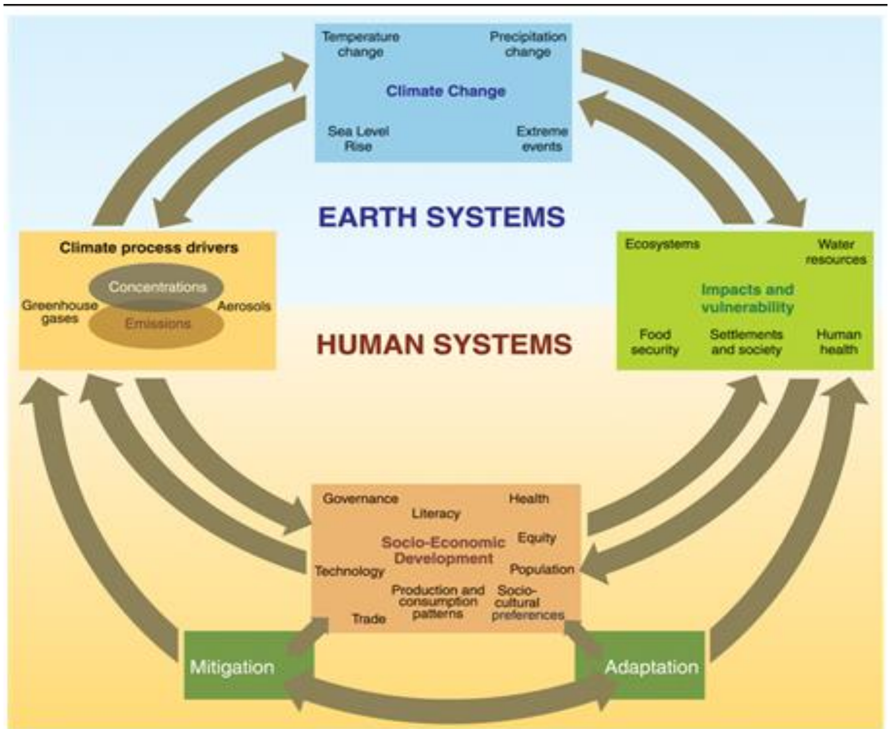


Figure 1: Interaction between the earth and human system (Source: IPCC 2007)

The key reason behind global climate change, otherwise known as global warming, is increase in concentration of gases (see Figure 2), known as greenhouse gases because they absorb and store heat. Of course, as indicated earlier, changes in surface infrastructure also affect the change in surface-atmosphere exchange of energy, hence atmospheric temperature. Today, according to IPCC, there is new and stronger evidence that most of the warming observed over the past 50 years is attributable to human activities.

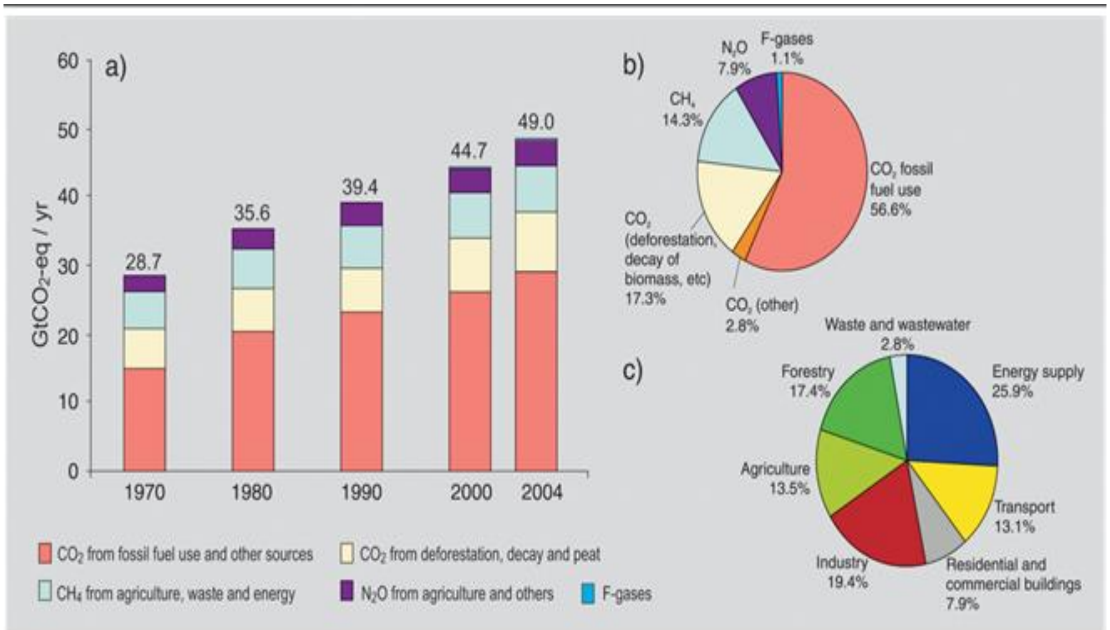


Figure 2: Concentration of different "Climate-Warming" gases in the atmosphere. (Source: IPCC 2007)

Climate Change and Urban Sustainability

The effects of urbanization and climate change are converging in dangerous ways. Cities are major contributors to climate change, although they cover less than 2 per cent of the earth's surface, cities consume 78 per cent of the world's energy and produce more than 60% of all carbon dioxide and significant amounts of other greenhouse gas emissions, mainly through energy generation, vehicles, industry, and biomass use, Okali, (2004). At the same time, cities and towns are heavily vulnerable to climate change. Hundreds of millions of people in urban areas across the world will be affected by rising sea levels, increased precipitation, inland floods, more frequent and stronger cyclones and storms, and periods of more extreme heat and cold. In fact, many major coastal cities with populations of more than 10 million people are already under threat. Sustainable development is widely cited as 'development which meets the needs of the present without compromising the ability of future generations to meet their own needs' (WCED 1987). Connelly and Smith (1999) explain the principles of sustainable development as the recognition that economic growth and environmental protection can, and must, be reconciled.

Climate change requires mitigation and adaptation, hence spatial planning contributes to both mitigation and adaptation. Urban development sustainability reacts to only those impacts characterized by gradual changes such as shift of climate zones, sea level rise and vegetation changes. It, however, cannot react to sudden events such as extreme weather events or amplification of natural hazards. Urban development sustainability has a vital role to play in the move to a low carbon energy future and in adapting to climate change. According to Fleischhauer (2005), climate change impacts that have a spatial relevance are those with a specific regional context and / or those that can be reduced by spatial planning. Climate change has several consequences for urban development in Nigeria. As a result, it calls for considerable urban sustainability before spaces are allotted to different uses as a result of the consequences of climate change in Nigeria. Since most of the economic activities in Nigeria are climate dependent activities, a change in climate will determine both in the short and long run how these activities are planned in the space.

Case Study

Akure is located in southwestern Nigeria. The climate is hot and humid, influenced by rain-bearing southwest monsoon winds from the ocean and dry northwest winds from the Sahara Desert. The rainy season lasts from April to October, with rainfall of about 1524mm per year. Temperatures vary from 28^{o}C to 31^{o}C with mean annual relative humidity of about 80%. *Igbekele Ajibefun (2010).* The climatic condition of Akure follows the pattern of southwestern Nigeria where the climate is influenced mainly by the rain-bearing southwest monsoon winds from the ocean and the dry northwest winds from the Sahara Desert. High temperatures and high humidity also characterize the climate. There are two distinct seasons, the rainy and dry seasons. The rainy season lasts for about seven months [April to October]. The rainfall is about 1524mm per year. The atmospheric temperature ranges between 28oC and 31oC and a mean annual relative humidity of about 80 per cent. The soil is made up of ferruginous tropical soils.

Figure 3: Map of Nigeria Showing Ondo State

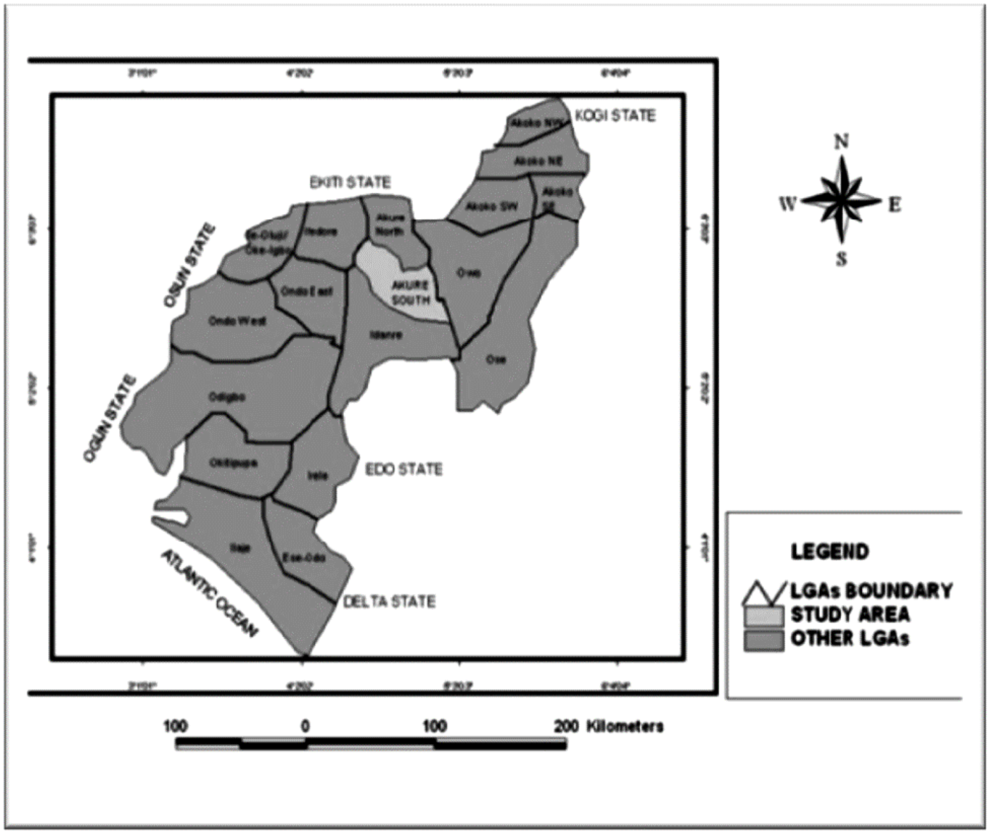


Figure 4: Map of Ondo State Showing the Study Area.

RESEARCH METHODOLOGY AND ANALYSIS

The research study uses an explorative qualitative approach (expert interviews, observation) and is integrated in a broader action research on adaptation. In order to measure change in climate and sustainable urban development in the context of climate change adaptation, an analytical framework was developed. Data on temperature and rainfall between year 2006 and 2015 were obtained from Ondo State Meteorological Center. Other major related data, such as development trend of the city, were obtained from the Internet, textbooks and journals. It outlines the basic concept to the practical objective of this research study by formulating categories, indicators and measurements.

Key Findings

In this paper, we evaluate the change in climate and sustainable urban development in the context of climate change adaptation strategies in sustainable development in Akure. The study investigates urban development with climate change as well as a measurement tool to monitor and evaluate the effectiveness those changes. Below are some observations based on the analysis of the interviews and secondary data collected.

It was noted in Table 1 that the minimum monthly temperature in 2008 and 2007 have similar trend with increasing temperature in January, February, March and April but dropped sharply in May, although, the trend of the temperature in 2008 rose again from July to September with sharp drop in September, but rose continuously to December. Temperature in 2009 rises in June to October and dropped in the rest part of the year to December. It was also observed that in 2014 and 2015 there was continuous increase in temperature monthly comparing both years.

In Table 2 and Figure above it was observed that rainfall consistence and do not increase yearly, it increase in one year and drop in the next years. In 2007, 2009 and 2011 rainfall was very high while low in 2006, 2008 and 2010. The decrease in rainfall continues till 2015. This assertion could be supported with the fact that most rains received in the years are within May and October, which serve as cooling factor that reduce intense influence of increased temperature.

Table 1: Monthly temperature of Akure from 2006 to 2015.

Month	2006 (ºC)		2007 (ºC)		2008 (ºC)		2009 (ºC)		2010 (ºC)		2011 (ºC)		2012 (ºC)		2013 (ºC)		2014 (ºC)		2015 (ºC)	
	Min	**Max**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**
January	21.5	31.5	21.7	31.6	23.8	34.2	22	33.0	23.6	32.8	22.7	33.5	22.8	32.8	23	33.4	22.9	33.3	23.6	34.2
February	22.1	31.7	21.4	31.2	25.8	35.1	23.2	32.9	24.1	33.1	24.6	33.9	24	33.2	24.1	33.5	24.1	33.6	24.1	35.1
March	22.5	31.2	21.3	30.1	23.3	33.9	22.5	32.6	24.6	33.7	24.6	32.8	24.1	32.7	23.4	32.9	23.6	33.4	24.6	33.9
April	21.9	31.4	22.1	31.9	23.8	35.7	21.7	31.9	22.7	33.5	23.7	32.5	22.7	31.9	22.9	31.8	22.9	31.9	22.7	35.7
May	21.4	31.1	22.3	32.6	22.1	33.7	22.2	33.2	21.7	32.4	23.5	31.6	22.4	31.6	23.6	31.9	23.4	32.0	23.6	33.7
June	21.7	32.8	22.6	32.5	23.7	33.6	24.6	32.8	22.5	33.7	23.2	32.6	22.2	31.5	22.7	32.3	22.5	32.4	22.7	33.6
July	21.1	32.5	21.2	32.3	24.2	32.7	24.5	32.4	22.5	33.2	24.6	33.7	24.7	33.1	24.6	32.9	24.8	33.1	25.1	32.9
August	21.7	30.1	22.7	31.5	24.2	34.3	25.3	32.5	23.8	31.9	21.4	32.6	24.5	33.2	24.5	31.9	24.7	33.3	24.7	34.3
September	22.2	31.9	21.9	31.8	25	33.9	21	31.7	22.3	32.7	22.1	32.9	24.8	33.5	24.9	33.7	25.1	33.9	24.5	33.9
October	21.6	32.6	21.5	31.4	25.6	34.1	24	33.1	23.9	33.2	22.3	32.4	22.8	31.7	22.7	31.8	22.8	32.3	23.1	34.1
November	21.3	32.4	22.2	31.7	25.1	33.2	22.4	33.8	23	31.7	24.4	33.1	22.9	31.6	23	31.6	23.3	32.3	23.5	33.2
December	21.8	31.7	22.0	31.1	24.7	34.4	22.1	33.5	24.5	33.3	24.5	32.7	22.7	32.1	22.9	32.8	22.8	33.2	23.1	34.4

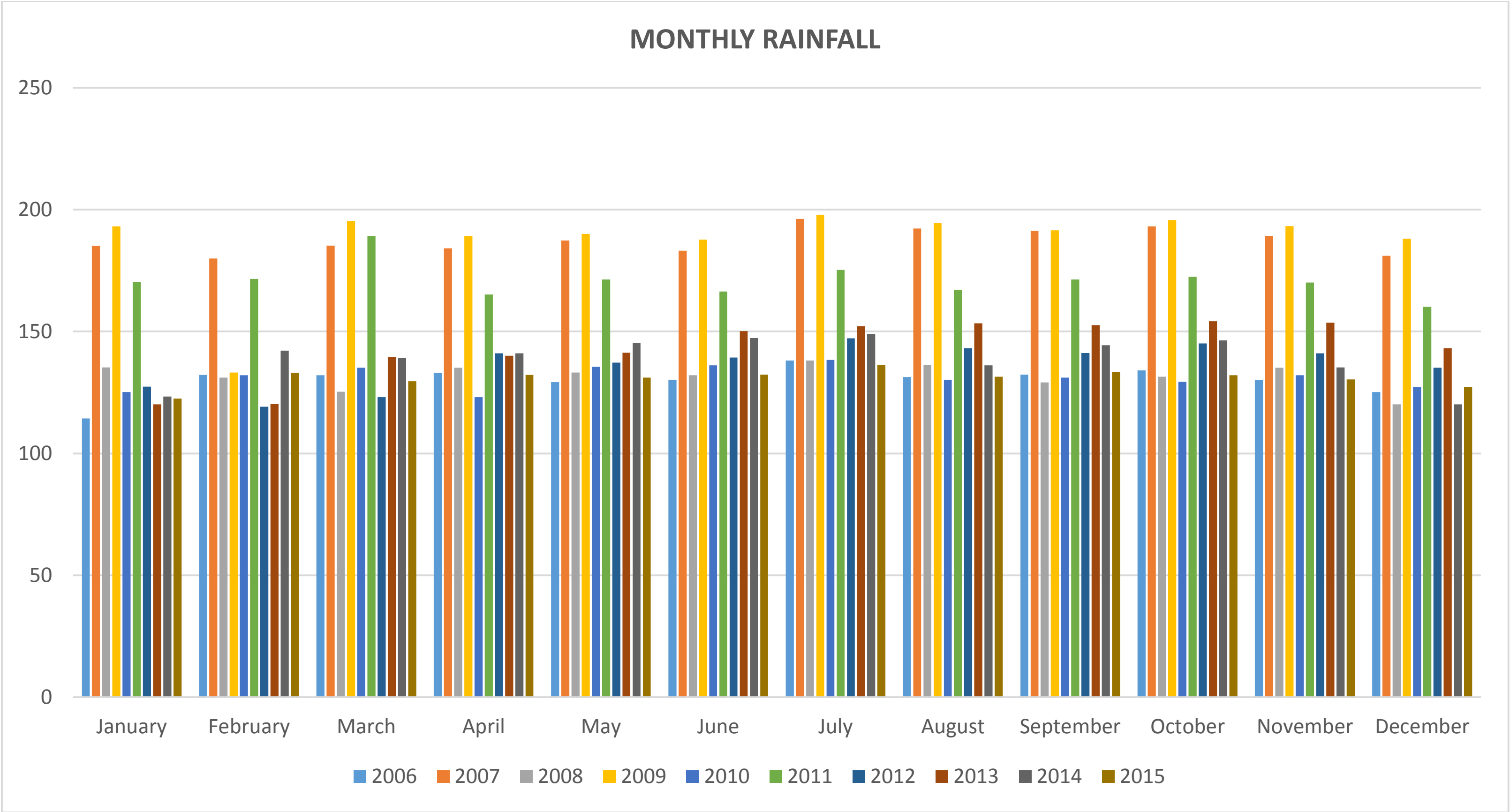
Source: NIMET, 2016

Table 2. Monthly rainfall data of Akure from 2006 to 2015.

YEAR	MONTH											
	January	February	March	April	May	June	July	August	September	October	November	December
2006	114.4	132.2	132.1	133.1	129.3	130.2	138.1	131.3	132.3	134.1	130.1	125.2
2007	185.1	180.0	185.2	184.1	187.3	183.1	196.2	192.2	191.3	193.1	189.2	181.1
2008	135.3	131.1	125.3	135.2	133.2	132.1	138.1	136.4	129.1	131.5	135.2	120.1
2009	193.1	133.2	195.2	189.2	190.1	187.7	197.9	194.5	191.5	195.7	193.2	188.1
2010	125.2	132.1	135.2	123.1	135.5	136.1	138.3	130.2	131.1	129.4	132.1	127.2
2011	170.3	171.6	189.2	165.2	171.3	166.4	175.3	167.1	171.4	172.4	170.1	160.1
2012	127.4	119.2	123.1	141.1	137.3	139.3	147.2	143.2	141.2	145.1	141.1	135.2
2013	120.1	120.3	139.5	140.1	141.3	150.2	152.1	153.4	152.6	154.2	153.6	143.1
2014	123.3	142.2	139.1	141.1	145.3	147.4	149.1	136.1	144.4	146.3	135.3	120.2
2015	122.5	133.1	129.6	132.2	131.1	132.3	136.3	131.5	133.3	132.1	130.4	127.2

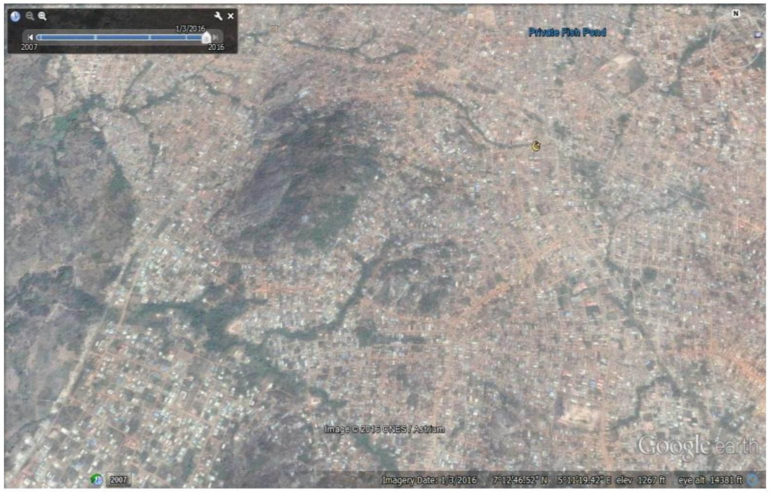
Source: NIMET, 2016

Figure 4: Monthly rainfall data of Akure from 2006 to 2015

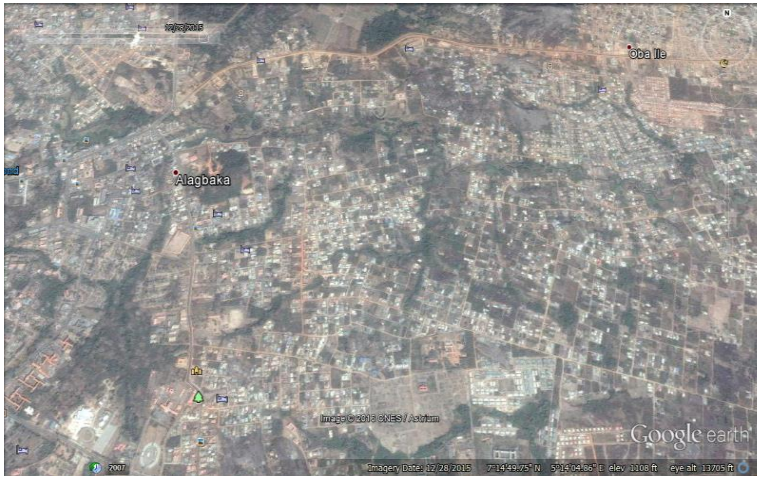


Source: NIMET, 2016

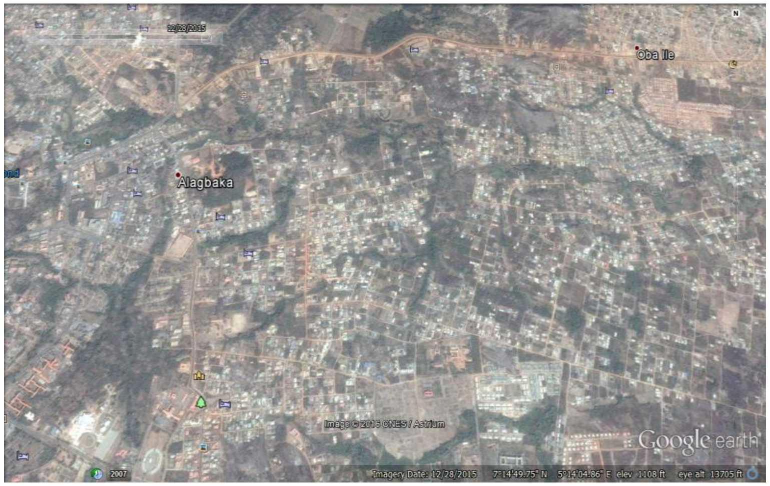
2007 Satellite Image of Akure



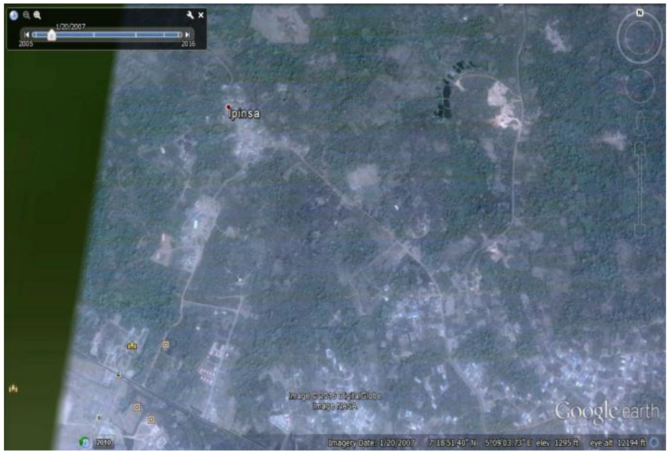
2016 Satellite Image of Akure



2007 Satellite Image of Alagbaka/Oba Ile in Akure



2016 Satellite Image of Alagbaka/Oba Ila in Akure



2007 Satellite Image of Ipinsa Area in Akure

2016 Satellite Image of Ipinsa Area in Akure

It was observed that urbanization, industrialization, unsustainable agriculture and various other activities which release greenhouse gases into the atmosphere is on the rapid succession in Akure. Vulnerability to climate changes comes both from various socioeconomic, demographic, and policy trends limiting its capacity to adapt to change. The high vulnerability to climate change stems first, from its geographical location – in the tropics and with a long coastline. Secondly, Akure has little capacity to adapt to climate change due to low levels of awareness, human and financial resources and institutional and technological capabilities.

It was recorded that due to constant massive construction and developmental projects in Akure are an urban centres, there is higher temperature compared to the surrounding sub urban or rural areas. This phenomenon occurs because urban development results in large a mounts of paved and tarred surfaces that absorb solar energy and radiate it in the form of heat causing surface and ambient air temperatures to rise. Other industries such as construction, housing, transport, energy generation and distribution are also contributed to climate change.

It was noted that excessive consumption of fossil fuel like oil, gas, and carbon, and less attention on alternative energy source has led to a more increasing danger of the lives and properties of residents' of Akure. For instance deforestation or cutting down of plant, is predominant in the area. One of the biggest threats is growing climate unpredictability, which can make economic life difficult. The increased volumes of carbon dioxide and other greenhouse gases released by the burning of fossil fuels, land clearing, and timber harvesting in the tropics alone contributes tons of carbon to the atmosphere. However it observed that the GHGs generated from the causes of climate change have predicted to have a range of consequences for human health arising from the direct and indirect impacts of changes in temperature and precipitation as well other environmental menaces.

The potential impact of climate change may be direct or indirect to urban development and it sustainability in the following ways;

- Geographical location – development suffer negative impact of sea level rise, coastal inundation and flooding. This includes tourism and recreational industries as well as oil and gas exploration and extraction;
- Nature of raw materials used by the development - when raw materials experience any moderate or severe changes in production due to climate change, industries that rely on this input becomes vulnerable; and
- Other industries such as construction, housing, transport, energy generation and distribution are also affected by the incidence of extreme weather-related condition.

Environmental degradation and attendant desertification are major threats to the livelihoods of the inhabitants of the states. This leads to increasing population pressure, intensive agricultural land use, overgrazing, bush burning, extraction of fuel wood and other biotic resources. Women and children are particularly the most vulnerable to the impacts of climate change.

Climate change have resulted into increased mortality in old people in Akure urban areas; Damage to crops; Heat stress on livestock; Extended range of pests and diseases; Loss of some crop/fruit; damage to property and increased insurance costs; Reduced rangeland productivity, increased wildfires, decreased hydropower; and damage to various ecological and socioeconomic systems

CONCLUSION

Climate change is definitely a global problem; however, studies have shown that certain countries like those in sub-Sahara Africa have a greater vulnerability to the impact of Climate Change than others. Akure is particularly vulnerable due to increase in urban activities and development increased drought and desertification in two-thirds of the study area; threat to food security and livelihood because agriculture in Akure is largely sustained by rainfall and can be adversely affected by changes in rain patterns; threat to health security because of the prevalence of diseases such as malaria, cholera, cerebro-spinal meningitis and other diseases which could be exacerbated by extreme weather events such as flooding, and changes in temperature and humidity patterns. Also energy and infrastructure are susceptible to disruption from extreme weather events. The issue of adapting the ways we live to climate change which includes planning for our urban and rural environment is being placed centre stage by recent flood events around the world and particularly in Nigeria. Our built environment professionals need to consider very carefully what they build and where they build it. Thus, urban sustainability is necessary if we wish to adapt to unavoidable climate change.

RECOMMENDATION

Having critically analyzed the challenges of climate change currently experienced in the community, it is important to state the mandatory steps that are required to mitigate the problems of climate change in the State. As a way of proactive measure, government should ensure it carries out an environmental impact assessment in the devastated areas of the previous flooding and other vulnerable areas around the community. Government should adopt the best global practice for the mitigation of global warming. There should be routine sensitization programme across communities to help mitigate the looming dangers of global warming/climate change to a significant level. A mechanism for recycling of wastes, and replanting of every tree that is removed should be put in place. Municipal laws should be strengthened to moderate the emission of greenhouse gases resulting from industrial energy. Finally, government must promote green revolution, this includes forest and wild life preservation.

REFERENCE

Adefalolu DO 2007. Climate change and economic sustainability in Nigeria. *Paper presented at the International Conference on Climate Change and Economic Sustainability* held at Nnamdi Azikiwe University, Awka, Nigeria. 12-14 June 2007.

Adger ,W N., Hug, S., Brown, K., Conway, D. & Hulme, M. (2003) Adaptation to climate change in the developing world. *Progress in Development Studies*, 3, pp. 179-195.

Connelly, J. and Smith, G. (1999) *Politics and the Environment: from theory to practice*, London: Routledge.

Elasha BO, Medany M, Niang-Diop I, Nyong T, Tabo R,Vogel C 2006. *Background paper on Impacts, Vulnerability and Adaptation to Climate in Africa*.

Fadairo, G. (2008) Impact of Flooding on Urban Housing: A Focus on Ala River in Akure, Nigeria. Ph.D. Thesis, Federal University of Technology, Akure, Nigeria.

Fleischhauer M 2005.Spatial planning as an adaptation strategy to climate change. *Paper presented at the National Conference: Climate Changes Spatial Planning* in Zeist. 11 February.

Gill, S.E, et al (2007): *Adapting cities for climate change*: the role of the green infrastructure. *Built environment* 22 (1).

Grimmond C.S.B. et al (2010) : *Climate and more sustainable cities* : climate information for improved planning and management of cities pp 247-272

Igbekele Ajibefun. "Akure City Profile" (PDF). International Water Management Institute. Retrieved 19 September 2010.

Intergovernmental Panel on Climate Change (2001): *The Third Assessment Report: Climate Change* 2001

Intergovernmental Panel on Climate Change (2007): *The Fourth Assessment Report: Climate Change* 2007

Nigerian Meteorological Agency (NIMET) (2013). *National Reports on Climatic Data*; Nigerian Meteorological Agency (NIMET): Akure, Nigeria.

Okali D 2004. *Nigeria Climate Change: A Guide for Policy Makers*, Ibadan: NEST.

Oke, T. R. (1977): The climate of urban areas. In *A Textbook of Science and Future. Encyclopaedia Britannica*, Chicago.

Osmond, P. (2011): *"Sustainability and urban climate*", Course notes, Sustainable Building Design short course, University of New South Wales, Sydney, Australia.

WCED (World Commission on Environment and Development) (1987) *Our Common Future*, Oxford: Oxford University Press.

Wilson E, Piper J 2010. *Spatial Planning and Climate Change.* London: Routledge.

www.wikipedia.org/wiki/Akure

ADAPTING TO CLIMATE CHANGE FLOODING IMPACTS- A GUIDE FOR ACHIEVING SUSTAINABLE BUILT ENVIRONMENT IN NIGERIA.

BELLO Nurudeen Akinsola[1], ADEPOJU Adetoye Sulaiman[2] & ADEOGUN Adekunle Sunday[1]

1 Department of Estate Management, Faculty of Environmental Sciences, University of Ilorin, Ilorin, Nigeria.

2 Department of Estate Management, Federal Polytechnic, Ado Ekiti, Ekiti State, Nigeria.

Flooding, a situation where land is covered with water (due to overflowing river caused by heavy rain) is one of the climate change natural disasters generated by human activities whi ch constitute a threat to human life, property and the built environment. Although risks cann ot be fully eliminated, however, adaptation to climate change can reduce the exposure and v ulnerability to extreme climate and sustain the built environment. This work surveyed litera ture on climate change flooding and its effects on Nigerian built environment to find out tha t most developed nations with longer water bodies and greater exposure to flooding disaster have been able to curtail the negative effects of climate change induced flooding over the y ears than Nigeria were able to minimise the negative effects of climate change flooding on t heir built environment whereas, Nigeria with comparable minimum and manageable length of water bodies continuously have higher negative impacts from flooding. The study found that the application of adaptation theory will mitigate against the effect of climate change fl ooding and lead to the achievement of a sustainable built environment in Nigeria. The work eventually recommended concerted efforts of all stakeholders in the built environment to co operate among themselves for the actualisation of gains of adaptation approach to climate c hange flooding in Nigeria towards achieving sustainable built environment.

Keywords*: adaptation, built environment, climate change, flooding, sustainable-development.*

joebellobje@yahoo.com

arcadedayo@gmail.com

Bello et. al., (2016). **ADAPTING TO CLIMATE CHANGE FLOODING IMPACTS- A GUIDE FOR ACHIEVING SUSTAINABLE BUILT ENVIRONMENT IN NIGERIA** Sustainable Built Environment and Climate change; The challenges of Post 2015 Development Agenda. School of Environmental Technology Conference, SETIC, 2016

INTRODUCTION

Every human activity affects the environment directly or indirectly and that increasing population and urbanisation are man's greatest activities that impact on the environment. Rapid urbanization and the growth of mega cities, especially in developing countries like Nigeria, have led to the emergence of highly vulnerable urban communities, particularly through informal settlements and inadequate land management. In the wake of this, as the concentration of urban populations is increasing coupled with growing occurrence of climate change induced disasters, millions of naira in property is lost and its cost is increasing by the day. According to United Nation Development Programme (UNDP) in 2010, Climate change is one of the major challenges of our time and adds considerable stress to our societies and the environment. From shifting weather patterns that threaten food production, to a rise sea level that increase the risk of catastrophic flooding, the impacts of climate change are global in scope and unprecedented in scale. Without drastic action today, adapting to these impacts in the future will be more difficult and costly. Flooding has been observed as one of the climate change causative natural disasters generated by human activities which consequently hinder sustainability of the built environment (Adeofun, 2011). It is a situation where the land is covered with water due to overflowing of river triggered by heavy rainfall, an aspect of negative response to climate change, and due to its destructive effects on the built environment. It is an impediment to sustainable development. Flooding is identified as threats to human life, property and the built environment worldwide, most frequent in the developed countries, but mostly the degree of its vulnerability is much felt by the developing countries (Ojo, 2011), perhaps due to lack of proper adaptation. Hundreds of millions of urban dwellers in developing nations are at risk from the direct and indirect impacts of climate change. The trend and occurrence of flood rise and flooding are a factor of increased frequency and incidents severity.

According to Satterthwaite et al (2007) a third of the world's population are most at risk from sea-level rise and from the heat waves, storms and floods (as recently experienced in India, Indonesia, United States of America and United Kingdom) and many of the urban centres will need to adapt fast to avoid serious impacts of climate change flooding. The developing countries have large deficiencies of the preconditions for successful adaptation because they are ill-equipped due to inadequate provision for the infrastructure and services needed to reduce climate-change-related risks and vulnerabilities. Without effective adaptation measure to climate change flooding, there will be very serious consequences for the people, the environment and the national economies. For instance, in England and Whales 10,000 properties were flooded during Autumn in 2000 with negative effects on the road and rail services which made insurance claims total 1 billion pounds, also in Scotland, the average annual damage from flooding was put around 20 million pounds (Ojo, 2011). In the wake of unavoidable climate change, over exploited coastal resources posed a great threat to the built environment in Nigeria because of lack of proper development and effective flood management. In 2011, Ibadan experienced a flood disaster that washed away 2,105 properties and 25 bridges and culverts which, according to the Oyo state task force on flood prevention and management will require 100 billion Naira and 4.31 billion respectively to reconstruct (Ojo, 2011). Also in 2012, there was a general flood affecting over 80% of component states in Nigeria, although the total loss was not documented, but it had a huge loss and damages to people and the built environments.

In preparation against negative effect of future flood, Olusina & Odumade (2012) used geographic information systems (GIS) to model future climate of Nigeria for 50 years (2000-2050) by comparing climate data from Nigerian Meteorological Services (NIMET) with World Clim model and application of their variation to obtain polynomial for predicting future temperature and rainfall change for Nigeria covering the period. The finding of the research indicated that future range of the changes in rainfall and maximum temperature to be between -192 to 198 (mm) and -1.59 to 2.48 (degree centigrade) respectively. Further findings include; expected negative and positive variations in rainfall across Nigeria, increase in temperature, coastal regions to expect average increase of 100mm rainfall monthly during rainy season. This however is a pointer for all stakeholders in the built environment in Nigeria to adapt to climate change flooding. The questions agitating the mind of these researchers are; which aspect of climate disaster is mostly noted in Nigeria and what are its causes? What are the effects of climate change flooding on the Nigerian built environment? To what extent can adaptation strategy be of use to flood disaster in Nigeria? And what are the adaptation strategies that can be applied for a reduction in flood disaster in Nigeria?

The focus of this paper is therefore on changes in the floods that might be related to changes in climate (i.e., referred to as 'climate-driven flooding'), rather than changes in engineering developments or land use and how such changes can be reduced and prevented for the purpose of having a sustainability in Nigerian built environment. To achieve the aim of the paper, it has been structured into 8 sections. The second section is devoted to climate change concept followed by section 3 which identify flooding as major visible natural disaster from climate change while section 4 discussed the climate change flooding effects on the built environment. Section 5 is on climate change flooding adaptation to built environment, section 6 observed flooding as a visible climate change induced disaster in Nigeria, the way out of climate change-flooding negative impacts on the Nigerian built environment was the focus of the seventh section before the work was concluded at the eighth section.

Climate change

Climate Change, according to Intergovernmental Panel on Climate Change (IPCC) (2012) is a change in the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and/or the variability of its properties and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forcing, or to persistent anthropogenic changes in the composition of the atmosphere or in land use. This definition differs from that in the United Nations Framework Convention on Climate Change (UNFCCC), where climate change is defined as: "a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods." The UNFCCC thus makes a distinction between climate change attributable to human activities altering the atmospheric composition, and climate variability attributable to natural causes. Global warming, as a resultant effect of climate change and the abuses of man on the environment is however noted to be the major causes of prolonged torrential showers of rains and the resultant runoff that lead to devastating floods.

According to Mosha (2011) climate change indicate any long term and significant change in weather (temperature, precipitation and wind patterns) experienced by a given region. Climate events have increased in frequency or magnitude, but populations and assets at risk have also increased, with consequences for disaster risk (IPCC,2012). Adverse impacts are considered as disasters when they produce widespread damage and cause severe alterations in the normal functioning of communities or societies. Climate extremes, exposure, and vulnerability are influenced by a wide range of factors, including anthropogenic climate change, natural climate variability, and socioeconomic development. Figure 1 present the relationship between the climate change and the implied disasters attached to it. However, climate change may pose short term changes (e.g. flooding, storms, heat waves and drought) and long-term changes (e.g. increasing average temperatures and sea level rise).

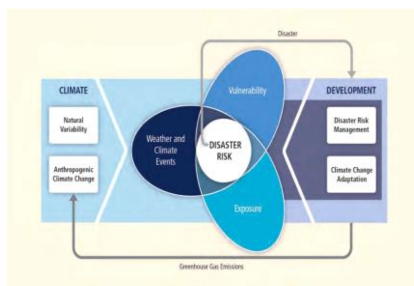


Fig. 1The relationship between climate change and adaptation
culled from IPCC, 2012

Within the built environment sector, climate change may be for adaptation or for mitigation purpose. Mitigation means efforts to limit the man-made causes of climate change, it has to do with taking actions aimed at reducing the extent of climate change factors, but adaptation is often used simply to mean changes that can be made to the design or construction (less often the operation or use) of buildings and landscaping in order to cope with the consequences of one or more of the impacts of climate change. Both terms therefore mean reduction of natural cause and prevention of human cause of climate change impact on the built environment. Currently, many existing buildings are wrongly adapted, indicating that the way they have been built increases their potential vulnerability to the effects of climate change. Moreover, in some cases it is not considered cost-effective to modify existing buildings to cope with a changing climate. Population growth and the planning system therefore, have a significant influence on the built environment and its evolution, including how it adapts to climate change. It is actions taking to minimize the negative effects and taking advantage of the opportunities, of climate change (both current and those yet to come).

It may also be an adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderate harm or exploit beneficial opportunities.

(United Kingdom climate impact Panel UKCIP, 2009). Climate-change has both positive and negative current and potential effects on people and their livelihoods/investments (e.g. buildings, neighbourhood and city). These effects can be direct, as in larger and/or more frequent floods, or more intense and/or frequent storms, or heat waves, or less direct as climate change negatively affects livelihoods or food supplies (and prices) or access to water needed for domestic consumption or livelihoods. Changing climate may come along with an increase in the frequency of drought, extreme rainfall, high temperatures, wind events is expected and we can expect an exacerbation of the health impacts associated with these events, it will increase the frequency and intensity of heavy rainfall events, thereby increasing the risk of urban flooding.

Flood and flooding as climate change natural disaster

A flood is the overflowing of the normal confines of a stream or other body of water, or the accumulation of water over areas that are not normally submerged include river (fluvial) floods, flash floods, urban floods, pluvial floods, sewer floods, coastal floods, and glacial lake outburst floods (Satterthwaite, 2008). The main causes of floods generally are intense and/or long-lasting precipitation, dam break (e.g., glacial lakes), reduced conveyance due to landslides, or by an intense local storm (Smith & Ward, 1998). Usman & Tunde (2009) observed that the restriction of the flow of precipitation and water bodies as a result of human actions majorly caused flood in most urban centres thereby causing damages and losses to build and ecological environments. Distinguishing between primary and secondary causes of flooding, the primary causes of flooding with natural tendency have been traced to any or combination of; heavy or torrential rains or rainstorm, ocean storms and tidal waves along coast while the secondary cause of flooding with human influence have been traced to blockage of river drainage through indiscriminate waste disposal and development of structures along river setbacks. Flooding is affected by various characteristics of precipitation, percolation and infiltration such as intensity, duration, amount, timing, and phase (rain or snow). A change in the climate physically changes many of the factors affecting floods (e.g., precipitation, snow cover, soil moisture content, sea level, glacial lake conditions, and vegetation) and thus may consequently change the characteristics of floods. It is also affected by drainage basin conditions such as water levels in the rivers, soil character and status (frozen or not, soil moisture content and vertical distribution), urbanization, and the existence of dams, and reservoirs (Bates et al., 2008). Along coastal areas, flooding may be associated with storm surge events.

Urban flooding (Overbank, dam spills or dam burst levee failures, Flash, Coastal, Overland, and Infiltration) occurs in urban areas, where the impacts of extreme rainfall are exacerbated by high concentrations of impervious surface, infrastructure, buildings, and property and people (Omisore, 2011). Urban flooding can have serious implications for all components of built environment and infrastructure. As extreme flows of water during heavy rainfall events can cause gully erosion and damage both overland and underground storm water management infrastructure and road pavements. The resulting loss from flooding however depends on the vulnerability of the affected population to resist the hazard otherwise called resilience. Most of the associated climate-related threats could have major impacts on the built environment. The built environment sector may therefore need to consider suitable approaches for adaptation to a changed climate because of the associated direct threats it posed to the built environment and the people dwelling in it. However, those people and buildings close to the coast are particularly at risk when storm surges are combined with sea level rise. The major adaptation strategy to climate caused flooding involved the use of constructed defences to prevent and reduce the effect of flooding on built environment, raising of river banks and flood walls, creating sufficient storage reservoirs and canalization or channelization of flood passage and establishment of standard drainage system on roads.

Climate change flooding effects on the built environment

Most of the effects of climate change flooding are negative; for instance, such water may be increased in quantity and at the same time be decreased in quality, calling for concern from government and the built environmental professionals. However, Climate change effects are not all negative. Some are beneficial in nature, and for instance it may reduce energy bills and cold related deaths and hospital admissions. It may also reduce energy consumption and increase water supply. In some cases, overheating may lead to illness or death. Without action, likely consequences of the projected climate variables will be wide ranging from increasing flood risk and coastal erosion, potential water shortages, ground instability issues to associate health impacts of increased temperatures and detrimental effects on the current and future infrastructure. Warmer summers, on the other hand, may increase the risk of buildings becoming too hot and uncomfortable for human habitation. Climate change with its consequential effect on the built environment may increase the risk of subsidence affecting the properties which subsequently, may increase the risk of flooding for both residential and non-residential properties, thereby reducing their value, for instance, Ogbonna and Otegbulu (2014) observed the reduction of between 4-12% in housing prices in Nigeria due to flooding effect. Changes in water availability, particularly reductions in the summer, may lead to less reliable supplies, more frequent restrictions and potential water shortages in the longer term, unless more measures are taken to reduce demands and develop supplies. By and large the effect of climate change flooding on built environment can be identified as: events of drier summers and drought; reduced water availability/shortages, reduced water quality, reduced soil moisture content/ increased subsidence, changes in biodiversity, sea temperature rise; sea level rise, increased sea surge height, increased precipitation or more rainfall in heavier form, increased river flooding, increased urban drainage flooding, higher wind speeds; increased storm damage, outage of emergency, infrastructure and transportation services, reduction in property value.

Climate change adaptation to the built environment

Adaptation in human systems is defined as the process of adjustment to actual or expected weather and its effects. In order to moderate harm or/and exploit beneficial opportunities. In natural systems, it is defined as the process of adjustment to actual climate and its effects; human intervention may facilitate adjustment to expected climate (Eclipse Research Consultants, 2010). Within the built environment sector, climate change adaptation is often used simply to mean changes that can be made to the design or construction (less often the operation or use) of buildings and landscaping in order to cope with the consequences of one or more of the impacts of climate change. Adaptation involves taking actions to minimize the effects of inevitable climate change, and take advantage of its opportunities, both current and those yet to come (Eclipse Research Consultants, 2010). These definitions modify the IPCC (2007) definition that generically mean the "adjustment in natural and human systems in response to actual and expected climatic stimuli, such as to moderate harm or exploit beneficial opportunities." The essence of adaptation to climate change induced flooding is to ensure reduction in risks for inhabitants and built environment and have environmental, economic and socio political sustainability of built environment. Settlement patterns, urbanization, and changes in socioeconomic conditions have all influenced observed trends in exposure and vulnerability to climate extremes. Actions that range from incremental steps to transformational changes are essential for reducing the risk from climate extremes. Incremental steps aim to improve efficiency within existing technology, governance, and value systems, whereas transformation may involve alterations of fundamental attributes of those systems (IPCC, 2012). A prerequisite for sustainability in the context of climate change is addressing the underlying causes of vulnerability, including the structural inequalities that create and sustain poverty and constrain access to resources (medium agreement, robust evidence). This involves integrating flooding disaster risk adaptation into all social, economic, and environmental policy domains. The most effective adaptation and disaster risk reduction actions are those that offer development benefits in the relatively near term, as well as reductions in vulnerability over the longer term (high agreement, medium evidence). There are tradeoffs between current decisions and long-term goals linked to diverse values, interests, and priorities for the future. Short- and long-term perspectives on flooding disaster risk adaptation to climate change thus can be difficult to reconcile. Such reconciliation involves overcoming the discord between local risk management practices and national institutional and legal frameworks, policy, and planning. Progress toward resilient and sustainable development in the context of changing climate extremes can benefit from questioning assumptions and paradigms and stimulating innovation to encourage new patterns of response IPCC (2012). Successfully addressing disaster risk, climate change, and other stressors often involves embracing broad participation in strategy development, the capacity to combine multiple perspectives, and contrasting ways of organizing social relations. The interactions among climate change mitigation, adaptation, and disaster risk management may have a major influence on resilient and sustainable pathways (high agreement, limited evidence). Interactions between the goals of mitigation and adaptation in particular will play out locally, but have global consequences. There are many approaches and pathways to a sustainable and resilient future. However, limits to resilience are faced when thresholds or tipping points associated with social and/or natural systems are exceeded, posing severe challenges for adaptation. Choices and outcomes for adaptive actions to climate events must reflect divergent capacities and resources and multiple interacting processes.

Flooding as a visible climate change induced disaster in Nigeria

Most noted flooding the world over are those of coastal, river and urban categories caused by natural causes and aggravated by human causes. According to IPCC (2012), where vulnerability is high and adaptive capacity is low, changes in climate extremes can make it difficult for systems to adapt sustainable without transformational changes. Vulnerability is however often concentrated in lower-income countries although higher-income countries can also be vulnerable to climate extremes. Social, economic, and environmental sustainability can be enhanced by a good disaster risk management and adaptation approaches. In the ranking of countries with water bodies liable to floods, Nigeria was the least of 15 countries ranked having, 8,600km length of water bodies, while China was ranked the first with 110,000km length of water bodies (see table 1 and figure 2).

This was corroborated by the fact that the coastal region of Nigeria (Delta, Edo, Lagos, Ondo, Ogun, Akwa-Ibom, Bayelsa, Cross River and River state) covered about 70,000km2 representing only 7.5% of total land mass of Nigeria indicating that Nigerian flooding problem should be manageable compared with other countries. Flooding is therefore expected to be much more pronounced in the coastal areas because of rise in sea level and riverside areas because of overflowing of river banks after torrential rainfall, the coastal land and property are more liable to wash away by sea erosion and aquatic life, wetland and tourist beaches are also threatened by the floods (New England Aquarium, 2012). In Nigeria, coastal flooding coupled with beach erosion is the most common climate change disaster applicable to the build environment and their widespread is due to the higher waves generated by on shore storm winds (Patunola-Ajayi, 2014). While Halley (2001) identifies the major cause of flood in Africa to be inadequacy of drainage, but study of cause of flood in Nigeria has been identified to be excessive rainfall (Akanin and Bilesanmi, 2011; Ojo, 2011, & Aderogba, 2012) occasioned by increased precipitation. While some of the flooding could be due to natural occurrence or closeness to coastal areas, the case of urban flooding in Ibadan, a non-coastal city in Nigeria is a typical example of man-made flood disaster. Projections of flood changes at the catchment/river-basin scale are also not abundant in the scientific literature and very rare in Africa (Taye et al., 2011). Bates et al. (2008) argued that more frequent heavy precipitation events projected over most regions would affect the risk of rain-generated floods (e.g., flash flooding and urban flooding). Despite the fact that Nigeria has a manageable length of water bodies, it still lacks the required materials and resources for flooding adaptation approach when compared with other countries with a longer length of water bodies as indicated in table 1 and figure 2. The resultant effect is that Nigeria has manageable flooding risk but magnificent negative flooding impact.

Table 1: Ranking of length of global Navigable Rivers, canal and other inlands bodies of water

S/N	Country	Length in kilometers	Rank
1	China	110,000	1st
2	Russia	102,000	2nd
3	Brazil	50,000	3rd
4	United States	41,009	4th
5	Colombia	24,725	5th
6	*Indonesia*	21,579	6th
7	Vietnam	17,702	7th
8	Congo	15,000	8th
9	India	14,500	9th
10	Burma	12,800	10th
11	Argentina	11,000	11th
12	Papua New Guinea	11,000	12th
13	Boliva	10,000	13th
14	Peru	8,800	14th
15	Nigeria	8,600	15th

Source: Patunola-Ajayi (2014) adapted from the world fact book

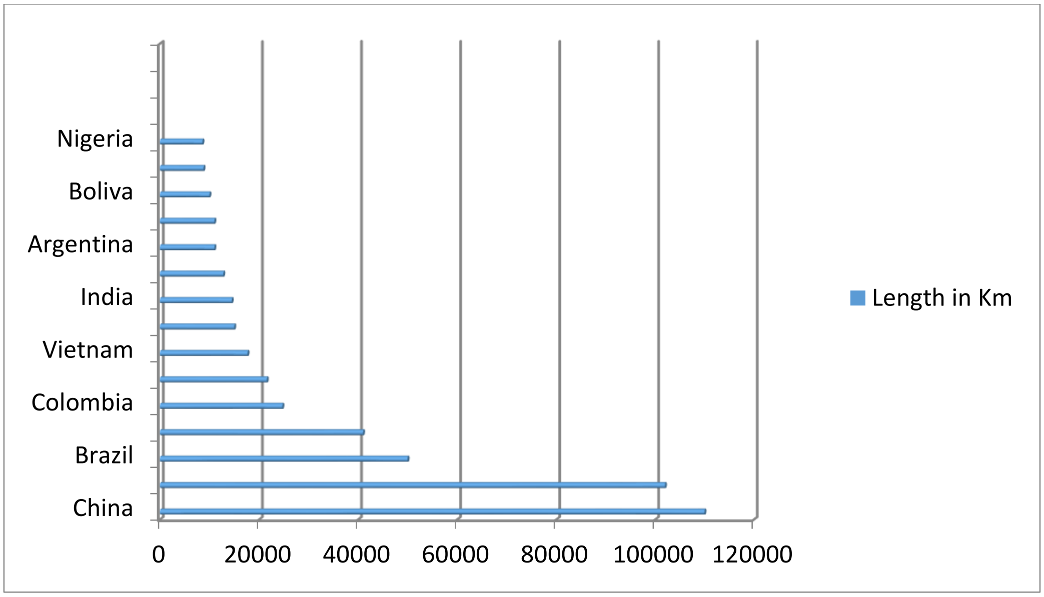


Fig 2: Ranking of length of global Navigable Rivers in selected nations

Some states with evidences of flooding occurrences in Nigeria include Oyo (1980 &1990), Lagos (1970-2015), Kano (2001), Delta (2001), Edo (2015), Adamawa (2001-2015) and Kogi (2012) with negative effects on the built environment; destruction, submerging or washing away of buildings and structures, water pollution, bridge collapses and road wash away. The worst flooding occurrence in the history of Nigeria has been that of June/July 2012 when Benue and Niger rivers overflowed their banks. Although this was predicted early by the Nigerian Meteorological Agency, but governments at all tiers took no adaptation or mitigation actions. This singular incidence affected 30 of the 36 states in Nigeria, about 250 local government areas (representing 32% of 774 total local governments in Nigeria). About 30% of Nigerian land mass was submerged by flood affecting 7.7million people, 300 were dead, and over 2million people were displaced. Kogi state was the mostly affected state, but it was only in Plateau state that 200 homes were documented to have been destroyed. From the report of National Emergency Management Agency (NEMA) in 2012, between June and September 2012, over 363 lives were lost and about 1.2 million Nigerians were displaced. Adapting buildings to the impact of climate change requires an integrated approach to environmental design and the performance of buildings in use, Ezeabasili & Okonkwo (2013) are of the view that building designers and spatial planners in Nigeria are responding to adaptation of flooding through improved building design and layout of cities. The Environmental Agency (2007) was of the view that if the environmental issues are taken into account, building in the right places and in the right way can be an adaptation for mitigation of effect of climate change induced flooding for the benefit of both current and future generations.

Way out of climate change-flooding negative impacts on Nigerian built environment.

A more resilient built environment will be a key element in the creation of places and communities that are more resistant to the effects of climate change, and in the protection of the people living in and using them. A programme for increased resilience in Nigeria will need to look at the existing built environment, as new buildings and as opportunities for change within existing communities. It will also consider both public and private action and consider both barriers as well as opportunities for early action. Although, already built structure can be modified for people to cope with the changing climatic conditions, their location, the way structures are built and the way in which structural changes are carried out can make this easier or more difficult to accomplish. But the major problem is that many existing buildings in Nigeria are maladapted. In other words, the way they have been built increases their potential vulnerability to the flooding effects of climate change especially the ones close to coasts. The following general strategies can therefore be adopted to increase the ability of the built environment to adapt to climate change flooding in Nigeria:

- A strong need and emphasis on climate adaptation in planning policy, including action on coastal change and water resources are required. This must ensure that building design is done to be climate sensitive and conscious of high-risk areas through more stringent development control, building regulations is not only set but enforced, with minimum water efficiency standards to ensure their structural stability and climate change allowances is appropriately incorporated in engineering standards applied to flood defences and water supply systems.
- Continuing investment in community-wide and property-level flood protection, and steps to improve management of local flood risk. Planning policy should focus on directing most new development away from locations where it might flood especially in the coastal region or make them to be safe and resilient to flooding. The extent of future population growth must be properly analysed as it will add to the challenge of adapting the built environment to climate change in an appropriate and timely way.
- Encouragement of planting of trees to support cooling, drought resilience and drainage. To improve homeowner knowledge and risk-reducing behaviour through education and enlightenment. For instance, they should make them aware of future and potential risks posed by surface water flooding to buildings, neighbourhood and the city as a whole. Individual homeowners can have a significant role in reducing risk through protecting their own homes and reducing their contributions of storm water to municipal sanitary sewers and storm water management systems.
- Drainage should be designed in an environmentally friendly way of dealing with surface water run-off that avoids the problems associated with existing drainage practice aiming at reducing the potential impact of surface water drainage discharges in new and existing developments. There is a need to maximise the density of development in non-flood risk areas and minimise density of coastal and flood risk areas.

Buildings, neighbourhoods and cities may be vulnerable to an increasing frequency of heavy precipitation events. What are required to be done to adapt to the climate change flooding occurrence in Nigeria built environment can also be segregated to 3 levels: building, neighbourhood and city:

Building-there is a need to open water courses across the site for amenity and flood absorption on the site and provision of emergency access points. It is required to provide temporary/permanent flooding defences for properties that are at risk to flooding and a need to fit (removable) flood defence products to properties. Electrical services should be located above flood levels if it is discovered that the building is wet proof un-protectable buildings. Also, mechanical or UV light systems need to be installed to prevent damp and mould growth, peak run-off and annual surface water run-off rates need to minimised, sustainable urban drainage systems (permeable paving attenuation systems, filter drains, ponds, wetlands) should be used, people should avoid development in flood risk locations and where already built, provide temporary/permanent flooding defences for at risk properties. Building design and building materials that can withstand flooding threats should be used and back up of drains into the building should be prevented.

Neighbourhood- soft defences should be used as the buffer as part of green infrastructure and water courses should be opened across neighbourhood for amenity and flood absorption. The development should be appropriately set back from flooding and flood defences and vulnerable users should be ensured located away from areas of high risk. Emergency access points as well as temporary/permanent flooding defences should be provided for existing and new properties at flood risk. Local safe retreat facilities should be provided against failure of flood defences as appropriate and engagement of the community in risk assessment/response. Sustainable urban drainage systems (permeable paving attenuation systems, filter drains, ponds, wetlands) should be used and landscaping including tree canopies should be encouraged to intercept and soak up rain. Lastly, impermeable surfaces should be avoided, especially where soils have high infiltration capacities and routes for emergency vehicles should be well planned to have secure access in the event of flooding, repair and construction of newly constructed drainages.

City- provision of flood plans for up and down stream flooding is highly desired in cities and emergency access routes and points should be provided alongside with city-wide safety retreat facilities against failure of flood defences. Consideration of river restoration for storing water temporarily in green spaces alongside rivers at identified vulnerable areas across the city (e.g. where known incidence of surface water flooding is detected with low drain capacity and soils with high infiltration rates). In vulnerable areas of the city the use permeable paving attenuation systems, filter drains, culverts, ponds, and wetlands should be used appropriately and permitting development in flood risk locations should be avoided entirely.

Conclusion

There exists an once-in-a-lifetime chance to develop and deploy the strategies and technologies that will secure future and realize the economic opportunities presented by climate change, being reason why developed national economies depends on well-functioning and resilient built environment in their urban centres. Urgent action is therefore needed now both to address urban centres' current vulnerabilities to extreme weather and to build into expanding urban centres protection from likely future changes. As most buildings and infrastructure have long lives; what is built now needs to be able to cope with the climate change-induced risks over the next few decades, the epitome of sustainability. There is a need for promoting a strategy for catalyzing support for sustainable building design and construction and the key challenge is to plan, design and construct cities, neighbourhoods and buildings, in accordance with the principles of sustainable development that perform effectively not just in terms of today's climate but in the future as well. To achieve resilience of the existing built environment in Nigeria, there is a need to adapt the new buildings and ensuring modifications of existing buildings in the communities by joint actions of public and private sectors. It will also have to consider both barriers to and opportunities for early action. Although buildings can be modified later to help them stand the test of changing climatic conditions, their location, the way they are built and the way in which structural changes are carried out can make this easier or more difficult to accomplish. All big urban centres and cities have had to make very extensive "adaptations" to environmental conditions, site characteristics, natural-resource availabilities and environmental hazards to be able to function as urban centres. Climate change's multiple impacts should be taken into account when planning and designing new developments and when refurbishing and regenerating the existing stock of buildings. The importance of public awareness through effective hazard education is desired towards changing people's attitude to the climate change challenge. There is also a need for weather data for testing future performance of urban drainage and water supply systems in Nigerian urban centers. By and large, there is a need for concerted efforts of all stakeholders in the built environment (land surveyors, urban and regional planners, quantity surveyors, estate surveyors, architect, engineers, planning authorities and other statutory authorities, urban dwellers and urban building owners and governments)to cooperate with themselves for the actualisation of adaptation approach to climate change flooding in Nigeria.

REFERENCES

Adeofun, C.A. (2011) "Human activities and natural disasters as major impediments to Sustainable development" being a paper delivered at the MCPD of Ogun state branch of Nigerian Institution of Estate Surveyors and Valuers (NIESV) at Abeokuta on 1st December 2011.

Aderogba, K. (2012). "Substantive Causes and Effects of Floods in South Western Nigeria and Sustainable Development of the Cities and Towns". Journal of Emerging Trends in Educational Research and Policy Studies (JETERAPS) Vol. 3 No. 4 pp. 551-560.

Akanni, O., and Bilesanmi, L. (2011). "Flood: Lagos Residents Forced to Relocate and Drowning Teenager Rescued". Published by Vanguard Media Limited Lagos. Friday, July10), pp 20.

Bates, B.C., Z.W. Kundzewics, S. Wu, and J.P. Palutikof, (2008) "Climate Change and Water". Technical Paper of the Intergovernmental Panel on Climate Change. IPCC Secretariat, Geneva, Switzerland, pp. 210

Eclipse Research Consultants (2010) “climate change, it is time to act-Adapting to the impact of climate change on buildings, neighbourhoods and cities a briefing guide for the North West’, Prepared on behalf of CCI NW, Cambridge, March pp 1-35 available at http://www.climatechangenorthwest.co.uk/for the Northwest Climate Change Adaptation Group, Cambridge, March

Environment Agency (2007) “Stepping stones; river flooding” No 1 in the series of educational fact sheet available at www. environmentagency.gov.uk

Ezeabasili, A. C. C. and Okonkwo, A.U. (2013) “Climate Change Impacts on the Built Environment in Nigeria’ African Research Review an International multi disciplinary Journal, Ethiopia Vol. 7 No. 4, Serial No. 31, September, pp. 288-303

Halley (2001) “Impact of 1998 Flood Nutrition and Health. What can we learn from Future Disaster?” Dhaka: Helen Keller International, Bangladesh and Institute of Public Health Nutrition.

Intergovernmental Panel on Climate Change (IPCC) (2012) “Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation” a Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change

Field, C.B., V. Barros, T.F. Stocker, D. Qin, D.J. Dokken, K.L. Ebi, M.D. Z. Sen, and I.A. Mosha, A.C. (2011) “The effect of climate change on urban human settlements in Africa” in climate change and sustainable urban development in Africa and Asia. Springer; Netherlands pp.69-100

New England Aquarium (2012) “Changing climate, changing coasts”, a joint symposium on climate change and the marine environment organised by New England Aquarium and Woods Hole Oceanographic Institution, Boston.

Ogbonna I.O. and Otegbulu A. (2014) “Valuers and security of investments in coastal/riverine areas in times of climate change” paper delivered at NIESV 44th national conference held at Uyo, AkwaIbom state on 25-29 March.

Ojo, O. (2011) “Flooding , a major impediment to sustainable environment”, being a paper delivered at the MCPD of Ogun state branch of Nigerian Institution of Estate Surveyors and Valuers (NIESV) at Abeokuta on 1ST December 2011.

Olusina J.O. and Odumade O.M. (2012) “Modelling climatic variation parameters of Nigeria using the statistical downscaling approach” FIG Working Week 2012 TSO7F-Task force on surveyors and the climate change II,6099.

Omisore E. O. (2011) ‘Flooding , a major impediment to sustainable environment”, being a paper delivered at the MCPD of Ogun state branch of Nigerian Institution of Estate Surveyors and Valuers (NIESV) at Abeokuta on 1ST December 2011

Patunola-Ajayi, B.J. (2014) “Maritime, coastal and inland water investment and management in national development” paper delivered at NIESV 44th national conference held at Uyo, Akwa-Ibom state on 25-29 March.

Satterthwaite, D., Huq, S., Pelling, M., Reid, H. and Patricia Romero Lankao, P.R. (2007) ‘Adapting to Climate Change in Urban Areas The possibilities and constraints in low- and middle-income nations’ Human Settlements Discussion Paper Series Theme: Climate Change and Cities-1 working paper produced by the Human Settlements Group

Satterthwaite, D., (2008)“Climate Change and Urbanization: Effects and Implications for Urban Governance” Paper presented at the United Nations Expert Meeting on Population Distribution, Urbanization, Internal Migration and Development, New York, NY, 21-23 January 2008, United Nations Population Division, New York, NY, 29 pp.,un.org/esa/population/meetings/EGM_PopDist/P16_Satterthwaite.pdf.

Smith, K., and Ward, R. (1998) Floods Physical Processes and Human Impacts. John Wiley, Chichester, UK,.

Taye, M.T., Ntegeka, V. Ogiramoi, N.P. and Willems, P. (2011)“Assessment of climate change impact on hydrological extremes in two source regions of the Nile River Basin”. Hydrology and Earth System Sciences, Vol. 15 No. 1 pp. 209-222. UKCIP (2009) available at http://www.ukcip.org.uk/index.php?option=com_content&task=view&id=54&Itemid=179

United Nation Development Programme (2010) ‘Climate change, an overview’ available at http://www.unep.org/climatechange/

Usman, B.A. and Tunde A.M. (2009) “Climate change and sustainable development in Nigeria planning for climate resilient cities” in law and climate in Nigeria edited by Egbewole W.O., Munthar, A.E. and Olugbenga A.O. University of Ilorin: Ilorin. Pp 107-121

CONFRONTING THE CHALLENGE OF CLIMATE CHANGE ON BUILT ENVIRONMENT IN NIGERIA: Utilizing a resilient response

TAUHEED, I. A. and Alonge, D.O.
Department of Architecture, Federal University of Technology Minna

The world climate is changing as its attendant effects are now here. Nigeria, and indeed Africa may not be a major contributor to climate change, but bear the brunt of it together with the rest of the world. The implication of climate change in Nigeria is that more destruction will be added to existing dangers of poverty, disease and insecurity. The likelihood of more drought and desertification, flooding, erosion, storms and general ecological devastation will affect the environment, built space, and a large proportion of the population. The aim is to introduce the need to utilize resilience as an adaptive capacity against climate change in the built environment in Nigeria. An extensive literature review was done. The review indicated that the fight against climate change could be multi-dimensional and that poverty is the greatest clog in the wheel of any form of adaptation/mitigation strategies in Nigeria. Long lasting solution, lies in building resilience across communities in the built environment. This offers to engage the citizens at the grass root in preparing for the consequences of the climatic excesses with federal/state/local governments/and relevant institutions, together with civil society organizations that may key into the program to provide the lead, organization and financing as the way to preparing resilience for the built environment for climate change risks.

Keywords: built environment, challenge, climate change, resilient, response

arcisahtauheed@yahoo.com

TAUHEED[1], I. A. and Alonge[2] ,D.O. (2016). **CONFRONTING THE CHALLENGE OF CLIMATE CHANGE ON BUILT ENVIRONMENT IN NIGERIA: UTILIZING A RESILIENT RESPONSE** Sustainable Built Environment and Climate change; The challenges of Post 2015 Development Agenda. School of Environmental Technology Conference, SETIC, 2016

INTRODUCTION

Climate change has become a critical global issue of immense importance. It has become the greatest environmental threat of this century. Climate change effects pose enormous challenges to sustainable development in all the countries of the world. Although the full implications of climate change are not understood, scientific analyses suggest that it is the cause of rising sea levels, severe weather effects, drought and water shortages, food shortages, and changing disease patterns(IPCC,2007)

The depletion of ozone layer through human activities are responsible for the cause of climate change and global warming. About 40% of this GHG is contributed by the built environment. For instance, the emission of carbon dioxide, (Co_2) into the atmosphere by burning of fossil fuel to provide energy. Similarly the loss of forests to city expansion exacerbates the heat intensity on the earth surface. In Nigeria, 405,000 hectares of rainforest is lost yearly since 1970 (Anthony & Peter, 2015). The (IPCC SYR, 2014) assessment report warned of the danger of not acting quickly could result in pervasive and irreversible situations worldwide. Therefore, based on this scientific analyses on the enormity of climate change, there is a call for concern and immediate action not only to prevent the expected climate change effects but also to adapt to the impacts of the one already occurring.

Nigeria is highly vulnerable in all sectors of the economy because of the high poverty level, large population, illiteracy, insecurity and lack of adaptive capacity as confirmed by Ifeanyi et al, 2012 and by some effects that are already been felt. The built environment is not left out. Interiors of buildings are becoming hotter and uncomfortable, rainfall is getting heavier with longer duration in some regions, communities are getting flooded and aridity is getting more pronounced as desertification is encroaching from north. The built environment professionals must act comprehensively to confront the excesses of climate change.

To this effect, we believe, in Nigeria, utilizing the resilience approach for the built environment is a better option than the traditional sustainable approach of addressing climate change environmental impacts and reducing its effect. Resilience as described by John & Stephanie (2007), from ecology, means that a system should be able to "tolerate disturbances without collapsing into qualitatively different states that is controlled by different set of processes". This means the ability to bend without breaking or regain the original pre-bend shape. The entire concept is based on adaptive capacity.

The aim of this paper is to introduce the need to confront climate change risks by utilizing the resilience approach as a way of preparing the built environment for the expected and unexpected extreme climate conditions of now the future. The resilience approach requires building resilience (over a period) that will incorporate the governments (National/state/local), the communities, the neighborhoods, citizens and built environment professionals.

METHODOLOGY

The study is non-experimental and based on comprehensive literature review. Related published literatures and documents were searched and identified electronically and also from non-electronic database.

CLIMATE CHANGE, BUILDINGS AND ENVIRONMENTAL PROBLEMS

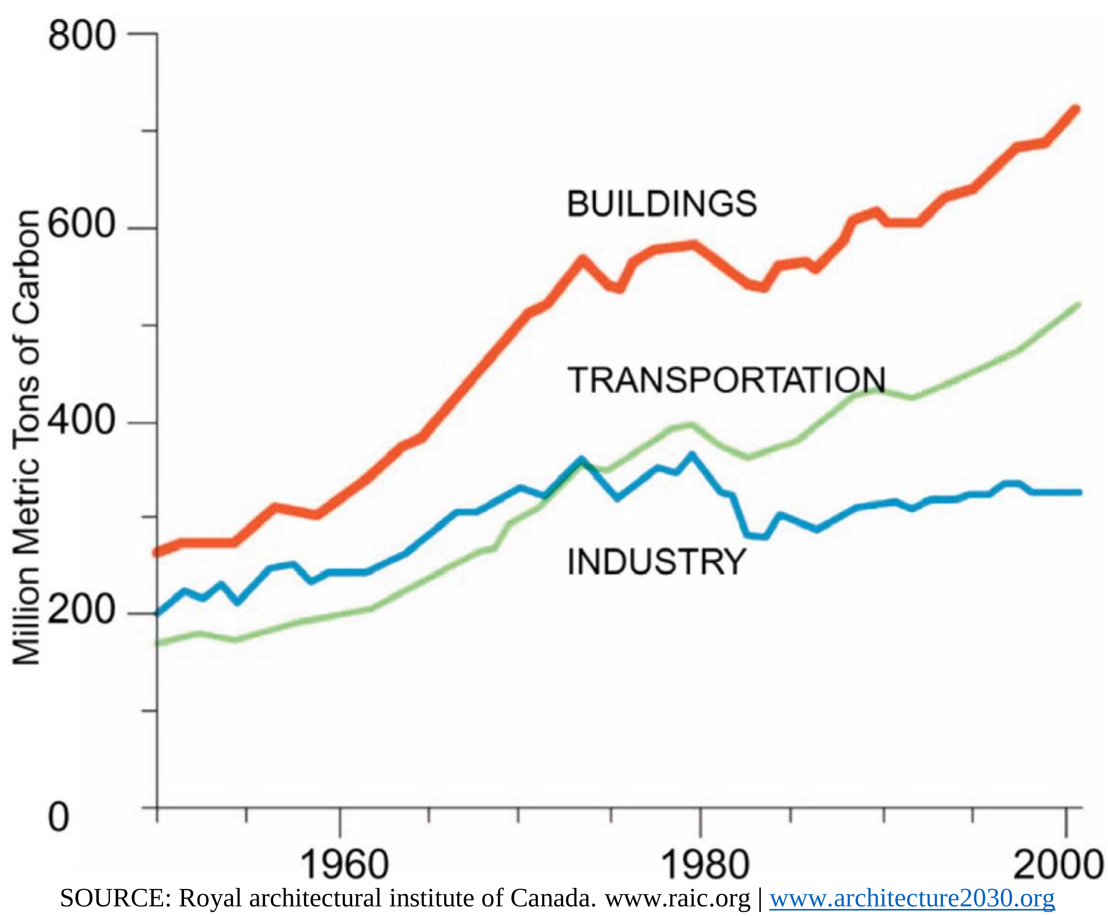
Climate change refers to any significant change in the measures of climatic parameters such as temperature, rainfall/precipitation or wind extending over a long period (decades or more) as result of human activities e.g. burning of fossil fuel, deforestation, reforestation, urbanization and natural factors like changes in sun's intensity and changes in the ocean circulation; volcanic eruption and desertification (Olotuah, 2015).

Environment is referred to as all the external factors, conditions, influences and conditions that affect an organism or community. This includes all natural and human-made elements. Environmental concerns contribute to human security by providing resources for good life and social relations. When this is overtaken by hazards, the community or society's wellbeing is disrupted (Omozokpia and Mamman, 2014). Scientific evidence has indicated that the world climate has been changing steadily since the beginning of industrial era, attributed to human activities on earth (Ann, 2013). The direct consequence of this change on the environment, human life and socio economic activity is global warming (Olusola, 2012). Steady temperature rise is warming the earth surface as a result of increase in concentration of Green House Gas (GHG), particularly carbon dioxide (Co_2) which has increased in the pre- industrial era from approximately 280 parts per million by volume to 380 parts per volume in 2007 and it expected to rise over 500 parts per million by 2050 (Daramola,S. A., et al, 2012; RIBA, 2009).

All available scientific facts suggest that between 40% and 50% of the world's Green House Gas (GHG) emissions come from the built environment especially in the heavily industrialized world (Ifeanyi-Obi, et al, 2012; Ann, et al., 2013; Nwofe, 2014;Oluwafemi, et al, 2015). Other gases like methane (CH_4), nitrous oxides (N_2O) also make up the pollutants of the atmosphere (Michael, O.A, 2012). Researchers have also warned that global temperatures must not rise above 2^oC so as to have the chance of reducing its risks. It took a period of 150 years (1860-1990) for the global temperature to rise 1^oC and it is predicted to rise to 2^oC by 2045 and may continue if unchecked to the dangerous 3^oC level of no return by 2065 (Sue, et al, 2009).

As world's population rises (including that of Nigeria), a huge demand for buildings have led to the clearance of large acres of forest land (destruction of ecology) to make way for buildings, settlements and farmlands. This has also led to increased urban centers and high demand for services such as water, energy, roads and communication lines into the built space. The result, of course, is the direct high solar intensity on earth surface and carbon emissions. With the improvements of socio-economic activities and advancements in technical know-how, the built environment became more sophisticated and more vulnerable as it becomes more dependent on supply lines of power, water, and telecommunication.

The rise in urban developments in the last century have brought some irreversible changes to the environment as natural habitats are fragmented, degraded, disrupted and sometimes isolated. Although it is believed that urban centers constitute only about 1-6% of the total earth surface, it consumes a chunk of the earth's resources and production of waste. This stresses the importance of environmental impact on built environment (sietze, et al, 2010). The figure below shows the ever increasing carbon emission (GHG) by buildings, industrial and transport sectors.



SOURCE: Royal architectural institute of Canada. www.raic.org | www.architecture2030.org

In Nigeria, studies have shown that temperature change between 1971 and 2000 has a yearly maximum of 0.025ºC and minimum of 0.014ºC increase. This represents an increase in maximum and minimum temperatures of 0.8ºC and 0.4ºC over a period of more than thirty years. The incidence of longer hot days (heat waves) has increased by twenty days and it's projected to rise and spread over the country over time. Rainfall has also increased over the same period in most ecological zones with earlier onset and longer durations (BNRCC, 2011;

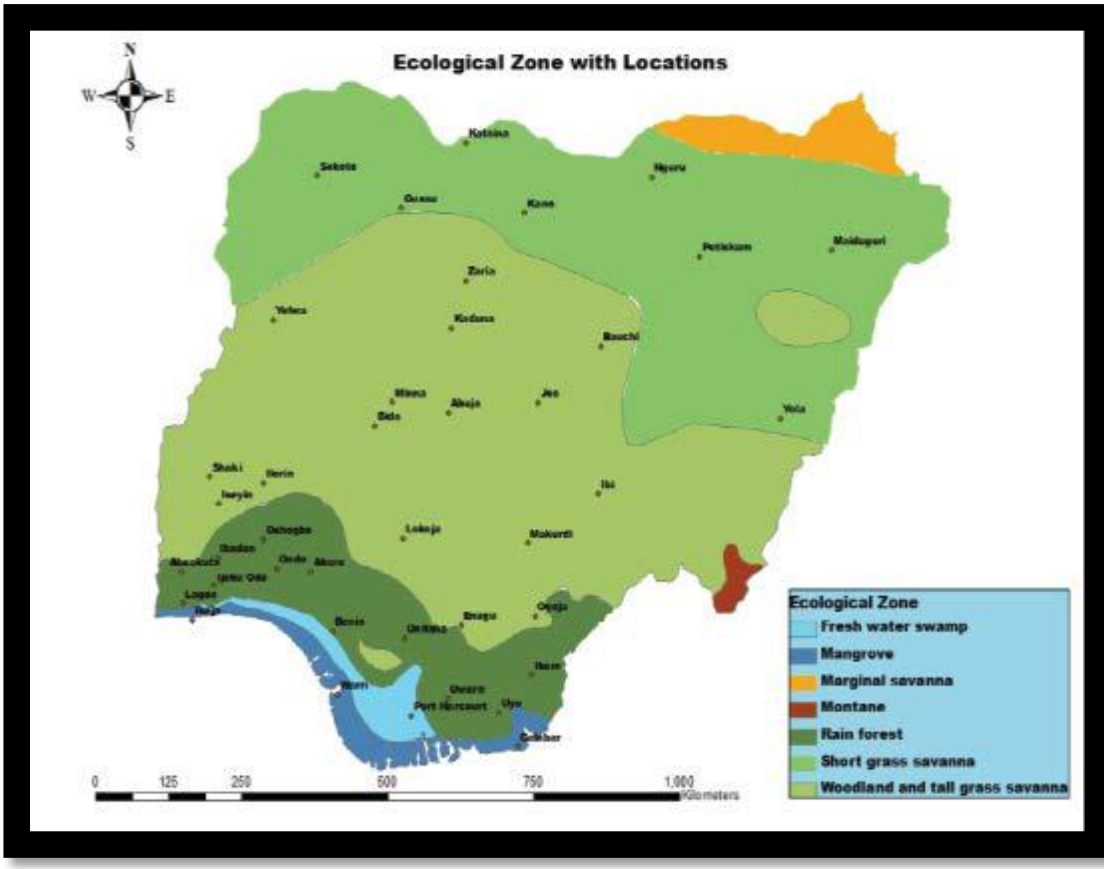
Ifeanyi et al, 2012). These have led to higher increases in the semi-arid regions and lower in the coastal regions. These are already impacting negatively on the environment, buildings, and socio-economic activities of the people.

CLIMATE CHANGE IMPACTS ON BUILT ENVIRONMENT IN NIGERIA

The built environment can be regarded as the physical representation of the society Sietze et al, (2010) and includes millions of residential buildings, in urban and rural areas, hospitals, industrial buildings, other building types and wider environment under the responsibility of Federal, States and Local Governments. The built environment, though contributes about 50% of GHG to the atmosphere bears the brunt of the harsh realities of climate change. The impacts of climate change on built environment is already been felt in Nigeria with varying experiences according to the different ecological zones of the country. We have seen heavier rainfall leading to flooding of built up areas, communities, and farm lands from the coastal areas across to the North central zone (savanna region). Increased water shortages in semi-arid areas due to reduced soil moisture and ground water replenishment. Health is affected as air quality produces bad condition of health in the communities and reduced water quality have affected plants and animals. Transportation, Power and communication lines have suffered disruptions, both air and land (Ezeabasili and Okonkwo, 2013).

Drought and desertification are rapidly encroaching in the Sahel and Sudan savanna regions of the north. Coastal zones of the south are facing erosion and rising sea levels (BNRCC, 2012). Nigeria, with high population and poverty level is indeed one of the most vulnerable countries to the impacts of climate change in the world because of its non- adaptive capacity. The IPCC projections of climate change scenarios putting into consideration a wide range of population and economic growth, technological advancements and improvement in energy efficiency shows uncertainty in factors that contribute to climate change, and thereby making resilience planning more appropriate.

A review of literature shows a lot has been done to curb emissions in areas of sustainable/green buildings or energy efficient buildings using Mitigation approaches. However, we believe, a resilient approach is more sustainable. This study takes a look at the concept of resilience within the context of climate change by first asking, what is resilience?



The figure above shows the ecological zones of Nigeria. Marginal Savanna is also referred to as Sahel, the region of short grass is referred to Sudan Savanna, the region of woodland and tall grass is referred to as Guinea Savanna, the rain forest and mangrove swamp form frontal area or coast a to the sea . (SOURCE: BNRCC, 2012)

For proper comprehension, of the subsequent parts of this paper, we have compared from literature, the various definitions of terms commonly used in the climate change arena. An array of terms such as adaptation, adaptive capacity, vulnerability and resilience often have similarity and or distinctions according to the different authors.

PERSPECTIVES ON MAIN CONCEPTS OF CLIMATE CHANGE

(Resilience, vulnerability, adaptive capacity, and adaptation) and mitigation

CPED (2011), categorized the fight against climate change under two broad classes namely, adaptation and mitigation. Mitigation refers to measures taken to minimize the increase of human- induced climate change by reducing Green House Gas (GHG) emissions. While adaptation refers to as adjustment of our built environment, infrastructure, and social systems in response to actual or expected climatic events, thereby reducing vulnerability and enhancing their resilience against the adverse effects of climate change (IPCC, 2007).

However, opinions in literature, show a lack of consensus between these terms used in the climate change community. Certain definitions of vulnerability tend to view it as opposite of resilience, and therefore increase in vulnerability is viewed as decrease in resilience, and that also means vulnerability should be countered with resilience. Other views argue that vulnerability is not exactly opposite of resilience. The difference between them is that vulnerability refers to the capacity to preserve the structure of system while resilience refers to its capacity to recover from non-structural changes in dynamics (Aditya et al, 2010). This view was corroborated by Ifeanyi et al, (2012) in their definition of vulnerability as:

> *"The degree to which a system is susceptible to or unable to cope with adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, Magnitude, and rate of climate variation to which a system is exposed, its sensitivity and its adaptive capacity".*

A lack of consensus also exists in the understanding and relationship between adaptation and adaptive capacity. One view holds that these terms refer to "ability/capacity/potential of systems or components of systems to be resilient to disturbances" and another view perceives adaptation and adaptive capacity as "reference to the component of resilience that relates to learning by system in response to disturbances". Therefore when resilience is used as an adaptation approach, it is viewed as another name for adaptive capacity, since adaptive capacity "refers to improving capacity (resilience) and thereby reducing vulnerability of individuals or states to respond to climate change impacts" (Aditya et al, 2010).

It is important to stress here, that our perspective in this paper, is that some definitions of resilience, adaptation and adaptive capacity overlap in meaning and understanding, and that vulnerability is considered separate and opposite to the rest. This study takes a look at the concept of resilience in other fields by first asking, what does resilience mean to them? It is imperative to understand the term resilience as it is applied today across many disciplines

THE TERM "RESILIENCE" AS USED ACROSS DIFFERENT FIELDS

Resilience is the term used to signify the ability to return quickly to previously good condition after disasters. This is popularly used in climate change adaptation and disaster risk management. However, resilience, has multiple and diverse meaning across many disciplines. For broad understanding this paper, takes a look at them from literature. Aditya et al, (2010), outlined the meanings of the term 'resilience' as used across disciplines as follows:

In the field of psychology, resilience describes the capacity to withstand the impact of stressor and to fight stress or capacity to recover after a stress. In genetics, resilience refers to quality that prevents individuals who are at risk for maladaptation and psychopathology from being affected by the problems. In structural engineering, resilience is understood to be the property of systems which has reduced failure likelihoods, and consequences for failure, like damages, loss of lives and negative economic and social consequences and reduced recovery time. Enterprise resilience, in corporate organization, refers to ability to manage risks and everyday operations for robust business. In the field of humanistic psychology, resilience describes individuals' capacity to thrive and fulfill potentials, despite odds. Resilient individuals overcome strains and stressors and view the experience or challenges as learning and development opportunities.

In social sciences resilience is seen in terms of society and ecology (in the context of social and ecological systems). This is simply an interrelationship between people and nature (environment) thereby creating a socio-ecological system. The resilience or adaptive capacity is mainly determined by social structures. Therefore, an increase in social structures in relation with uncertainty means increase in resilience (Sietze et al, 2010). The concept of resilience is therefore, based on adaptive capacity. The first stage towards building adaptive capacity or resilience is assessment of vulnerability of systems to extreme climate change in the built environment.

ASSESSING VULNERABILITY IN THE BUILT ENVIRONMENT

Preparing the built environment for resilience to climate change requires an assessment of hazards to the environment, buildings and its inhabitants. The assessments, according to CPED (2011), are to determine, (1) - exposure assessment (identification of risk source) including frequency and magnitude of occurrence, (2) - impact assessment (of a specific hazard or stressor to the population) and (3) - damage assessment (fatalities, economic losses, and infrastructure losses) associated with a specific event. The integration of these three elements to form a complete vulnerability assessment for a region, neighborhood, and site scales is needed to know where and what problem is occurring or likely to occur, and what might be vulnerable and its capacity to cope in the region, neighborhoods, and building scales. Vulnerability assessment is best understood and packaged for resilient development as outlined by USGBC, (2011) in the different scales.

At Regional scale: The first step is to understand climate change within the region and the susceptible elements. Regional scale includes the wider urban areas, cities, communities and the systems that support the socio-economic activities within it. The susceptible systems of energy, water and transportation provide cities, neighborhoods and buildings with the needed services and allow movement and linkages within and without the region. For instance, climate change can put energy supply at risk and can affect generation, transmission and distribution aspects and also siting of new facilities. Transportation, by water, air and land can become hazardous with extreme weather. Resilience is needed to keep the efficiency across the systems.

At Neighborhood scale: Neighborhood links the individual building sites to the rest of the city or town. This is the primary scale and also the first point of intervention by the built environment professionals. Location of buildings must take cognizance of areas prone to risks, for instance flooding (either due to heavy rainfall or overflow of rivers and banks and storm water runoff), and sea level rises, coastal erosion, sandstorms. Improper neighborhood planning can put it at risk of increased urban heat island (UHI) or heat waves and storm water runoff. Resilient communities will help at this level.

At site or project scale: This refers to the individual buildings and dwellings on a site. In identifying Site or project level vulnerabilities, it must be associated with those at neighborhood, city, and regional scale. This is the major point of intervention by the built environment professionals. Site location, architectural design, urban planning, construction, materials selection, landscaping, structural and non-structural systems can make a building vulnerable to climate change hazards. Resilient buildings and landscapes are needed to keep the system.

FACTORS THAT DETERMINE RESILIENCE.

The concept of resilience in the built environment revolves around developing adaptive capacities (resilience) in social (citizens), economic, environmental, infrastructural and building systems in the cities, communities and neighborhoods. Since adaptive capacity is closely linked to social and economic development, resilient capacities are unevenly distributed around the world (IPCC, 2007). Citizens and Social structures; effective governance or institutions; finance; planning and preparedness; community involvement and learning and are factors distilled from literature that can lead to resilience of the built environment (Aditya et al, 2010).

- ***Citizens and social structures:*** The people (citizens) are the engine of resilience. Association of individuals by the creation of strong self organized groups or civil society institutions can promote coordination and cooperation in the community. Shared community values, culture and attitude complement the societal cohesion needed to promote harmony, trust and help equitable access to resources across local/state/federal level during disasters and hence greater resilience.
- ***Governance and institutions:*** Highly efficient central government will serve as fuel for resilience. With good coordination and control mechanisms in conjunction with institutions/states/local government would enhance community cohesion and build resilience across the neighborhoods and the nation.
- ***Finance:*** This, also serves, as part of the fuel for resilience necessarily required to drive the adaptation strategies; organize and coordinate institutions; encourage community planning for orderly recovery. Financing can be made available from government, insurance and multilateral sources.

- ***Planning and preparedness:*** Planning and preparing that change is coming and when it happens, there is adequate preparation to accept and live with it. This includes survival and recovery plans, people and neighborhood readiness, financing means, tools to be used for reconstruction and rescue, arrangement for the security, safety and care for the vulnerable. Planning and preparation is coordinated by the central government in conjunction with institutions/ states/local government.

- ***Community involvement:*** involving communities, and with particular attention to the diversity in social structure such as age, composition, and capabilities. Community is allowed to take the lead in resilience building as advantage of local knowledge of the area cannot be over-emphasized. The official Government response is complementary.
- ***Learning:*** Learning from passed occurrences helps planning, coordination, responses and understanding of resilience in built environment. Proper feedback mechanisms helps policy adjustments to the realities on the ground.

CLIMATE CHANGE ADAPTATION ATTEMPTS IN NIGERIA.

Resilience capacities in the built environment (and indeed all sectors) are less in the developing world as a result of low financial capacities, thereby making the call for financial aid from the wealthier countries more necessary now than ever. Although, developed countries have made agreements to help the developing countries in climate finance, very little have been contributed so far. For instance, up till May, 2015 Nigeria has leveraged a total of $63 million dollars of multilateral funds for climate change (NIAF, 2015).

The National Adaption Strategy and Plan of Action on Climate Change in Nigeria (NASPA-CCN) report, was prepared by Canadian International Development Agency (CIDA) in 2011 for Federal Ministry of Environment (special climate change unit, SCCU) in conjunction with National Environmental Study/Action Team, (NEST) as part of Building Nigeria Response for Climate Change (BNRCC) outlines the strategies for building adaptive capacities in all sectors for the nation and puts the public sectors (federal/states/local government) to provide the leading role for the nation, with states and local governments playing specified leadership roles in the regions to complement each other. This has largely remained a paper preparation with little or no follow-up action plan. The failure of the world leaders to quickly reach an agreement on emission reduction by nations (before 2015) might have also contributed to the slow government response.

However, some adaptions (of biophysical nature), limited to community level of fighting desertification (tree planting), and promotion of biogas as alternative fuel is carried out by the Federal Ministry of Environment. Rainwater harvesting and irrigation systems to reduce dependence on rain-fed agriculture. Corruption at high and low levels has prevented the enforcement of building and environmental regulations (Ifeanyi et al, 2012).

UTILISING RESILIENCE IN THE BUILT ENVIRONMENT IN NIGERIA

This paper argues that the central (federal) government can as matter of policy institute resilience development strategies in the built environment that can lead to resilience of this sector. The resilience concept emphasizes the development and utilization of adaptive capacities in social, economic, environmental, infrastructural and building systems in the cities, communities and neighborhoods. Resilience, itself takes time to actualize, but with consistent strategies over a period of time, it is achievable.

In line with vulnerability assessment, development of resilience follows the regional, neighborhood, and site/project or building scale and thus defining the roles of public institutions, private institutions including the built environment professionals at each scale. At the Centre, Federal Government (FG) should provide good environment by creating enabling laws to guide resilience mechanisms; incorporate resilience development plans into national development plans such as Sustainable Development Goals (SDGs). The Special Climate Change Unit (SCCU) should continue to gather data for climate change planning and policies; make annual budgetary allocations for climate change; coordination of ministries and relevant departments; reposition institutions such as National Emergency Management Agency (NEMA) as part of resilience aid and link up with the state climate change units; channeling of resources disbursement through SCCU at federal to state SCCU and local Governments' SCCU for grass root implementation. Giving grass root autonomy for implementation is highly necessary for quick results especially now that corruption is being eliminated from our society.

Feedback mechanisms should be properly coordinated through the same pattern to the top. At the State Government level (SG), the climate change unit should engage in down scaling of climate change data to reflect the local level realities. This will help the built environment professionals develop resilient urban and built environment structures. The state government should engage with civil society and community based organizations to develop resilience strategies for any specific hazard events in collaboration with the Local Government (LG) SCUU. This may include awareness building to prepare people and neighborhood readiness, rescue arrangement, security, safety, and care for the vulnerable, repairs and reconstruction plans.

Strong and properly supervised climate change compliant building codes give resilience to buildings and infrastructures. This will make architects and engineers design resilient buildings and structures for specific climate change hazards prevalent in the any ecological zone of the country .The urban planners to guide away built environment from hazardous areas, and engage in urban resilient planning so as to reduce heat waves and other environmental problems.

CONCLUSION

Developing resilient capacity to our built environment takes time, but once it is achieved it becomes permanent and other developments thereafter follows the existing pattern. Retrofitting the existing buildings, (though expensive, against certain specific hazards) which were not developed with the new Climate Change data can speed up resilience of a community and also the city. This, we believe, is possible with consistent and proper policies and planning in place and with the anti-corruption drive of the current dispensation.

Resilience in the built environment offers the opportunity for all the professionals in building industry, namely the architects, engineers, urban planners, surveyors to play a role to succeed. Citizen participation leads the way to resilience. We believe, that resilient approach cannot only create resilient citizens but also resilient environment, buildings, infrastructure, and resilient economy for the people, the community, the town/city, and the country at large.

REFERENCES

Aditya, V. B, Maggi, I. and Thomas, T., (2010). The resilience renaissance? Unpacking of resilience for tackling climate change disaster. Discussion paper 1. Institute of development studies UK.

Agboola, O.P. (2011). Importance of climate to Architectural design in Nigeria. *Journal of Environmental Issues and Agriculture in Developing Countries, 3(1)*

Ann, A. N.I; Ebele, L. and Wilfried U. (2010). Risk Management and challenge of climate change in Nigeria. *Journal of human ecology, 41 (3): 221-235*

Anthony p; peter O. O, (2015). Climate Change and Thermal Comfort: Implications for Building Design in Southern Nigeria *Civil and environmental Research. ISSN 2224-5790(paper), ISSN-0514 (online), 7(8)*

BNRCC (2011). Climatic change scenarios for Nigeria: Understanding Biophysical impacts. Climate systems analysis group, University of Cape Town, Rondebosch, South Africa.

BNRCC (Building Nigeria Response to Climate Change, (2012). Learning from Experience-Community-based Adaptation to climate change in Nigeria. Climate systems analysis group, University of Cape Town, Rondebosch, South Africa.

CPED (Centre for Population and Environmental Development), CEPD Policy paper series, (2011). *Climate Change and Advocacy on Adaptation Strategies at Local Level in Nigeria*. Internal Research and Development Centre Otike-Odibe Avenue Isiohor Via Ugbowo, Benin city, Nigeria.

Ezeabasili A .C.C and Okonkwo, N.U. (2013). Climate Change impacts on the Built Environment in Nigeria .*International multi-disciplinary journal, Ethiopia 7(4): 288-303*.

Ifeanyi – obi, C.C; Etuk, U.R and Jike- wai , O. (2012). Climate change effect and Adaption strategies: implication for Agricultural Extension system in Nigeria. *Greener Journal of Agricultural Science, 2(2): 053-060.*

Ifeanyi C. E; officha, M.C; Ezenue A.M., and Agbonomem, P.C. (2012). Adapting Nigerian cities to climate change options: A Review. *British journal of applied science and technology 2(4) -378*

IPCC (intergovernment Panel on climate change), (2007). Climate change,2007:synthesis report. Contribution of working groups to the fourth assessment of Intergovernmental Panel on Climate Change, Geneva: IPCC

IPCC SYR (Intergovernmental Panel on Climate Change Synthesis Report), (2014). Climate Change 2014 synthesis Report. http://www.ipcc.ch

Michael O. A., (2012). The Built –Up Environment and Micro Climate Variation in Lokoja, Nigeria. *America International Journal of Contemporary Research, 2(12).*

NIAF (Nigeria Infrastructure Advisory Facility), (2015). *Introduction to climate finance in Nigeria*. Kirsten.jack@adamsmithinternational.com

Olotuah, .A.O. (2015). Climate –responsive architecture and sustainable housing in Nigeria. http://www.researchgate.net/publication/280948718

Oluwafemi, K. A; Oluwayemi, F. and Ikenna C.M. (2015). Sustainable Appraoch To Developing Energy Efficient Buildings For Resilient Future Of The Built Environment In Nigeria. *American Journal of Civil Engineering and Architecture, 3(4): 144-152.*

Omozokpia E. R. and Mamman E. J. (2014). The role of built environmental professionals on Environmental hazards: A review. *Journal of Environmental Sciences and Resources Management.*

P.A. Nwofe (2014). Need for energy efficient buildings in Nigeria. *International Journal of energy and Environmental Research, 2(3): 1-9*

RIBA (Royal Institute of British Architects), (2009).*Climate Change toolkit: 01 Climate Change Briefing.* www.architecture.com/climate

Daramola, S.A.; Toyin, A. and Damilola A. (2012). Green Architecture and sustainable development in Nigeria. *Journal of sustainable development and environmental protection 2(2).*

Sietze A; Meijer, Marcel, R.M, and Arjan Van Timmeren. (2010). Knowledge collaboration and learning for sustainable innovation ERSCP-EMSU. A conference paper presented at Delft, Netherlands.

Sue R; David C. and Ferus N., (2009). *Adapting Building and Cities for Climate Change. A 21st Century Survival Guide. Second edition.* Elsevier architectural press.

USGB (US Green Building Council), (2011). *Green Building and Climate Resilience: understanding Impacts and preparing for changing conditions*. University of Michigan; U.S. Green Building Council.

CLIMATE CHANGE AND ITS THREATS TO SUSTAINABLE BUILT ENVIRONMENT

ONUIGBO Ifeanyi Chukwudi
Department of Surveying and Geoinformatics, Federal University of Technology, Minna, Niger State,

The potential impacts of climate change are the greatest social and economic challenges that humanity is currently dealing with. It is also a known fact that mankind is the cause of climate change due to man's activities within the environment. A rapid and continuous warming will not only be disastrous to agriculture but also lead to the wide spread of death of forest trees, uncertainty in water supplies and the flooding of coastal areas. The rapid growth of urbanization is already causing massive air pollution and environmental degradation; this is a threat to sustainable built environment. Development anywhere carries with it environmental consequences that could ultimately negate the goals of the development process. As the built environment develops, access to clean water, rising levels of air pollution, and its consequences become problems. Most of these developments cannot be separated from the effects of high rate of population growth. Because of the environmental problems associated with built-up environments, and their implications, there is the need to rebuild the built environment, especially the unplanned areas. If adequate measures are implemented soon, they can reduce the social, economic, environmental, and political impacts of climate change. With the continuous rise in Mean Sea Level (MSL) as a consequence of global warming, all urban developments and engineering activities must be properly and accurately controlled altimetrically by referencing them to the mean sea level and not the ellipsoid or other arbitrary datum if appropriate measures are to be taken to forestall the possibility of mass inundation in the nearest future especially in flood prone cities like Lagos, Minna, etc. One of the findings is that the world is showing increased interest in sustainable development and environment. Also the increasing human population is affecting the environment; the more the population growth, the worse the situation. It is recommended that laws and guidelines be put in place, and enforced, to guard against turning urban areas into slums and making the built environment unsustainable. There is the need to constantly strive for sustainable built environment in spite of climate change challenges which are enormous and affecting every facet of the human environment, including urban development and urban management. There should be adequate and frequent monitoring of growing urban areas.

Key words: *climate change, environment, remote sensing, sustainable, built-up, geoinformatics*

anyi.onuigbo@futminna.edu.ng

INTRODUCTION

Climate is the average weather condition over an area for a period of time not less than 30 years. The Environment consists of the Air, Water and Land. Information about the environment are obtained from the atmosphere, the land and the oceans. "The natural world within which people, animals, and plants live interacting with the air, water and land is known as the environment(Encarta, 2014)" It goes on to say "It is regarded by many as being at risk from harmful influences of industrialized society."

What connects human beings world over, in our daily lives is the global environment. More and more we are realizing that what we do to the environment has far reaching ramifications. The environment in which we live is supposed to be healthy and conducive always, but the situation is not so, rather the opposite is prevalent. The environment is continuously being degraded to the detriment of human race. There are now many environmental problems that are facing mankind (and if not properly handled they can become major challenge to human survival on earth). We are today faced with great ecological and climatic problems for which we are largely responsible. The major environmental problems include Climate change, Global warming, Deforestation, and Pollution. Environmental protection has become very important and a global concern. Evidence suggests that production of Carbon dioxide and Methane from human activities has already begun to change the climate and that radical steps must be taken to halt any further change. The potential impacts of climate change could well make it the greatest social and economic challenge that humanity will have to face in this century.

HUMAN POPULATION INCREASE AND CLIMATE CHANGE

The increasing human population is affecting the climate. Man's activities within the environment have led to problems such as Global Warming, Ozone layer depletion, loss of biodiversity, desertification, deforestation and climate change. The more the population increase, the worse the situation. Gases produced and used by man cause ozone layer depletion and global warming. The fact that heat- trapping gases have been accumulating in the atmosphere is well established. The increase has come about because human activities, especially the burning of Coal and Oil and the destruction of forests, have released greater quantities of carbon dioxide into the atmosphere than have been removed by diffusion into the oceans or by photosynthesis on land. A rapid and continuous warming will not only be disastrous to agriculture but also lead to the widespread of death of forest trees, uncertainty in water supplies and the flooding of coastal areas. The relationship between population growth and environmental degradation are not simple and can come in many forms.

POPULATION GROWTH AND THE BUILT ENVIRONMENT

The increasing human population is affecting the environment. Human activities on earth are increasing and in many dimensions, and most are environmentally unfriendly. Nigeria's ever growing population, currently put at about 170 million in the estimation of the National Population Commission (NPC) is increasing at a yearly rate of 2.98%. The rapid growth of Urbanization is causing massive air pollution; so also advancements in technology. Osagie

(2000), commented in a paper entitled "*Sustainability within the context of Population and Natural Resources in Nigeria,"* that the increase in Nigeria's population since independence almost equaled the total increase during the last century. "It is the yearly increase in absolute numbers that is so critical to Nigeria's prospects for sustainable development…" Osagie observed. The population statistics of Nigeria from 1911 to 1991 shows steady increase.

Table 1: Population of Nigeria for four selected years.

Year	1911	1931	1963	1991
Population(million)	16.05	20.06	55.66	88.51

Source: National Population Commission (1992)

Table 2: Projected National Population, 1990 – 2040

YEAR	Projected Population	Projected Crude Densities(per Km^2)
1990	85,993,487	92
1995	99,207,942	107
2000	115,224,312	124
2005	133,766,926	144
2010	154,801,325	166
2015	178,575,651	192
2020	205,437,137	221
2025	235,556,077	253
2030	268,813,190	289
2035	304,610,540	324
2040	341,986,340	368

Source: (NPC, 1991)

DEVELOPMENT OF THE BUILT ENVIRONMENT

Development anywhere carries with it environmental consequences that could ultimately negate the goals of the development process. Past ignorant choices of man in the course of his economic operations have initiated some harmful effects on the environment. Physical development (infrastructures), industrialization, and agricultural practices are some of the ways man interacts with the environment and create problems in the environment. Because agricultural development depends on the direct utilization of such physical components of the environment as soils, climate, flora, surface and ground water, etc., they constitute the most widespread channels of contact of man with the environment in his economic pursuits. The increasing human population is affecting the environment; the rapid growth of urbanization is causing massive air pollution. Concern for the impact of development on national and global environments has been growing as evidence accumulates of changes in weather patterns and increase in pollution levels and the sustainability of patterns of the use of natural resources is questioned.

As the built environment develops, access to clean water, rising levels of air pollution and its consequences (e.g. acid rain, ozone depletion) become problems. Excessive pesticide use, and the consequences of the persistence of residues which contaminate food chains, disposal of solid wastes (both domestic and industrial) especially those that are hazardous, soil erosion, and deforestation increase. Most of these developments cannot be separated from the effects of high rates of population growth, which reduce the period over which adjustments can occur to changed patterns of land use, increased emissions and higher levels of consumption of products deleterious to the environment. The computer technology has brought a new dimension to geographic and particularly land information gathering, storage, analysis and presentation for effective management of man's environment….(Musa, 1991).

THREATS OF CLIMATE CHANGE

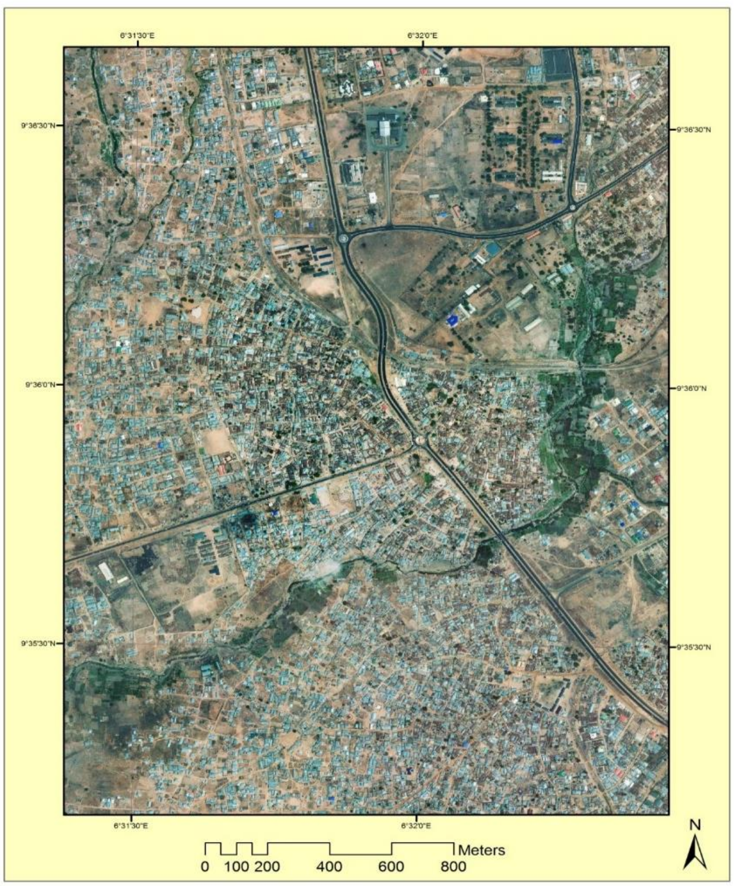
A rapid and continuous warming will not only be disastrous to agriculture but also lead to the wide spread of death of forest trees, uncertainty in water supplies and the flooding of coastal areas. Forests absorb carbon dioxide (Co2) and give out Oxygen thus providing stable climate. But the forests are no longer spared. The rate of deforestation is alarming. In the tropics more than 16.8 million hectares are destroyed every year by agricultural expansion, ranching, logging and over-exploitation for fuel wood. When forests disappear, so do the soil on which they stood, and the peoples and species which live in them. Deforestation is responsible for between a quarter and a third of the Co2 humanity has added to the atmosphere to date, increasing the risks of global warming. Over 80% of the planet's forests have been destroyed or degraded; a quarter of the world's mammal species are at serious risk of extinction, and biological diversity is disappearing at an alarming rate. More than half the world's coral reefs are threatened by human activities, and marine fisheries are being over-exploited to the point that their ability to quickly recover is in doubt (Toepfer, 2000).

THREATS TO SUSTAINABLE BUILT ENVIRONMENT

Recent years have witnessed rising concern about whether environmental constraints will limit development and whether development will cause serious environmental damage, impairing the quality of life of this and future generations. According to W.D.P.(1992), the most immediate environmental problems facing developing countries are unsafe water, inadequate sanitation, soil depletion, indoor smoke from cooking fires, and outdoor smoke from coal burning. The 2015 United Nations Climate Change Conference (COP 21/ CMP 11) was held in Le Bourget, Paris, France, in December. The conference objective was for all the nations of the world to reach a legally binding and universal agreement on climate change, aimed at reducing greenhouse gas emissions and hence preventing global warming due to human activities.

RESEARCH METHODOLOGY

The research was carried out through review and analysis of documents on climate change issues. The built environment was considered, discussed, and articulated. There was extensive review and assessment of the built environment and threats or impacts of climate change on it. Remote sensing which has made tremendous impact on man's quest to understand his environment and the impact of his activities on the environment was also used in this research. Remote sensing technology can be used to improve the quality of the life of the people in a sustainable manner. Remote sensing combined with GPS gives access to real-time data. Satellite data is now responsible for over 90 % of credible and cost effective data in use today. Over 80 % of all planning and decision- making process are anchored on ge-information.



Source: INFOTERA 2012

Satellite image of Kpakungu area of Minna (An example of unplanned built-up area)

SURVEYING AND GEOINFORMATICS SOLUTIONS

There are measures which if implemented soon, can reduce the social, economic, environmental and political impact of Climate change. With the continuous rise in Mean Sea Level (MSL), as a consequence of global warming, all urban developments and engineering activities must be properly and accurately controlled altimetrically by referencing them to the mean sea level and not the ellipsoidal or other arbitrary datum if appropriate measures are to be taken to forestall the possibility of mass inundation in the nearest future especially in flood prone cities like Lagos, Minna, etc. The reference datum adopted for heights measurement throughout the federation is inconsistent as it varies from state to state based on convenience and closeness to the ocean (Apapa Datum used in the South West, Trigonometric heights used to co-ordinate L-40 for the North Central etc.). This implies that the height system for the country is yet to be unified and as such it will be difficult to centrally and holistically solve national flooding problems. However, ellipsoid height obtained via GPS can be related to their orthometric equivalent.

DISCUSSION

Most of our built-up areas are faced with many environmental problems that adversely affect the inhabitants and the environment as a whole. There is the need to rebuild the built environment to take care of the environmental problems associated with the built – up environment, and their implications. There are environmental problems especially in unplanned built up areas.

In rebuilding, drastic positive measures must be taken even when the people oppose such moves out of ignorance, or fear of displacement or dispossession of their lands. It is recommended that laws and guide lines be put in place, and enforced, to guard against turning urban areas into slums and creating environmental problems. There should be adequate and frequent monitoring of growing urban centres.

FINDINGS

1. The world is showing increased interest in sustainable development and the environment.

2. Among the tools that are currently being used to inform decision-making and in the management of climate change and built environment problems are remote sensing and geographic information systems.

SUMMARY

The more the population grows, the worse the environment problems associated with it. The rapid growth of urbanization is already causing massive air pollution and environmental degradation; this is a threat to sustainable built environment. Development anywhere carries with it environmental consequences that could ultimately negate the goals of the development process. As the built environment develops, access to clean water, rising levels of air pollution, and its consequences become problems. Most of these developments cannot be separated from the effects of high rates of population growth. Because of the consequences of environmental problems in the built-up environment, especially the unplanned ones, it is very necessary to rebuild the built –up environment; and in rebuilding it, drastic positive measures must be taken even when the people oppose such moves out of ignorance, or fear of displacement or dispossession of their lands.

CONCLUSION

A healthy environment should have plenty of trees to absorb carbon dioxide and give us enough oxygen. A healthy environment presents clean water, fresh air, and healthy surroundings, thus keeping diseases and sickness away. In a healthy environment there is constant and efficient disposal of waste products, both solid and liquid.

Most of our built –up areas are faced with many environmental problems that adversely affect the inhabitants and the environment as a whole. Because of the environmental problems associated with built-up environments, and their implications, there is the need to rebuild the built environment, especially the unplanned ones. It is recommended that laws and guide lines be put in place and enforced to guard against turning urban areas into slums and making the built environment unsustainable.

There is the need to constantly strive for sustainable built environment inspite of climate change challenges which are enormous and affecting every facet of the human environment, including urban development and urban management. If adequate measures are implemented soon, they can reduce the social, economic, environmental and political impacts of climate change.

RECOMMENDATIONS

1. Mankind must do everything possible to stem the rate of environmental degradation.

2. Modern technologies such as Remote Sensing should be applied more vigorously in solving environmental problems.

3. We should be more serious with the campaign against human activities destroying the environment and biodiversity.

4. Our population growth-rate must be checked/controlled.

5. There should be adequate and frequent monitoring of growing urban centers/areas.

REFERENCES

Encarta (2014). Microsoft Encarta. Premium Suite.

Musa, A. A., (1991). “Land Information Systems – with special reference to developing Countries”. Paper presented at the International Conference on Information Technology and Developing countries, at F. U. T. Minna.

National Population Commission (NPC),(1991).Nigeria at a glance – Census 1991.

Osagie, O. (2002). “Sustainability Within the Context of Population and Natural Resources In Nigeria”. The Guardian Newspaper, Wednesday, 17, 2002. P.5

Toepfer, K., (2000). Editorial, in OUR Planet. The United Nations Environment Programme Magazine. Vol. 11. No.1

World Development Report (1992). Development and the Environment.

EMISSION REDUCTION AT THE EXHAUST OF A DIESEL INTERNAL COMBUSTION ENGINE BY PARTIAL FLOW TECHNOLOGY

MUSA Nicholas Akhaze and FATONA Stephen Ayodele
Department of Mechanical Engineering, Federal University of Technology, Minna,

This research work presents the development of a diesel exhaust of an internal combustion engine using the partial flow technology for the reduction of emissions. Exhaust emissions from automobiles have been a major threat to human life and the environment. Conventional automobile exhaust and mufflers have been of tremendous help in reducing the effect of these emissions. As the number of diesel fuel dependent automobiles in use increases, there is a further need to evolve a technology that will reduce the emissions. So an automobile exhaust was developed by the introduction of cascade stoppers to create a partial flow thereby reducing emission. When the developed exhaust was tested, the concentrations of CO, CO_2, NO_X and O_2 emitted through the exhaust were found to have reduced by 10.9%, 11.35%, 9.23% and 6.34% respectively.

Keywords: *Diesel, Internal Combustion Engine, emission, exhaust.*

madonick1@yahoo.com,
ayofatona2000@yahoo.com

INTRODUCTION

Diesel Internal Combustion Engine emissions have been a subject of research for the last three decade and researchers are still working till date to minimise emissions resulting to the depletion of the ozone layer. As environmental and political pressures to limit the effects associated with greenhouse gas (GHG) emissions are mounting, the minimization of emissions and fuel consumption on Diesel Internal Combustion Engine is receiving constant improvement. Diesel engine manufacturers have been trying to reduce greenhouse gas emissions not only for marketing purposes, but for environmental and economic reasons. The level of greenhouse gas emissions is a proxy for fuel consumption in diesel engines, and it is likely that in the near future GHG emissions will have a monetary cost Miguel, (2010). According to AEC et al (1993), the primary pollutants from internal combustion engines are oxides of nitrogen (NO_X), hydrocarbons and other organic compounds, CO, and particulates, which include both visible (smoke) and non-visible emissions. Nitrogen oxide formation is directly related to high pressures and temperatures during the combustion process and to the nitrogen content, of the fuel. The other pollutants, HC, CO, and smoke, are primarily the result of incomplete combustion.

Thirty seven billion tons of carbon dioxide (CO_2) approximately six tons for each person in the world is released to the air from burning fossil fuels every year, and CO_2 contributes to Green House Gases (GHG) and climate change. Other emissions from the exhaust includes nitric oxides (NO_x) and particulates matter (soot)Delucchi, (2003).

Society relies on Internal Combustion engines for transportation, commerce and power generation: (Earth-moving equipment, tractors, propeller aircraft, ocean liners and ships). Due to the various applications and uses of diesel engines, millions of barrels of diesel are used daily to power diesel engines, and the large amount of energy used is tied up in chemical bonds, which brings continuous increase to emissions and pollution.

Nowadays, diesel engines that burn mainly diesel fuels in an internal combustion engines have given concerns over atmospheric pollution and continuous rise in emission. Environmental legislations have continued to stimulate research on new, clean and fuel efficient vehicle technologies. An efficient exhaust design requires minimum fuel consumption and maximum utilization of exhaust energy in reducing the exhaust emissions. Design of each device in the exhaust should offer minimum pressure drop across the device, so that it should not adversely affect the engine performance (Jääskeläinen,2007).

A lot of methods have been developed, reported and asserted by researchers for reducing emissions from diesel engines. Notable among these researchers are Gupta(2016), who opined that for controlling emissions from diesel engines, the existing technology being used are selective catalytic reduction, exhaust gas recirculation and diesel particulate filter. APT(2016) that stated that there is a technology called emulsified fuel technology that reduces the gaseous and solid emissions of fossil fuel. It alters the combustion of fossil fuels in a favourable manner, increase fuel efficiency. Bade-Shrestha et al(2000) asserted that through an addition of a small amount of hydrogen to the main fuel, combustion process can be considerably enhanced in internal combustion engine producing significantly lower levels of exhaust emissions. Helgeson et al(2010) developed environmental solution worldwide diesel oxidation catalyst filtering technology to reduce PM emissions up to 60%. More so developed robust particulate filter to reduce PM emissions from diesel engine up to 90%.

Fiebig et al(2014) asserted that internal engine modification such as cooled exhaust gas recirculation. Optimized injection systems adapted changing systems and optimized combustion processes with high turbulence make it possible to minimize particulate and nitrogen oxide emissions with nearly no reduction in power. Pilusa et al(2012) evaluated the effect of using a whale filter on the overall vehicle exhaust emission. Their results revealed a significant average reduction in CO(35.3%), NO_X(26.1%) and hydrocarbons(34.3%) emissions. Resitoglu et al(2015) opined that NO_X content in the exhaust of a diesel engine has the highest percentage among the pollutant emission and of the researches so far exhaust gas recirculation, lean NO_X trap and selective catalytic reduction are the most focused technologies to substantially eliminate the NO_X emissions

Since the use of diesel engine is increasing, there is a great need to evolve a technology that will complement or be an improvement on the existing technologies to reduce the emissions from it.

It is to this end this work was conceived, to take a critical look at the exhaust of a diesel engine in order to minimize the emissions thereof. This research work focuses on the development of a diesel exhaust by incorporating cascade stoppers to produce minimum emission.

MATERIALS AND METHOD

Design Theory and Calculations

The parts of the exhaust considered for the design include (1) cylindrical section (2) truncated conical sections (3) cascade stoppers and (4) orifice plates

Parameters of Design and Benchmarking

From the specification of the test rig engine stated by Fatona (2015), the following data

were obtained

Bore (D) = 96 mm

Stroke (L) = 92 mm

No. of Cylinders (n) = 6

Engine power (P) = 412 hp

Max. RPM (N) = 7500 rpm

Allowable back pressure for muffler = 10 in H_2O (2491.74N/m^2)

Transmission Loss Noise target (muffler) = 30 dB

Operating pressure = 135000Pa

Determination of the Engine Firing Rate

According to Patel and Khokhar (2013), the Cylinder Firing Rate (CFR) is given as

$$\mathrm{CFR} = \frac{\text{Engine Speed in RPM}}{120} \tag{1}$$

Therefore, $\mathrm{CFR} = 7500/120 = 62.5$

Also, according to Patel and Khokhar (2013), Engine Firing Rate (EFR) is given as

$$\mathrm{EFR} = \mathrm{n\ x\ (CFR)} \tag{2}$$

Where n =no. of cylinders

Therefore, EFR = 6× 62.5 = 375 Hz

Determination of Muffler Volume

According to Shah et al (2010), the volume swept by each cylinder V_s is given by

$$V_s = \frac{\pi \text{ x } D^2 \text{ x } L}{4} \tag{3}$$

Where D is the diameter of cylinder
L is the stroke length

$$V_s = \frac{3.142 \text{x } 0.096^2 \text{ x } 0.092}{4}$$

$V_s = 0.00067 m^3$

Total swept volume , $V_s = \mathrm{n} \times V_s$

Where n=6

$V_s = 6 \times 0.00067 = 0.00402\ m^3$

According to Shah et al. (2010), muffler or silencer volume must be at least 12 to 25 times the volume. In this design, a factor of 12 was adopted.

Therefore, the volume of the cylindrical portion of the muffler or silencer = 12 x 0.00402 = $0.04824m^3$

Truncated conical sections are to be incorporated at the inlet and outlet of the exhaust. Back pressure at the lengths/heights of 70mm, 80mm, and 90mm of the conical sections were simulated using solid works and the result obtained at 70mm was found to be the most suitable to achieve the best back pressure. So the length/height of the conical section was taken to be 70mm.

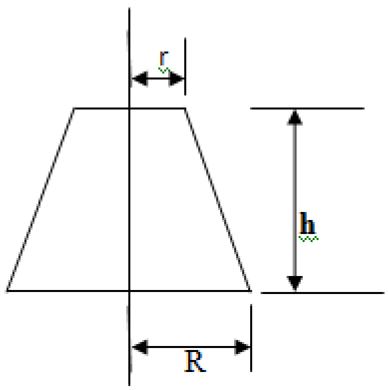


Fig. 1 Truncated conical section of the exhaust

The volume of the inlet and outlet truncated conical sections is given as

$$V = 1/3\pi(r^2 + Rr + R^2)h \times 2 \tag{4}$$

where V is the volume of the truncated conical section

r is the radius of the truncated conical section = 30mm

R is the base radius =75mm

h is the height of the truncated conical section=70mm

Therefore,

$V= 1/3\times22/7(30^2+30\times75+ 75^2)70\times 2$

$=1.047(900+2250+5625)\ 70\times2$

$= 1286649mm^3$

$= 0.001287m^3$

Total Volume or the volume of the muffler = 0.04824+0.001287 = $0.049527m^3$

Determination of Number of Perforated Holes in the Element of the Muffler

Cylindrical perforated pipe forms an important acoustic element of muffler, which is tuned in line with the problematic frequencies identified. According to Shah *et al.* (2010), the diameter of the hole to be drilled / punched on the cylindrical perforated pipe is calculated by a thumb rule is given as:

$$d_o = \frac{1.29}{\sqrt{N}} \tag{5}$$

where N is the number of perforated holes and d_o is the diameter of the exhaust cylindrical perforated pipe(short length) which is taken to be 50mm

$$\sqrt{N} = \frac{1.29}{d_o} = \frac{1.29}{0.05} = 25.8$$

$$N = (25.8)^2 = 666$$

Cascade Stoppers (Partial Flow Technology)

The cascade stopper consists of circular orifice plates and the same diameter with that of the exhaust which is 150mm. The cascade stopper is fitted tightly to the muffler and perforated in such a way that it holds the cone and had other perforations in that it allows the exhaust gas to pass through it.

Determination of Thickness of the Orifice Plate

According to Khurmi and Gupta (2005), to calculate the thickness of a flat circular plate, the following relation may be used:

$$t_1 = k_1 . d \sqrt{\frac{P}{\sigma_t}} \tag{6}$$

Where t_1 is the thickness of flat circular plate, d is diameter of plate = 0.15m,

P is the total pressure = 135000 N/m^2 [operating pressure as stated by Faton a(2015)]

k_1 is the slenderness ratio given to a flat circular plate = 0.42

σ_t = 365MPa obtained from Khurmi and Gupta (2005). This was also used for the orifice, since they are of same material. Factor of safety was taken as 6.

$$\sigma_t = \frac{365}{6} = 60.8\ MPa.$$

$$\sigma_t = 60.8 \times 10^6\ Pa$$

$$t_1 = 0.42 \times 0.15\sqrt{\frac{135000}{60.8 \times 10^6}}$$

$$t_1 = 1.4 \times 10^{-3}\, m = 1.39mm \cong 1.4mm$$

But, the plate was constructed with a plate thickness of 1.5mm which was readily available.

Determination of the Mass flow Rate of Exhaust Gas through the Orifice

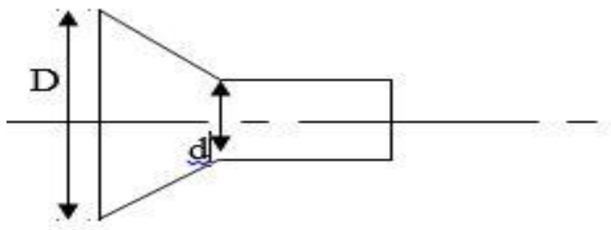


Fig. 2: Orifice

According to Peter (2008), orifice flow rate can be calculated by using the relation,

$$q_m = c\varepsilon\pi \times d^2\sqrt{2(\mathrm{P}_1 - \mathrm{P}_2)\rho}/\ 4\sqrt{1-\beta^4} \qquad (7)$$

P_1= 135000Pa [Operating pressure as stated by Fatona (2015)]

P_2= 134370Pa (obtained from simulation at 70mm length of the truncated conical section of the exhaust).

D= 0 .15m

d= 0.06m

β= .06/.15= .4

β = Ratio of diameter of orifice to diameter of pipe

Therefore, for well-rounded and cone like pipe discharge coefficient, C = 0.98 obtained from (Peter, 2008)

Fuel gas density ρ=1.340kg/m^3 (Perry, 1984).

Ɛ the expansibility of gases (compressible) and, hence, is greater than 1. The expansibility of the exhaust gas was taken as 1.24

$$q_m = 0.98 \times 1.24 \times 3.143 \times 0.06 \times 0.06\frac{\sqrt{2(135000 - 134370)1.340}}{(4\sqrt{1-.4^4})}$$

$$= \frac{0.0137497 \times 1688.4}{0.9744}$$

$$= \frac{23.21499}{0.9744}$$

$q_m = 23.82$ Kg/s

Determination of the Rate of Heat Loss through the Exhaust

According to Jadhao and Thombare (2013), heat loss can be calculated by

$$Q = \dot{m} \times Cp \times \Delta T \tag{8}$$

Where Q =Heat loss in (KJ)

$\dot{m}$= q_m = mass flow rate (kg/s)

Cp= specific heat of diesel =1.23kJ/kg.K

ΔT= Temperature difference for diesel = T_1-T_2

T_1= 640 K (stack gas temperature of the exhaust)

T_2= 308 K (ambient temperature)

$\mathrm{Q} = 23.82 \times 1.23 \times (640 - 308)$

$= 9727.14$KJ/s

Determination of the Back Pressure:

According to Barnabas *et al*. (2013), back pressure can be calculated by

$$\Delta P = \frac{\dot{m}^2 \times S \times L \times 3600000 + Ps}{D^5} \tag{9}$$

Where L = Total equivalent length of pipe = 0.59m

Q= Exhaust gas flow = 9727.14 kJ

D =Diameter (inside) of pipe (mm) = 150 mm

Ps = Pressure drop of silencer co-efficient = 0.98

S = Density of gas (kg/m^3) = 0.962kg/m^3 (Jääskeläinen, 2011) on interpolation.

$$\Delta P = \frac{9727.14^2 \times 0.962 \times 0.59 \times 3600000 + 0.98}{150^5}$$

$$= \frac{193330296788867}{75937500000}$$

$$\Delta P = 2545.91 kPa$$

$$= 2545.91 kPa$$

Based on the design theory and calculations, the exhaust was fabricated. The pictorial view of the developed exhaust is shown in plate I. The orthographic view of the developed exhaust is shown in figure 3 and of its component parts are shown in Figures 4, 5, 6, 7. 8 and 9 respectively, with all dimensions in millimetres.

Plate I: The developed exhaust with 70mm inlet and outlet truncated conical sections

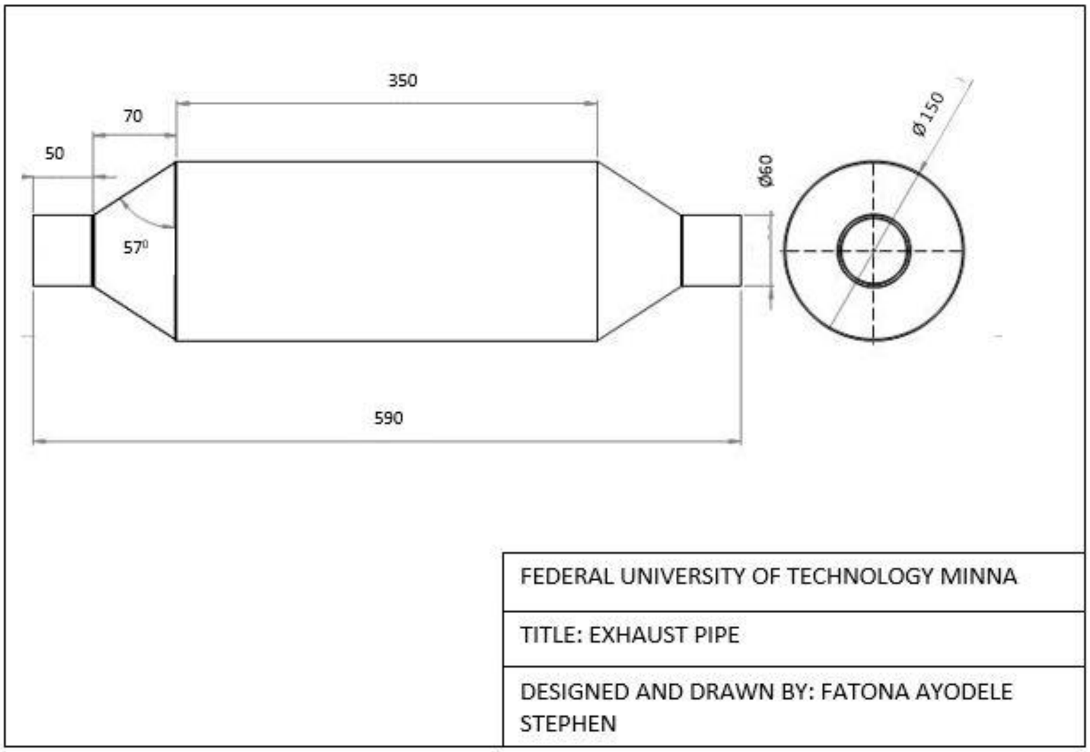


Fig. 3: Orthographic view of the developed exhaust

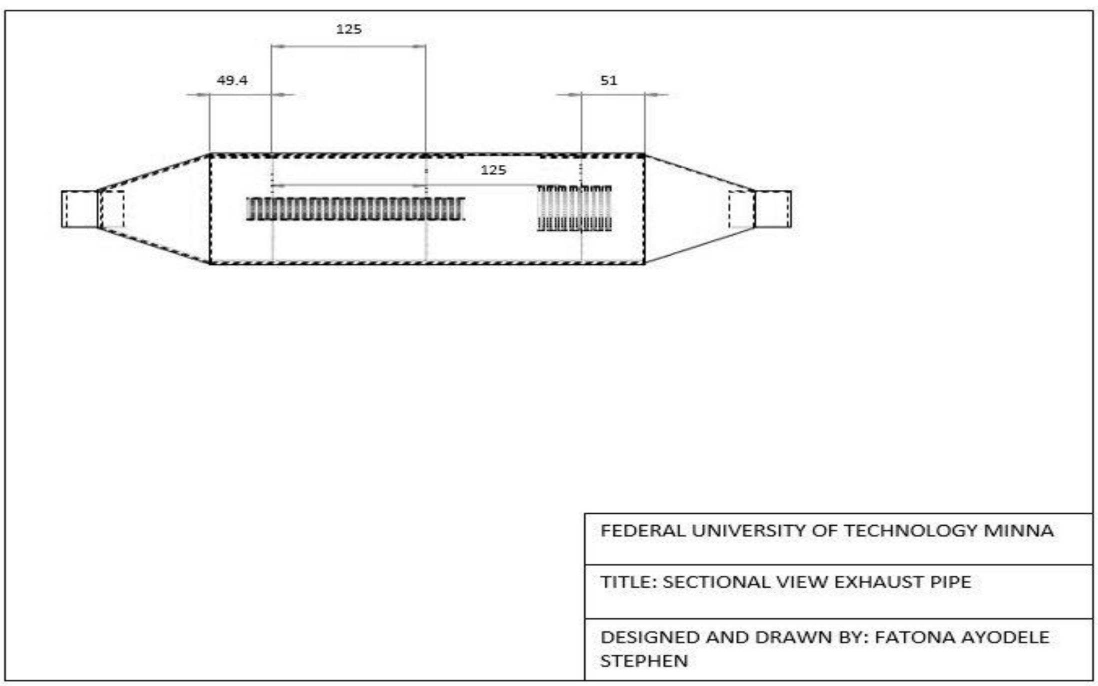


Fig 4: Exhaust with cone and perforated cylinders

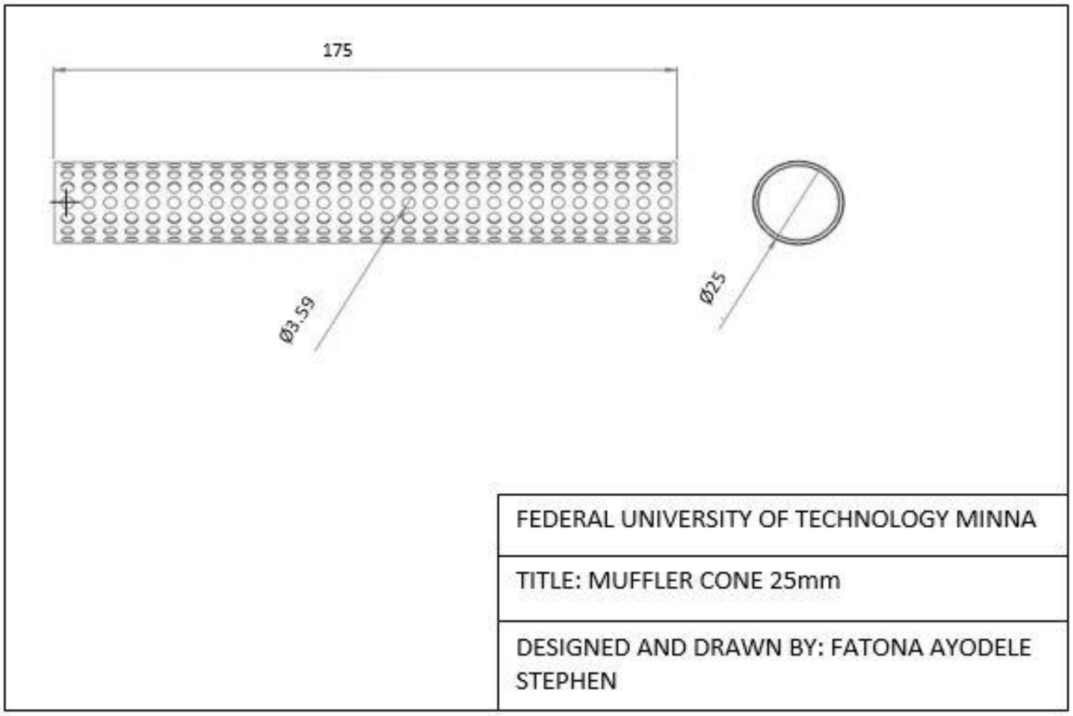


Fig. 5:Exhaust cylindrical perforated pipe (long length)

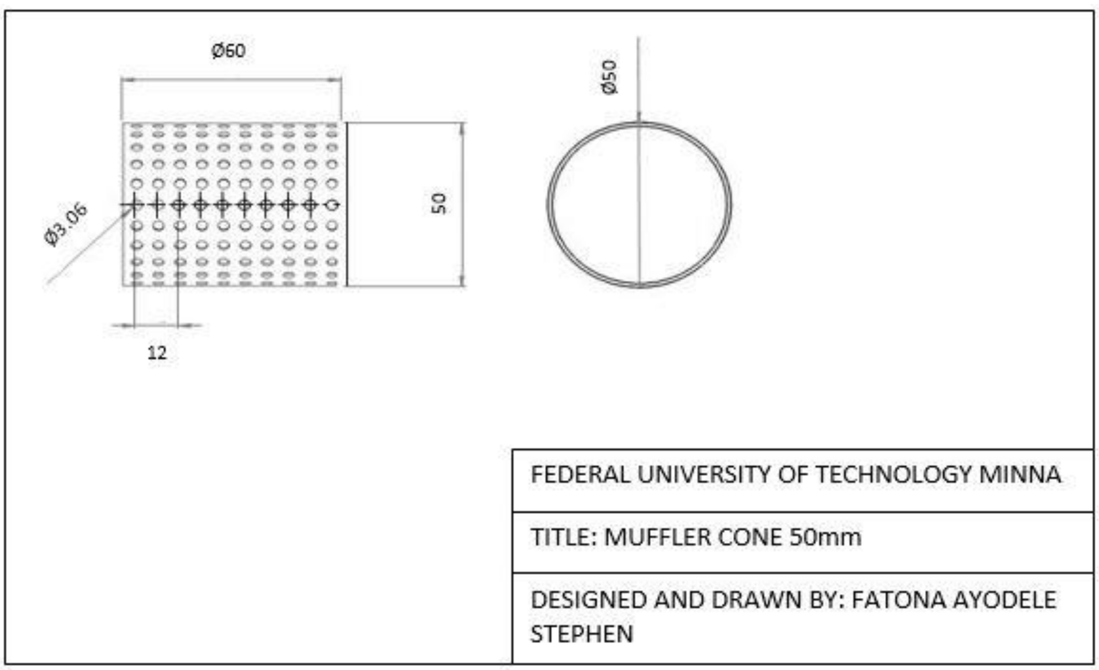


Fig.6: Exhaust cylindrical perforated pipe (short length)

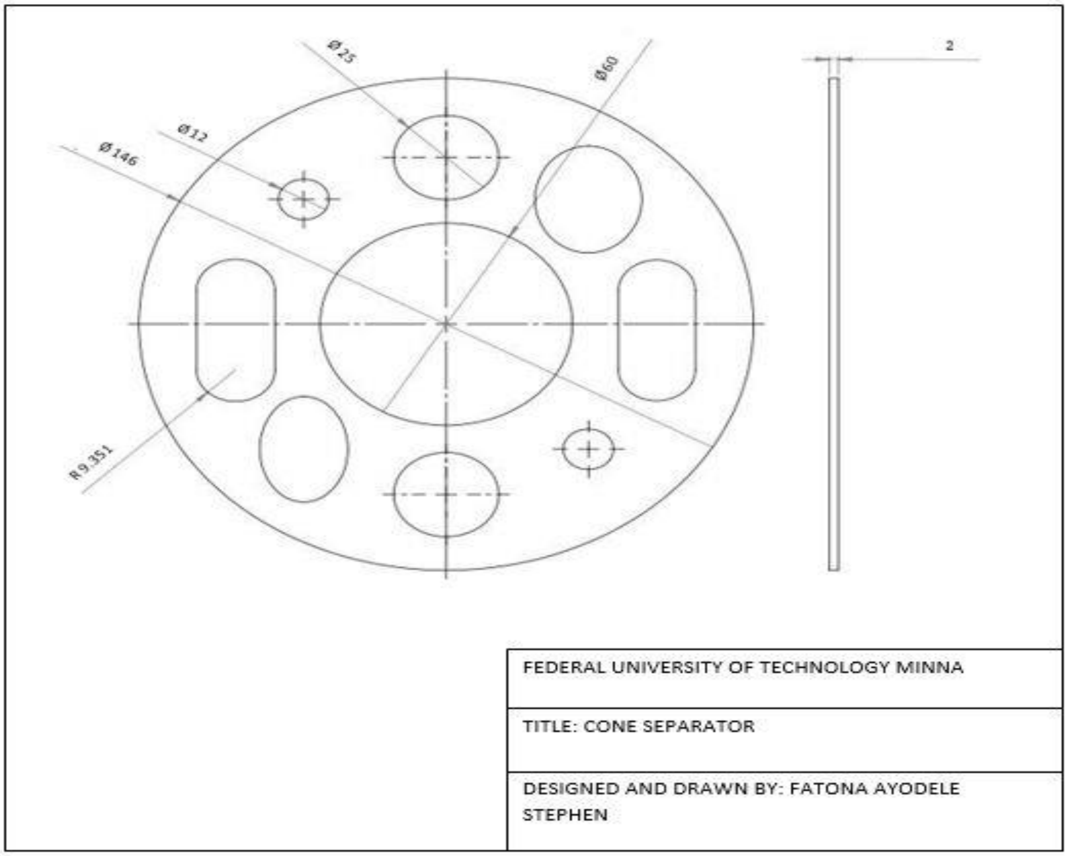


Fig. 7:Cone separator 1 (cascade stopper)

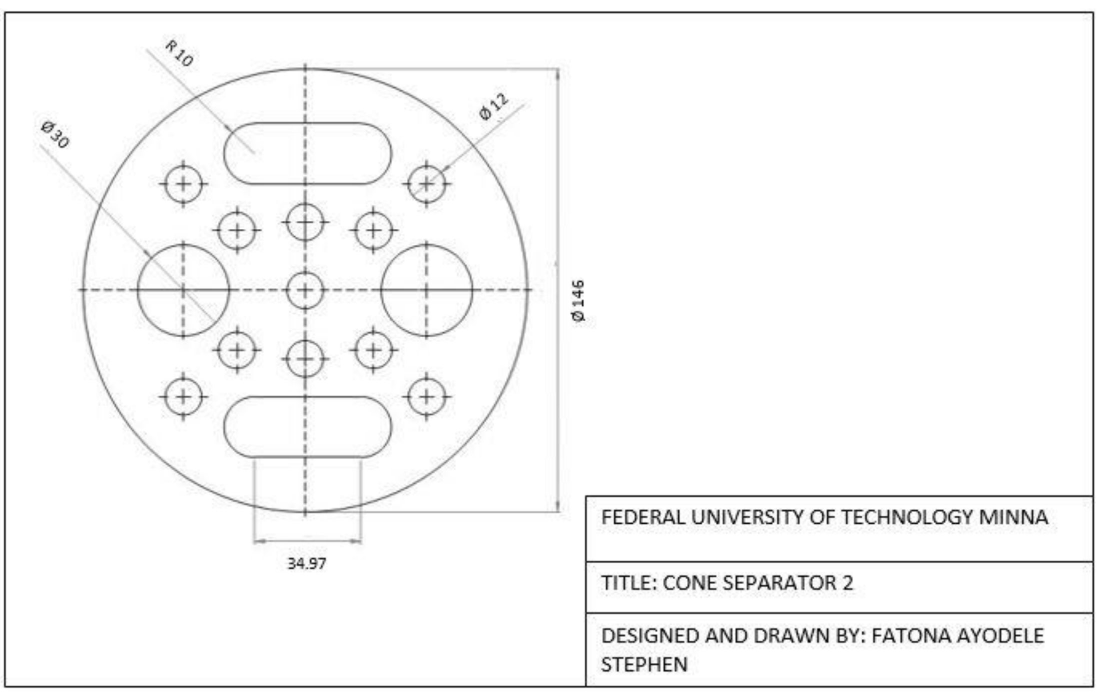


Fig. 8: Cone separator 2 (cascade stopper)

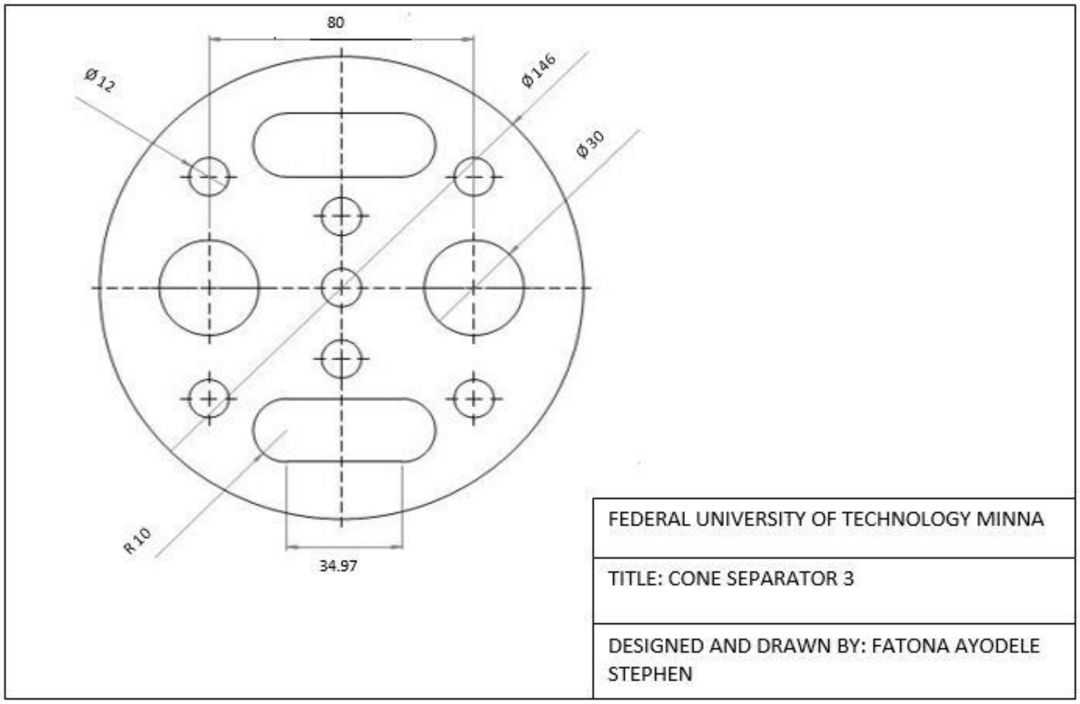


Fig.9: Cone separator 3 (cascade stopper)

Performance Evaluation

A test rig which comprises of a diesel engine which is mounted on the dynamometer work bench, connected to the fuel hose and the dynamometer digital control as well as the exhaust was used to carry out the performance evaluation of the developed exhaust. It was loaded (that is engaged) for useful work for twenty minutes (20minutes) to ensure that the engine was faultless and run freely. The engine was thereafter subjected to loads of 4kg, 6kg, 8kg, 10kg and 12kg and the exhaust gases were measured with Gas Analyser IMR 1000-4 made in U.S.A by environmental equipment, Inc at 5 minutes interval for the various load of the engine. The readings were taken and classified as pivot experimental readings

The original test rig engine exhaust was removed and the developed or fabricated exhaust was fitted to the engine and the same procedure stated above was carried out, the readings were taken and classified as fabricated exhaust readings.

RESULTS AND DISCUSSION

The measured emissions from the test rig exhaust (pivot experiment) and from the developed or fabricated exhaust fitted to the test rig engine are presented in this section, interms of their variations with time and load. More so total emitted gases from both test rig engine exhaust and the developed or fabricated exhaust is presented.

Figure 10 depicts the variation of concentration of CO, NO_X and O_2 with time

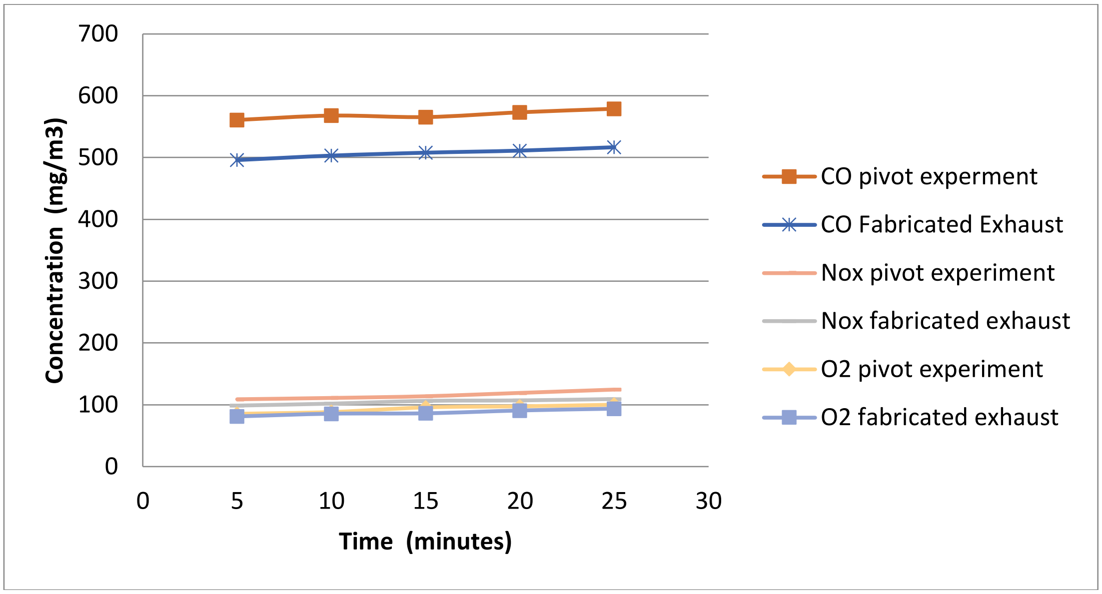


Fig.10. Variation of concentration of CO, NO_X and O_2 with time.

Figure 11 shows the variation of CO_2 with time

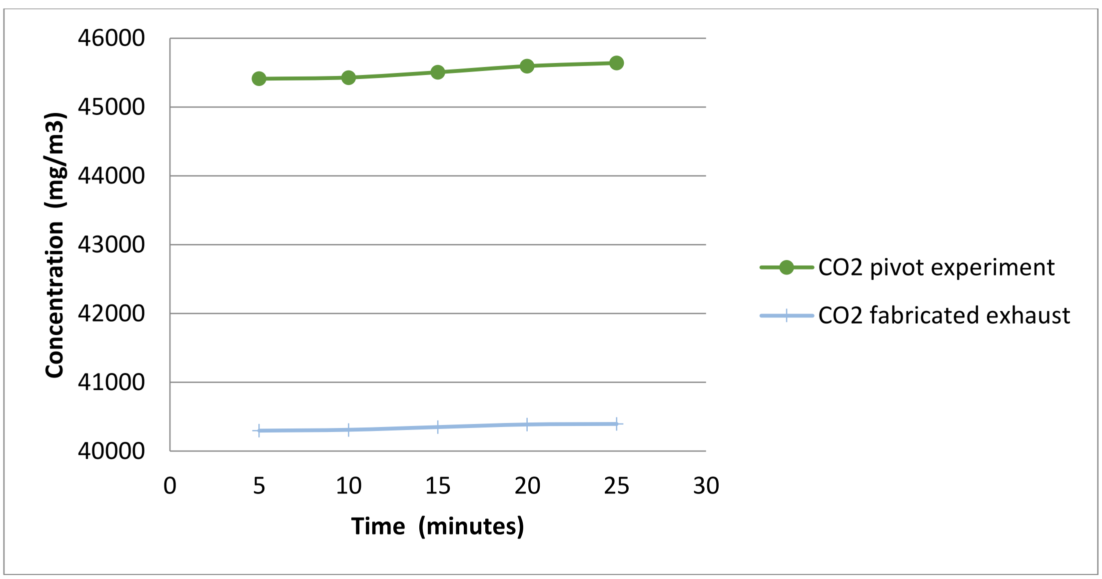


Fig. 11. Variation of concentration of CO_2 with time

Figure 12 depicts the variation of the concentration of CO, NO_X and O_2 with load.

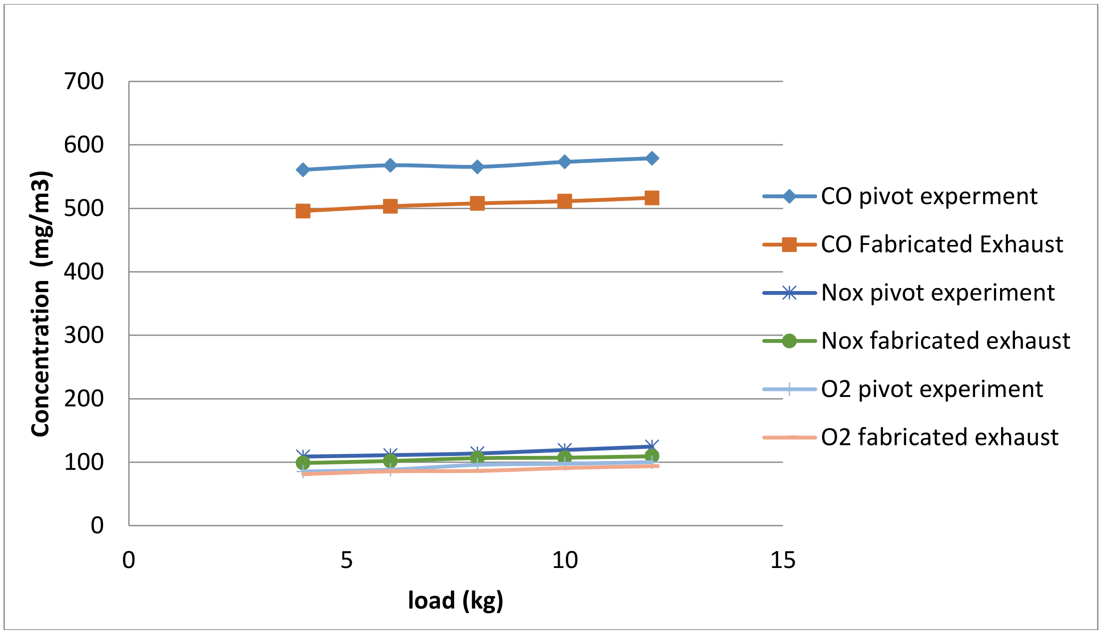


Fig. 12. Variation of concentrations of CO NO_X and O_2 with load.

The variation of concentration of CO_2 with load is shown in figure 13.

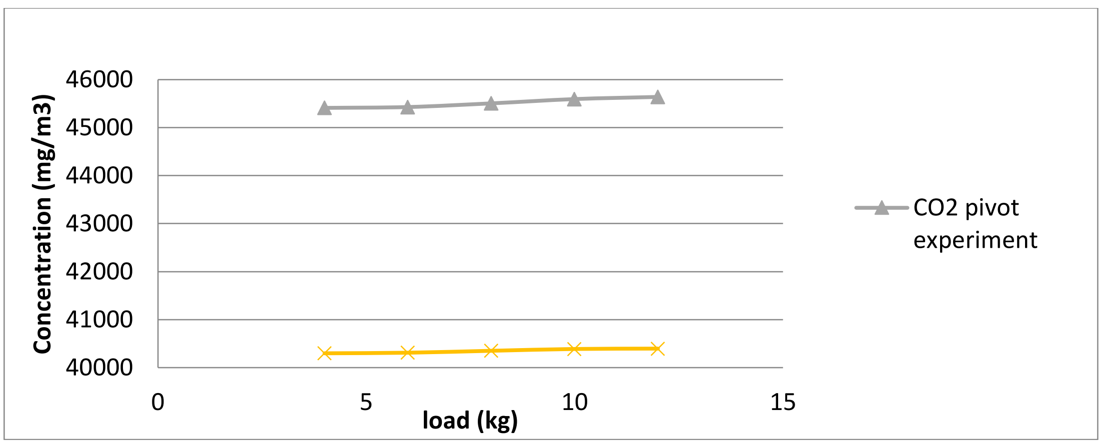


Fig.13. Variation of concentration of CO_2 with load

It can be seen from figure 10 that the concentrations of CO, NO_X and O_2 and from figure 11, the concentration of CO_2 emitted from both pivot experiment and the developed or fabricated exhaust increased with time. It is evident in figure 12 that the concentrations of CO, NO_X and O_2 and from figure 13, that the concentration of CO_2 increased with increase in load. Higher concentrations of CO, NO_X and CO_2 are emitted from the pivot experiment compared to the developed exhaust. This could be attributed to the three levels of the cascade stoppers installed in the fabricated exhaust, which delays the gases emitted.

Comparison between the total emitted gases from the test rig engine exhaust and the developed exhaust as well as the percentage reduction of the emitted gases is shown in Table 1.0.

Table 1.0 : Total emission obtained from the pivot experiment using the test rig engine exhaust and the developed exhaust

Emitted Gases	**Test Rig Engine Exhaust(Pivot Experiment) (Mg/m^3)**	**Developed Exhaust (Mg/m^3)**	**Percentage Reduction of Emitted Gases (%)**
CO	569.25	506.98	10.9
CO_2	45515.26	40348.9	11.35
NO_X	115.51	104.84	9.23
O_2	93.43	87.51	6.34

The concentrations of CO, CO_2, NO_X and O_2 were found to have reduced by 10.9%, 11.35%, 9.23% and 6.34% respectively, when the developed or fabricated exhaust was used as evident in Table 1.0.

CONCLUSION

The development of an exhaust with partial flow technology was carried out. The partial flow technology was adopted which enhances emission reduction. The results obtained from the pivot experiment and the developed or fabricated exhaust shows that there is a reduction in the gases emitted. This has shown the efficacy of using partial flow technology in reducing emissions from the exhaust of a diesel engine.

REFERENCES

AEC, Aul, E and Pechan E. H(1993). Emission Factor Documentation for a AP-42 Section Lignite combustion. Retrieved from http://www3.epagov/ttnchie1/ap42/ch01/bgdocs/b01so7 .pdf on the 28th of August, 2015.

APT(2016) Optimal Control of Particulate Emissions in Diesel engines. Retreived from http://www.altpetrol.com/PDF/APT%2003- EERC%202007%20paper_201006b on the 12th of june, 2016

Bade-Shrestha, S. O, Leblanc, G, De Souza, M(2000) A before Treatment Method for Reduction of Emissions in Diesel Engine. *SAE Technical papers. 10.4271/2000-01-2791*

Barnabas, J. K., Ayyappan, R. and Devaraj, M. R. (2013). Design and Fabrication of Exhaust Silencer for Construction Equipment. *Proceedings of the National Conference on Emerging Trends in Mechanical Engineering (NCETIME – 2k13)*

Delucchi M, (2003)" A Lifecycle Emissions Model (LEM): Lifecycle Emissions from Transportation Fuels, Motor Vehicles, Transportation Modes, Electricity Use, Heating and Cooking Fuels, and Materials". *Institute of Transportation Studies Publication.*

Fatona, A. S (2015) Development of an Improved Exhaust for Diesel Internal Combustion Engine. *M. Eng Thesis Submitted to the Department of Mechanical Engineering, Federal University of Technology Minna, Niger State, Nigeria*

Fiebig M, Winrtalla A, Holderbaum B and Kiesow, S(2014). Particulate Emissions from Diesel Engines:Correlation between Engine Technology and Emissions. *Journal of Occopied Medicine and Toxicology. 9(6) :1-18*

Gupta, D(2016) Fabrication of Emission Control of Diesel Engine. Retrieved from http://www.linkedin.com/pulse/fabrication-emission-control-diesel-engine on the 15th of February, 2016

Helgeson, N, Trueblood, D, Jack, J and Griffin, G(2010) Diesel Engine Air Emission Reduction Technologies. Technical reports. *Naval Facilities Engineering Command. Engineering Service centre Port Hueneme, California, pp1-54.*

Jääskeläinen, H (2011). *Diesel Exhaust Gas*. Retrieved from https://www.dieselnet.com/tech/diesel_exh.php on the 4th of June, 2015

Jääskeläinen, H (2007). Engine Exhaust Back pressure. Retrieved from https://dieselnet.com/tech/diesel_exh_pres.php on the 4th of June, 2015

Jadhao J. S., Thombare D. G. (2013). Review on Exhaust Gas Heat Recovery for Engine. *International Journal of Engineering and Innovative Technology (IJEIT)* (2), Issue 12.

Khurmi. R.S, and Gupta. J.K, (2005) A text Book on Machine Design. First MulticolourEdition. *(A Textbook for the Students of B.E. / B.Tech.U.P.S.C. (Engg. Services); Section 'B' of A.M.I.E. (I)*

Miguel, F (2011). Vehicle Routing Problem for Emissions Minimization. Retrieved fromhttp://web.cecs.pdx.edu/~maf/Journals/Emissions%20Minimization%20Vehicle%20Routing%20Problem%202.pdf on the 15th of February, 2016.

Patel B.S., and Khokhar. S., (2013) "A Review paper on Design of Muffler toward Reduce Sound in Exhaust System of IC Engine", *Proc. of Int. Conf. on Emerging Trends in Engineering and Technology*.

Perry, R.H., (1984). “Perry's Chemical Engineers' Handbook”, McGraw-Hill, New York, 6th edition

Peter, l (2008), Calculation of Flow rate from Differential Pressure Devices -Orifice plate. *Technical Research Institute, Sweden.* Retrieved from http//www.ematem.org on the 15th of September, 2015.

Pilusa T. J, Mollagee, M. M and Muzenda E(2012) Reduction of Vehicle Emissions from Diesel Engines using the Whale Concept Filter. *Aerosol and Air Quality Research.* 12:994-1006

Resitoglu, I. A, Altinisik, K and Keskin A (2015).The Pollutant Emissions from Diesel Engine vehicles and exhaust after treatment systems. *Clean Techn. Environ. Policy 17:15-27*

Shah, S., Kuppili, S., Hatti, K., and Thombare, D(2010). A Practical Approach towards Muffler Design, Development and Prototype Validation. *SAE Technical Paper 2010-32-0021, 2010, doi:10.4271/2010-32-0021.*

CLIMATE CHANGE AND TREATS TO SUSTAINABILITY OF THE BUILT ENVIRONMENT: THE IMPACT OF CHARCOAL AS A SOURCE OF DOMESTIC COOKING ENERGY ON THE BUILT ENVIRONMENT, A CASE STUDY OF NIGER STATE.

Ndawashi B. M., Morenikeji F. T., Salihu U. T., & Otijele G. O.
Federal University of Technology Minna

Charcoal is used in domestically in households for cooking energy, the demand of which is increasing due to the high cost of cooking gas and kerosene in the country. Large volume of forest trees are being destroyed in the process of charcoal production resulting to numerous environmental and climatic hazards. A combined effect of the processes involved in the production of charcoal and its use in households is rapidly declining the quality of the environment and its ability to sustain life. This paper discusses the impact of the use of charcoal as a cooking energy on the built environment in Niger state. The paper will identify the sports where charcoal is mostly produces and consume in the state and identify the impacts of the production and consumption on such sports. Data will be collected through direct observation and questionnaires and from the concerned ministries in the state. The results will be analyzed using simple statistical tools and tables and charts will be used for the discussion of the results. The paper will conclude by providing alternative measures to the use of charcoal and its production in the state.

Key Words – *Built Environment, Charcoal, Climate Change, Cooking Energy, Environmental Hazards*

mbnbello@gmail.com

Ndawashi et. al. (2016). **CLIMATE CHANGE AND TREATS TO SUSTAINABILITY OF THE BUILT ENVIRONMENT: THE IMPACT OF CHARCOAL AS A SOURCE OF DOMESTIC COOKING ENERGY ON THE BUILT ENVIRONMENT, A CASE STUDY OF NIGER STATE.** Sustainable Built Environment and Climate change; The challenges of Post 2015 Development Agenda. School of Environmental Technology Conference, SETIC 2016

INTRODUCTION

Household fuels constitute energy sources used for domestic cooking, space heating and lighting, but, according to ESMAP (2003), excludes fuels for transportation. Many of the different types of households' fuels in use in developing countries come under the category of "traditional", which include animal dung and agricultural residues, as well as wood fuel. Wood fuel, in the view of World Resources (2001), comprises of charcoal, firewood and other wood-derived fuels; and also constitutes the most important form of non-fossil energy used in households. Charcoal can be an excellent domestic fuel. Charcoal can be made from virtually any organicmaterial,likewood,straw,coconutshells,ricehusks,bones.Amongwood,usually the hardwood species are preferred for charcoal making (e.g.Acacia, Mangroves, Oak, Prosopis).Charcoal is cleaner, easier and less smoky and smelly than other biomass fuels. It can be used in smaller quantities with cheap burning devices for domestic application.

The major determinant of the amount and type of energy used by households in urban area is a function of population and urbanization. Research indicated that household consumption of domestic energy corroborated with "energy ladder" that implies that households consumes less costly energy and less conventional (biomass) energy, of immediate price and quality (kerosene) to more expensive highly convenient types of energy (LPG, electricity) as their income increases and or habits changes over time (Sathaye and Meyer 1990; UNCHRS, 1991; Smith, 1994) but the inflation rate has changed the whole situation as households depend on biomass to beat the effect of inflation. There has been increase in the use of kerosene among the middle and low income group in recent past (Sathaye and Meyer 1990) but the trend has changed for high consumption of charcoal due to recent increase in pump price of petroleum product in early 2012. The key factors that affect the consumption of any kind of energy in urban area by households include: the price of the energy, the availability of the energy, income and cultural preference.

Despite a major shift in the use of household energy, many households rely solely on charcoal as their primary source of cooking energy, especially in urban areas. The popularity of the transition to charcoal was brought to the fore following the acute scarcity of firewood and kerosene as well as their exorbitant prices. Uzoma (2006) reports that the kerosene scarcity led to the invention of Abacha Coal Pot - a locally made stove that use charcoal. Over the years, the cooking technology of the coal pot became widely accepted and used. Also, the high initial investment cost of kerosene stove, gas and electric cookers, coupled with low generation, and cost of electricity discouraged the use of alternative fuels in favour of charcoal. Because of these, African ministers on African preparatory conference for the World Summit on Sustainable Development in 2001, submitted that at least 80% of African population continues to depend on traditional biomass fuels (charcoal and firewood) for their energy needs. Also, Harsch (2001) reports that the continents' urban population, growing at an average rate of 4% per annum, is putting more demand for charcoal, and by extension the forests and other biomass services. It is therefore reasonable to infer that biomass (mainly charcoal) will remain the key source of energy for most of the population in sub African continent for several decades to come. This observation is shared by various institutions including the World Energy Council (World Energy Council in its WEC statement in 2000), the Food and Agricultural Organization (FAO) (Gustatson, 2001), and the UNDP (2000).

The use to which charcoal is subjected to is as old as man. Charcoal, very often constitutes the most frequent type of archaeobotanical remains on archaeological sites. The information it provides, according to Zapata, Pena, Ibanez and Gonzalez (2003) is two-fold. First, environmental, showing at least the presence of different taxa in the vicinity of a site; and secondly, ethnobotanical, showing patterns of wood provision and preferences of human groups when collecting trees and shrubs for fuel. However, Asouti and Austin (2005) suggest that greater integration of charcoal and archaeological data is needed when evaluating charcoal preservation and sample composition, and that a more coherent theory of the complex ecological and cultural processes affecting species availability and firewood management needs to be developed.

Charcoal was used during the world war to power commercial road vehicles usually buses; where oil was scarce or completely unavailable. In North Korea, such vehicles are still in use till today. Besides its household use, charcoal has industrial applications, as well as in metallurgical operations, as a reducing agent (FAO, 1983). Even in developed countries, there is an increasing demand for charcoal as barbecue fuel. This heavy reliance on charcoal that characterize energy consumption in much of the urban households in developing countries, like Nigeria, seems to be tied to socio-economic characteristics of the households and as well as some factors that propel its choice. The sole aim of this paper is to assess the impact of the use of charcoal in domestic households.

OBJECTIVES OF THE STUDY

This study seeks to fulfil the following objectives:

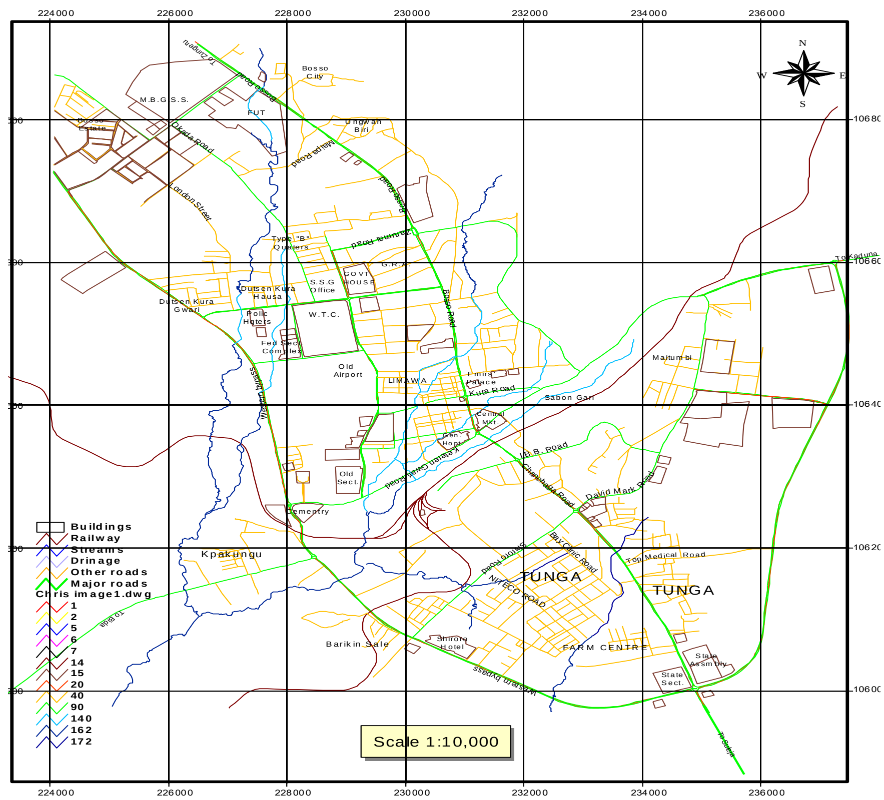
i. Determine the reason for the use of charcoal as a source of fuel in domestic households.

ii. Determine the impact of it use on the environment and the health of the users.

STUDY AREA

The research was conducted in Niger state. The state is situated in the North Central geo-political zone, shares its borders with the Republic of Benin (West), zamfara state (North), Kebbi (North-West), Kogi (South), Kwara (South-West), Kaduna (North-East) and FCT(South-East). The state is blessed with vast land, characterized by appreciable rainfall that facilitates agriculture. Charcoal production is common among the people of the state particularly among the people around Bida region. Villages like Essan-Nubupi, Gurara Kataeregi, Kakakpangi, Kochikota, Epan, Bokungi and kpakuti among others are largely engaged in the production of charcoal in the state. The study on the household consumption of charcoal was limited to the state capital city Minna.

Minna is emerging as one of the growing cities in Nigeria with population density of 56 persons per/Km2the growth of the city recently has been due to increase in the developmental projects embarked upon by the government and individuals in the city especially after it became the state capital. The residential land use in Minna shows three characteristics; that is high, medium and low densities with mixture of these densities except for the low density that is clearly demarcated. Many neighbourhoods of the high density found in the inner -city of Limawa, UngwanDaji, UngwanKaje, Kpakungu, Bosso etc. have buildings of low quality and improper planning in the process of their development. Many of the buildings in these neighbourhoods lack accessibility due to lack of planning, the mode of accessibility has been through footpath that are narrow and not motorable. There is no adequate setback and are poorly ventilated. This area belongs to the low income earners and the few medium density for those planned by the government as residential layout such as Tunga Estate, M.I Wushishi Estate, Bosso Estate, Bosso Low cost and recently Talba Estate. The only low density area is the GRA that is characterized with high quality housing and proper layout; though there is distinction in the types of residential area but there is uniformity with each other in terms of population density, housing density, housing quality and the general neighbourhood conditions.



Source:Ministry Of Land and Housing, Minna

Fig 1.3: Road Map of Minna

TYPES AND USES OF CHARCOAL

Charcoal is the dark grey residue consisting of impure carbon obtained from vegetation substance, and is produced by slow pyrolisis, the heating of wood or other substances in the absence of oxygen. FAO (1983) sees charcoal as a soft, brittle, lightweight, black, and porous material that resembles coal. Charcoal burning is probably the oldest chemical process known to man. Commercial charcoal is found in either lump, briquette or extruded forms (Resende, 1983). The lump charcoal which is the commonest is made directly from hardwood material and usually produces far less ash than briquette. Briquettes are made by compressing charcoal, typically made from sawdust and other wood by-products. Extruded charcoal is made by extruding either raw ground wood or carbonized wood into logs without the use of a binder. A number of literatures have dwelt on the various uses of charcoal for various purposes, beside its household use in cooking and boiling (FAO 1983, Kaale 1985, and WorldBank 2000). In addition to these, Foley (1986) enumerates three distinct uses of charcoal that makes it unique as household fuel. They are:

- Excellent domestic fuel: charcoal is cleaner, easier, and less smoky and smelling than other biomass fuels,
- Light weight: conversion of wood intocharcoal reduces its weight, and makes it easier and cheaper for transportation. It can also be used in smaller quantities, with cheap burning devices for domestic applications, and
- High energy content: the calorific value of charcoal primarily depends on its quality, depending on the amount of water, volatility and ash content. Charcoal commonly used for domestic purposes have a net calorific value of 28Mj/kg. This net energy value is roughly twice as much as air dried fuelwood. This big difference makes charcoal cheaper to transport over a longer distance compared to fuelwood.

EMERGENCE OF CHARCOAL AS A HOUSEHOLD FUEL

In Africa, over 90% of the wood taken from forest is woodfuel (Amous, 2000). This majority is consumed directly as fuel. This substantial amount is transformed into charcoal. Substantiating this, Pereira et al (2001) claims that more than 80% of it is used in urban areas, making charcoal the most important source of household energy in many African cities. To buttress this, Kalu and Izekor (2007) discovered that charcoal enterprise has been adopted to meet some socio-economic benefits and energy needs of the people. Also, Alemu et al (2009) report that annual charcoal production in Kenya is estimated to be around 1.6 million tons, and households are consuming between 350 to 600 kg annually; and estimate that about 2 million people are economically dependent on charcoal production, transportation and trade.

The importance of charcoal is also reflected by the fact that 4 African countries rank among the 8 countries with the highest charcoal production worldwide (Williams, 2000). In the ranking, Nigeria is the 2nd in Africa, after Kenya, and 4th in the world with 1.8 million tons per year. The pattern of household energy consumption represents the stage of welfare as well as the stage of economic development. As the economy develops, more and cleaner energy is consumed. Rapid urbanization increases the total urban demand for household energy, as well as facilitates the process of fundamental transformation in the organization of human behaviour.

RESEARCH METHODOLOGY

Primary data used for the study were collected from cross-sectional survey of55 households in Dutsen Kura using structured questionnaires. A multi stage sampling procedure was employed in selecting the representative households. The first stage involved division of thearea into 5 existing wards. At the second stage, 11 households were randomly selected from each of these wards, making a total of 55 respondents. The wards include, London Street, Bajago, DutsenKuran Hausa, DutsenKuranGwariand Jikpanarea.

RESULTS AND DISCUSSION

Trend In Price Of Petroleum Product In Nigeria

All the macro-economic policies of the government of Nigeria have been having effect on the price ofpetroleum products in the country, since the period of oil boom of late 1970s and early 1980s.Since then the price adjustment embarked upon by the government due to advise of the World Bank and IMF have had untold hardship on households in termsof the energy use by the households especially the poor. There has been increase in the price of petrol, for example from N0.60 in 1991 to about N97.00 in 2012. The trend indicated that the price was N11.00 in 1994 and was changed to N20.00 in 1998. This implies that between 1991 and 1998 there has been an increase of over 3000%. There has been increase in price of kerosene and Liquefied Natural Gas (LPG), for example the cost of kerosene which is the major source of energy for household cooking rose from N0.40 per litre in 1991 to N6.00 in 1994 and N17.00 in 1998, it has since the advent of the democratic dispensation rose to N50.00.A 12.5kg cylinder of LPG rose from N200 in 1991 to about N3, 900.00 in 2012. Table 1 shows the rate of increase in the price of petroleum product used for domestic cooking by households.

Table 1: Price of Petroleum Product Used for Domestic Cooking in Minna.

Year	Kerosene		LPG	
	N/litre	% change	N/litre	% change
1991	0.40	-	80	-
1993	2.75	587.5	200	150.0
1994	6.00	118.2	200	-
1998	17.00	183.3	450	125.0
2000	17.00	-	1,000	122.2
2002	24.00	58.3	1,200	20.0
2004	50.00	34.2	1,500	25.0
2008	50.00	-	2,500	66.7
2012	50.00	-	3,900	56.0

Source: Adapted from NNPC Annual Report, 2012.

The effect of increase in petroleum price adjustment on household poverty indicated that over 73.0% of the households in Nigeria are badly affected by the increase in the price (Tomori, 2005). This has led to households shifting from this conventional energy to non-conventional ones. The proportion of consumers using firewood for cooking purposes has increased tremendously especially in Niger state where there is availability of shrubs to be cut down for charcoal and wood fuel as source of cooking in Niger state due to the economic meltdown. The change in the proportion of people using the charcoal and firewood in Minna Niger state according to Abdulrazak (2012) is tabulated in table 2 below.

Table 2: Number of Households using Different Energy Source for cooking in Minna.

Energy type	2000-2003		2004-2008		2009-2012	
	Low %	Medium %	Low %	Medium %	Low %	Medium %
Firewood	10.0	4.0	45.0	25.0	65.0	54.0
Charcoal	2.0	5.0	15.0	11.5	21.0	17.0
Kerosene	84	60.0	35.0	30.0	6.5	15.0
LDG	1.2	25.0	0.0	1.5	0.0	2.0
Electricity	1.0	5.0	1.0	3.0	0.5	1.0
Others	0.0	0.0	0.0	20.0	0.0	0.0
No response	1.8	2.0	4.0	5.0	7.0	10.0

Source:AbdulrazakN.T.A.(2012)

The analysis shows that the consumers of kerosene have shifted to the use of firewood and charcoal due to the fact that they are low income earners and the increase in the price of kerosene have not allowed them to use the product often. Furthermore, it was revealed that the price of the product is not what the government place on it due to scarcity and non-availability of the product in the market.

The effect of the scarcity and increase in price of this conventional energy is the use of charcoal, firewood which has also increased the users and sellers of the product. There has been an increase in the number of participants (both men and women) who are now involved in the marketing of firewood. The price of firewood overtime has also increase not minding the consequential effect on the environment and users health. A bundle of firewood that cost N10 in 1992 was sold for N50 in 1999 and now cost about N100 in 2014. This quantity of firewood is about enough for the cooking need of an average household in a day. It also results to the increase in the production of charcoal. Charcoal is readily available anywhere in many neighbourhoods for as cheap as N20 one can buy charcoal from vendors shop. The pictures below show bag of charcoal at a vendor's shop which is sold for N1200 per bag and N20 per retail quantity.

SourceAuthor'sFieldSurvey, 2014

HOUSEHOLDEXPENDITUREONENERGY FORCOOKING

Household have been spending money to provide necessary energy for cooking on a daily basis and Because of poverty and dwindling economy the propensity of the households to spend more on domestic energy has resulted in changing from conventional to non-conventional method so as to reduce the cost of energy provision by the households. The increasing cost of kerosene has shown that between 2000 and 2012 the cost rose astronomically, from ₦17 per litre to ₦50 a litre in the open market, but because of non–availability and the activities of middlemen has increased the price to as much as ₦160 per litre at the black market. This implies that the upward review of petroleum product has increased the daily expenditure on purchase of this product. The survey indicates that households are spending more than ₦500/daily on the provision of kerosene for cooking. This has led to the indiscriminate use of fire wood and charcoal which seems cheaper and readily available. The numbers of people engaged in production and consumption of biomass has increased greatly. The analysis of the household expenditure on energy for cooking is tabulated thus in table 3 below.

Table 3: Monthly Expenditure on Energy for Cooking by Household in Niger state

Amount (N)	Lowincome 2000–2003	2004–2008	2009–2014	Middleincome 2000–2003	2004–2008	2009-2014
1-1,000	22.6	20.4	18.3	34.1	10.9	20.3
1001–2,000	70.2	68.6	70.6	63.3	64.4	72.6
2,001–3,000	6.5	10.5	9.9	6.6	20.3	4.6
Above 3,000	0.7	0.5	1.2	0.0	4.5	2.5
	100	**100**	**100**	**100**	**100**	**100**

Source: Author's Field Survey, 2014

The analysis indicated that the low income earners, those who spend about N1000 on domestic energy for cooking has diminished from 22.6% in 2010 to 18.3% in 2014. Also those who spend betweenN1000 - N2000 varied between 68.6% in 2004 and 70.6% in 2014. Also, those that spend between N2001 and N3000 increases to 5% in 2000 and 10% in 2004 and also those that spends more than N3000for domestic energy for cooking.

Furthermore, the expenditure of the households in medium income group on domestic energy use all shows the same characteristics with the low income earners while there was decrease in those that spends within N1000 from 34.1% in 2000 to about 20.3% in 2014;Also there has been an increase in the number of households that spend between N1000 to N2000 on domestic energy with 63.3% in 2000 and 72.6% in 2014. Those that spend above N3000 in 2000 were initially nonexistence but have increased to 4.5% in 2004. This however increases the percentage of households that live below the poverty index. The major reason why households have shifted from the use of domestic fuel to alternative domestic energy source like firewood and charcoal is because of the relative cheap prices of these energy sources compared to kerosene and LPG and this is observed to be the adaptive measure developed by the various households to mitigate the impact of the high cost of domestic fuel.

IMPACT OF THE USE AND PRODUCTION OF CHARCOAL

There is a direct relationship between Poverty, Energy consumption and Environment. The use of Biomass for energy is mostly used in traditional African cities and is favoured because of its cheapness and its availability. Sub-Saharan Africa, accounts for about 40% of the world hardwood (FAO, 2004). The use of fuel wood accounted for between 70% and 90% of the total consumption of domestic energy use in Nigeria today (Abd'razack and Ahmad Nazri, 2011), this corroborated the estimation of 91% of biomass been used by households in Nigeria for domestic energy consumption by Kerekezi (1999).

The consumption of any form of energy has effect on the environment though their impacts vary from lowest in LPG and highest in biomass. The loss of varieties of forest resources such as trees, animals as well as soil erosion, deforestation and desertification has emerged as environmental effect of consumption of biomass in Nigeria. About 75% of the population of Nigeria depends on this biomass for their energy use (Adelekan and Jerome, 2006). This has placed a lot of pressure on the forest resources of the country, it has been estimated that about 45,000 hectares of woodland are lost annually on this illegal felling of trees and shrubs for domestic biomass and charcoal production. If the trend continues like this, the implication is that by 2020 all the forest resources would be lost (Oladosu and Adejulugbe, 1994). One of the factors thatcause climate change is the accumulation of CO_2 in the atmosphere, which is above the required atmospheric limit; this has caused the depletion of Ozone layer and created global warming. CO_2 is the major contributor to the generation of greenhouse gases. The consumption of biomass has been one of the major contributors to Ecological Footprint in Nigeria (Abd'razack and Ahmad Nazri, 2012).

The use of biomass exposes women and children who are saddled with responsibility of cooking to high level of Indoor Air Pollution (IAP). The level of poverty has also led to the reduction in the type of windows been used by households because standard are not followed in the construction of dwellings, especially in the low-income neighbourhoods. The effect of this is poor ventilation which further exposes women and children to IAP. World Health Organization estimated that Africa accounts for 24% of the world IAP death in the world as related by Warwick and Doig (2004). IAP as a "killer in the kitchen" accounts for 1.6 million death globally (WHO, 1996). This call for change in household energy consumption pattern due to the effect it has on users and the environment. The consumption of biomass is fast becoming the order of the day as the cost of the alternative energy is on the increase. For example, the tariff of electricity was increased by 52% between 2011 and 2012. This aggravates the consumption of the biomass in Minna. This has created micro climate as deforestation is highly common especially at the city fringes. There are a lot of trucks that brings in biomass to Minna every day (see plates 3 and 4 below) from within and surrounding villages for domestic consumption. Various health and environmental issue in wood fuel consumption are discussed thus:

Plate 3: Showing A charcoal Smuggler, Smuggling into the town of Minna
SourceAuthor'sFieldSurvey, 2014

Plate 4: Showing ATraveler Buying Charcoal in his Journey along Minna-Bida Road
SourceAuthor'sFieldSurvey, 2014

INDOOR AIR POLLUTION

Majority of the buildings in the selected neighbourhoods of DutsenKuran Hausa, DutsenKuranGwari and Jikpanarea (Low-Income group) have poorly ventilated dwellings, which aggravate IAP and also the use of outdoor kitchen. The low-income neighbourhoods shows non-compliance with building regulations as buildings looked clustered without setbacks, the structures are dilapidated with inadequate spacing, though the buildings in middle-income areas of London Street and Bajago area shows different outlook but their characteristics are similar.

The analysis of the cooking habits of the neighbourhoods indicated that 63.3% of the low-income

Neighbourhood has their kitchen built in while 10.7% cooked in the kitchen detached from their dwellings, this is similar to medium-income neighbourhoods which indicated that 81.7% of the households cooked in built-in kitchens, and 8.3% in the detached kitchens. Other ways of cooking include cooking in the room, corridors etc. The analysis of cooking facilities is shown in the table 4.

Table 4: Cooking Facilities for the Households

Cooking Facilities	Income Level	
	Low (%)	Medium (%)
Built in Kitchen	63.3	81.7
	10.7	8.3
Inside the room	15.1	5.7
Within the Corridor	10.4	4
Total	100.0	100.0

Source: Author's Field Survey, 2012

Cooking in the room and corridors has health implication as it aggravate IAP which exposes the households to health hazard, coupled with poor ventilation that has greater effect on their lives. Poor ventilation in majority of low-income neighbourhoods aggravates the concentration of IAP in these neighbourhoods. Other pollutants in biomass consumption include Suspended Particle Matters (SPM), CO, NO, formaldehyde and compound such as Polyaromatic hydrocarbon etc. The consumption of biomass causes the accumulation of toxic substances in the atmosphere.

Though a lots of women are not aware of the implication of consumption of biomass except the smoke and blackened pots and walls. The associated environmental and health hazard of consumption of wood fuel are thus: sore and redness of eye, burning and irritation of the body due to burning of biomass; it also lead to exhaustion, tiredness and illness as a lot of energy is required in lighting and fanning of the woods; discomfort due to heat trapped in the kitchen and smelling of clothes due to settled smoke on it among others.

Plate 4: Showing Awoman and her child reacting to smoke in the kitchen
Source:UCS, 2008

DEFORESTATION

The city limits which include the peri-urban have suffered greatly as deforestation has set in due to the activities of felling of shrubs and trees in Minna and its environs. The reserve forest has been depleted. Nearlyall the wood fuel consumed in Minna is obtained from the peri-urban and the villages within the Minna region. There is felling of trees that are as far as 40Km from the city of Minna (in the villages of Essan-Nubupi, Gurara Kataeregi, Kakakpangi, Kochikota, Epan Bokungi etc.) to cater for the consumptions in Minna, Bida, Suleja ans other parts of the State. There are more than 50 sale points identified by the research within Minna city alone and alot more could be identify in other parts of the state. The majority of the consumers of the biomass purchase it from these sale points (93.5%) while about 6.5% obtained the product directly from their farmlands. The scarcity of kerosene and its cost has also aggravated the use of biomass. There has been increase in the participation of this trade in recent time (though it has started as far back some 15 years ago). The effect of this has led to increase in the cost of measure of the product and rate of deforestation and desertification.

CONCLUSION

The type of energy used by majority of a population reflects the extent of economic development and civilization already attained. Specifically, the nature of domestic energy demand is vital for ensuring sustainable development and reduction of indoor environmental pollution. The results have shown that a lot should be done in ensuring that safer and cleaner sources of energy are available to rural households. Conventionally, availability, affordability and convenience of usage are critical issues to be taken into consideration when making choices among alternative energy sources that are available. There is the need for governments' intervention in making kerosene available to rural poor. This is the source of energy that was mostly used. This effort will reduce pressure on the forest and also reduce the negative impacts it has on the households and the environment.

REFERENCES

Abd'razack,NelsonT.AandAhmadNazirbinM.L(2012):BenchmarkingSustainabilityandEcologicalFootprintofAfricancities.BookofProceedingsofSEATUCConference,Bangkok,Thailand. March.

Adelekan, I.O and Jerome, A.T (2006): Dynamics of Household Energy Consumption in a Traditional African City,Ibadan.*Environmentalist.*SpringerScienceBusinessMedia.LLC.2699-110.DOI10.1007/s10669-006-7480-2.

AlemuM*etal*(2009).Incomealonedoesn'tdetermineadoptionaschoiceoffueltypes:Evidence fromhouseholdsinTigraiand major citiesinEthiopia.EFDPolicyBrief.

AmousS(2000).Reviewof woodenergyreportsfromACPAfricancountries. EC-FAO PartnershipProgrammeWorkingDocument, Rome.

AsoutiEandAustinP(2005).ReconstructingWoodlandVegetationanditsExploitation byPastSocieties, BasedontheAnalysisand Interpretation of Archaeological WoodCharcoal Macroremains, EnvironmentalArchaeology,10:1-18.

ESMAP(2003).HouseholdfueluseandfuelswitchinginGuatemala.Joint UNDP/world BankEnergySectorManagementAssistanceProject.

FoodandAgriculturalOrganization(FAO)(1983).Woodfuelsurveys.GCP/INT/365/SWE,FoodandAgricultureOrganizationoftheUnitedStates,Rome.

FoleyG(1986).Charcoalmakingindevelopingcountries.TechnicalReportNo 5.IIED.Earthscan.London.

HarschE(2001).AfricanCitiesunderStrain.AfricaRecovery,Vol15,No1-2, UnitedNations.

kaaleBK(1985).Utilizationoffuelwoodandcharcoal in EastAfrica. EnergyResourcesGroupReviewPaper 38.MinistryofLand,NaturalResourcesandTourism.

KaluC,IzekorDN(2007).CharcoalenterpriseinBeninCity, EdoState. J.Ap.Sc.Env. Mgt.11(30):63-67.

Karekezi, S. (1999): Access to Modern Energy-A View from Africa in *"Energy after the Financial Crisis: Energy andDevelopmentReport1999"*.Washington,WorldBank.

Maxlock,(1980):FinalDraftcopyofMinnaMasterplan.MaxlockPublishers,Maiduguri.Nigeria.

NationalPopulationCommission,(2010):Priority Tablesfor2006PopulationandHousing Census.NPCPublications,PresidencyAbuja

Oladosu,G.A.andAdegbulugbe,A.O.(1994):Nigeria'sHouseholdEnergySector:IssuesandSupply/Demandfrontiers.*EnergyPolicy*.22 (6)538–549.

RezendeME(1993).CommercialCharcoalManufactureinBrazil.FirstBiomasEnergyCongressoftheAmericas, Burlington, Vermont,USA.

SathayeJandTaylerS(1991).Transition inhouseholdenergyusein urbanChina,India,thePhilippines,Thailand,andHongKong.AnnualReview ofEnergyand theEnvironment.

Sathaye,JandMeyer,S. (1990):UrbanEnergyUsein DevelopingCountries:AReview.CitedinDesai,A.V.(ed):PatternofEnergyuseinDevelopingCountries.IDRCandUNUWilleyEasternLimitedNewDelhi.

Smith,K.R.(1994):AirPollutionandtheEnergyLadderinAsianCities.TheInternationalJournal of Energy.18 (5).

UzomaCD(2006).IndigenousPeopleRightCrusader. WRM'sBulletinNo106.

United Nations Development Programme (2000) World EnergyAssessment,UNDP/UNDESA/WEC

WilliamsE(2000).GlobalProductionChains andSustainability:theCaseofHighPuritySiliconanditsApplicationinITandRenewable Energy.UnitedNationsUniversity.

UNCHS(Habitat)(1991):UseofEnergybyHouseholdsandinConstructionandProductionofBuildingMaterials.Themepaperpresentedto thethirteenthsessionofthecommissionon humansettlementsHarare,Zimbabwe,29April-8May,1991.

Warwick,H.andDoig,A.(2004): *Smoke-theKiller in theKitchen*,ITDGPublishing,London.

WorldBank/UNDP:1989,*Senegal:UrbanHouseholdEnergyStrategy*,ESMAPReportNo.96/89.

WorldResources(2001).PeopleandEcosystem:TheFrayingWebofLife.WRI.WashingtonD.C.

HUMAN CONTRIBUTIONS TOWARDS THE DEVASTATION OF FLOOD ON COMMUNITIES IN KADUNA STATE

SALIHU Usman Tyabo, MORENIKEJI Fisayo Teniola,
MUHAMMAD Bello Ndawashi & OTIJELE Godwin Omachoko
Department of Architecture, Federal University of Technology Minna, Niger State.

Rife is the gospel of sustainable development which has led to new millennium development goals with a 2030 deadline to improve the survival of life on earth in the face of the challenges arising from climate change. Climate change is a variation in the global weather pattern over a long period of time due to increasing atmospheric temperature resulting from the release of greenhouse gases. Consequently, related risks such as floods are on the increase and posing threats to human settlements through disease spreads, population displacement, injuries and in extreme cases, death. This paper has examined the impact of flood on the affected communities within Kaduna state. Particularly, it looked at the causes of flood in the affected areas, adverse effects and how human activities have influenced recurrence. Flood is a natural mishap primarily caused by heavy rainfalls and often times due to obstacles along water ways. The tragic incident in recent years has claimed lives and destroyed properties in several neighbourhoods. Using the descriptive survey method of research, questionnaires were administered in five (5) local government areas. Data obtained from the field were converted to descriptive statistics for ease of interpretation. The results show that flooding in Kaduna state is caused by accumulation of wastes dumped in drainages. 31.8% of respondents in Soba local government area blame urban development. This research pointed that property loss is the most common adverse effect of flood. In addition, 25% of the respondents suggested that the waste management system be improved. Finally, this research emphasises the need for educating the general public on human activities impacting on global warming.

***Keywords**: Climate Change, Greenhouse Gases, Flood, Global Warming, Rainfalls*

ibnsalih19@yahoo.com

SALIHU et. al. (2016). **HUMAN CONTRIBUTIONS TOWARDS THE DEVASTATION OF FLOOD ON COMMUNITIES IN KADUNA STATE** Sustainable Built Environment and Climate change; The challenges of Post 2015 Development Agenda. School of Environmental Technology Conference, SETIC, 2016

INTRODUCTION

Life on earth is rapidly affected by the consequences of climate change which has negative impacts on the environment. These impacts have been categorised by scientists into three (3) broad groups namely; human health risks, altered ecosystems and weather extremes, posing the most threat to life as it affects water balance resulting in flood. Flood in some cases is caused by heavy rainfalls which the ground absorbs beyond its retaining capacity. It is also a natural occurrence whose damages are resultants of human activities (Douglas et al., 2008). The rapid development in urban areas has brought about an increase in population around floodplains, particularly by the poor. Activities carried out in these settlements have further hampered run-off and restricted the flow of water through natural channels. Of all world natural disasters, flood is the most disastrous, frequent and widespread (Bashir et al., 2012). Flood has benefits that counter its adverse effects (Bradshaw et al., 2007) if only it occurs in its natural state away from areas inhabited by humans. It is not a challenge if human settlements are not affected. In 2012, Nigeria experienced excessive flooding resulting from the dam walls release in Cameroon during which lives were lost, people displaced, properties destroyed and economic activities disrupted (Tawari-Fufeyin et al., 2015) affecting about eleven (11) states. Similarly, fifty-three (53) people were killed and over one hundred thousand (100,000) were displaced across eleven states due to flood in 2015 ("National Tragedy: Floods kill 53, Displace 100,420 People across Nigeria," 2015). Meanwhile, humans are directly or indirectly responsible for the effects of climate change the world is presently facing and those that may emerge in no distant future.

The quality of life on earth inspired the aim of this research which is to investigate the contributions of human activities towards the occurrences of flood in Kaduna state. It focused on the flood that occurred in 2015 and checked if the victims were aware of the impact their activities have on global warming. Flood devastation experienced in recent times have gotten worse due to rapid urbanisation and increasing population. Notwithstanding, this research paper discussed far-reaching solutions that can be adopted for mitigation against adverse flood effects.

Flood in Nigeria: Natural or Manmade Disaster

Rising sea levels are caused by global warming (Kolawole et al., 2011) and the negative impacts of greenhouse gases on the climate. This has greatly influenced the intensity of flooding. Flood may occur naturally or may be induced by human activities. According to Etuonovbe (2011), flooding occurs in the following forms in Nigeria:

- Coastal flooding; which occurs around coastal regions such as the Niger-Delta
- Flash flooding; occurs when heavy rains suddenly convert rivers in inland areas to torrents
- River flooding; occurs along the floodplains of large rivers
- Urban flooding; occur in urban areas where drainage systems are inadequate, blocked with wastes or absent

- Dam related flooding may also arise from dam spills or levee failures

Although flood is associated with rain water and water bodies, non-coastal areas are sometimes affected. Hirabayashi et al., (2008) established that flood risks are expected to increase in tropical Africa. Recently, Nigeria experienced “killer floods” during which non-coastal cities were affected. According to Adetunji et al., (2013), Ibadan is one of such cities and has been experiencing flood devastation since 1933. With each year, flood hazards in Nigeria tend to be worse than the previous year.

Kaduna state has had its fair share of the natural disaster, destroying infrastructure within the municipality (Ijigah and Akinyemi, 2015) and socio-economic losses due to floodplain encroachment (Ndabula et al., 2012).

Effects of Flood on Human Settlement

Numerous effects have been attached to the tragic event called flood, some of which are considered adverse. They could be social, economic and/or health related effects which affect lives of the victims, properties and the environment. According to Adedeji and Salami (2011), effects of flood on buildings are of three (3) types namely; structural, health and economic. They further explained that the buildings may collapse due to dampening of the base blocks. Plate I below shows the damage done to a building by flood. Health risks associated with floods include water-borne diseases through contamination. The economic affects as described by Rabalao (2010) include tourism declination, shortage of food, inflation and costs of rebuilding damaged infrastructure. Flood victims in most cases are poor people who cannot afford to live in city cores as such, find solace around floodplains. Usually, flood alerts and warnings are made prior to occurrences by the agency in charge of metrological observations in municipalities.

Plate I: Eroded Foundation of an uncompleted Building due to Flood

Unfortunately, victims are sometimes emotionally attached to their homes located in these flood prone zones. The magnitude of the disaster varies according to region, volume of water and duration of the flood. Adverse effects may last for weeks, months or a lifetime in instances where loved ones are lost. In reality, the memories are never gone.

Human Influence in Increasing Flood Vulnerability

Many factors determine the peak discharge of flood (Konrad, 2014) including land use and human activities. Contrary to the run-off processes in forests and green lands characterised by vegetation, urban areas lack the adequate capacity to store rain water simply because surfaces such as roads are impermeable. Human activities have altered natural processes. These include:

- Urbanisation; an all-encompassing word used to describe the human activities that result in flooding. Urban development involves land clearing, road construction and building erection, increasing the likelihood of flooding (Doswell, 2003).
- Deforestation; the climate gets drier when parts of forests are removed. This phenomenon is called deforestation. According to Chakravarty et al., (2012), flooding increases with increase in deforestation. This activity makes soil particles loose thereby causing rapid soil erosion.

- Climate Change; flood is a climate related natural hazard with increased risks based on changes in temperature and precipitation globally.

Another important human factor is the dredging of the river bed.

Flood Management and Mitigation

Key consideration in flood management is the drainage system which requires careful planning strategies and policy implementation. From inception, areas vulnerable to flooding need to be identified (Ishaya et al., 2009) to ensure precautionary measures are put in place for prevention and control. In same vein, Amadi and Ogonor (2015) reiterated the need to enlighten the poor inhabitants of coastal areas and flood plains on the dangers posed by climate change.

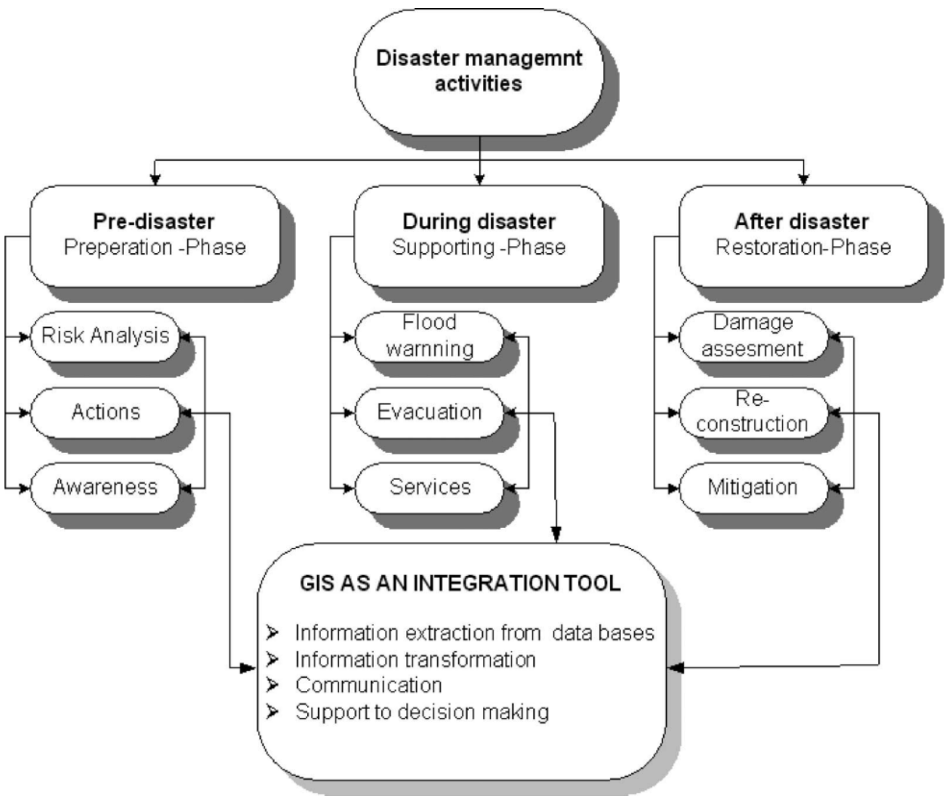


Figure 1.0: Disaster Management Framework

Figure 1.0 explains the various phases of flood disaster and how it can be managed. Before flooding occurs, risk analysis should be carried out on prone areas and the residents of such areas made to understand the hazards attached. Although warnings are not heeded, the agencies involved are expected to exhaust all efforts in ensuring that people are informed. This exercise is best carried out through the media. Furthermore, evacuation of flood victims should be the spine of the mitigation strategies.

RESEARCH METHOD

Data obtained for this research were gotten through primary sources using the questionnaire as a research instrument and secondary sources by reviewing published and unpublished literature. A total of one hundred and twenty five (125) questionnaires were administered uniformly in five (5) local government areas of the study area Kaduna state, namely; Kachia, Kaduna North, Kaduna South, Kajuru and Soba. The selection was determined using the communities affected by flood which are located in these areas. Using the random sampling technique, one community was selected in each of the five (5) local government areas. Ninety-one (91) copies were returned and analysed using the Statistical Package for Social Sciences (SPSS). The results discussed were presented using descriptive statistics such as tables and charts. Table 1.0 below shows the selected areas that constitute the sample size. Kaduna state, made up of twenty-three (23) local government areas is located in north-west Nigeria characterised by wet and dry seasons. Average rainfall per year is about 1323mm (Abaje et al., 2015) spanning between early April and middle of November.

Table 1.0: Selected Areas and the Sample Size

S/No.	Local Government Areas	Affected Communities	Number of Questionnaires returned
1	Kachia	Kachia	19
2	Kaduna North	Rafin Guza	22
3	Kaduna South	Nassarawa	20
4	Kajuru	Ungwa-uku	17
5	Soba	Maigana	13
Total			91

Source: Researcher's Field Work 2015

FINDINGS AND DISCUSSION OF RESULTS

With regards to the context of discourse as reviewed in existing literature, flood hazards are disastrous and disrupt the socio-economic activities of the affected areas. Factors responsible for their occurrence are numerous and differ along climatic factors and geographical conditions. Although climatic factors are readily sighted, causes of urban floods have been blamed on the accumulated human activities over a period of time. A critical analysis of the flood cases in Kaduna state show that the frequency of flood has increased with increased conversion of land use in urban areas. However, the field exercise carried out during the cause of this research captured the opinions of the respondents' resident in the affected areas. Table 2.0 shows the causes of flood in Kaduna state.

Table 2.0: Causes of Flood in Affected Areas of Kaduna state

	Factors Responsible for Flooding						
Local Government Areas	No Drainage (%)	Heavy Rainfall (%)	River Overflow (%)	Wastes Dumped in Drainages (%)	Urban Development (%)	Poor Planning (%)	Total (%)
Kachia	11.1	22.2	5.6	33.3	16.7	11.1	100
Kaduna North	5.3	26.3	5.3	36.7	21.1	5.3	100
Kaduna South	10.5	15.8	15.8	47.3	5.3	5.3	100
Kajuru	7.7	15.4	15.4	38.4	15.4	7.7	100
Soba	9.1	27.3	4.5	18.2	31.8	9.1	100

Source: Researcher's Field Work 2015

By inference to Table 2.0 above, 33.3%, 36.7%, 47.3%, 38.4% and 18.2% of the respondents in Kachia, Kaduna North, Kaduna South, Kajuru and Soba local government areas respectively claimed that wastes dumped in drainages are the primary causes of flood in the affected areas of the state. The second ranking factor as observed from the table is heavy rainfall which is based on the increase in precipitation recorded yearly in the state for over a decade. While a larger percentage of the respondents affirm that drainages exist, a fraction believe that flooding in the state is as a result of poor planning. In Soba local government area, 31.8% of the respondents claimed that urban development is the main cause of flooding in the area. The urban development in this area is low-scale when compared to Kaduna North and Kaduna South local government areas, both of which are located in the state capital. Figure 2.0 shows the common adverse effects of flood experienced by the respondents. It is almost impossible for flood to occur without having adverse effects on affected areas. This informed the research to enquire from the respondents what these common effects are.

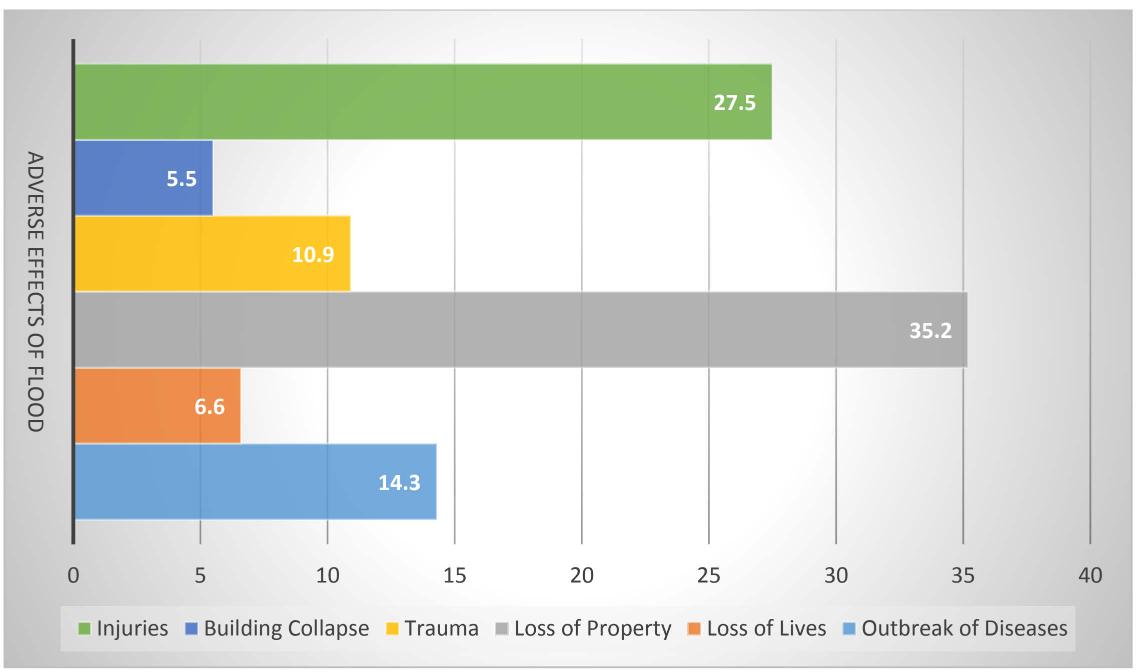


Figure 2.0: Most Common Adverse Effects of Flood

Figure 2.0 shows the opinions of respondents on common adverse effects of flood. 35.2% of the respondents claim property loss is the most common effect of flood, 27.5% went with injuries, 14.3% claimed it is the outbreak of diseases, 10.9% are of the view that trauma is most common, 6.6% chose loss of lives while 5.5% believe building collapse is the commonest adverse effect. Although these effects and many more are witnessed before, during or after flood occurrences, some are predominant in certain areas over time. In addition, people react differently to flood hazards.

Property loss is the most common adverse effect peculiar to the affected areas of Kaduna state. Other effects such as loss of lives and building collapse occur less in most cases. In few other cases, injuries are sustained and possible outbreak of diseases. Water-borne diseases are usually post-disaster effects which may become widespread and difficult to treat. Despite this life threatening challenges, only few of the victims relocate permanently. Most of the residents stay back, rebuild, live and pray for little or no flood next time. Figure 3.0 below points out reasons why people live around coastlines.

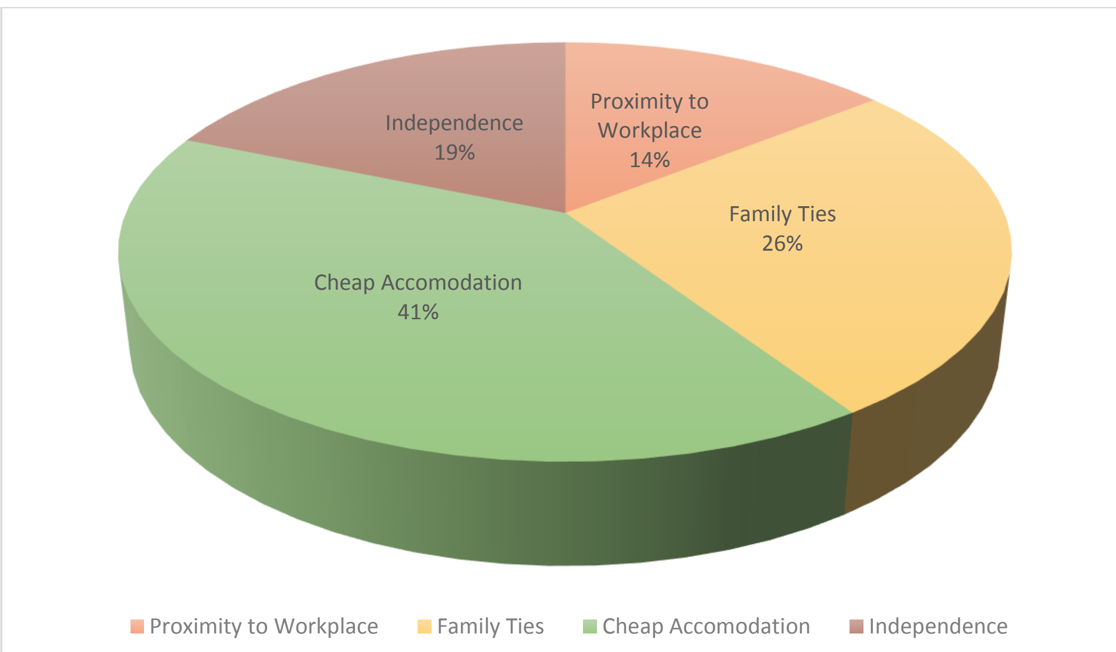


Figure 3.0: Reasons why People Live around Coastlines

Sometimes common sense is abundant, although it is uncommon in some scenarios considering the increasing human population around floodplains and sometimes coastal lines. The obvious reasons are shown in Figure 3.0 above. 41% of the respondents claim that cheap accommodation is the reason why people live in areas prone to flooding. 26% believe that residents of such areas remain there so as to maintain bonds of kinship. 19% understand that some of the residents are old enough to cater for themselves as such, leave home in search of independence while 14% claim the residents choices are based on nearness to their workplaces. Unless the residents are fishermen, living around coastlines is almost unnecessary. Usually, housing within towns and cities are quite expensive making people opt for cheaper alternatives in the suburbs. Nonetheless, respondents were asked to suggest possible measures for flood management. Figure 4.0 below expresses respondents' approach to flood mitigation.

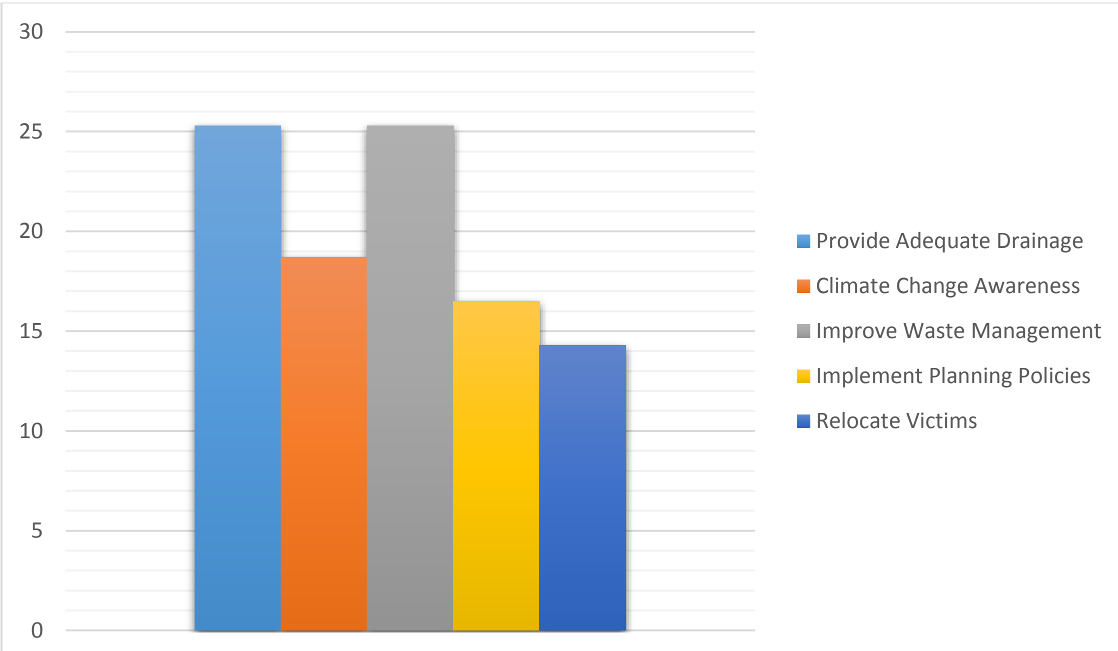


Figure 4.0: Flood Mitigation Measures

According to figure 4.0 above, 25% of the respondents suggested that adequate drainage be provided to mitigate against flood. Similarly, another 25% are yearning for improved waste management system. 19% of the respondents are advocating for climate change awareness. 17% are asking for the proper implementation of planning policies while 14% are of the opinion that victims be relocated. Relocating victims is actually a short-term move to say the least and unsustainable considering the financial implications. Although there are drainages in these areas, they are block by accumulated wastes hence, hindering their proper functioning. Climate change is a sensitive subject whose consequences are detrimental to human existence. Unfortunately, people are heedless of this menace especially in developing and under-developed countries.

CONCLUSION

Flood risks have increased with regards to human activities contributing to global warming. Although seemingly impossible to prevent its occurrence, it is feasible to reduce the damages caused by the disaster. Enlightenment campaigns should be embarked upon in order to create awareness on climate change. The effects of flooding can also be reduced if adequate drainages are provided with well integrated waste management systems. Afforestation should be encouraged on a large scale to replace lost ground cover and vegetation. Also, the government should ensure that structures built along water channels are removed while enacting laws that will discourage construction on waterways.

REFERENCES

Abaje, I. B., Sawa, B. A., Iguisi, E. O. & Ibrahim, A. A. (2015). Assessment of Rural Communities' Adaptive Capacity to Climate Change in Kaduna State, Nigeria. Journal of Environment and Earth Science, 5(20), 14-23. Retrieved from http://iiste.org/Journals/index.php/JEES/article/view/26534/27174

Adedeji, A. A., & Salami, A. W. (2011). Environmental hazard: Flooding and Its Effects on Residential Buildings in Ilorin, Nigeria. Retrieved from https://unilorin.edu.ng/publications/adedeji/(21)-Environmental%20Hazards.pdf

Adetunji, M., & Oyeleye, O. (2013). Evaluation of the Causes and Effects of Flood in Apete, Ido Local Government Area, Oyo State, Nigeria. *Civil and Environmental Research*, *3*(7), 19-27. Retrieved from http://www.iiste.org/Journals/index.php/CER/article/download/6111/6245

Amadi, L., & Mac Ogonor, C. U. (2015). Climate change, environmental security and displacement in Nigeria: Experience from the Niger Delta Flood Disaster, 2012. *African Journal of Environmental Science and Technology*, *9*(1), 53-64. Retrieved from http://www.academicjournals.org/journal/AJEST/article.../612E82749518

Bashir, O., Oludare, A., Johnson, O. & Aloysius, B. (2012). Floods of fury in Nigerian cities. *Journal of Sustainable Development*, *5*(7), 69-79. http://dx.doi.org/10.5539/jsd.v5n7p69

Bradshaw, C. J. A., Sodhi, N. S., PEH, K. S. H., & Brook, B. W. (2007). Global evidence that deforestation amplifies flood risk and severity in the developing world. *Global Change Biology*, *13*(11), 2379-2395. http://dx.doi.org/10.1111/j.1365-2486.2007.01446.x

Chakravarty S, Ghosh S. K., Suresh C. P., Dey A.N., and Shukla G. (2012). Deforestation, Causes, Effects and Control Strategies. In C. A. Okia (Ed.), *Global Perspectives on Sustainable Forest Management* (pp. 3-29). Retrieved from http://www.intechopen.com/download/pdf/36125

Doswell III, C. A. (2003). *Flooding.* Norman, OK: University of Oklahoma. Retrieved from http://curry.eas.gatech.edu/Courses/6140/ency/Chapter8/Ency.../Flooding.pdf

Douglas, I., Alam, K., Maghenda, M., Mcdonnell, Y., McLean, L., & Campbell, J. (2008). Unjust waters: climate change, flooding and the urban poor in Africa. *Environment and Urbanization*, *20*(1), 187-205. http://dx.doi.org/10.1177/0956247808089156

Etuonovbe, A. K. (2011). The Devastating Effect of Flooding in Nigeria. *Hydrography and Environment.* Retrieved from http://www.fig.net/resources/proceedings/fig_proceedings/fig2011/papers/ts06j/ts06j_etuonovbe_5002.pdf

Hirabayashi, Y., Kanae, S., Emori, S., Oki, T., & Kimoto, M. (2008): Global Projections of Changing Risks of Floods and Droughts in a Changing Climate. *Hydrological Sciences Journal, 53*(4), 754-772. http://dx.doi.org/10.1623/hysj.53.4.754

Ijigah, E. & Akinyemi, T. A. (2015). Flood Disaster: An Empirical Survey of Causative Factors and Preventive Measures in Kaduna, Nigeria. *International Journal of Environment and Pollution Research, 3*(3), 53-

66. Retrieved from http://www.eajournals.org/wp-content/uploads/Flood-Disaster-An-Empirical-Survey-of-Causative-Factors-and-Preventive-Measures-in-Kaduna-Nigeria.pdf

Ishaya, S., Ifatimehin, O. O., & Abaje, I. B. (2009). Mapping Flood Vulnerable Areas in a Developing Urban Centre of Nigeria. *Journal of Sustainable Development in Africa*, *11*(4), 180-194. Retrieved from http://jsd-africa.com/Jsda/V12NO2_Winter2009_B/Pdf/Mapping%20flood%20vulnerable%20Areas%20in%20a%20Developing%20urban%20centre%20of%20Nigeria.pdf

Kolawole, O. M., Olayemi, A. B., & Ajayi, K. T. (2011). Managing flood in Nigerian cities: Risk analysis and adaptation options-Ilorin city as a case study. *Archives of Applied Science Research*, *3*(1), 17-24. Retrieved from https://unilorin.edu.ng/publications/olayemi/4.pdf

Konrad, C. P. (2014). Effects of Urban Development on Floods. Retrieved from http://pubs.usgs.gov/fs/fs07603/

National Tragedy: Floods kill 53, Displace 100,420 People across Nigeria (2015, September 20), Premium Times. Retrieved from http://www.premiumtimesng.com/news/headlines/190364-national-tragedy-floods-kill-53-displace-100420-people-across-nigeria.html

Ndabula, C., Jidauna, G. G., Oyatayo, K., Averik, P. D., & Iguisi, E. O. (2012). Analysis of Urban Floodplain Encroachment: Strategic Approach to Flood and Floodplain Management in Kaduna Metropolis, Nigeria. *Journal of Geography and Geology*, *4*(1), 170-182. http://dx.doi.org/10.5539/jgg.v4n1p170

Rabalao, R. T. (2010). The Social, Psychological and Economic Impact of Flooding In Ga-Motla and Ga-Moeka Communities of Moretele District in North West Province, South Africa (master's thesis). University of The Free State, Bloemfontein, South Africa.

Tawari-Fufeyin, P., Paul, M., & Godleads, A. O. (2015). Some Aspects of a Historic Flooding in Nigeria and Its Effects on some Niger-Delta Communities. *American Journal of Water Resources*, *3*(1), 7-16. http://dx.doi.org/10.12691/ajwr-3-1-2

ENVIRONMENTAL IMPACT OF CONSTRUCTION OF GEN. M.I WUSHISHI HOUSING ESTATE ON VEGETATION AND CLIMATE

Muhammad Abdullahi ABDULSALAM[1] & Abdulahi Sule ARGUNGU[2]
[1]Department of Architecture, Federal University Birnin Kebbi.
[2]Department of Water Resources and Enviromental Engineering, A B U Zaria.

In order to cope with the population growth, Urban Migration and impact of climate change, Nigeria like other developing counties demands for more developmental Building Construction projects. The nature of construction today, is such that it impact negatively on the environment in terms of its vegetation. Cutting down of trees and removal of shrubs and grasses has been one of the common practice at the most of the building construction sites. This paper aims at assessing the vegetation changes and subsequent climatic impact of the construction of General M.I Wushishi housing estate at Minna. The aim was addressed by highlighting the number of cut-down tress and affected area of ground cover due to construction activities. The data were collected at the site by used of methods of observation and oral interviews with the residence. The reforestation and soft landscape on the site after the construction was examined. Fifty nine housing units were randomly selected and assessed for afforestation and soft landscaping. Induction method was adopted to ascertain the vegetation density of the area before construction. The total floor area occupied by the constructed structures was also calculated. The outcome of the analysis exposes that mostly "non-economic trees" were destroyed in the course of construction. Afforestation was also significant and high at the three-Bedroom units, by the occupants. Information was also obtained from the project supervisors posted by the Ministry of Works and Housing Corporation. However, the consequences of deforestation highlighted include climate change, soil erosion and the greenhouse effect which have several effects on global ecology.

Key Words: Building counteraction, Ecology, Deforestation, Afforestation.

abdulsalam_muhammad@yahoo.com

ABDULSALAM M. A. & ARGUNGU A. S. (2016). **ENVIRONMENTAL IMPACT OF CONSTRUCTION OF GEN. M.I WUSHISHI HOUSING ESTATE ON VEGETATION AND CLIMATE** Sustainable Built Environment and Climate change; The challenges of Post 2015 Development Agenda. School of Environmental Technology Conference, SETIC, 2016

INTRODUCTION

Nigeria like other developing countries is undergoing rapid growth accompanied by rapid development pressure with high demand for Housing and Infrastructure as a result of population growth. In 2000 the United Nation food and Agriculture Organization (FAO) found that "the role of population dynamics in local setting may vary from decisive to negligible and that deforestation can result from "a combination of population pressure and stagnation of economy, social and technological condition". The present administration of Niger State Government embarked on mass constructions projects in order to reduce the alarming demands of housing. This leads to the obliteration of the natural environment.

Forests are being destroyed for several reasons, among which are the continued urbanization of the world and thus the need for construction of roads and buildings. The need for fuel and timber for construction is another major factor leading to deforestation (Domries and Salati, 1991). However, over half of the worlds tropical rainforest have already been destroyed, and they are continuing to be destroyed today (Dowroes 1991). Moreover, the nature of construction in Nigeria has visibly affected the environment. Environmental Impact Assessment (EIA) in Nigeria is faced with so many challenges from enforcement of laws governing the necessity of EIA in some projects by relevant agencies of Government to collation of adequate baseline data and implementation processes of the project. The socio-economic benefits arising from proper EIA cannot be over-emphasized from environmental sustainability and socio-economic empowerment of the community where the project is undertaken (Hussaini, 2015).

Site clearance is the starter of most construction project and has negative impact on vegetation. Vegetation, as defined by Oxford Advanced Learner's Dictionary; are plants considered collectively, especially those found in a particular area, habitat or environment. Trees, grasses and shrubs are said to be component of vegetation (land scaped elements) and Niger state has the vegetation called Sudan Savannah. Site clearance involves cutting down of existing tress and removal of ground cover. In fact it has become an avenue of deforestation in Minna and its environs.

This paper focuses on the vegetation changes and subsequent climatic impact of the construction of Gen. M.I. Wushish housing estate of Minna. The induction method was adopted in which the number of trees on site was determined before the construction and was compared with the number of trees that have survived the deforestation caused by the construction activities. See plate 1 and 2 below.

Plate 1: The site before construction.

Plate 2: The site after construction

Although, the 2005 report by the united Nation Food and Agricultural organization (FAO) estimated that the Earth's total forest area continues to decrease at about 13 million hectares per year, the global rate of deforestation has recently been slowing down (FAO, 2005). These might be proportional to the rate of construction in an effort to cater for population growth and urbanization. However, the difficulties of estimating deforestation on rates were more apparent in the widely varying estimates of rate of rainforest deforestation. Some environmental groups argue that one fifth of the world's tropical rainforest was destroyed between 1960 and 1996, that rainforest 50 years ago covered 14% of the worlds land surface and have been reduced to 6%, and that all tropical forests will be gone by 2090 (Leakey and Roger, 1996). Some scientists have predicted that unless significant measures (such as seeking out and protecting old growth forests that have not been disturbed) are taken on a worldwide basis, by 2030 there will only be 10% of forest remaining, with another 10% in a degraded condition, 80% will have been lost, and with them hundreds of thousands of irreplaceable species. This is significant at the study area where up to 30% of the forest was destroyed due to construction activities.

It is obvious that deforestation has great effect on the environment most of which are negatives. According to Myers despite the differing statistics among scientists about numbers rather than issues of weather changes there are certain truths which cannot be ignored, whether the figures are valued or not. Carbon dioxide accounts for at least one half of the greenhouse effect, in which atmospheric gases, mostly produced by human activities, trap the sun's heat slowly warning the Earth (Myers, 1991). Trees are half carbon and burning them we release all of that carbon into the atmosphere. At least three quarters of deforestation in the tropics is due to burning which release about 2.4 billion tons of CO_2 into the astrosphere each year (myers, 1991). However the greenhouse effect will have several affects on global ecology, such as rising sea levels, drought and on future agricultural activities (IUCC, 1993).

Deforestation and forest degradation increase the concentration of greenhouse gases in the atmosphere, but forest and tree growth absorbs carbon dioxide which is the main greenhouse gas. FAO notes how a more sustainable management of forests will result in a reduction in carbon emissions from forests and has a vital role to play in addressing the impacts of climate change (FAO, 2015). Wide-scale deforestation, besides its contribution to the greenhouse effect by converting trees to CO_2 and reducing vegetation available to store CO_2, also profoundly alters local and regional climates. This alteration can take several forms. By removing vegetative cover, deforestation reduces the water retention capacity of the soil, increasing soil erosion and making lowland areas more vulnerable to flooding. Extensive deforestation appears to have been a large factor in continental runoff.

In addition, wide-scale deforestation appears to dry the climate of the surrounding region with studies suggesting such effects in parts of India, Malaysia, parts of the Philippines, Ivory Coast and the Panama Canal area and perhaps also in southwestern China, northwestern Costa Rica and northern Tanzania (Myers, 1988). The local and regional climatic disruption, especially parching of agricultural lands, may be of much greater climatic impact to many areas than the changes produced by greenhouse-induced warming. Other human activities in addition to deforestation, e.g. drainage of wetlands, summer fallowing, bush clearing, and grazing of livestock, may also have regional climatic implications. Several different models and studies indicate that deforestation will lead to a reduction in average rain fall and increased surface temperature (Hastenrath, 1991 and shukla, 1990). The cutting down of trees and removal of ground cover leads to rapid soil erosion which eventually leads to greater run off and increase sedimentation in rivers and streams. The combination of these factor leads to flooding and increase of the soil salinity (Domries, 1991 and Hastenroth, 1991).

The aim of this paper was addressed by highlighting the forest situation before the inception of the project. Plate 1 illustrates the situation. The construction of Gen. M.I Wushishi housing estate was started in 2007 by the administration of Dr Muazu Babangida Aliyu, OON, and the chief servant of Niger State. Legend konsult was the contracting firm assigned for the project through private partnership participation (PPP) to construct the 500 housing Units along by-pass road Tunga to be completed in 3 month. The contract was later terminated by the state government and the state Housing Corporation was assigned to takeover and completes the project. However the project was successfully complete in the first quarter of 2010 and was commissioned by the honorable Minister of Works, Housing and Urban Development, Mr Nduiese Essien on 1st June 2010, shown on plate 4. (Audi, 2010)

Plate 3: The site after construction, showing the road, drainage and planted shrubs

Plate 4: The Commissioning of the Estates.

MATERIAL AND METHODS

The construction of Gen. M.I Wushishi housing estate was developed within 62,500,000 m^2 (61/4 hectares) of land (Site layout plan) and include 200 blocks of 2 bedroom semidetached and one hundred number of three bedroom units, See figure 1 below. The sizes of plots allocated in the layout were (15 X 20) M and (20 x 20) M for two bedroom and three bedroom units respectively (Site layout plan).

Three hectares was randomly selected in adjacent virgin forest and was assessed. The average vegetation density was inducted to ascertain the clear picture of the areas before construction and descriptive method was used to confirmed it see plate 1. Out of 153 housing units that was presently occupied by residence, 59 units were systematically and randomly picked for sampling for assessment of reforestation in the estate. However, relevant information was collected by direct observation at the site. In addition, interviews were carried out with respondents and specific questions related to the study were asked. Physical inspection was also carried out to determine the level of forest destruction by the construction activities of M.I Wushishi estate. The layout plans of the estate were fully implemented and show the extent of the vegetation area affected by the construction. The layout area was calculated and deducted from the total area of the estate. The paper also examines how construction leads to afforestation and deforestation.

Furthermore, the climatic impact analysis of changes on annual, seasonal, and monthly surface air temperature and precipitation was carried out using the experience of people living in the region for over ten years. The historical spatial-temporal changes in complex social–ecological systems information and perceptions have great potential to complement scientific information and enhance our understanding of ecosystem processes (Ayeni et al., 2015).

Figure 1: Design of the Estate layout plan

Result and Discussion

The finding of this research showed a clear confirmation of the effect of construction on the environment in terms of its vegetation. The following tables explained better.

Table 1: The Determining factor of the number of trees that exist on site before the construction

Selected sample of hectares Adjacent to the site	Number of trees counted per hectares
Sample 1	21
Sample 2	19
Sample 3	23
Total	63
Average	21

Sources: Field study

It was determined that the Gen. M.I Wushishi housing estate was developed within 62,500,000 m^2 (61/4 hectares) of land (Site layout plan). Since the Table 1 above showed that the area consist of 21 trees per hectares, therefore the study area was covered with 131 trees before the construction.

Observation shows that over 90% of the vegetation within the entire site layout was destroyed by the construction activities during and after the project. These was Analyzed in the Table 2 below

Table 2: Analysis of the vegetation area affected by the construction activities

S/No	Structure.	Size of plot (M)	Number of repeat	Total Area (M^2)	Percentage (%)
1	3- Bedroom	(20 x 20)	100	40,000	21.4
2	2- Bedroom	15 x 20	400	120,000	64.3
3	Primary Health Centre	30 x 50	1	1,500	0.8
4	School	50 x 70	1	3,500	1.9
5.	Main Gate	4 x 7	2	56	0.03
6	Major Road /Drainage	1,000 x 12	-	12,000	6.4
7	Minor Road/Drainage	1,070 x 7	-	9,630	5.2
TOTAL				**1,86686**	**100%**

Source: Field study

The table above has reaffirmed that the 2-Bedroom units raked with 64.3% of the total vegetation area destroyed by the construction activities while the access Gate destroyed the lowest ground cover of 0.03% of the table destruction.

The induction and deduction from the table 1 and 2 above lead to the development of table 3 which analyzed the negative impact of construction on the vegetation of M.I Wushishi estate Tunga.

Table 3: An assessment of the effect of construction on vegetation

Category of vegetation (x)	**Density Before Construction (x_2)**	**Density After Construction (x_1)**	**Destruction Density. Dx = ($x_2 – x_1$)**
Trees(Number)	131	23	108
Percentage (%)	100	17.6%	82.4
Grasses and shrubs (%)	100	70	30
Ground Cover(M$^{2)}$	6,250,000 m^2 (≈ 61/4 hectares)	43,831,400 m^2 (≈ 41/2 hectares)	18,668,600 m^2 (≈ 2 hectares)

Source: Field Study

The above data of the assessment has revealed that trees within the environment of the study area were mostly affected by the construction while only 30% percent of the ground cover was destroyed. About 2 hectares of 61/2 hectares of the vegetation was affected. Destruction density highlighted that up to 108 trees were cut down in the area and therefore the study area was confirmed to be a forest before the construction. The root causes of contemporary deforestation include; corruption of government institution; inequitable distribution of wealth and power; population growth and urbanization (Burgoni, 2008). Due to the above fact the residence of Gen M.I Wushishi contributed to the high cost of plant species in Minna. Afforestation became necessary in the study area, for more details, See Table 4 below.

Table 4: Afforestation within the estate

Housing Type	**Number of housing Unit**	**Number of Economic tree planted**	**Number of Non-economic tree planted**	**Other**	**Total**
3-Bedroom	14	3	-	-	3
2-Bedroom	22	2	1	2	5
[-	9	-	3	3	6
	4	2	3	2	7
TOTAL	**59**	**7**	**7**	**7**	**21**

Source: Field Study

The above discussions have revealed that about 108 trees and 186,686 m2 of ground cover were destroyed at the Gen. M.I Wushishi estate and the consequences were also highlighted. Therefore, reforestation is necessary for the wellbeing of the residence and their neighboring community. About 153 housing units were presently occupied by the residence. 59 housing units were randomly selected and assessed on the afforestation of their environment .See plate 4, 5, and 6.

According to Mallan Haruna Isah, the residence of house number F304, when the residence decided to compensate the environment with reforestation for their wellbeing, they are spending a lot in planting of trees and landscaping of the environment; and that the four different trees he acquired cost him =N=1,300. Economics trees with highest cost of =N=400 per one were also recognized. The consequences of deforestation in the study area lead to the above data. The table shows that the 3-

Bedroom unit has the high number of plantation of trees with smaller number of economic trees while the 2-Bedroom planted the higher number. It can be deducted that, since 21number of trees were planted in 59 housing unit of 153 residences present. Therefore, in future the residence of study area would have planted up to 178 trees against the 131 before the construction. This can leads to the positive impact on the environment. In an interview with Mr Joseph; one of the residences the reforestation is imperative in the estate because the buildings were exposed to the high intensity of the sunlight, rainfall and wind storm. But according to Miss Kaode, to plant and nurse a tree to maturity stage is a great challenge and therefore, she said “I don’t think all the planted trees will survive hash weather of the environment”. The common planted trees within the estate were; Masquerade, Mango, Guava, pawpaw, umbrella, lemon palm and satellite tree while flowers were yellow atlanta, Green atlanta and Queen of the night.

Plate 5: The site after construction, showing the afforestation

Plate 6: The site after construction, showing the afforestation

Climatic Impact Analysis:

The investigation on changes to annual, seasonal, and monthly surface air temperature and precipitation revealed noticeable difference. The temperature in the region was observed to be high than any time during the last ten years due to exposed surface. Despite the lack of unequivocal attribution for the enhanced greenhouse hypothesis, the evidence that climate change is happening in the area is very clear. With such unprecedented climate change, Impacts to all parts of the climate system in the area are likely to be substantial. Failure to introduce some form of environmental degradation reduction strategy will merely extend the nature and the consequences of the environmental problems that were observed already.

CONCLUSION

Tunga area as the immediate community to the Gen. M. I. Wushishi estate is bound to be greatly affected by the effect of deforestation from the study area. Based on the analysed data of this research; deforestation sound to be the major phenomenon and a challenge to the building professionals. In Minna, the population growth and urbanization remained the major source of construction and one of the causes of deforestation. The frequent removal of trees without sufficient reforestation has resulted in damage to habitat, biodiversity loss and aridity. It has adverse impacts on bio-sequestration of atmospheric Carbon-dioxide. Deforestation enhanced soil erosion and run off which are the major problem in Minna. Therefore, Government must support the reforestation, imposed and manpowered the relevant agencies for the realization of full implementation of the EIA decree No.86 of Nigeria. This decree was enacted as a response to the need to ascertain the environment impact of any project embarked upon by either the private or public sector. To this effect, it is recommended that, no sketched plan of any project should be allowed to the site without approved Environment

Impact Assessment (EIA).This may facilitate our professionals in the building industry to be designing with nature in mind and hence the rate of deforestation on the construction sites would be drastically reduce. There should be an awareness campaign on the effect deforestation to the community. Moreover, the government can make it obligatory that every able-bodied citizen between the ages of 11 and 60 plant three to five trees per year or do the equivalent amount of work in other forest services. However, economic trees such as Mango, Guava and Lemon palms trees were recommended for afforestation program in Minna.

REFERENCES

Ayeni A.O., M.A. Cho, R. Mathieu, J.O. Adegoke (2015); The local experts' perception of environmental change and its impacts on surface water in Southwestern Nigeria. Environmental Development Journal (EDJ) (2015), http://dx.doi.org/10.1016/j. envdev.2015.09.007i (2015). http://www.sciencedirect.com/science/article/pii/S2211464515300166: version online.

Burgonio, T.J. (2008). "Corruption blamed for deforestation". Philippine Daily Inquirer. http://newsinfo.inquirer.net/breakingnews/nation/view_article.php?article_id=110193.Retrieved on 3rd August,2010.4:39pm

Domroes, M. (1991). "The Tropical Forest Ecosystem: Reviewing the Effects of Deforestation on Climate and Environment." The Global Environment. Ed. K. Takeuchi and M Yoshino. Berlin: Springer- Verlag. PP. 70-80.

FAO, (2005). Forestry education in sub-Saharan Africa and Southeast Asia: trends, myths and realities. Forestry Policy and Institutions Working Paper No. 3. Rome

FAO, (2015). Forestry Outlook Study for Africa. FAO Forestry Paper 241. Rome

Hastenrath, S. (1991). Climate Dynamics of the Tropics. Kluwer Academic Boston: Publishers.

Hussaini, A. (2015). The current status of environmental impact assessment in Nigeria (EIA): challenges and prospects, HSE 1(1), p. 28-37.

Information Unit on Climate Change (1993). "An Introduction to man-made climate change." World Scientists' Warning Briefing Book. Ed. Union of Concerned Scientists. Cambridge: Union of Concerned Scientists. PP. 17-18.

Laurance, W. F. (1999). "Reflections on the tropical deforestation crisis". Biological Conservation, Volume 91, Issues 2-3. pp. 109–117.

Leakey, Richard and Roger L, (1996). The Sixth Extinction : Patterns of Life and the Future of Humankind, Anchor, ISBN 0-385-46809-1

Myers, Norman (1988). 'Tropical deforestation and climatic change'. Environmental Conservation, Vol. 15, No. 4, the Foundation for Environmental Conservation, Switzerland, (winter).

Myers, N. (1991). "Trees by the Billions: A Blueprint for Ecology." International Wildlife. 21.5:PP.12-15.

Salati, E. (1991). "Forests: Their Role in Global Change, with Special Reference to the Brazilian Amazon." Climate Change: Science, Impacts, and Policy. Proc. of the 2nd World Climate Conference. Ed. J. Jagar and H.L. Ferguson. New York: Cambridge Univ. Press.PP. 391-394.

Shukla, J., C. Nobre, and P. Sellers (1990). "Amazon Deforestation and Climate Change." Science 247:PP. 1322-1325.

Teja Tscharntke, Christoph Leuschner, Edzo Veldkamp, Heiko Faust, Edi Guhardja, eds. (2010). Tropical Rainforests and Agroforests Under Global Change. Springer. pp. 270–271. ISBN 978-3-642-00492-6.

INTERVIEWS:

Ahmed, Yusuf; A Quantity Surveyor, Niger State Housing Corporation, beside Railway quarters Minna, Niger State; Interview on 11th August, 2010, 9:47am

Audi, I. Musa; An Estate Surveyor in charge of Gen. M. I.Wushishi Estate;Interview on 13th August,2010,4:53pm.

Haruna, Isah; A Residence of F304; 2-Bedroom Housing Unit at Gen. M. I.Wushishi Estate; Interview on 13th August, 2010, 6:20pm.

Joseph, David; A Residence of F112; 2-Bedroom Unit at Gen. M. I.Wushishi estate; Interview on 13th August, 2010, 5:08pm

Kaode, Jiya.; A Wife at Residence of F13; 3-Bedroom Unit at Gen. M. I.Wushishi Estate; Interview on 13th August, 2010, 6:40pm

CLIMATE CHANGE INDUCED DISASTER

INNOVATIVE APPROACHES TO FLOOD RESILIENCE IN VULNERABLE URBAN COMMUNITIES: EXPERIENCES OF WOMEN IN MAKOKO - LAGOS, NIGERIA

LAWANSON, T. and ODUNBAKU, O.
Department of Urban and Regional Planning, University of Lagos, Nigeria.

The urban poor are especially vulnerable to the vagaries of climate change. This paper seeks to understand how flooding affects womens'everyday practices in a low income coastal community – Makoko, Lagos. This paper considers the impact of flooding on the community and using the theoretical construct of the livelihood framework, identifies the challenges being experienced in the community. The study utilised qualitative research methodology gathering data through focus group discussions and in-depth interviews with female members of the community. The study revealed that poverty was both a cause and consequence of flooding in the community as most of the houses were built on environmentally fragile land with poor drainage. Many houses were built on waste landfills. Furthermore, the four zones that make up Makoko were seen to be carrying out independent flood mitigation activities. The paper concludes by recommending an integrated stakeholder approach for flood management, poverty alleviation and community development in the area which integrated inclusive development (community participation), urban planning (provision of drainage channels) and livelihood (urban agriculture) strategies.

Keywords: community, flooding, Makoko, poor, women

oyadua@unilag.edu.ng, tlawanson@unilag.edu.ng

LAWANSON, T. and ODUNBAKU, O. (2016). **INNOVATIVE APPROACHES TO FLOOD RESILIENCE IN VULNERABLE URBAN COMMUNITIES: EXPERIENCES OF WOMEN IN MAKOKO - LAGOS, NIGERIA** Sustainable Built Environment and Climate change; The challenges of Post 2015 Development Agenda. School of Environmental Technology Conference, SETIC, 2016

INTRODUCTION

Intensive and unplanned human settlements in flood-prone areas appear to have played a major role in increasing flood risk in Africa over the last few decades (Di Baldassarre et al., 2010). Flooding is an especially prominent manifestation of climate change as had been recorded in literature and empirical studies (Few, 2003; Spurgeon et al., 2009, IPCC, 2009; Olajide and Lawanson, 2014). Flooding has also been identified as one of the major natural hazards which disrupt the prosperity, safety, infrastructure, livelihoods and wellbeing of human settlements, particularly in developing countries (ActionAid 2006). Literature further asserts that the urban poor, especially those in informal settlements of coastal cities, are particularly vulnerable to flooding, largely due to their locations in ecologically fragile areas (Bartone, 1991).

With specific reference to Lagos, Nigeria, Adelekan (2010) noted that the severity of storms has increased over the years and had devastating effects on residents' livelihoods, particularly those in the low income categories. However, in spite of the multiple exposure to various hazards consequent on their location in ecologically and ecologically fragile areas, for a number of locations the urban poor have developed more or less successful coping and adaptation strategies to reduce their vulnerability in dealing with changing environmental conditions (Nelson, 2011; Lawanson, 2015). Hence this study will seek to understand how poor communities respond to vulnerabilities occasioned by floods and flood related incidents.

Even among poor communities, women and men are impacted differently by climate change related incidents, including flooding at both household and community levels (Carvajal et al, 2008). It is therefore important that differentiated responsibilities of women and men be taken into account when seeking to understand the outcomes of environmental change, including climate change, and when developing mitigation and adaptation activities (Nelson, 2011). However this is not the case in recent studies on climate change and flooding in Lagos (See Olajide and Lawanson, 2014; Odunuga et al, 2012) have largely dwelt on community level impacts, without specific consideration of gender-specific issues.

Therefore, this study attempts to understand women's every day practices in response to vulnerabilities occasioned by flooding at household and community levels. The study is set in Makoko, a low income community along the Lagos Lagoon which has been identified as being particularly prone to flooding by various studies including those of ActionAid, (2006), Odunuga, Oyebade and Omojola (2012),and the Makoko/Iwaya Urban Regeneration plan of 2013.

Women, Floods Vulnerability and Informal urban Settlements: a livelihood Framework approach

In addition to urbanisation and uncoordinated urban expansion to flood prone areas, vulnerability to flood hazards is particularly intensified where combinations of inadequate and poorly maintained infrastructure, low-quality housing and low capability of the urban poor intertwine (World Bank, 2008), as is the case in over 100 informal settlements across Lagos (Gandy, 2006). The fact that the urban poor are typically accommodated and work in informal settlements, often densely populated, with poor construction materials and poorly constructed housing, and lack of access to adequate urban infrastructure facilities make them and their livelihoods more vulnerable to flood risks and associated hazards. McGranahan et al. (2007) noted that while economic activity and urban development often increase the environmental pressures that lead to flooding, it is the low income settlements and poor groups that tend to be the most vulnerable.

Particularly vulnerable are women in low income communities (Jha,Bloch and Lamond, 2012). Single mothers and women-headed households with small children, are least resilient to floods and storms (Campbell et al., 2009), while climate variability amplifies food shortages resulting in women consuming less food (Lambrou and Nelson, 2013) and suffering disproportionately from reproductive tract infections and water-borne diseases after floods (Neelormi,2009). However, a study conducted by Ajibade (2013) revealed that climate change impacts in Lagos were not gender related, hence this study will investigate gender specific (women's) flood vulnerabilities in the study area.

Furthermore, with government responses to flooding in Lagos being largely reactionary and isolated to the wealthier parts of the city (Kester, 2014) the poor are left to fend for themselves, largely leaning on assets as described in the Sustainable livelihoods framework (Sheffield and Landrigan (2011)). The Sustainable Livelihoods framework developed by DFID (1999) advances the argument that poverty is better understood by understudying the perspectives of the poor and how policies influence their vulnerabilities (Ellis, 2000; Adaawen and Horgensen, 2012). It offers a conceptualisation that helps to identify the priorities of the poor and associated opportunities and constraints, through a holistic prism. Within the livelihoods context, assets are generally defined as the stock of natural, physical, human, financial and social capital, which is used directly or indirectly by individuals and households in crafting their livelihoods (Carney, 1998; Ojong, 2011).

According to Ferguson and Murray (2001), key to the understanding of the sustainable livelihoods framework is how households and communities leverage their livelihood assets to mitigate vulnerabilities using sustainable techniques and interventions. According to Carney (1998), a livelihood is sustainable when it can cope with and recover from shocks and stresses, while maintaining its capabilities and assets without affecting the natural resource base. As such this study will seek to understand those assets that are leveraged by urban poor women in response to flood vulnerability within the analytical framework of the Sustianable livelihoods approach..

RESEARCH METHODS

The study area is the Makoko coastal community, Lagos, Nigeria. Makoko is an informal community located in the south-eastern part of Lagos Metropolis, abutting the Lagos Lagoon (see figure 1). Makoko occupies a total area of 3,577 square kilometres of which 22% is wetland (with housing on land, waste fills and stilts). The community has an estimated population of 80,000, and a population density of 5, 926 persons per square kilometre. Residents of Makoko are mostly engaged in economic activities centred around fishing and the informal economy.

Figure 1: Satellite Imagery of Makoko Community

Makoko is prone to seasonal flooding, which is commonplace across Lagos which is located about 2m below sea leval (Spurgeon et al, 2009; Olajide and Lawanson, 2014. Flooding is largely due to sea level rise, poor drainage channels, environmental management challenges and incessant land subsidence (Nicholls (2011) Gandy (2006). The two drainage channelst that service the community are 4km Dacosta-Makoko collector drain and 3km Oyadiran collector drain, both of which are usually filled with debris and/or weeds.

Methodologically, the study adopted the Sustainable Livelihoods Approach as an analytical framework for the research. This methodology was adopted because it helps in measuring direct impacts on individual livelihoods assets (Adelekan, 2010); while also aiding the understanding of community perceptions and responses (Moser and Stein (2011).

This framework also enables a broad range of research design and data collection methods, hence the adoption of a mixed methods data collection method which incorporated indepth interviews, focus group discussion and direct observation. The indepth interviews and the focus group discussions were conducted in the local language (Yoruba), to facilitate active participation. A cross section of women in the community (young, old, educated, illiterate, female head of household, settler and indigene) participated (twelve indepth interviews and twenty FGD participants). They represented the four zones in the community (Old Makoko, New Makoko, Isokan and Lagoon). Information addressing flooding and climate change challenges at household and community levels was collected and analysed.

FINDINGS AND DISCUSSION OF RESULTS

Socio- Economic Characteristics

The community is typical of most Lagos informal communities, with a young majority (53% ≤40years old). Average household size is 8, much larger than the Lagos state average of 5(LASG, 2004). There were many cases of female headed households corroborating NDHS (2013) that asserts that 18.5% of urban households in Nigeria are headed by a female. The major economic activities of the community centre around fishing, with other members of the community being engaged in home based enterprises. Dominant ethnic groups include the Yoruba, Ilaje, Egun and Ijaw; hence cultural practices from these ethnic groups are prevalent in the community. A significant proportion of the community live in absolute poverty, earning less than the national minimum wage of N25,000 (USD125), alongside a high level of youth unemployment. Average monthly household income in the community is around N19, 320 (USD96).

Housing and Environmental Profile

This study also revealed extensive vulnerability with regards to housing profile of the area. Makoko had been identified as a blighted area in Lagos as far back as 1984 (LASG, 2004), and is thus under the constant threat of eviction. There are about 5,148 buildings in Makoko community with about 55.5% of residents being owner occupied, each accommodating one or two households (Makoko Iwaya Urban Regeneration Plan, 2013). A typical house in Makoko is a wooden contraption with corrugated roofing sheets. Those close to the lagoon are built on stilts, while those on land (wastefill sites) may have sandcrete blocks. These constructions are incremental, with the structures lacking permanence and basic facilities.

Sanitation is through small shacks that flow directly into the lagoon, while water supply is from commercial boreholes in the community. Other community facilities include the local primary school and fish market. There is no health care facility, police post or fire station. However, the local governance structures led by the local chiefs coordinates the local vigilante group to provide security. The community is especially vulnerable to environmental health hazards due to poor access to water, sanitation and health hazards, environmental risks due to poor infrastructure, lack of secure tenure and flood prone location.

Flooding Experience

The entire community is vulnerable to flooding because of its geographical location and morphology. It was discovered that the flooding issue was more prevalent in the houses on land and waste fills than in those on stilts. However, even though most flooding incidents are time specific, with the highest occurrence during the months of September and November, a period termed '*Iyo*' in local parlance, many households are vulnerable throughout the year.

According to a respondent:

'Amongst all the houses in this area, I can't point out any that escaped the flood. This is because even when it is no longer raining, sometimes the lagoon is so full that it's spreading all over the place. That's even worse because the entire streets are dry but our houses are not dry because the water comes and enters our houses'.

Reasons adduced for flooding in the community include some houses located along the natural drainage channel, poor drainage pattern, blocking of the natural drainage channel by construction, poor maintenance of the canals, and ineffective waste management deployment by the local authorities. According to one respondents"

'Flooding comes during rainfall and sometimes without rainfall and the main cause of this are the block(ed) drains which obstructs free flow of water. The drainages don't extend into the canal and the ones that extend into the canal are blocked and they didn't clear them. So there is no escape channel for the entire water gathering around.

Another responded added:

'All this water flooding our houses won't be this bad if there were to be canals, drainages and all the necessary amenities are in place. PSP don't come often enough and some people dump their waste in the canal'

Impact and Response to Flooding Incidents

The most visibly devastating impact of flood is the damage to physical structures. At the community level, literature asserts that large scale flooding can cause damage to community infrastructure, particularly roads, which are often the major way of accessing flood affected communities Jha et al. (2012: 161). In Makoko, the few roads have experienced deterioration due to flooding. Other community infrastructure impacted include electricity poles and the school building, which were not promptly repaired or replaced by relevant authorities.

According to one of the respondents:

'When the last flood came, three electricity poles collapsed. It took NEPA(Electricity Agency) more than a month to come and see the damage. We were in darkness for over a month"

At the household level, physical assets such as households' assets damaged by floods include clothing, mattresses, wooden furniture and electrical appliances such as televisions, radio sets and refrigerators. As most of the respondents operate home based enterprises, their livelihoods were also adversely affected as many of these appliances are also used for income generating activities, and in some cases entire loss of livelihoods.

According to one respondent:

'M*y son who was a barber lost all his barbing equipment and his business because of the flood. Now I have to feed him and his children every day'.*

In extreme cases, loss of lives have occurred

According to one respondent:

> *'The water gets out of hand causing damages to things. It even takes away lives. A few years ago, my neighbour was scooping away the water, it was up to his waistline till he slipped and died in the processes*

With the vulnerability to floods come increased health vulnerability. Many of the respondents complained of increased cases of water and sanitation illnesses (malaria, typhoid fever, cold, diarrhoea) during this period, resulting in more funds expended for health care and medicine

As stated by one of the respondent:

> *'The only people who make any money during the floods are the local herbalists (Elewe omo) and patent medicine sellers (chemist)'*

Another respondent stated that:

> *'So when this water comes, there's no hiding place for anybody; little children and adults alike become sick'*

The respondents deployed various strategies in responding to the flood incidents. A prevalent one was relocating younger children or the entire family to stay with kinfolk in drier parts of the community during the floods, pointing to the strong social networks and the support mechanisms ethnic alliances offer (Lawanson and Oduwaye, 2014). It was discovered that residents also leaned on such associations for post-flood recuperation especially for non-monetary support. There were cases of communal cooking so that families whose supplies were destroyed could feed. There were also cases of local artisans working pro-bono on reconstruction of destroyed homes and supporting structures.

Another mitigation measure relates to environmental sanitation and keeping the canal free flowing. The social organisation (community development association) served as an enforcement mechanism

A respondent stated thus:

> *'Nobody dumps waste into the canal anymore. All the CDAs now have vigilante (local security groups) that man vicinities around the canal. And everybody knows that there is a fine to pay when you violate these measures.'*

It was also discovered that many of the members also considered their membership of cooperative societies as important strategies for coping with the challenges experienced during and after floods, corroborating extant literature which states that informal social organizations, especially kin-based and neighbourhood based networks play an important role in helping the poor adapt to the exigencies of city life (Kachenje, 2005; Meagher 2010, Oluyombo, 2012).

According to one respondent:

> *'When I lost all but my house during the Iyo of two years ago, I was able to start again by taking a loan from the cooperative society. I have since paid it off and taken another*

DISCUSSION AND POLICY RECOMMENDATIONS.

The study revealed that the community is vulnerable to flooding primarily due to her location in a low lying area, but more importantly due to lack of infrastructure and poor engineering in the construction of the drainage channel that passes through the community. Furthermore, there is poor waste management administration in the community, and the community as a whole receives scant attention from the government, chiefly because of the lack of secure tenure, thus corroborating the literature which states that governments had perpetually considered informal communities as illegal settlements undeserving of meaningful commitment (Khalifa, 2015).

Furthermore the study revealed an important social capital that can be leveraged for development in the community. This are social networking and community governance structures. According to Lawanson (2015), the poor have harnessed this strength by pooling resources, both tangible and intangible, to mitigate the effects of obvious challenges faced within their communities, and so these structures can be utilised for engendering long term development. One way of leveraging this social capital in Makoko is by implementing an integrated stakeholder approach to flood mitigation in Makoko.

Integrated Stakeholder Approach to Flood Mitigation

Participation of stakeholders in community development provides a collaborative process by which community inhabitants reach common goals, engage in collective decisions, and create places, which serve as material expressions of their collective efforts.(Feldman. & Westphal, 2000). Thus, community participation is an important component of community development and reflects a grassroots or bottom- up approach to problem solving. Effective community participation leads to social and personal empowerment, economic development, and socio-political transformation (Kaufman and Alfonso, 1997). As a result of community participation, conflicts between officials and community groups diminished, community groups assume responsibility for their infrastructure and sustainable development is entrenched.

For Makoko, this approach which allows a partnership of professionals, policy makers and the community to address the issue of flooding holistically can also serve as a platform for achieving inclusive development, infrastructure upgrading and poverty alleviation (See Figure 2). By adopting this approach, the community will be involved in all decision making and will also provide socially acceptable strategies for implementing the plans.

Effective flood mitigation in Makoko will involve three major steps:

a. Total clearance of structures along the natural drainage course of the community, to provide setbacks along the canal. Those whose houses are demolished can be relocated to other areas within the community. As a pro-poor strategy, urban farming along the setback is proposed. This will serve as a means of community income generation and potential poverty alleviation strategy.

b. Creating artificial reservoir at designated points to rejuvenate the ecological functions of the stream system. This will allow a gradational release of waters into the canal, effectively reducing the flooding propensity of the area.

c. Improvement of the canal and drainage flows, as well as construction of embankments to raise the effective river bank and artificially reduce flood water levels.

d. Improvement in urban management and infrastructure upgrading of the community using established strategies as are currently being practiced albeit informally.

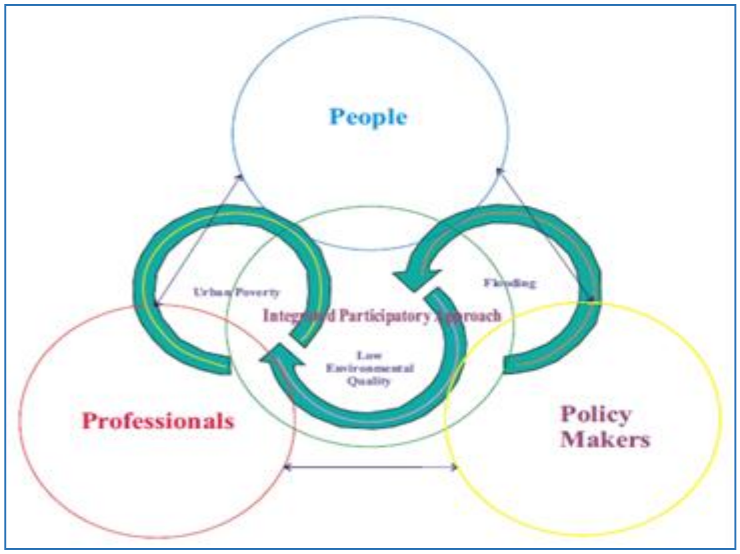


Fig2: Integrated Stakeholder Approach to Flood Mitigation in Makoko

CONCLUSION

The research has outlined the multiple vulnerabilities faced by women in Makoko community, and their responses to the challenges occasioned by flood and flood related incidents. The study has also highlighted an often ignored strength of the urban poor, which is the social networks and recommended the implementation of an integrated stakeholder approach to mitigating flooding and also achieving pro-poor development based on partnerships and ecologically sustainable development.

ACKNOWLEDGEMENTS

The authors acknowledge the fieldwork support and sponsorship of Heinrich Boell Stiftung Nigeria

REFERENCES

ActionAid, (2006). Climate Change, Urban Flooding and the Rights of the Urban Poor in Africa: Key findings from six African cities. ActionAid International, Johannesburg

Adaawen. S and Jørgensen, S (2012) Eking out a living: The livelihood implications of urban space regulation on street hawking in Accra, Ghana. African Review of Economics and Finance, Vol. 3, No.2, pp 1-14

Adelekan, A. 2010. Vulnerability of poor urban coastal communities to flooding in Lagos, Nigeria. Environment and Urbanization, 22(2): 433–50.

Ajibade, Idowu M.,(2013) Climate Change and Human Rights: A Case Study of Vulnerability and Adaptation in Coastal Communities in Lagos, Nigeria. PhD Thesis. Department of Geography, University of Waterloo

Bartone.C (1991) 'The Environmental Challenges of Third World Cities', APA Journal, 5(44), pp. 411-415.

Campbell, B., S. Mitchell, and M. Blackett, 2009: Responding to Climate Change in Vietnam. Opportunities for Improving Gender Equality. Oxfam; UNDP, Hanoi, Vietnam, pp. 1-63.

Carney, D (1998) 'Implementing the sustainable rural livelihoods approach', in Carney, D. (ed.) Sustainable Rural Livelihoods: What contribution can we make? DFID, London.

Carvajal . Y., Quintero. M., and Garc´ıa ,M. (2008).'Women's role in adapting to climate change and variability', Advances in Geosciences 14, 277–280, www.adv-geosci.net/14/277/2008/

di Baldassarre.G, Montanari. A, Lins. H, Koutsoyiannis. D, Brandimarte. L, (2010) Flood fatalities in Africa: from diagnosis to mitigation. Geophysical Research Letters 37 (22)

Ellis, F. (2000) Rural Livelihoods and Diversity in Developing Countries. Oxford University Press, Oxford

Feldman, Roberta M. & Westphal, Lynne M. 2000. Sustaining human settlement: A challenge for the new millennium. Great Britain: Urban International Press.

Department for International Development. (1999). Sustainable Livelihoods Guidance Sheet: Introduction. http://www.livelihoods.org/info/info_guidancesheets.html#1.

Federal Government of Nigeria (2013) National Demographic and Health Survey

Few, R. (2003) 'Flooding, Vulnerability and Coping strategies: Local Responses to a Global Threat', Progress in Development Studies, 3(1), pp. 43-58.

Gandy. M, (2006). Planning, anti-planning and the infrastructure crisis facing metropolitan Lagos. Urban Studies, 43: 371– 96.

Heinrich Boell Foundation (2013) (Makoko Iwaya Urban Regeneration Plan, 2013).

Intergovernmental Panel on Climate Change (IPCC). 2009. Proceedings of Scoping Meeting for an IPCC Special Report on Extreme Events and Disasters: Managing the Risks on 23–26 March 2009 in Oslo, Norway. Stanford , Calif.: IPCC.

Jha, A.K., Bloch, R. and Lamond, J. (2012) Cities and Flooding: A Guide to Integrated Urban Flood Risk Management for the 21st Century. Washington DC: The World Bank.

Kaufman, M. qnd Alfonso, H. D. (eds.) (1997) Community Power and Grassroots Democracy. The transformation of social life, London: Zed Books

Kester. A(2014) Emerging 'New cities' in Africa and socio-spatial inequality: A case study of the Eko Atlantic City project in Lagos, Nigeria. Unpublished Master of Urban Planning Thesis submitted to the University of Amsterdam

Khalifa. A (2015) Evolution of informal settlements upgrading strategies in Egypt: From negligence to participatory development. Ain Shams Engineering Journal 6 (4):1151–1159

Lagos State Government (LASG). 2004. State of Lagos Megacity and Other Nigerian Cities: Report 2004. Lagos: Lagos State Ministry of Economic Planning and Budget

Lambrou, Y. and Nelson, S. 2013. Gender Issues in Climate Change Adaptation: Farmers' Food Security in Andhra Pradesh, in Alston M, Whittenbury K (eds) Research, Action and Policy: Addressing the Gendered Impacts of Climate Change, Springer, Netherlands.

Lawanson.T (2015)Potentials of the Urban Poor in Shaping a sustainable Lagos Metropolis. In Allen.A, Lampis .A and Swilling M (eds) Untamed Urbanisms. London:Routledge.'

Lawanson, T. and Oduwaye. L. 2014. Socio Economic Adaptation Strategies of the Urban Poor in the Lagos metropolis. African Review of Economics and Financet, 6(1): 140– 160.

McGranahan, G., Balk, D. and Anderson, B. 2007. The rising tide: assessing the risks of climate change and human settlements in low elevation coastal zones. Environment and Urbanization, 19(1):17–37.

Meagher, K. (2010) 'The Tangled web of associational life: Urban Governance and the Politics of popular livelihoods in Nigeria. United Nations University Working Paper 2010/50

Moser.C and Stein.A (2011) Implementing Urban Participatory Climate Change Adaptation Appraisals: A methodological guideline. Environment and Urbanization 23(463)

Murray, J and Ferguson. M(2001). Women in Transition Out of Poverty. Toronto: Women and Economic Development Consortium. January.

Nelson.V (2011)Gender, Generations, Social Protection and Climate Change: Athematic Review. Research Report for Overseas Development Institute

Neelormi, Sharmind (2009) 'Climate-change related migration from a gender perspective: patterns, challenges and opportunities for intervention'. Gender CC, Bangladesh, SBSTA Side Event, Bonn, 09 June 2009

Nicholls, R.J. 2011. Planning for the impacts of sea level rise. Oceanography 24(2):144–157, http://dx.doi.org/10.5670/oceanog.2011.34.

Odunuga. S., Oyebade. L. and Omojola. A (2012) Social-Economic Indicators and Public Perception on Urban Flooding in Lagos,: Nigeria. Hydrology for Disaster Management: Special Publication of the Nigerian Association of Hydrological Sciences, 2012

Ojong, N (2011) 'Livelihood strategies in African cities: The Case of Residents in Bamenda Cameroun', African Review of Economics and Finance, Vol 3 No 1, pp1-13

Olajide, O. and Lawanson, T. 2014. Climate change and livelihood vulnerabilities of low income coastal communities in Lagos, Nigeria. International Journal of Urban Sustainable Development, 6(1): 42–51.

Oluyombo, O (2012) Cooperative Finance in Developing Economies. Soma, Lagos

Sheffield. P and Landrigan (2011)Global Climate Change and Children’s Health: Threats and Strategies for Prevention. Environmental Health Perspectives 119 (2) :291-298

Spurgeon, J., Wasilewski, C., Ikpi, A. and Foster, S (2009) Impact of Climate Change on Nigeria’s Economy to Climate Change Impacts and Strengthening Disaster Risk

World Bank. (2008). Climate Resilient Cities: 2008 Primer Reducing Vulnerabilities

FLOODING AND THE LIVELIHOOD OF RESIDENTS ALONG BENUE RIVER, MAKURDI

Nenger-John Danjuma E.T & Umar Haliru Vulegbo
Department of Urban and Regional Planning, Federal University of Technology, Minna

Flood is a natural phenomenon that is associated with endemic destruction and devastating effect on human lives and properties. As a growing natural phenomenon, the resultant effect is targeted at social and economic obstruction to human livelihood. Research reveals that climate inconsistency is a major player in the many changes that occur within the environment. This review reveals studies on flooding, bringing to limelight people's perception and coping measures on the recent occurrence of flooding and its negative effects on the inhabitants of Makurdi town, Benue State. Conclusions are that flooding will continue to occur due to climate inconsistency but with adequate policies and processes targeted at enforcing aggressive infrastructural provisions and public awareness and sensitizations, human lives and properties will be saved.

Keywords: *Climate Change, Flood Disaster, Livelihood.*

terfa.nenger@gmail.com;
vuleex@gmail.com

Nenger-John Danjuma E.T[1*] & Umar Haliru Vulegbo[1] (2016). **FLOODING AND THE LIVELIHOOD OF RESIDENTS ALONG BENUE RIVER, MAKURDI** Sustainable Built Environment and Climate change; The challenges of Post 2015 Development Agenda. School of Environmental Technology Conference, SETIC, 2016

INTRODUCTION

Zabbey and King (2007) revealed that climate change is any alteration from elements of weather like temperature, humidity, pressure, wind and precipitation. Change in climate variability comes from natural activities of the interaction of the oceans and the atmosphere, changes in energy received from the sun and volcanic eruptions as well as human-induced alterations of the natural world have contributed to high increase in the rate of atmospheric emission of gaseous substances for global warming *(Tunde, Adeleke and Adeniyi, 2013).* The recurring attributes of droughts, high rate of deforestation, and soil degradation are exacerbated by climate change.

According to Glop, (1998), livelihood is sustainable; it enables people possess the ability to avoid or withstand and recover from stress and shocks without undermining the natural resource base. Livelihoods serve as a shield for human existence in an environment. The environmental co-inhabitants enable individuals and group cope and recover from stress and shocks in other to uphold human survival in the environment. Human activities one cannot do without threats from the occurrence of natural hazards such as flood, earthquake, human illness, accidents conflict and disputes, joblessness, inflation, corruption, crop and health shock, soil erosion, desertification, governance, politics and technology.

Aderogba, (2012), affirms that flooding occurs when a river, stream, drainage/channel fails to respond naturally to water coping retention. This retention failure by water bodies release water to dry land Morristown (2010). Similarly, Caldwell (2012) revealed that flood is any high flow, overflow, or inundation by water which causes or threatens damage. Flooding can rise from overflowing rivers (river flooding), heavy rainfall over a short duration (flash flood) or an unusual inflow of sea water onto land (ocean flooding.

The various opinions suggest that flooding is not only about the natural phenomenon that occurs over a short period of time where rivers, streams, valley/ channel loose their water holding capacity and intrude into dry land, threatening lives (human, flora and fauna), properties as well as disruption of social, religious, economic and political activities but also a phenomenon that incorporates the inability and the sum of the various ways by which nature takes advantage of the negligence of human in containing with excess water within water bodies and channels. The occurrence of flooding assumes a source and destination where a degree of influence is exercised. Therefore, flooding is seen in the 21st century as the menace from the occurrence of high rainfall on normally dry land and the inability of water bodies and channels to withhold the pressure of water, disrupting human activities, properties and loss of lives.

Description of the study area

Makurdi lies on latitudes 7037’ and 7047’North and longitude 8027’ and 8040’East. The town is drained by the River Benue which divides into two parts-north and south banks. Other rivers that drains the town, and in turn empty water into the River Benue includes: Rivers Idye, Genebe, Urudu, Kpege and Kereke. Due to the general low relief of Makurdi, sizeable portions of the area is waterlogged and flooded during heavy rainstorm. The rainfall of the area is highly seasonal, coming inform of intense, violent, convectional showers of short duration. The geology of Makurdi town is of cretaceous and consists of fluvio-deltaic sediments with well-bedded sandstones which are of hydro geological significance in terms of groundwater yield and exploitation.

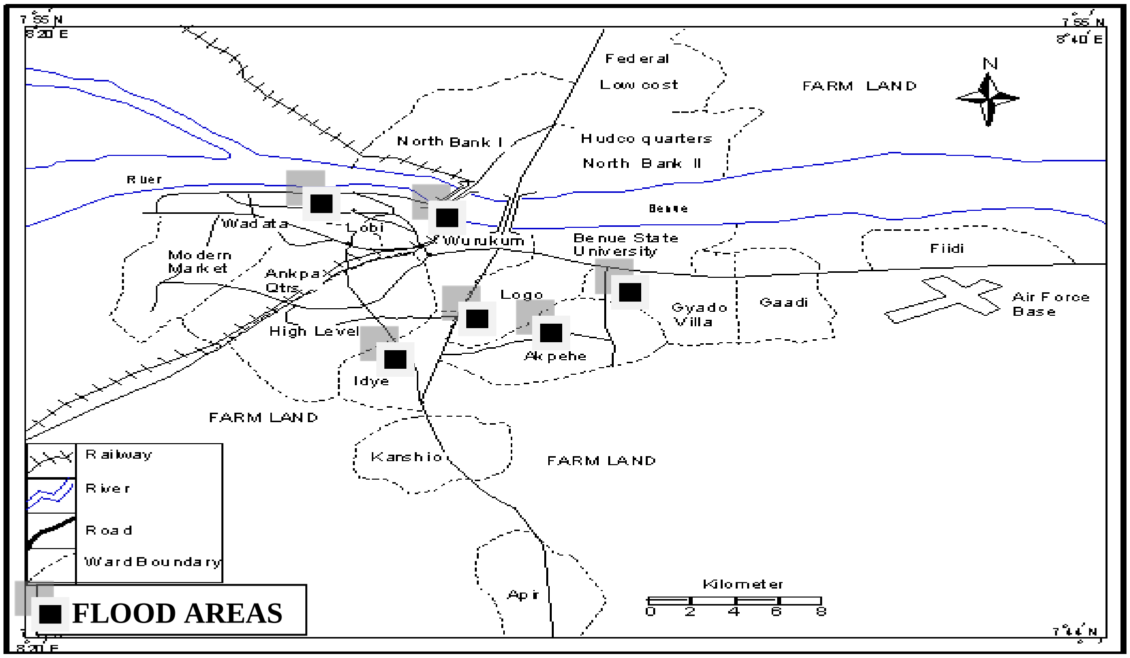


Fig. 1. Map of Makurdi Town Showing Flood Prone Areas
Source: Ministry of Land and Survey, Makurdi.

Benue Flooding

NEMA (2011) discloses that flooding has become an annual event resulting to loss and destruction of properties worth millions of naira. Flooding is said to have occurred in different parts of Makurdi town in 1996, 2000, 2005, 2007 and 2008. The latest flood and recent in Makurdi town is the one caused by the effect of dam failure from Cameroon where many residents of the town were rendered homeless and properties worth millions of naira were destroyed and people displaced, especially those along the river banks.

Highlights from the Leadership newspaper (2012), affirms that over 300 houses in Makurdi were flooded as a result of heavy downpour which destroyed properties and rendered many homeless. The occurrence disrupted activities in some schools, churches and markets. Areas covered by the flood include Wadata, Idye, Atsusa, Wurukum, Akpehe, Logo1 and Logo 2, Ankpa Quarters extension, Nyiman and Gyado villa. (Ocheri and Okele, 2012).

In a report on flood in Benue State by Duru and Yusuf (2012),worst hit by the devastation were houses within the banks of the river and most structures within five kilometers radius of the river and some of the communities were affected.This Day Live (2015)reported that four persons were allegedly missing as rain destroys property in Ilorin, Makurdi. In a report by Hammed Shittu in Ilorin and George Okoh in Makurdiin THISDAY Check, (2015) reported thatproperties worth several millions of naira were destroyed in Ilorin, Kwara State capital following a three-hour heavy down pour which started around 4.00 pm of Thursday evening in the city. While in Benue, the areas affected include the roundabout at the railway crossing Makurdi, to Wurukum market and Judges Quarters on Gboko road, the personal residence of the Second Republic governor, Aper Aku, Benue State University (BSU), Living Faith and Dunamis Churches, Wurukum Market, Steam Fast, were all submerged in water. Shops and stalls were filled with water, which destroyed goods valued at millions of naira, just as the rain forced motorists to park their cars off the roads.The occurrence of this is the release of water from Lagdo dam which apparently indicates that, for the Benue axis, the worst was yet to come.

Atedhor, Odjugo and Uriri (2011) posited that flooding occurs mainly because of blocked natural and man-made drainages and poor maintenance of water dams/reservoirs which seldom give way after persistent heavy downpours while the increasing rainstorm, obstruction of drainage system; absence of drainage system, poor land use control, global warming and soil are major causes of flooding

Challenges And Effects

The resultant effect of flooding include diarrhea, skin disease and soft-tissue infections as identified by Jenkins (2011) who opined that, dirty water, mud and silt that floods bring into our homes, backyards, streets and local play grounds cause a range of conditions. In the same vein Queensland Government (2012), confirmed that flood destroy homes, kill animals and humans alike. Floods traumatize victims and their families for long periods of time as displacement from one’s home will cause continuous stress. The resultant effect of flooding are loss of human life, damage to property, destruction of crops, loss of livestock, deterioration of health conditions owing to water-borne diseases, damage to public infrastructure. While all these occur, flooding brings soil and new life to the land they affect while degrading already degraded systems, removal of vegetation in and around rivers, increased channel size, long-term benefits to agricultural production by recharging water resource storages, especially in drier inland areas, and by rejuvenating soil fertility by silt deposition.

Human Perceptions And Coping Measures

While analyzing public perception of flood risk on the Belgian Coasts Kellens, Zaalberg**,** Neutens, Vannenville, and Maeyer, (2011), in their report sees the attempt as “increasingly important” in knowing how the people feel towards natural hazards. This perception they said, gives an ample knowledge of the public’s risk perception in steering development of effective flood mitigation strategies. The devastation caused by urban floods especially on households, in most cases, is usually a reflection of their lack of preparedness (Ojigi, Abdulkadir and Aderogu, 2013).

Prelog and Miller (2013), sees the avenue as a means of providing information towards future occurrence.These submissions have revealed the importance of knowing the feelings of the people towards the frequent occurrence of and the measures employed to resist and cope with these happenings.

NEMA circulated flood alerts to four Rivers Local Governments to forestall the disastrous occurrence of flood in the stateVictor (2015). Atedhor,Odjugo and Uriri (2010),have identified the construction of embankment; either concrete or sandy as a means to prevent water from entering residential houses. More so, three strategies were identified by Kolawole, Olayemi and Ajayi (2011) in the areas of environmental policy reforms that results from changes in urban and housing design, removal of laws that can inadvertently increase flood vulnerability; capacity building to integrate climate change and its impact into urban development planning involving local communities, raising public awareness and education on climate change and enabling representation at international meetings as well as planting of vegetation to reduce extra water, terracing hillsides to slow flow down hills as well as control of man-made channels to divert flood water among others as adaptation strategies/control. In the submission of Upa and Torkwase (2013),flood disaster can be possible through construction of embankment, enactment of environmental laws to control land use, educating people on the effects of climate change. Government and other well-meaning individuals should carry out flood adaptation strategies to meet the prevailing challenges and the proper land use control be enforced to prevent people from blocking drainages and building on areas prone to flooding. This will prevent and check citizens from blocking drainages and building on water channels.

CONCLUSION

Upa and Torkwase (2013), have concluded that the challenges of flood disaster comes with negative effects and several losses resulting from the occurrence of heavy rainfall, positing further that the resultant effect is bad human activities and lack of drainage infrastructure in most cities that eventually leaves people distressed and homeless..

Two outstanding measures have been identified as a way forward; processes and policies which can fully compliment measures from construction of embankments, clearing of waterways, drainages, afforestation, public awareness and participation, while enforcement of policies to effectively mitigate the occurrence of flood will provide efficient flood care and effective early warning systems for flood prone areas.

REFERENCES

A.J. Prelog, & L.M. Miller, (2013). Perception of Disaster Risk and Vulnerability in Rural Texas. Journal of Rural Social Sciences, 28 (3),2013.

Atedhor, G.O, Odjugo, P.A.O and Uriri, A.E. (2011). Changing rainfall and anthropogenic-induced flooding: Impacts and adaptation strategies in Benin City, Nigeria. Journal of Geography and Regional Planning 4(1) pp.42-52.

Ayado, S. (2012). Nigeria: 300 Houses, Markets Flooded in Makurdi Downpour, Leadership Newspaper, 7th October, 2012.

Caldwell, D.B. (2012). Definitions and General Terminology. Operations and services, Hydrological Programs. National weather service manual 10-59. Retrieved February 11, 2013 from http://www.nws.noaa.gov/directives/.

Duru, P and Yusuf, U. (2012, September 12). River Benue Surge: Disaster hits Makurdi. Vanguard. Retrieved February 18, 2015 from http://www.vanguardng.com/2012/ogriver-benue-surge-disasterhits- Makurdi/.

Glop, (2008). DFID's Sustainable Livelihoods Approach and its framework. http://www.livelihoods.org/info/info-guidancesheets.html (accessed 23.07.2015)

Hammed, S. and George O. (2015). This day Live: Four Persons Allegedly Missing as Rain Destroys Property in Ilorin, Makurdi. Monday 24 August, 2015 Updated 8:06

Jenkins, R. (2011). Health risks remain after flood subsidies. Retrieved February 18, 2013 from http://www.abc.net.au/health/features/stories/2011/02/10/3135043.htm.

K.A. Aderogba, (2012). Qualitative Studies of Recent Floods and Sustainable Growth and Development of Cities and Towns in Nigeria. International Journal of Academic Research in Economics and Management Sciences,1(3),2012,200-216.

Kolawole, O.M, Olayemi, A.B, and Ajayi, K.T.(2011).Managing Flood in Nigerian Cities: Risk analysis and adaptation options. Scholars Research Library 3(1) 17-24

Morristown, T.N. (2010). Definition of flood and flash flood.Retrieved February 11, 2013 from http://www.5rh.noaa.gov/mrx/hydro/flooddef.php.

M.L. Ojigi, F.I. Abdulkadir, and M.O. Aderogu, (2013). Geospatial Mapping and Analysis of the 2012 Flood Disaster in Central Parts of Nigeria. 8th National Symposium, Damma, Saudi Arabia, 2013.

NEMA, (2011) Rain Forcast bad for Nigeria's Socio-economy, Daily Trust, Thursday, 19th May, 2011.

Ocheri, M. and Okele, E. (2012). Social Impact and People's Perception of Flooding in Makurdi Town, Nigeria, Special Publication of the Nigerian Association of Hydrological Sciences, http://www.unaab.edu.ng.

Queensland Government. (2012). What are the consequences of flood. Retrieved February 9, 2013 from http://www.chiefscientist.qld.gov.au/publications/understanding-floods/consequences.aspx.

T. Shabu, and T.E. Tyonum, Residents Coping Measures in Flood Prone Areas of Makurdi Town, Benue State. Applied Ecology and Environmental Science, 1(6), 2013, 120-125.

Tunde, A.M, Adeleke, E.A and Adeniyi, E.E. (2013). Impact of Climate Variability on Human Health in Ilorin, Nigeria. Environmental and Natural Resources (3)1, 1-134.

Upa, C.T and Iyortyer C.T, (2013). Current Issues in Flood Disaster: Challenges and Implications for Science and Technology to Enhance Environmental Education. Academic Journal of Interdisciplinary Studies. Vol. 2 No 6, Published by MCSER-CEMAS-Sapienza University of Rome August 2013.

Victor, E. (2015). NEMA alerts on flood in 4 Rivers LGs: Daily Trust News, Tuesday August 18, 2015, page 10.

W. Kellens, , R. Zaalberg, T. Neutens, W. Vannenville, andP.D. Maeyer, An Analysis of the Public Perception of Flood Risk on the Belgian Coast. Risk Analysis,31(7),2011,408-414.

Zabbey, N and King, D. (2007). Climate change and flood: Fate of Riverine Communities in the Niger Delta. Retrieved February 11, 3013, from http://www.google.com.ng/ search?=climatechangeandfloodbyZabbeyandKing.

IMPACTS OF CLIMATE CHANGE ON FLOODING INCIDENCE IN ZARIA, NIGERIA.

KUBAI ZONKWA
Department Of Geography, Federal College of Education, Zaria

The human populations, infrastructure and ecology of cities are at risk from the impacts of climate change which affect urban ventilation and cooling, urban drainage and flood risk and water resources. Built areas exert considerable influence over their local climate and environment, and urban populations are already facing a range of weather-related risks such as heat waves, water pollution and flooding. Although climate change is expected to compound these problems, building designers and spatial planners are responding through improved building design and layout of cities. This paper examined significant climate change impacts expected to shape the future character and functioning of urban systems, in Zaria, people's attitude to the change, the findings have serious implications for how hazards are managed. The paper also stated categorically strategies for managing and preventing climate change on built environment. The importance of public awareness through effective hazard education was also suggested.

Keywords*: Build Environment, Climate Change, Sustainable Development.*

zonkwakubai@yahoo.com;

zonkwakubai50@gmail.com

KUBAI ZONKWA (2016). **IMPACTS OF CLIMATE CHANGE ON FLOODING INCIDENCE IN ZARIA, NIGERIA.** Sustainable Built Environment and Climate change; The challenges of Post 2015 Development Agenda. School of Environmental Technology Conference, SETIC, 2016

INTRODUCTION

Increasing attention is being paid to the potential impacts of climate change on urban environments. At present, roughly 50 Per cent of the world‘s population live in cities, but this figure is expected to rise over the years. Most of the future growth of the urban population is anticipated in the developing world. Many low-income countries are already exposed to shortages of clean drinking water and poor sanitation, and often occupy high-risk areas such as floodplains and coastal zones (Haines et al., 2006). As the concentration of urban populations is increasingly mixed up with growing risks of extreme events, millions of naira is lost and the cost is increasing by the day.

The significant contribution made by the world‘s major cities to global climate change and the urgent need for energy efficient infrastructure and changed patterns of resource consumption is notable (Hunt, 2004). With such a range of issues to tackle, it is not surprising that there have been calls for wider participation and more effective interaction between complementary disciplines (Oke, 2006).

Climate change will increase the frequency and intensity of heavy rainfall events, thereby increasing the risk of urban flooding. While addressing infrastructure issues is a necessary component of reducing urban flood risk, individual homeowners can have a significant role in reducing risk through protecting their own homes and reducing their contributions of storm water to municipal sanitary sewers and storm water management systems. However, the barriers of low public awareness will have to be overcome to effectively engage homeowners in urban flood risk reduction. Urban flooding occurs in urban areas, where the impacts of extreme rainfall are exacerbated by high concentrations of impervious surface, infrastructure, buildings, property and people.

Urban housing is often the major part of the infrastructure affected by disasters, according to Jacobs and Williams (2011). Extreme events like cyclones and floods inflict a heavy toll, particularly on structures built with informal building materials and outside of safety standards (United Nations, 2011). Dhaka’s 1998 floods damaged 30 percent of the city’s units; of these, more than two-thirds were owned by the lower-middle classes and the poorest (Alam and Rabbani, 2007). Adelekan (2012) shows that a relatively modest increase in wind speeds during storms caused widespread damage in central Ibadan. Relative to the preceding decade, the period from 1998 to 2008 showed higher mean maximum wind gusts and more frequent windstorms with peak gusts greater than 48 knots, and the impacts were severe in part because of the high concentration of residents in damaged buildings. Increased climate variability, warmer temperatures, precipitation shifts, and increased humidity will accelerate the deterioration and weathering of stone and metal structures in many cities (Bonazza et al., 2009; Grossi et al., 2007; Smith et al., 2008; Stewart et al., 2011; Thornbush and Viles, 2007).

Urban flooding can have serious implications for both buildings and infrastructure, as extreme flows of water during heavy rainfall events can damage both overland and underground storm water management infrastructure and road pavements.

Flooding has also become the greatest reasons for the numerous gully erosion problems because of concentration and discharge to many unsafe areas. These are mainly due to poor road designs, numerous public and private building springing up and exposing land surface in many built up areas (Diagne, 2007).

Climate Change and Urban Flooding

Under a changing climate, an increase in the frequency of drought, extreme rainfall, high temperatures, and wind events is expected and we can expect an exacerbation of the health impacts associated with these events. It has been argued that extreme events that currently have return frequencies of 1 in 100 years could have return frequencies of 1 in 5 or 1 in 10 years by prevailing climate change conditions.

As temperatures increase, evaporation will also increase and the atmosphere will be able to hold more moisture. Higher amounts of moisture in the atmosphere will result in more severe precipitation in Zaria. Although the precise impacts of climate change will differ depending on the climatic and environmental characteristics of specific regions, it is often thought that extreme precipitation events could increase in severity by approximately 15 percent.

Stormwater management infrastructure in Zaria has traditionally been designed with the assumption that weather and climate conditions are static, and historical climate conditions can be used to accurately predict the future climate. Increasing frequencies of extreme rainfall events caused by climate change will mean that storm water management infrastructure design standards will be less reflective of the frequency and intensity of events that we will experience in the future.

Understanding public perceptions of natural hazards is an important part of non-structural hazard management. In comparison to structural approaches to hazard management, which attempt to alter the hazard to reduce risks to population (e.g., building dams and levees to control flooding), non-structural approaches attempt to alter human behaviour to reduce vulnerability. A commonly applied non-structural measure may be the use of floodplain maps to steer development away from flood prone areas. Non-structural measures also include education programs and actions designed to increase the awareness and riskreducing actions of the individuals who are exposed to hazard risk (Bartlett, 2008).

Hazard perception studies were first conducted in the 1960s, and throughout this time, a few findings have generally remained constant in the literature. First, people who live in areas subject to hazards are largely unaware that they could sustain damages, personal injury, or death. In most cases, less than half are aware of their exposure to natural hazards.

Second, people who live in hazard prone areas rarely take actions to protect themselves. Many studies have revealed that less than 15 percent of individuals exposed to hazards take actions to reduce their risk of sustaining damages. When people do take action, they generally take inexpensive and less effective actions such as evacuating at the last minute, or moving valuable items to a higher level in their home during a flood event typically of what obtained in some built environment in Zaria local Government, Kaduna State Nigeria (Silver *et al*, 2013)

Finally, perception studies have frequently revealed that people with property prone to flooding rely highly on government built structural mitigation mechanisms, such as dams, levees and floodwalls, to protect them from damages. Studies have also revealed a high reliance on the government for flood protection, and that often the blame for damages caused by natural hazards is placed on government rather than extreme natural events or on those who choose to occupy hazard prone areas (Wilby, 2007).

Homeowners are more likely to attribute responsibility to their municipalities than to take action they to reduce urban flood risk. Those findings have serious implications for how hazards are managed, specifically highlighting the importance of public awareness through effective hazard education.

Changing Global and Urban Climate

It has been established by study that most of the global warming over the last 50 years is attributable to human activities; that human activities will continue to change the composition of the atmosphere; and those global mean temperatures and sea levels will continue to rise for many centuries to come. The risk of a heat wave like that experienced across Europe in 2003 is thought to have doubled due to historic greenhouse gas emissions (Stott et al., 2004).

However, the range of potential impacts is expected to go beyond heat waves. Other anticipated consequences of climate change for Nigerian cities include fewer periods of extreme cold; increased frequency of air and water pollution, rising and changes in the timing, frequency and severity of urban flooding associated with it (Haines *et al*, 2013).

Detection of climate driven trends at the scale of individual cities is problematic due to the high inter-annual variability of local weather and factors such as land-use change or urbanization effects. It has long been recognized that built areas can have urban heat island (UHI) that may be up to 5-6oC warmer than surrounding countryside (Oke, 1982). Compared with vegetated surfaces, building materials retain more solar energy during the day, and have lower rates of radiant cooling during the night. Urban areas also have lower wind speeds, less convective heat losses and evapotranspiration, yielding more energy for surface warming. Artificial space heating, air conditioning, transportation, cooking and industrial processes introduce additional sources of heat into the urban environment causing distinct weekly cycles in UHI intensity (Wilby, 2003).

The physical constituents of built areas and human activities within urban centres also interact with other climate drivers. For example, runoff from impervious surfaces can have dramatic effects on downstream risks of flooding and erosion (Hollis, 1988), as well as water quality via uncontrolled discharges of storm water (Paul and Meyer, 2001). Urban air pollution concentrations may also increase during heat waves with significant consequences for mortality. This is because high temperatures and solar radiation stimulate the production of photochemical among as well as ozone precursor biogenic volatile organic compounds (VOCs) by some plants.

Potential climate change impacts of built environment in Zaria

Flooding * More frequent and intense rainfalls leading to flooding and overwhelming of urban drainage systems.

Water Resources* Heightened water demand in hot, dry times

* Reduced soil moisture and groundwater replenishment.

Health * Poorer air quality affects asthmatics and causes damage to plants and buildings.

* Higher mortality rates in Nov. - June due to heat stress.

Biodiversity * Increased competition from exotic species, spread of disease and pests, affecting both fauna and flora.

* Increased ground movement in affecting underground pipes and cables.

* Reduced comfort and productivity of workers.

Transport * Increased disruption to transport systems by extreme weather.

* Reduction in cold weather-related disruption.

Urban Drainage and Flood Risk

Assessing urban flood risk is further complicated by the performance of the urban drainage system, which responds to highly localized effects such as blocked culverts or overwhelming of the hydraulic capacity of sewers (Ashely et al., 2005). There is also a wide variety of tangible and non-tangible secondary impacts associated with flooding in urban areas. In Nigeria Reports estimates that many urban properties are presently at risk from flooding caused by heavy downpours, yielding average annual damages of billions of Naira. However, the authors concede that considerable uncertainty surrounds the incidence of flooding because of the complex interplay between the amount of precipitation change in relation to the excess capacity of drain and drainage pipes and it is also difficult to quantify other costs associated with water flooding, or risks to human health such as diarrhoeal and respiratory diseases (Ahern et al., 2005). There could also be significant disruption to system-wide performance of transportation networks all over the urban areas.

Adaptive Strategies for Building Design

Building flexibility into design to allow for the unexpected makes investment decisions robust to most possible changes in climate conditions. This may include no-regret strategies that bring benefits even in the absence of future climate change, e.g. strengthening tile fixtures securely to a roof to avoid wind damage.

Beyond these measures, designers should be researching localised risks of climate change and preparing their buildings for the predicted hazards which may include: increasing temperatures, coastal storm surges and inundation, flooding, tropical cyclones and intensified downpours.

Increasing Temperatures

Passive design strategies have the double benefit of countering increasing temperatures without undermining mitigation efforts. The fundamentals of passive design are:

- Thermal mass to reduce the internal temperature variation
- Insulation and the use of low emissivity roofing paints and high performance glazing to reduce the rate of heat transfer through building structures
- External shading of vulnerable building surfaces, and strategic sitting of deciduous vegetation cross ventilation and mixed modedesign to cool internal spaces
- Green roof and roof design technology

- Photovoltaic glazing
- Low heat producing lighting, equipment and plant
- Photovoltaic, solar, biomass, and wind-powered cooling technology

Architects should assess whether these provide sufficient protection against climate change impacts anticipated for the lifetime of the building. Given that individuals can pay off the higher construction costs over the life of a mortgage, building design measures that can adapt to a certain level of flooding can be a cost-effective and affordable approach.

Besides citing, there are many options available to reduce the flooding risk and damage potential when designing and constructing new buildings. In order of priority, these are: Exceed minimum floor levels, Consider multi-storey construction, Design and construct buildings for flooding occurrences, Use water resistant materials, Design to ensure water can easily escape once flooding has subsided, Raise flood awareness and preparedness with building occupants, including designing and providing information about access routes

For existing buildings, the recommendations are similar to those for new buildings. Raise or move the building, Build a second or multiple stories and use the lower storey as non-living or non-productive‘ space, Replace cladding, flooring, and linings with water-resistant materials, Build a levee or flood wall around the building, Raise flood awareness and preparedness with building occupants.

Typically, commercial buildings are at greater risk of flooding than houses, mostly due to their urban location, being surrounded by impermeable surfaces, and the likelihood of urban storm water drainage systems being overburdened. Therefore, these buildings may be at risk of more damage than houses.

Conclusion

There is no doubt that the human populations, infrastructure and ecology of cities are at risk from the impacts of climate change. However, tools are becoming available for addressing some of the worst effects. For example, appropriate building design and climate sensitive planning, avoidance of high-risk areas through more stringent development control, incorporation of climate change allowances in engineering standards applied to flood defences and water supply systems, shoreline protection works. Citizens also have a responsibility to mitigate their collective impact on the local and global environment through reduced resource consumption and changed behaviour (Hunt, 2004).

This review has described the most significant climate change impacts expected to shape the future character and functioning of urban systems, in Zaria and Nigeria at large. Several important knowledge gaps have emerged. First, there is an on-going need to improve preparedness and forecasting of climatic hazards, such as intense heat island or air pollution episodes, to safeguard human comfort and health.

Second, there is clearly a need for improved representation of intraurban flooding, at local, city and catchment scales.

New modelling techniques will also be needed to exploit fully emergent probabilistic climate change information. But there could be new cost implications arising from the use of such data, dependent on the level of risk and uncertainty that is acceptable in the resultant engineering design.

References

Ahern, M., Kovats, R.S., Wilkinson, P., Few, R. and Matthies, F. (2005). Global health impacts of floods: epidemiologic evidence. Epidemiologic Reviews, 27, pp. 36-46

Ash, A, (2010), ‗Climate change and Coasts: Impacts, vulnerability and the need for adaptation', Climate Change Adaptation Forum, Canberra

Ashley, R.M., Balmforth, D.J., Saul, A.J. and Blanskby, J.D. (2005) Flooding in the future - predicting climate change, risks and responses in urban areas. Water Science and Technology 52(5), 265-273

Baum, S, Horton, S, Low Choy, D, Gleeson, B, (2009). ‗Climate Change, Health Impacts and Urban Adaptability: Case study of Gold Coast City', Urban Research Program Research Monograph 11

CIBSE (2004). Energy Efficiency in Buildings. CIBSE Guide F. Chartered Institution of Building Services Engineers, London.

CIRIA (2005). Climate Change Risks in Building: An introduction, London: CIRIA.

Hacker, J.N, Belcher, SE, Connell, RK (2005). Beating the Heat: Keeping UK buildings cool in a warming climate, UK Climate Impacts Programme briefing report. Oxford: UKCIP,

Hacker, J., et al., (2007). Climate scenarios for urban design: a case study of the London urban heat island. In: Proceedings International Conference on Climate Change (ICCC2007), Hong Kong.

Haines, A., R. S. Kovats, D. Campbell-Lendrum& C. Corvalan (2006). Climate Change an d Human Health: Impacts, Vulnerability, and Mitigation. Lancet 367 (9528): 2101–2109.

Hayhoe K, Wake C, Huntington T, Luo L, Schwartz M, Sheffield J, Wood E, Anderson B, Bradbury J, Holman IP, Rounsevell M, Shackley S, Harrison P, Nichols R, Berry P, Audsley E (2005a) A regional, multisectoral and integrated assessment of the impacts of climate and socio-economic change in the UK, part I, methodology. Clim Change 71:9–41

Hollis, G.E. (1988). Rain, roads, roofs and runoff: hydrology in cities. Geography, 73, pp. 918.

Hunt, J. (2004). How can cities mitigate and adapt to climate change? Building Research and information, 32, pp.55-57

Kousky, Carolyn, and Roger Cooke. (2009). ―Climate Change and Risk Management: Challenges for Insurance, Adaptation, and Loss Estimation.‖ Resources for the Future. http://www.rff.org/rff/documents/rff-dp-09-03_format.pdf .Accessed May 17, 2012.Magadza,

C.H.D. 2000. Climate change impacts and human settlements in Africa: prospects for adaptation. Environmental Monitoring and Assessment 61: 193 – 205.

Munich R. E. (2005). Worldwide Natural Disasters – Effects and Trends, NatCatSERVICE, Munich Reinsurance Company, Germany

Oke, T.R. (2006).Towards better scientific communication in urban climate. Theoretical and Applied Climatology, doi:10.1007/s0074-005-00153-0.

Oke, T.R. (1982). The energetic basis of the urban heat island. Quarterly Journal of the Royal Meteorological Society, 108, pp. 1–24.

EFFECT OF FLOOD DISASTER ON THE FOOD SECURITY STATUS OF CASSAVA FARMERS IN KOGI STATE, NIGERIA: EMERGING ISSUES FOR THE POST 2015 UNIVERSAL SUSTAINABLE DEVELOPMENT AGENDA

COKER, Ayodeji Alexander Ajibola; ADEBAYO, Cornelius Owoniyi, and CHIDIEBERE, Ezine Gift
Department of Agricultural Economics and Extension Technology, Federal University of Technology, Minna,

The flood disaster which ravaged Kogi State in 2012, left in its trails, colossal devastation, including destruction of farm houses, farmlands, crops, livestock, and other personal effects, with associated displacements, culminating in food shortages, human morbidity and mortality, amongst others. This study therefore examined the: food security status of the respondents; determined the effect of the flood disaster on the food security status of cassava farmers and identified the coping strategies used by respondents to cushion the effect of the flood. The study used cross-sectional data covering 120 respondents; quasi-experimental design, food security index, double differencing estimates, Tobit model and t- test of significance to achieve the objectives of the study. The results revealed that food insecurity increased by 12.5% amongst the flood affected cassava farmers compared to a decrease of 21% within the control group. The double differencing estimate of -1.3 further confirmed that the flood disaster had a negative effect on the flood affected farmers. However, the t-test of significance established that any difference in the food security status of the two populations at 5% probability level could only have been due to chance. The Tobit regression results further affirmed the absence of a causal link between the flood disaster and respondents' food security status at 5% probability level, probably, due to the short term nature of the incident, customary coping strategies adopted, prompt response by the governments and development partners. In spite of these efforts, but considering the magnitude of food insecurity established, there is the need to critically review the food security situation in the state and align the food security strategic plans and objectives to the national and global frameworks, particularly, those bordering on Sustainable Development Goals 2 (zero hunger) and 13 (climate concerns) respectively, with the view to achieving an enduring and sustainable food security for its over 3 million population, within the context of the Universal Sustainable Development Agenda.

***Keywords**: Climate Change, Flood, Food Security, Sustainable Development Goals.*

ayodejicoker@futminna.edu.ng

INTRODUCTION

In recent times, food security threats have been of concern in many developing countries, including Nigeria, given the climate-dependent nature of the agricultural systems and weak mitigation and coping capabilities (Bello *et al.*, 2012).Thus, the effects of climate change have been documented in several literature to be associated with numerous disturbing scenarios, including drought, flood, high level disease and pest infestations, leading to poor crop growth, low productivity, output, food insecurity and eventually poverty (Bello, 2012; Adejuwon, 2004; Zoellick and Robert, 2009; Schmidhuber, *et al.*, 2007; Parry *et al.*,1999). According to the Inter Governmental Panel on Climate Change (IPCC) (2014), the negative impact of climate change on crop yields have been more prevalent than the positive impact. Schmidhuber *et al., (2007)* established that between 5 million and 170 million additional people are at risk of hunger by 2080, while Parry *et al*., (1999) put it at between 70 and 90 million within same period. In Nigeria, the 2012 flood which ravaged numerous states, including Kogi, impacted negatively on various areas of the Nigerian economy (National Emergency Management Agency, 2012). The disaster was not unconnected to excessive rainfall within the country, as well as water released from Lagdo reservoir in Cameroun. According to Action Aid (2006), floods are mainly due to the effect of large volume of rainfall which causes a rise in the water level of a river. IPCC (2014) noted that when climate-related hazards impact the poor, it manifest in the areas of livelihoods, dwindling crop yields, or destruction of homes and indirectly, through increased food prices and food insecurity. In extreme cases, floods have been associated with loss of lives, over-flooding of river banks and washing away of economic crops, trees and livestock (Adeleye and Rustum, 2011). Many food security researchers have argued that modern agriculture demands a sustainable and environmentally production system if it were to unlock its economic, environmental, social and cultural benefits. Flooding has been known to cause great impact on the physical and socio-economic system of modern agriculture within the intervening domain. The 2014 IPCC report also alluded to the effect of flood on human socio-economic activities, food security and poverty. This study therefore answered the following research questions: what is the effect of flood on the food security status of affected cassava farmers?; what were the strategies adopted by the affected farmers in coping with the disaster?. The broad objective of the study was to ascertain the causal linkage between the 2012 flood on the food security of cassava farmers in Kogi State. The specific objectives were to: determine the food security status of the respondents; ascertain the effect of the flood on the food security of the respondents; and determine the coping strategies adopted by affected farmers to cushion the effect of the flood disaster. The justification for the study stems from the need to have a deep understanding of the dynamics of the economic effect of flood on the food security of cassava farmers and its implication on the Global Sustainable Development Goals (SDGs). The study will also be beneficial to the various stakeholders in the agriculture sector in the State, particularly, the government, farmers and other private sector operators.

REVIEW OF LITERATURE: CLIMATE CHANGE, FOOD INSECURITY AND SUSTAINABLE DEVELOPMENT GOALS

Climatic change refers to an alteration in the state of the climate that can be identified by changes in the mean and/or the variability of its properties and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forces such as modulations of the solar cycles, volcanic eruptions, and persistent anthropogenic changes in the composition of the atmosphere or in land use (IPCC, 2014). The United Nations Framework Convention on Climate Change (UNFCCC), in its Article 1, referred to climate change as: "a change of climate, which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods."Wikipedia encyclopaedia (2010) further posited that climate is the long-term pattern of weather in a particular area. It is measured by assessing the patterns of variation in temperature, humidity, atmospheric pressure, wind, precipitation, atmospheric particle count and other meteorological variables in a given region over long periods of time. Bello *et al*., (2014) hinted that climate change is one of the environmental life-threatening variables to economic development and sustainability of man-kind worldwide. Numerous researchers have argued that the problems of climate change are global in nature and that developing countries, particularly Africa will be mostly affected (Parry *et al*,.1999). Climate change, thus has the likelihood of increasing flood risk significantly and progressively over time. Bradshaw *et al.*,(2012) further established that rising level of atmospheric carbon dioxide can cause a rise in sea level and flooding.

Floods are mainly sudden and unpredictable. Aside these, they may only last a short-while, but their economic effect are devastating if mismanaged. According to Action Aid (2006), flood has been one of the major factors hindering the African continent from escaping poverty and by extension, food security. Effects of flood on the socio-economic lives of humans include destruction of economic crops, washing away of homes and generally food insecurity. Floods have been categorized in various ways according to the magnitude, intensity and duration. Bariweni *et al.,* (2012) categorized flood into six groups, namely (i) tidal flood; (ii) fluvial flood; (iii) flash flood; (iv) groundwater flood; (v) pluvial flood; (vi) flood from sewer; and flood from man-made infrastructure. Floods have been noted to be due to several factors, such as heavy rainfall, severe wind over water, unusual high tide, failure of dam, retention ponds (Halley, 2001) and also by human action, as was also partly the case with the 2012 flood in Nigeria. Research has shown that cassava was the second most affected crop in the 2012 flood experienced in Nigeria (Sidi, 2012).

The 1996 World Food Summit held in Rome, Italy agreed that 'Food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy lifestyle.' Following up logically, the Federal Ministry of Agriculture and Water Resources (2008) posited that food insecurity exists when an individual or group of people are undernourished as a result of the physical unavailability of food, lack of access to, and/or inability to use food effectively due to infection or disease. The source noted the wide range of factors that place people at risk of becoming food-insecure, from unrestrained population growth, climatic factors to political instability. Food and Agriculture Organization (2010) noted that153 States ratified the International Covenant on Economic, Social and Cultural Rights (ICESCR) and thus have an obligation to progressively realize the right to adequate food. This is not unconnected to the visible evidence of food insecurity across the globe. National Planning Commission (2001) established evidence of national food production failure to keep pace with the population growth and the decline in per-capital terms, despite various efforts by government to stimulate food production. Shittu (2015) revealed that 62 percent of Nigerians live on less than $1.25 per day, 55 percent is under-nourished while the country ranks 14.8 on Global Hunger Index (GHI), even though, trend analysis established decline in hunger levels.

Shittu (2015) referred to the SDGs as proposed set of development objectives and targets relating to future international development. The SDGs built on the Millennium Development Goals (MDGs) which expired at the close of 2015 and was perceived of being too narrow and exclusionary. The SDGs were adopted by the UN summit in September 2015 and became globally applicable in January 2016. The SDGs contains 17 Goals and 169 targets, covering a wide range of development issues, ranging from zero poverty and hunger, improving health and education, making cities more sustainable, combating climate change, protecting the environment, among others. The focus on hunger (Goal 2) is to ensure access by all people, in particular, the poor and people in vulnerable situations, including infants, to safe, nutritious and sufficient food all year round; achieving by 2025 the internationally agreed targets on stunting and wasting in children under five years of age, and addressing the nutritional needs of adolescent girls, pregnant and lactating women, and older persons. The emphasis under climate change (Goal 13) relates to strengthening resilience and adaptive capacity to climate related hazards and natural disasters in all countries; integrating climate change measures into national policies, strategies, and planning; promoting innovation and infrastructure, ensuring sustainable cities and communities, improving education, awareness raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction, and early warning.

Conceptual Framework

The conceptual framework in figure 1 depicts the relationship between climate as proxied by flood and food security status of the respondents in survey. The flow is such that with the interaction of climate (intervening variable) on the production variables of the cassava farmers may draw both positive and negative outcomes, but mainly with respect to the latter, given the severity of the flood. The framework therefore details the dependent and independent variables, intervening factors, assumptions and the resulting effect and impact. Ekong (2013) noted that conceptual representations are robust system of explanations rooted largely on tested and improved assumptions of realities.

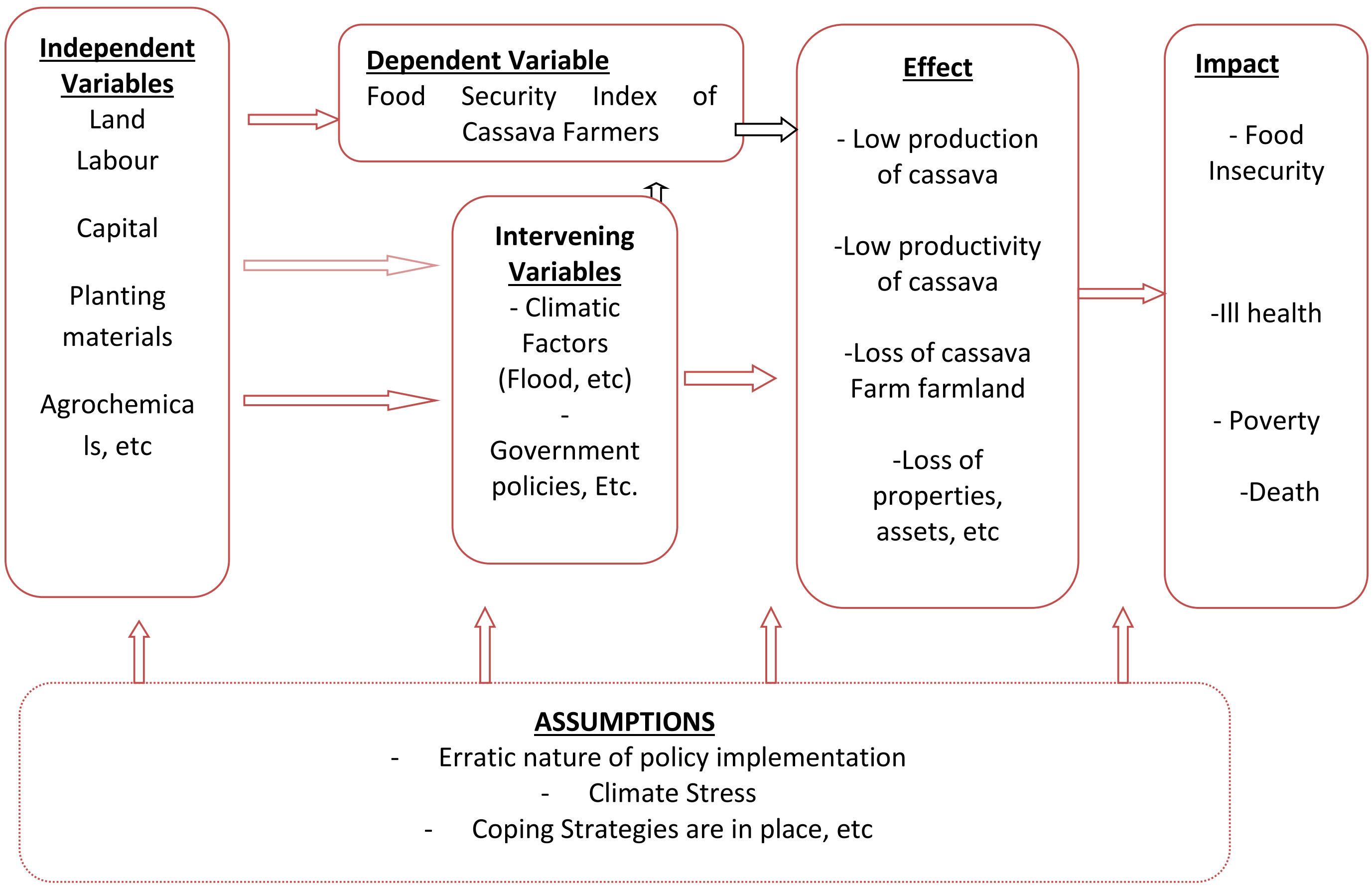


Figure 1: Causal Linkage of Flood and Food Security Status of Cassava Farmers

3.0 RESEARCH METHODOLOGY

The study was undertaken in Kogi State, in the North Central of Nigeria. It lies within Latitude 7°30N′and Longitude 6°42′ E. The State has a land area of 1,498 km^{2}and an estimated population of 3,314,043 (National Population Commission (NPC), 2011), which is put at about 3,658,083 as at 2015, using a population growth rate of 2.5%. Estimated average annual rainfall is put at 1,231 mm, mean and average high temperatures are 22.1° and 32.7°C respectively. This gives an annual average temperature of 27.4° C (Climate Nigeria, 2014). Its vegetation falls within the northern guinea savannah, while rainfall supports growth of cereals, legumes and root crops.

Sampling Techniques and Sample Size

To achieve the objectives of the study, multi-stage sampling procedure was employed to collect data from the flood affected farmers and the control. The first stage involved a random selection of Kogi State from the 27 States affected by the flood disaster, the second stage covered the simple random selection of eight Local Government Areas (LGAs), namely Dekina, Omala, Ankpa, Bassa, Kogi, Lokoja, Koton Karfi and Ibaji; made up of 5 LGAs from the flood affected areas and 3, from the non-flood affected areas. The third stage of sampling was the selection of 29 villages from the population. The last stage was the selection of 71 flood affected and 49 non-flood affected cassava farmers using a random technique at 5% level of precision and 95% confidence interval.. The unequal distribution reflects the differing population of respondents within the sampling frame.

Data Collection

The data for the study were obtained through well-structured questionnaire and covered respondents' production, income, expenditure data and other specific, and socio-economic related characteristics of respondents under the two population. Data were collected through the use of experienced Enumerators from the Kogi State Agricultural Development Programmed.

Analytical Techniques

The method of data analysis involved the derivation of a relative food security index, a counterfactual analysis covering the flood affected and control group, involving a double differencing approach and a Tobit binary regression analysis, employed to ascertain the effect of flood on the food security status of the respondents.

Model Specification

Relative Food Security Index (FSI)

The FSI was employed to determine the food security status of the respondents (Flood affected and non-flood affected farmers). The model is specified as follows:

$$Fi = \frac{\text{Per Capita Food Expenditure for the ith Household}}{\text{2/3 Mean Per Capita Food Expenditure of all Households}} \quad (1)$$

Where Fi = Food Security Index

When Fi ≥ 1 = Food Secured ith Household

Fi < 1= Food Insecure ith Household

Double Difference Model

This is a quantitative method used to estimate and compare change in outcome (food security status) pre and post occurrence for flood affected and non-flood affected cassava farmers (Chen *et al.*, 2006). The model is specified as follows:

$$DD = \left(\frac{1}{P}\sum_{i=1}^{P}\left(Y_{1\,ia} - Y_{1\,ib}\right)\right) - \left(\frac{1}{C}\sum_{j=1}^{C}\left(Y_{0\,ja} - Y_{0\,jb}\right)\right) \text{----------} \quad (2)$$

Where:

DD = outcome difference between the respondents;

P = number of flood affected farmers (affected);

C = number of non-flood affected farmers (control group);

$Y_{1\,ia}$ = number of flood affected farmers after the flood;

$Y_{1\,ib}$ = number of flood affected farmers before the flood;

Y_{0ja} = number of non-flood affected farmers after the flood;

$Y_{0\,jb}$ = number of non-flood affected farmers before the flood.

Test of Hypotheses

The estimation of the significant difference between the food security status of the flood affected and the non-flood affected farmers was tested using paired samples t-test specified as:

$$t_{cal} = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{\delta_1^2}{n_1} + \frac{\delta_2^2}{n_2}}} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (3)$$

Where,

$\bar{x}_1$ = the mean food security index of flood affected farmers

$\bar{x}_2$= the mean food security index of the non-flood affected farmers

δ_1^2 = standard deviation of variable for flood affected farmers.

δ_2^2= standard deviation of variable for non-flood affected farmers.

n_1 = number of flood affected farmers

n_2 = number of non-flood affected farmers

Tobit Regression Model

The Tobit model was used to determine the effect of flood on the food security status of the flood affected farmers. The empirical Tobit model is explicitly specified as:

$Y^* = \beta o + \beta_1 CRED + \beta_2\, HHSize + \beta_3\, LAN + \beta_4 LAB + \beta_5\, PLTMAT + \beta_6\, FLDSTAT + e$

Where,

$Y^* = 0$, If the household food security index is less 0 or less than 1 and $Y^* =1$, where food security index is 1 or greater than 1.

CRED = Credit received by household (Naira)

HHSize = Household Size (Number)

LAN = Land (Hectares)

LAB = Labour used (Man-days)

PLTMAT = Planting Materials (Bundles)

FLDSTAT = Flood Status of Respondents (Flood Affected =1; Non Flood Affected = 0).

e = error term

β_0 = Intercept estimated

$\beta_0 - \beta_6$ = Coefficients estimated

4.0 FINDINGS AND DISCUSSION OF RESULTS

The results of the relative food security analysis are shown in Table 1.0. The analysis revealed that 23% of the flood affected farmers were food in-secured before the flood disaster compared to 29% under control. Following the flood disaster, the flood affected farmers witnessed an increase of 12.5% (from 16 to 18 households) in the numbers of non-food secured population compared to a decrease of - 21% (from 14 to 11 households) obtained under the control population. The implication of this finding is that food insecurity situation increased amongst the flood affected households after the flood incidence. The incidence of food insecurity is not uncommon within the Nigerian terrain as researchers like Orewa and Iyangbe (2009) and Ibrahim *et al.*, (2009) have all reported cases of food insecurity arising from social, physical and environmental intervening variables associated with the farming households.

Table 1.0: Food Security Status of Respondents

Food Security Status	**Flood Affected**				**Non-flood Affected**			
	Before	**%**	**After**	**%**	**Before**	**%**	**After**	%
Food un-secured	16	22.5	18	25.4	14	28.6	11	22.4
Food secured	55	77.5	53	74.6	35	71.4	38	77.6
Respondents	71				49			

Source: Field Survey, 2014

Table 2.0 represents the outcome of the double differencing analysis covering the effect of the flood incidence on the food security status of the respondents. The results showed that there was a decrease in the food security status of the flood affected cassava farmers as indicated by a double differencing (DD) value of -1.3. This implies that the flood disaster had a negative effect on the food security status of the flood affected cassava farmers. However, the results of the t- test undertaken to ascertain the significant difference between the food security indexes obtained from the two populations indicated that there were no significant difference between the food security statuses of the two populations at 5% probability level and that, any observed difference must have been probably due to chance. In general, the outcome of this study aligns closely with the findings of Okwoche and Asogwa (2012) in their analysis of food security situation among Nigerian rural farmers, who established that that 30% of the sampled population were food in-secured. The result is however contrary to the findings of researchers like Ajani *et al.,* (2006); Akarue and Bakporhe (2013) and Adeniyi and Ojo (2013) who established that most of respondents under study were food in-secured. The result under the study, though contrary to expectations, but may not have been unconnected to the short duration of the disaster, use of customary coping mechanisms by respondents, and probably, prompt intervention and support for affected cassava farmers by governments and development partners.

Table 2.0: Results of the Double Differencing (Effect) Analysis

Food Security Status	**Flood Affected**		**Non-flood Affected**	
	Before	**After**	**Before**	**After**
Summation of Food Security Index	125.8	124.6	60.3	60.4
Difference	-1.2		0.1	
Double Differencing (Effect)	-1.3			
Respondents	71		49	

Source: Field Survey, 2014

The output from the Tobit analysis (Table 3) revealed that flood had no significant effect on the food security status of the respondents in survey as indicated by a z- value of -1.67. This results runs contrary to the findings of Emaziye *et al.,* (2012), Schmidhuber *et al.,*(2007) and Parry *et al.,(*1999) who established relations between climate change and food security. This result may probably be due to the short term influence of the flood disaster, even though harvests and assets, such as lands, homes and other tangible properties were lost in the incident. However, variables such as credit and labour were significant at 5% probability levels, implying that these were factors which could have been relevant in explaining the food security status of the respondents rather than the flood incident.

Table 3: Tobit Regression Analysis Results on the Effect of Flood on Food Security Status of Respondents

Variable	Coefficient	Std Error	z-test
Constant	0.9051774	1.49	0.61
Credit	0.9279714	0.435508	2.31
Household Size	-0.0642886	0.0719037	-0.89
Land	-0.0079771	0.336586	-0.24
Labour	4.98E-06	2.15E-06	2.32
Planting Material	3.44E-06	3.06E-06	1.12
Flood Status	-0.8099194	0.4856358	-1.67
Log likelihood	-114.24		
No of Observations	120		
LR Chi2	16.02		
Prob.>Chi2	0.0136		
Pseudo R^2	0.0655		

Source: Analyzed results from field survey data (2014)

Table 4.0 shows the coping strategies adopted by the flood affected farmers after the flood disaster. The table revealed that most of the flood affected cassava farmers relied on multiple measures in coping with the effect of the flood. Majority (85.92%) adopted multiple farming systems, while substantial numbers too relied relatives and on government support. The adoption of these coping strategies must have probably limited the adverse effect of the flood disaster on the cassava farmers. Okwoche and Asogwa (2012) established that majority of the respondents relied on intercropping as a way out of food stress in the study area. However, much depends on the affected cassava farmers to urgently review their life styles and production practices with a view to effectively coping with future occurrences of climatic challenges, such as flood.

Table 4: Coping Strategies Adopted by Respondents After Flood Disaster

Coping Strategies	Frequency	%
Adoption of New Farming Systems	61	85.92
Government Donations	36	50.07
Support from Relatives	43	60.56
Foreign Organizations and NGOs	30	42.25
Personal Savings	40	56.34
Total	210*	

Source: Field survey, 2013
*Multiple responses

Emerging issues and action points for the achievement of the SDGs in Kogi State, especially as it relates to Goals 2 and 13, should be directed at increasing investment in support of ending hunger, through monetary and fiscal means; ensure holistic and effective alignment to the existing national food security policy, support rural infrastructure development, agricultural research and extension services, ensure regular and bio-technology development integration into the food security strategy, amongst others. Shittu, (2015) noted the need to strengthen resilience and adaptive capacity to climate related hazards and natural disasters, integrate climate change measures into national policies, strategies, and planning; improve education, awareness raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction, and early warning. The urgent need to raise capacities for effective climate change related planning and management, including focusing on the marginalized groups, particularly women and youth have also become imperative if the State is to achieve the global sustainable development goals and targets.

5.0 CONCLUSION AND RECOMMENDATIONS

Arising from the outcome of the study, it is evident that in relative terms, substantial numbers of the respondents are still food in-secured. However, it was established that the 2012 flood disaster had no causal link with the food security in the study area, implying that the disaster had no significant effect on the food security status of the affected farmers, probably due to the short duration of the disaster, adoption of traditional coping strategies and prompt intervention of government and development agencies. However, to achieve zero hunger and poverty in the light of the current global SDGs and adequately redress the climate concerns, the study recommends the following: (i) the need to re-align the state's development planning framework with the national and global SDGs; (ii) effectively and holistically ensure the implementation of the national food security strategies; (iii) strengthen farmers coping and resilience capacities through encouraging the development of climatic information sharing and mitigation groups; (iv) institutionalization of awareness campaigns geared towards re-orientating the flood affected cassava farmers on sustainable environmental management and diversification practices.

REFERENCES

Action Aid, (2006). Food Security in the Occupied Palestinian Territory, Rome and Geneva, FAO and Geneva University.

Adeniyi, O. R. & Ojo, A.O. (2013). Food Security Status of Rural Farming Households in Iwo, Ayedide and Ayedaade Local Government Areas of Osun State, South Western Nigeria. *African Journal of Food, Agriculture, Nutrition and Development* 13(5):8210-8223.

Akarue, O. B. & Bakporhe, O.T. (2013). Food Insecurity and Its Determination of Rural Households in Ughelli North Local Government Area of Delta State, Nigeria. *International Journal of Innovative Agriculture and Biology Research* 1 (2):20-30.

Ajani, S.R., Adebukola, C.B. and Oyindamola, B.Y. (2006). Measuring Household Food Insecurity in Selected Local Government Areas of Lagos and Ibadan, Nigeria. *Pakistan Journal of Nutrition 5:62-67*.

Bariweni, P, Tawari, C.,& Abowei, J. (2012). Some Environmental Effects of Flooding in the Niger Delta Region of Nigeria. *International Journal of Fisheries and Aquatic Sciences,* 1(1):35-46.

Bello, O. B. , Ganiyu O. T., Wahab, M. K. A., Afolabi, M. S., Oluleye, F., Ig, S. A., Mahmud, J., Azeez M. A.,& Abdulmaliq, S. Y.Evidence of Climate Change Impacts on Agriculture and Food Security in Nigeria. *International Journal of Agriculture and Forestry* 2012, 2(2): 49-55.

Chen, S., Ren, M, & Martin, R. (2006). "Are there lasting impact of aid to poor areas. Evidence from Rural China. Development Research Group, World Bank Policy working paper 4084, December . Pp.12-23.

Ekong, E. E. (2003). *An Introduction to Rural Sociology. An Introduction and Analysis of Rural Nigeria*. (Third Edition). Dove Educational Publications, Uyo, Nigeria.

Emaziye, P.O., Okoh, R.N. & Ike, P.C. (2012). An Evaluation of Effect of Climate Change on Food Security of Rural Households in Cross River State, Nigeria. *Asian Journal of Agricultural Sciences* 5(4):56-61, 2013.

Federal Ministry of Agriculture & Water Resources (2008). National Food Security Programme, Area 11, Abuja, Nigeria.

Food and Agriculture Organization, (2010). Learners' Note, Impact Assessment of Large Scale Food Security Programmes, Rome, Italy.

Free encyclopedia. https://en.wikipedia.org/wiki/climate Accessed 15th December, 2015.

Ibrahim, H,. Uba-Eze, N.R., Oyewole, S.O. and Onuk, E.G. (2009). Food Security Among Urban Households: A Case Study of Gwagwalada Area Council of the Federal Capital Territory, Abuja, Nigeria. *Pakistan Journal of Nutrition* 8(6), 810-813.

Intergovernmental Panel on Climate Change (IPCC), (2014): Summary for policymakers. In: Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Field, C.B., V.R. Barros, D.J. Dokken, K.J. Mach, M.D. Mastrandrea,T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea, & L.L. White (eds.)]. Cambridge University Press, Cambridge, United Kingdom and NewYork, NY, USA, pp. 1-32.

National Population Commission (NPC), (2011). National and State Population Statistics

Okuneye, B. (Undated). Climate Change, Food Security and Agriculture in Lagos State: The Challenges, Vulnerabilities, Adaptation and Mitigation.

Orewa, S.I. & Iyangbe, C.O. (2009). Household Food Insecurity in Nigeria: An Assessment of the Present Status of Protein-Energy Malnutrition Among Rural And Low-Income Urban Households. Journal of Applied Sciences Research 5(10) 1615-1621.

Parry, M., Resenzweig, C., Inglesias, A. Fisher, G. and Livermore, M. (1999). Global Environmental Change, *Elsevier*, Volume 9, Supplement 1, October, 1999.

Schmidhuber, J., Tubiello, F.N, (2007). Global Food Security and Climate Change. Proceedings of the National Academy of Sciences of the United States of America.

Shittu, J. (2015). Towards Achieving Sustainable Development For All: Prioritizing Targets For Implementation: Which Way Forward For Nigeria? Centre for Policy Alternatives, 3rd Floor, West Wing Catholic Mission, Lagos Island, Lagos, Nigeria.

Zoellick, S. & Robert, B. A. (2009). Climate Smart Future. The Nation Newspapers. Vintage Press Limited, Lagos, Nigeria, pp 18.

CLIMATE CHANGE INDUCED DISASTERS

Nwose, I.A. , Gbedu, A.M. & Ibrahim P.O.
Department of Surveying and Geoinformatics, FUTMinna, Niger State Nigeria

Climate change is one of the most critical challenges facing human beings. The impacts range from rise in sea level, increased incidences of drought and flooding, melting ice caps and glaciers, and so on. The change is already leading to more agricultural shortfalls, spread of vector borne diseases and endangered water security. The world has recognized that climate change is no longer solely on environmental problem. Rather, it has become an economic and security issue that will increasingly dominate global and national policies as its impacts become more apparent. Whilst mitigating climate change is highly imperative, its inevitable effects should be concretely looked into. The effects are felt mostly by the developing countries who are the least responsible. Since climate change is a global problem, it needs a global response that embraces the interests and needs of all nations. This paper examines the causes of climate change, projections for climate change, the impact of climate change on key sectors, the impact of Africa, Asia and Europe, climate change and induced disasters and methods and strategies of addressing the problem. Conclusion and recommendations were drawn from the observed reports.

piusibrahim.uk@gmail.com

Nwose, I.A[1] , Gbedu, A.M[2] , & Ibrahim P.O. (2016). **CLIMATE CHANGE INDUCED DISASTERS**
Sustainable Built Environment and Climate change; The challenges of Post 2015 Development Agenda. School of En vironmental Technology Conference, SETIC, 2016

INTRODUCTION

For most people, the expression "climate change" means the alteration of the world's climate that humans are causing, through fossil fuel burning, clearing forests and other practices that increase the concentration of greenhouse gases (CoHG) in the atmosphere. This is in line with the official definition by the United Nations Framework Convention on Climate Change (UNFCCC) that "climate change is the change that can be attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability, observed over comparable time periods" (UNFCCC, 2008). Scientists often use the term for any change in the climate, whether arising naturally or from human causes. The Intergovernmental Panel on Climate Change (IPCL) defined climate change as a change in the state of the climate that can be identified by changes in the mean and, or the variability of its properties, and which persists for an extended periods, typically decades longer" (IPCC Fourth Assessment Report, 2012). Each of these three definitions is very relevant and important in a study of this nature. '

The World's climate has always varied naturally but compelling evidence from around the world indicates that a new kind of climate change is now under way, foreshadowing drastic impacts on people, economies and ecosystems (Whorf, 2009). For example, levels of carbondioxide and other greenhouse gases in the atmosphere have risen steeply during the industrial era owing to human activities like fossil fuel use, deforestation, spurred on by economic and population growth. Like a blanket round the planet, greenhouse gases trap heat energy in the earth's lower atmosphere. If levels rise to high, the resulting overall rise in air temperatures – global warming – is liable to disrupt natural patterns of climate (Milano, 2013). The Intergovernmental Panel on Climate Change (IPCC) conclude in its fourth assessment report, that the evidence that climate change is already occurring is unequivocal and is due, in large part, to human activity. The IPCC says the world noted an average temperature rise of around 3^0C this century if greenhouse gas emissions continue to rise at their current pace and are allowed to double from their preindustrial level. The impacts of this climate change, particularly temperature increases, are already being witnessed on natural and human systems around the world and they are very likely to increase.

There are strong indications that people in some areas may benefit from climate change, but many more will struggle to cope. Developing countries will suffer more than others, as their lack of resources makes them especially vulnerable to adversity or emergencies on a major scale.

Certainly the needs of developing countries in adapting to climate change is of critical importance. In several key ways, the problem of climate change is interlinked with development: economic growth is essential for developing countries to improve the health, economic livelihood and quality of life of their citizens. Economic growth is also essential to increase the capacity of developing countries to adapt to the negative impacts of climate change. But historically, increased economic development and the corresponding increase in energy use have also led to increased emissions of green house gases (Lawson, 2014). There is therefore, the need to break the link between economic development and green house gas emissions.

BACKGROUND

The First World Climate Conference held in 1979 marked the emergence of scientific evidence of human interference with the climate. In the 1980s, public awareness of environmental issues continued to increase and governments expressed greater concern about climate issues. The United Nations General Assembly adapted resolution 43/53, proposed by the government of Malta in 1988, which urged "the protection of global climate for present and future generations of mankind". The governing bodies of the World Meteorological Organization and of the United Nations Environmental Programme created a new body, the Intergovernmental Panel on Climate Change in 1988, to marshal and assess scientific information on the subject.

In 1990, the IPCC issued its first assessment report, which confirmed that the threat of climate change was held in Geneva and it is called for the creation of a global treaty. Consequently, the General Assembly responded by passing resolution 45/212, formally launching negotiations on a convention on climate change, to be conducted by an Intergovernmental Negotiating Committee (INC). The IPCC in 1990 confirmed the treaty posed by climate change, and therefore, proposed the threat posed by climate change, and therefore, proposed the creation of a global treaty.

In February, 1991, the INC met and its government representatives adopted the United Nations Framework Convention on Climate Change, after 15 months of negotiations on 9 May, 1992. The new convention was opened for signature at the Riode Janeiro United Nations Conference on Environment and Development (or Earth Summit) of June, 1992. It however, came into force on 21 March, 1994. Thirteen years later, 191 States and the European community had joined the convention. The convention therefore, became the most universally supported of all international environment agreements. Since its formation, those countries that have ratified, accepted, approved, or acceded to the treaty have met annually at the conference of the parties, known informally as the COP. They are saddled with the responsibility of fostering and monitoring its implementation and continued negotiations on how best to tackle climate change. The decisions taken by the COP at its sessions now make up a detailed set of rules for practical and effective implementation of the convention (Pryor, 2010).

At the first conference of the parties (COP), held in Berlin, Germany in early 1995, a new round of talks was launched to discuss firmer, more detailed commitments for industrialized countries, a decision known as the Berlin Mandate. In December, 1997, a substantial extension to the convention that outlined legally-binding commitments to emissions cuts was adopted at COP3 in Kyoto, Japan. The Kyoto protocol sketched out basic rules, but did not specify in detail how they were to be applied. It also required a separate, formal process of signature and ratification by governments before it could enter into force. The negotiations launched in Buenos Aires, Argentina at COP4 in November, 1998 linked negotiations on the protocol's rules to implementation issues, such as technology transfer and finance under the umbrella of the convention. (Palmer and Ralsanen, 2012).

In July, 2001, governments struck a political deal, the Bonn Agreements, signing off the controversial aspects of the Buenos Aires plan of action. A third report from the IPCC improved the climate for negotiations by offering the most compelling scientific evidence so far presented, of a warming world (Milly, et al., 2012).

COP7 was held a few months later in Marrakesh, Morocco. There, negotiators built on the Bonn Agreements and brought a major monitoring cycle to a close by adopting a broad package of decisions. The Marrakech Accords spelt out more detailed rules for the protocol as well as advanced prescriptions for implementing the convention and its rules. The protocol entered into force after atleast 55 parties to the convention had ratified it. The first parties ratified the protocol in 1998. With the ratification of the Russian Federation on 18th November, 2004, the prescribed 90-day count down was set in motion. The Kyoto protocol entered into force on 16th February, 2005.

A critical assessment of the devastating impact of climate changed on the atmosphere or “global climate system” earth surface and oceans, would require a stronger commitment, by all parties to the conventions, to the implementation of the agreements. The gathering of the world leaders in France in December, 2015 to discuss the rampant green house gas emission should be commended. However to achieve a clear cut result, the decisions arrived at must be binding on all parties.

This paper examines the causes of climate change, projections for climate change, the impact of climate change on key sectors, the impact of Africa, Asia and Europe, climate change and induced disasters and methods and strategies of addressing the problem. Conclusion and recommendations were drawn from the observed reports.

Causative Factors in Climate Change

Climate change is predicted to have a range of serious consequence, some of which will have impact over a longer term, like spread of diseases and sea level rise, while some have immediately obvious impacts, such as intense rain and flooding. In fact, the earth’s climate has varied considerably in the past as reported by the geological evidence of ice ages and sea-level change, and by the records of human history over many hundreds of years (Mechl, 2007).The causes of past changes are not always clear but are generally known to be related to changes in ocean currents, solar activity, volcanic eruptions and other natural factors (Rousels, 2013).

Global temperatures have risen rapidly over the last decades. There is evidence of increases in average global air and ocean temperature, widespread melting of snow and ice, and rising average global sea levels. The report of IPCC Fourth Assessment states that the global warming is unequivocal. Atmosphere and ocean temperatures are higher than they have been at any other time during at least the past five centuries, and probably for more than a millennium (IPCC Fourth Assessment Report, 2007).

Today, it is well known that the atmosphere’s green house gases act as a blanket which traps incoming solar energy and keeps the earth’s surface warmer than it otherwise would be, and that an increase in atmospheric green house gases would lead to additional warming (Saunders, 2008). The focus of the Kyoto protocol is on carbondioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydroflurocarbons (HFC_s), perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6). Carbondioxidde (CO_2), methane (CH_4) and nitrous oxide (N_2O) account for 50, 18 and 6 percent, respectively, of the overall global warming effect arising from human activities (Brown, 2013).

Albeit, these gases are naturally occurring, their emissions have increased dramatically over the past two centuries due to human activities. CO_2 is produced in large quantities from the consumption of energy from burning fossil fuels, and deforestation. CH_4 and N_2O emissions are produced mainly from agricultural activities. The HFCs and PFCs are used as replacements for ozone-depleting substances such as chlorofluocarbons (CFCs) currently being phased out under the montral protocol. Sulphur hexafluoride (SF_6) is used in some industrial processes and in electric equipment (Trans, 2010).

The impact and relative level of one of the six green house gases is compared using their respective Global Warming Potentials (GWP). A GWP is a measure, defined by the IPCC, of the relative effect of a substance in warming the atmosphere over a given period (100 years in the case of the Kyoto protocols), compared with a value of one for carbondioxide. The methane's GWP is 25, according to IPSS assessment report (Landson, 2010).

The current concentration of green house gases in the atmosphere is now the highest it has been for the past 600,000 years, having grown by 70% between 1970 and 2012 alone, heaving reached this level exceptional quickly (IPCC Fourth Assessment Synthesis Report, 2011). While there has been some controversy in the past, it is now widely accepted that human activities, in particular fossil fuel use and changing land-uses, are the dominant factors in this growth and are responsible for most of the warning observed globally over the last 60 years (IPCC Fourth Assessment Report, Working Group I (2011).

Projections for Future Climate Change

The future projections of climate patterns are largely hinged on computer-based models of the climate system which incorporate the factors and processes of the atmosphere, the oceans and the expected growth in greenhouse gases from socio-economic scenarios for the coming decades. The published results from different models have been examined by IPCC, and on the basis of the evidence, has estimated that by the year 2100:.

1. The sea level will rise between 18 and 59cm;
2. The oceans will become more acidic;
3. The global average surface warning (surface air temperature change) will increase by 1.1 to 6.4^0C;
4. It is likely that tropical cyclones (typhoons and hurricanes) will become more intense with larger peak wind speeds and more heavy precipitation associated with ongoing increases of tropical sea surface temperatures;
5. It is very likely that there will be more precipitation at high latitudes and it is likely that there will be less precipitation in most sub tropical land areas; and
6. It is very likely that hot extremes, heat waves and heavy precipitation events will continue to become more frequent (Rooney, 2010).

Effect of Climate Change on Key Sectors

The likely effects of climate change on key sectors were postulated by Aberdeen (2010) and summarized as follows:

Health: The health status of millions of people is likely to be altered by projected changes in climate. The heat waves, floods, storms, fires and drought will result in increased deaths, disease and injuries.

There will also be an increase in malnutrition, diarrhea and malaria in some areas, and vulnerability to extreme public health and development goals will be threatened by damage to health systems from disasters.

Food: for people at lower latitudes, particularly in seasonally dry and tropical regions, the increase in temperature and the frequency of droughts and floods are likely going to affect crop production negatively and could result in hunger, displacement and migration. However, those at the mid-latitude and high latitude areas will initially benefit from higher agricultural production.

Industry, Settlement and Society: the industries, settlements and societies that are most vulnerable are those located in coastal areas and river flood plains, and those whose economies are linked with climate – sensitive resources. Such locations are those prone to extreme weather events or those areas undergoing rapid urbanization. The economic and social costs of those events will increase when the extreme weather events become intense or frequent.

Water: By mid century, water availability will likely decrease in mid latitudes in the dry tropics and in other regions supplied by melt water from mountain ranges. In fact, more than one sixth of the world's population is currently dependent on melt water from mountain ranges. Heavier precipitation events are very likely to increase in frequency leading to higher flood risks.

Effect of Climate Change on Africa, Asia and Europe

The devastating effects of climate change are more pronounced among the poorest people in underdeveloped and developed countries. This is because they live mostly in high risk areas such as unstable slopes and flood planes and cannot afford well built houses. Majority of them depend on climate sensitive sectors such as agriculture, and they have no means of coping with climate change, owing to low savings, zero property insurance, and poor access to public services. Many developing countries are likely to witness increase in death rates of their citizens and several illnesses due to climate change. The latter is also expected to lead to low incomes. Abudahab (2014) stated that Africa, small Island States, and the Asian and African mega-deltas are likely to be particuallry affected by climate change.

Africa: Due to multiple stresses and low adaptive capacities arising from endemic poverty, weak institutions, and complex disasters and associated conflicts, Africa is particularly vulnerable to the effects of climate change. Adegbija (2013) reported that "drought will continue to be a primary concern for many African populations, and that the frequency of weather and climate related disasters has increased since the 1970ss, and the Sahel and Southern Africa have become drier during the twentieth century. Water supplies and agricultural production will become more severely diminished". It is also reported that by the year 2020, agricultural yields in some African countries could be reduced by 50%. And in 2080, the area of arid and semi-arid land in Africa will likely increase by 5 to 8% (Jawal, 2013).

Asia: the continued melting of glaciers in the Himalayan region has been projected to increase flooding and rock avalanches and to adversely affect water resources in the next two to three decades. The sustainable development in the continent will also be challenged as climate change compounds the pressures that rapid urbanization, industrialization, and economic development have placed on natural resources (Lisbon, 2011). The availability of adequate fresh water, by the 2050s will be a concern for possibly more than one billion people. The heavily populated coastal areas, the delta regions, will become more prone to increased flooding due to the rising sea levels and flooding of river.

Europe: the concern areas of focus of the continent are the retreating glaciers, reduced precipitation in southern Europe, and the possibility of more droughts in some areas, as well as increased risk of flash floods. Health risks and frequency and severity of widefires will be increased as a result of higher temperatures and heat waves. There are also the likelihood of reduced forest area and agricultural productivity and greater vulnerability of low-lying coastal areas, and rising sea levels. Less water will reduce hydro power potentials, tourism and crop production in Southern Europe (Babalola, 2014).

Climate Change Induced Disasters

The combination of an exposed, vulnerable and ill-prepared population or community with a hazard event, result in a disaster. Therefore, natural hazards by themselves do not cause disasters. Climate change will affect disaster risks in two ways: through the likely increase in weather and climate hazards; and through increases in the vulnerability of communities to natural hazards, essentially through ecosystem degradation, reductions in water and food availability, and changes to livelihoods. Climate change engenders environmental degradation and rapid unplanned urban growth, further reducing communities abilities to cope with even the existing levels of weather hazards (Lisbon, 2011).

From 1991 to 2010, more than 9,460 million people were affected by disasters, 3,780,000 people died and economic losses were US $12,163 billlion (Centre for Research on the Epidemology of Disasters (CRED, 2012). It has been observed also that poor countries are disproportionately affected, due to intrinsic vulnerabilities to hazards and comparatively low capacities for risk reduction measures (Mills, 2008). Many small countries are also vulnerable – Grenada lost 919 millions dollars due to hurricane Ivan in 2004 and were equal to 2.5times its GDP. In the last three decades, 76% of all disaster events were hydrological, meterological or climatological in nature. These accounted for 45% of the deaths and 79% of the economic losses caused by natural hazards. Today, there is already evidence of increase in extreme conditions for some weather elements in some regions (Meehl, 2007).

It has also been revealed that several long term precipitation trends have been observed, including significant increases in eastern parts of North and South America, Northern Europe and Northern and Central Asia, and more dry conditions in the Sahel and Southern Africa, throughout the Mediterranean region, and in parts of Southern Asia (Deque, 2003). The observed frequency of heavy precipitation events has increased over most land areas, which is consistent with global warming and the observed increase of atmospheric water vapour (Patz, 2009).

Since 1970s, more intense and longer droughts have been observed over wider areas, particularly in the tropics and sub tropics. Pielke (2009) stated that higher temperatures and decreased precipitation have increased the prevalence of drier conditions as well as contributing to changes in the distribution of droughts.

Wind patterns, decreased snow pack, snow cover, and changes in sea surface temperatures, have been linked with changing drought occurrence (Saunders, 2008). Widespread changes in extreme temperatures have been observed in many regions of the globe over the past 50years – notably the higher frequency of high-temperature days and nights, and heat.

There is however, strong evidence for an increase of more damaging intense tropical cyclone activity in the North Atlantic since 1970s, which is correlated with increases in tropical sea surface temperatures (Keatinge, et al., 2008). Today, there is no clear trend evident in the global annual number of tropical cyclones (Trenberth, 2010). Generally however, it is impossible to be absolutely certain about all the disaster – related effects of climate change, due to the intrinsic uncertainty in the climate projection, the diverse and rapidly changing nature of community vulnerability and the random nature of individual extreme events (Mills, 2008). There is however, plenty of information on the serious impacts of events that have occurred in the past decades, and on this basis, there is much to be concerned about.

Excessive heat waves will increase the number of deaths, particularly among the very young, to the elderly and those who are chronically sick and therefore, socially isolated. (Palmer and Ralsanen, 2012). Increased drought in some regions will likely lead to land degradation, damage to crops or reduced yields, more livestock deaths, and an increased risk of wildfire. Such conditions will increase the risks for populations dependent on subsistence agriculture, through food and water shortage and higher incidence of malnutrition, water-borne and food borne diseases, and may lead to displacements of populations. Emmanuel (2010) also observed that increased frequency of high precipitation in some regions will trigger floods and landslides, with potentially large losses of life and assets. These events will disrupt agriculture, settlements, commerce and transport and may further increase pressures on urban and rural infrastructure. Although, it is quite obvious that increases in the number and intensity of very strong cyclones (typhoons and hurricanes) will affect coastal regions, with potentially large additional losses of lives and assets.

Brown (2013) stated that sea-level rise, coupled with coastal storms, will increase the impacts of storm surge and river flooding and damage livelihood systems and protective ecosystems. He also posted that low lying settlements may become unviable, which may result in increased potential for movement of population. Higher temperatures and melting glaciers may also cause glacier lake outbursts that could flood downstream settlements (McCarthy, 2008).

Methods and Strategies of Addressing the Problem of Climate Change

Till date, countries are actively engaged in discussing ways of dealing with the problem of climate change. This is particularly within the United Nations Framework Convention on Climate Change (UNFCCC) which clearly spelt out steps to follow in tackling the problem. One of such steps is to address the root cause by reducing green house gas emission from human activity. This step will require, as it were, radical changes in the industrial operations, urban development, fossil fuel use and land use. The reduction of green house gas emissions is known as "mitigation"

Mitigation is conceptualized by the Intergovernmental Panel on Climate Change (IPCC) as "an anthropogenic intervention to reduce the anthropogenic forces of the climate system. It includes strategies to reduce green house gas sources and emissions and enhancing greenhouse gas sinks". Mitigation actions include actions such as developing new low-energy technologies for industry and transport, switching to renewable forms of energy, such as solar and wind power, reducing consumption of energy intensive products, and efficient furnace systems. Technologies are being developed today to capture carbon-dioxide at industrial sources and to inject it into permanent storage deep underground. Also, carbon (natural) sinks, such as soils, forests and vegetation, can be managed to absorb carbondioxide. (Christensen and Christensen, 2010).

Another relevant step in responding to climate change is the management of its impact. Christensen (2010) observed that due to the amount of green house gases already in the atmosphere from past decades of industrial and other human activity, and including the amounts from continued emissions over the next few decades until such a time that mitigation policies would become effective, future impacts on the environment and the society are really inevitable.

Adaptation, on the other hand, means the steps to cope with the changed climate conditions. It is particularly conceptualized by Intergovernmental Panel on Climate Change (IPCC) as "the adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderate harm or exploit beneficial opportunities". Adaptation therefore, include managing water resources, building settlements in safe zones, preparing risk assessments, protecting ecosystems, developing early warning systems, improving insurance coverage, developing social safety nets, and instituting better building designs and improving agricultural methods. The measures reduce the risk to lives and livelihoods and improve resilience of community to hazards. They are therefore, intrinsically linked to sustainable development. While mitigation measures can be planned to reduce, and not inadvertently exacerbate, disaster risks, adaption measures can contribute to the reduction of green house gas emissions (Environment Agency UK, 2005) (Pielke, 2009).

Disaster risk reduction is aimed at counteracting the added risks arising from climate change. It is defined as "action taken to reduce the risk of disasters and the adverse impacts of natural hazards, through systematic efforts to analyse and manage the causes of disasters, including through avoidance of hazards, reduced social and economic vulnerability to hazards, and improved preparedness for adverse events.

The Hyogo Framework for Action (2005-2015) sets out five priorities for action, each elaborated into a number of specific areas of attention which offer a strong basis for developing concrete risk reducing adaptation measures. These are, ensuring that disaster risk reduction is a national and local priority with a strong institutional basis for implementation; identification, assessing and monitoring disasters risks and enhancing early warning, using knowledge, innovation and education to build a culture of safety and resilience at all levels; reducing the underlying risk factors; and strengthening disaster preparedness for effective response at all levels (Trenberth, 2010).

Adaptation and disaster risk reduction measures can be viewed from three sectoral perspectives – water sector, health sector and agricultural sector.

Water Sector: the adaptation measures under this sector include actions such as developing flood ponds, water harvesting, desalination, improved irrigation, protecting water supply infrastructure, and traditionally water supply sources, non-water based sanitation, improved watershed and trans-boundary water resource management.

Health Sector: the measures under this sector include the enforcement of relevant regulations; supply for education, research and development on climate related health risks, early warning systems and air conditioning to address extreme weather events; vector control and safe water and food handling regulations; and systematic action on water and vector borne diseases to raise public awareness of watershed projection.

Agricultural sector: the measures here include changing planting times and cropping patterns, altering crop strains to enhance their drought and pest resistance, and altering land topography to improve water uptake and reduce wind erosion.

In the area of early warning systems, measures include instituting specific means to disseminate warnings to affected people in a timely, useful and understandable way, improving existing systems to cover the changed hazard circumstances, and providing advice on appropriate actions to take upon receiving warnings.

Also, in the area of environmental management, measures include protecting ecosystems, such as coral reefs or mangrove forests that shield communities from coastal hazards; supporting transitions of livelihoods away from those that degrade environments and aggravate risk; enforcing regulations concerning these practices; and strengthening of environmental management in areas of greater risk from weather hazards (Patz, 2009).

CONCLUSION

There is convincing evidence that changes in the earth's climate are taking place all over the world. This can be explained by taking into account human influence through the emission of greenhouse gases (GHGs). The theoretical understanding of the physical processes behind the influence of climate change on various extreme weather events indicate that more extreme events would in general be an expected outcome. Empirical evidence in some cases have revealed that climate change has already had an impact on some disasters in several parts of the world. However, given the increasing severity of extreme events, further and improved adaptation measures are needed.

RECOMMENDATIONS

1. There is an urgent need for the nations to raise and intensify the level of discussion on extreme events linked to climate change. In fact, there should be persistent discussion on policy action required to prevent or mitigate the impacts of extreme events, such as droughts, heat waves, flooding, desertification, and green house gas emission. There should be a follow up to the meeting of world leaders in Paris in December, 2015 where the issue of green house gas emission was discussed.
2. It is absolutely necessary for policy makers and environmental experts to always support better data gathering and scientific inquiry into extremes and dissemination of several conclusions drawn.
3. A thorough evaluation of plans is very important, particularly when funds are spent in the most effective ways. There is therefore, the need to review nations funding needs and persistent readiness for a future in which extreme events such as drought, heat waves and flash floods, are likely to occur.

REFERENCES

Aberdeen, E.A. (2010). Public Health Responses to Extreme Weather and Climate Change. American Meteorological Society, Vol. 99, 2709-2718.

Adegbija, A.M. (2013). Climate Variability and Change in Coastal Parts of Africa. Ibadan: International Publishers.

Babalola, F.T. (2014). A Data of Drought Severity in West African Sub-Region: Soil Moisture and Effects of Surface warming. Valdosta GA: Valdosta State University.

Brown, S. (2013). Temperature Extremes, the Past and the Future. Poster presentation, stabilization. *www.stabilization.2013.com*.

Christensen, J.H., and O.B. Christensen (2010). Sever Summer Time flooding in Europe, Nature, 421, 805 – 806.

Deque, M. (2013); Uncertainties in the Temperature and Precipitation Response of Prudence Runs over Europe. Abstract from the European Science foundation and prudence. 3rd Annual Conference on "Regional Climate Change in Europe" Wengen, Switzerland, September 29 – October3, 2003.

Emmanuel, K. (2010). Increasing Destructiveness of Tropical Cylcones over the past 30 years. Nature, 436, 4 August 2010, 686-688.

Environment Agency (U.K) (2005). The Thames Esturey; *http://www.environment-agency.gov.uk/regions/thames/323150/335688/335743/?version=lang=_e*.

IPCC Fourth Assessment Report, Working Group I, Glossary of Terms: *Http://ipcc.wgi.ucar.edu/wg1/report/AR4WGI.print.annexxes.pdf*

IPCC Fourth Assessment Synthesis Report: *http://195.70.10.65/pdf/assessment.report/ar4/syr/ar4-syr.pdf*.

Jawal, T.C. (2013). United Kingdom, Trends in Daily Intensity. International Journal of Climatology 931-942.

Keatinge, W.R., G.C. Donaldson, E. Cordiolo, M. Martinelli, A.E. Kunst, J.P. Mackenbach, S, Wayha, L, Vuori (2008). Heat related mortality in cold and warm regions of Europe: Observational study, BMJ: 321, 670-673.

Landson, A.A. (2010). Status of Global Climate in 2010. WMO Press Bulletin, 299.
Lawson, K.L. (2014). Adaptation to climate change in Europe EUR 20184 EN.
Lisbon, C.A 92011). Preliminary Description of the Terrestrial Natural Communities of California. California Department of Ecological Studies, Sacramento, CA.
McCarthy, J.J. (2008). Reply to Pielke, et al. American Meteorological Society, vol 86 No 10, October, 2008, 1483-1484.
Mechl, G.A. (2007). An introduction to trends in extreme weather and climate events. Observations, socio-economic impacts, terrestrial ecological impacts, and model projections. Bull American Meteorological Society 81, 413-416.
Milano, B. (2013). Flash food prevention and mitigation strategies. Global Perspectives: London Kogan Page.
Mills, E. (2008). Insurance in a climate of change. Science 310, 9 December, 2008, 1616.
Palmer, T.N. and J. Ralsanen (2012). Quantifying the Risk of Extreme Seasonal Precipitation Events in a Changing Climate. Nature 415, 512-513.
Pielke, R.A Jr (2009). Attribution of Disaster Losses, Science, 310, 9 December, 1615-1616.
Rodney, M. (2010). Ecology and Restoration of Northern California Dunes: Humboldt County Planning Department, Eureka, CA.
Rousels, D. (2013). Factors Responsible for Escalation of European Heat Wave in 2003. Newyork: Alfred .A. Knopf.
Saunders, M. (2008). Head of Climate Protection, Department of Space and climate Physics, University College, London, quoted in Jha, 2008.
Trans, Z. (2010). Trends in Climate Change over Past Decades. J. Climate, 14, 4922-4947.
Trenberth, K. (2010). Uncertainty in Hurricanes and Global Warning: Science, 308, 17 June, 1753-1754.
Tsar, J.O. (2012). Climate Variability: Observation and Reconstruction. Cambridge: Harvard University Press.
UNFCC Article I, Definitions: *http://unfcc.int/essential...background/comvention/* background/items/1349.php
Whorf, T.A. (2009). Occurrence of Extreme Floods in Central Europe. New York: Macmillan.

DESIGNING THE HUMAN SETTLEMENT FOR CLIMATE CHANGE

ASSESSING THE IMPACT OF KADUNA STATE UNIVERSITY, KAFANCHAN CAMPUS ON ITS HOST COMMUNITY, BINZOM – THE BEGINNINGS OF AN UNSUSTAINABLE RURAL TRANSFORMATION IN BINZOM COMMUNITY.

MUSA Sylvanus Hassan & **SHAMANG Kasham**
Dept. of Architecture, Kaduna State University

Since the inception of the Kafanchan Campus of Kaduna State University (KASU), in Kafanchan,Jemma'a local government area of Kaduna State, there have been notable changes in the rural landscape of the most immediate host community- Binzom,as it transforms to accommodate the university with its teaming population of staff and students. This paper therefore aims at assessing the impact that KASU, Kafanchan campus, has had on Binzom, in terms of environmental transformation and infrastructural developments. The methodology adopted includes qualitative and quantitative research methods based on multiple data sources, analyzed using descriptive and logical techniques, designed toshed light on the subject of unsustainable development, determine the population impact of KASU on Binzom, and identify the key changes in the community. The study revealed that rapid unplanned, informal development is taking place in Binzom at an unsustainable rate, even as farmlands are converted to residential layouts; private hostel accommodations are built up, and old/existing buildings are remodeled/redeveloped into student hostels; all of which is done without adequate professional design, planning and control/regulation. Thus proper design, planning and development control is needed to inhibit unsustainable rural transformation; and a system of public private partnership is advocated to aid the effective development of hostel accommodation for students. This research will hopefully add to the existing body of knowledge on the effects of rapid urbanization; provide a glimpse into the beginnings of the cause and effects of rapid development in Binzom; and also provide a basis for further research on the subject.

***Keywords**: unsustainable, rural transformation, Urbanization*

architectsly@gmail.com
Kashambiliyok@hotmail.co.uk

Musa, S.H and Shamang, K. (2016). **ASSESSING THE IMPACT OF KADUNA STATE UNIVERSITY, KAFANCHAN CAMPUS ON ITS HOST COMMUNITY, BINZOM – THE BEGINNINGS OF AN UNSUSTAINABLE RURAL TRANSFORMATION IN BINZOM COMMUNITY** Sustainable Built Environment and Climate change; The challenges of Post 2015 Development Agenda. School of Environmental Technology Conference, SETIC, 2016

INTRODUCTION

A tertiary institution with its population of staff and students essentially forms a small community within its host community; as a result there will inevitably be an increase in the general population of the host community, socio-economic and infrastructural developments and so on will also take place. Where the most immediate host community is a rural community like Binzom; close to the Kafanchan campus of Kaduna State University (KASU), in Jemma'a local government area of Kaduna State, there is bound to be significant changes in the landscape of the community, as it evolves to accommodate its new occupants. While the evolution of the rural landscape can be a welcomed development, rapid and uncontrolled development is not sustainable, and may lead to the degeneration of the community.

The research aims at assessing the impact of that KASU, Kafanchan campus has had on its host community-Binzom, in terms of environmental and infrastructural developments, through the following objectives:-

a. Determining the population impact of KASU on Binzom
b. Identifying the changes in land use, and cost of land
c. Identifying the pattern of infrastructural development

The research questions are:-

a. How is the presence of a tertiary institution affecting its host community?
b. What are the changes and trends/patterns of those changes?

The paper is in eight sections, following this introduction is the literature review section, which highlights the theoretical background by discussing relevant topics and themes on the subject matter, through the evaluation of relevant works. The study area section provides brief background information on KASU, Kafanchan campus and Binzom community, highlighting the physical setting, historical development, general profile, and choice of the study area. The methodology section outlines the research techniques and procedures used in conducting the research. The impact of KASU on Binzom section outlines the findings on the questions and objectives of the research, highlighting the changes in the community – as a result of KASU, and the processes of those changes. The findings sections present the results obtained from the field surveys, questionnaires, and analysis of data, along with the general discussion. The conclusion section culminates the paper with a summary of key findings, and recommendations based on inferences drawn from the results of the investigations.

LITERATURE REVIEW

Urbanization

One Wikipedia article describes urbanization as the process by which towns and cities form, grow, and expand; this is determined by factors like population migration, modernization and industrialization. Physical changes to the environment and social, cultural, and economic changes to the society/community are characteristics of urbanization; in effect, rural culture is replaced by a predominantly urban culture ("Urbanization", n.d.).

Population Growth as a Catalyst of Urbanization

Population growth is the factor directly responsible for the unprecedented rate of urban sprawl, and demand for infrastructure like transportation, water, and sewage and so on, and facilities such as housing, commerce, health, schools, recreation and so on (Ujoh et al, 2009).

Urban sprawl is unplanned, incremental, urban development, characterized by high population densities, congestion, and a general low quality of life for the inhabitants (Ujoh et al, 2009). Agbola and Elijah (2009) also elaborate on the characteristics and effects of urban sprawl, stating that the increased demand for land and landed property, results in uncontrolled, unorganized developments, which further lead to neighborhoods/communities without basic infrastructure facilities. Atanur (2011) states that population expansion and resulting effects causes radical changes in the structure of landscapes, a scenario which is already evident in Binzom community.

Institutions as a Catalyst for Urbanization

The provision of basic and adequate infrastructural facilities-like educational facilities, by government and private organizations, acts as catalyst in facilitating growth and development of Nigeria's rural area (Toyobo et al, 2011).Thus, the KASU Kafanchan campus can be viewed as an infrastructural catalyst to the transformation of Binzom community, bringing about significant infrastructural development, employment, and increased commercial activity to Binzom and other surrounding communities.

Effects of Rapid/Unsustainable Urbanization

As urban centres grow in population and sprawl, the peri-urban areas are undergoing rapid transformation as land comes under pressure through construction to provide space for an array of urban land uses (Heimlich and Anderson, 2001; Cited in Ujoh et al, 2009). The over use of space, natural resources, unsustainable human development, and lack of due attention to cultural-historical heritage creates an imbalance in the environment (Fanni, 2008). Rapid urbanization leads to inadequate sanitation, air and water pollution, deforestation, and general environmental degradation (Nsiah-gyabaah, 2003). Agbola and Elijah (2009) reinforce these postulations by stating that the long and short term effects of environmental degradation causes a decline in living standards of communities, and eventually leads to a local environment that is unable to sustain human populations.

This is evident in Binzom community, as rapid urbanization catalyzed by KASU, Kafanchan campus, has brought about land use changes- loss of agricultural land, unearned increment-rise in the value of cost of land and landed property, and construction of off campus housing. The growth and transformation of Binzom need not be a problem where adequate supporting infrastructure is provided, as observed by Horan and Craven (2014), stating that the rapid growth of cities need not necessarily be a problem where there is sufficient attendant infrastructure to support it, this will help inhibit against unsustainable development and environmental degradation.

Giving the current trends and activities in Binzom, it is logical to assume that the hitherto rural community is evolving into a slum. Niebergall et al(2008) (cited in Negera, 2012) describe a slum as an informal settlement characterized by High spatial heterogeneity, complex shape, substandard housing, high building density, small building size, irregular pattern of road network in poor condition, poor connectivity with infrastructure, no or little vegetation (open space), prone to hazardous locations.
The developments of slums are at the detriment of agricultural land, with the destruction of natural landscape; every slum passes through various stages during its development (Negera, 2012). Various stages of slum development have been classified by Abebe (2011) (cited in Nigera, 2012), as infancy, consolidation, and saturation; therefore, going by this classification Binzom community can be categorized as being in the infancy stage of slum development.

Student Housing

A major cause of the developments in Binzom is a sudden and sharp demand for accommodation-specifically student hostels or student housing (Sarah and Eric, 2010) outlined the importance of hostel accommodation (on and off campus) for students, university, and host community as follows:-

- Aiding students in settling down easily and developing good study culture.
- Aiding the tertiary institutions recruitment drive for new students.
- Off campus student housing enhance neighborhood life and help develop the partnership between the institution and the community (though with the risk of high financial cost and negative impact on relations with the community).

Various research studies have shown that quality housing, availability and options adequate for a significant number of the student population, play a role in the admission decisions of students and their sponsors/parents, thus providing schools with a competitive advantage (Rena and Delaney, 2012). There is therefore a need for the state government to increase the provision of student hostels in Kafanchan in order to increase its competitive advantage.

The nonresident nature of KASU, Kafanchan has greatly encouraged the development of off campus student housing, by private developers. The universities 66 room student hostel-which is still under construction at the time of this study, is grossly inadequate given the population of students of the institution. Thus, the university intends to allocate the building when completed for female students in the 100,200, and 400 levels, leaving the 300 level female students and the entire population of male students to opt for off campus private student hostels. Assuming that each room is allocated to 4 female students as is likely to be the case, the number of students the hostel can accommodate will come up to a mere 264 (female students of 100,200, and 400 level). Therefore, it is logical to conclude that the hostel is not only grossly inadequate but also the development is ineffective at meeting the needs of the University. This phenomenon is not peculiar to KASU Kafanchan campus, as observed by Gyasi and Kwesi, (2013), stating that there has been a global increase in the enrolment of students into tertiary institutions, without corresponding provision of student hostels, especially in developing countries. Government owned higher institutions have therefore had to resort to partnerships with other stakeholders or private developers for the provision of student hostels on or off campus. This partnership system is a more sustainable (cost effective and efficient) means of providing accommodation for students, which can be adopted by the Kaduna state government for KASU Kafanchan campus.

STUDY AREA

The boundaries of a city are hardly discernible and distinct, due to the sprawling nature of their development, interconnectivity and interdependence, and spatial stretching (Tonkiss 2013). This statement also applies to communities as part of human settlements, as it was discovered in the course of selection and /or delineation of a study area for this research; that the boundaries of Binzom community varied depending on who was interviewed. Therefore it was decided that the areas of Binzom within close proximity to the University and with noticeable land use and infrastructural changes and development since the inception of KASU, Kafanchan campus be established as the limits of the study area.

This section provides a brief background of KASU, Kafanchan and Binzom community, in terms of physical setting, historical development, general profile, and choice of the host community.

KASU,Kafanchan Campus

In May of 2004 KASU was promulgated into law, with two campuses to be located in Kaduna metropolis, andKafanchan; the Kafanchan Campus of KASU is located in Takau (Latitude 9.5848982 North, Longitude 8.2924213 East), in the old Government Day Secondary School. Two government secondary schools were converted for this purpose, the old buildings (classrooms, laboratories, offices, and staff quarters) were maintained (renovated, modified) and new buildings were constructed.

Academic activities commenced in the Kafanchan campus in 2013, with the faculties of Environmental Science, Agriculture, and the College of Basic Studies (CBS). The faculty of environmental science consists of four departments - Architecture, Estate management, Quantity Survey, and Environmental Management; whereas, the Faculty of Agriculture consisted of three departments – Crop Science, Animal Science, and Agricultural Economics. The CBS consists of the remedial and basic studies, and is run annually for students with deficiencies in academic requirements for admission into the University. At the time of conducting this research, the academic programs were currently in the third year with 300 level students for the two faculties. There is a full complement of other non-academic departments and units with their support staff, such as the Registry, Security Unit, Maintenance department, Health Services, Guidance and Counseling, and Accounting unit.

Binzom

Binzom is located in Kafanchan (Latitude 9.5667 North, Longitude 8.3000 East) Kaduna state, Nigeria as shown in figure 1. Binzom is one of the seven villages of the Kaninkon people's ethnic group. Other villages or *Ungwanai*(in Hausa language), include Ungwan Baki, Ungwan Ruwa, Ungwan Rana, Ungwan Railway, Ungwan Nko, Ungwan VIO, and Ungwan Fada.

The choice of Binzom for this study is based on the fact it is the most immediate host community to the university, separated only by the university fence, the extents of the community are also within short walking distance from the university – a factor which makes it appealing to the students. This close proximity to the university makes Binzom unique in the sense that it will logically be the first to feel the effects of the university and manifest any of the infrastructural, environmental, and even socio-economic changes that will come about as a result. It is therefore logical to assume that the effects of population impact will first be felt and evident in Binzom before spreading to other communities and Kafanchan township at large.

According to the United Nations (UN) (1971), cited in Toyobo et al (2011),a rural settlement is defined as an area with less than 20,000 people in population, engaging in primary activities such as farming, hunting, fishing, weaving, blacksmithing and other informal occupations. Therefore by this definition Binzom can be referred to as a rural community.D. Yashim (personal communication, October 14, 2015) revealed that the people of the community speak the *Kaninkon* language, and engage in agricultural activities such as farming and animal rearing, fishing, and hunting for their lively hood (mostly on a subsistence level). The farming activities are carried out within and around the community, thus the community is mostly characterized by small residential buildings – made up of a compound of rooms enclosing a courtyard or yard, and separated by farmlands. Lately, with increasing development and urbanization the landscape of the community has changed to include more residential buildings, while major farming activities have spread into less populated and or uninhabited areas (forest), though some farmlands are still maintained around residential buildings and empty plots of land, even the space around uncompleted buildings are farmed. The buildings are typically built with sundried bricks, rendered with mud or cement sand plaster, and some are built with sandcrete blocks; and roofed with thatch, or corrugated zinc sheets. Newer buildings are roofed with aluminum-zinc, or long span aluminum sheets. Accessibility is characterized by un-tarred roads and foot paths along buildings and farmlands. There is no pipe borne water in the community, most houses have wells, community development initiatives over the years has brought about a few manually operated boreholes, most of which no longer work.

RESEARCH METHODOLOGY

A combination of qualitative and quantitative research methods based on primary and secondary sources of data were used in the study. Below is an outline of the study strategy and the corresponding tools and processes used in conducting the research:-

i. Theoretical concepts on the research: Secondary data from previous documentation relevant to this research is reviewed and presented in the literature review section, discussing pertinent topics and themes related to the study.
ii. Determining the Population Impact of KASU on Binzom Community: Self-administered questionnaires were used to determine the number of full time staff and students of KASU living in Binzom community, the information acquired as a result established the effect of population increase and housing demand. The collated data is presented in a simple tabular format.

iii. Identifying the environmental transformation in Binzom: Satellite photographs were used to establish a fair timeline comparison of changes in the land use patterns, and to also delineate the areas of recent building infrastructural developments in Binzom.Field surveys and interviews conducted with prominent community members, private developers and members of the development control agency (KASUPDA) were used to determine the changes in cost of land and its use since the inception of the university.
iv. Identifying the pattern of infrastructural development: Case study analysis of select buildings was used to identify the pattern of infrastructural developments taking place in Binzom as a result of the increased demand in housing.

The data collected is analyzed using descriptive and logical argumentation; the information generated as a result is the basis of the discussions, recommendations and conclusions.

IMPACT OF KASU ON BINZOM

This sections uses various topics to study and discuss how Binzom community is responding and evolving since the inception of the university.

A Transforming Rural Landscape and Land Tenure System

A limitation to the study is unavailability of latest satellite images over the area of study covering the years 2012 to 2015. However based on the available satellite images from Google maps (figure 2 and 3), it is fairly evident that Binzom has been slowly evolving; however the most significant environmental changes can be seen within the period of time that academic activities commenced in KASU Kafanchan. The images in figure 3 show a decline in farming activities, which signifies the conversion of hitherto agricultural farm land into layouts for residential developments. As stated by Tonkiss (2013), it is clear that the eventual development and outlook of the community will be based on the activities of the inhabitants.

The land tenure system is customary in nature, where families own their lands and are exercise full control over it, however all sales must go through the traditional chiefs for records, witnessing and issuance of sales agreement, buyers can then use such sales agreement to process government issued documentation on the lands, and also to process building permits. Though, investigations revealed that most infrastructural developments are usually done with little or no input from the regulatory agency (D. Yashim, personal communication, October 14, 2015).

Population Pressure on Binzom

At the time of carrying out this research the university is in its third year (at only 300 level), surveys revealed that 35% of the population of both registered students and full time staff of KASU, Kafanchan campus live in Binzom, (see Table 1.0), and 99% of the total KASU population living in Binzom are students. This development has brought about an increased need for student housing in Binzom, which in turn lead to a supply of various student housing projects in the community.

The population of KASU Kafanchan is set to increase each year with every fresh intake of students, so also the staff populations with every employment batch; and also as new academic programs are added to the campus, its growth will no doubt have a direct effect on Binzom, other surrounding communities, and Kafanchan at large. As both staff and student seek for nearby accommodation off campus, this is partly due to the insufficient number of staff quarters and the uncompleted student hostel project, which even when completed lacks the capacity to accommodate the entire student population.

One might argue that the population increase in Binzom is temporary throughout the year as the students and staffs usually vacate during holidays, however it is important to note that the direct consequence of the increased population is permanent.

Table 1.0: Population impact of KASU, Kafanchan staff and students on Binzom

	Total Population of KASU (Staff & Students)	**Total Population of Staff Living in Binzom**	**Total Population of Students Living in Binzom**	**TOTAL**
No.	960	4	374	378
%	100%	0.4%	39%	39.4%

Source: Authors Fieldwork (2015)

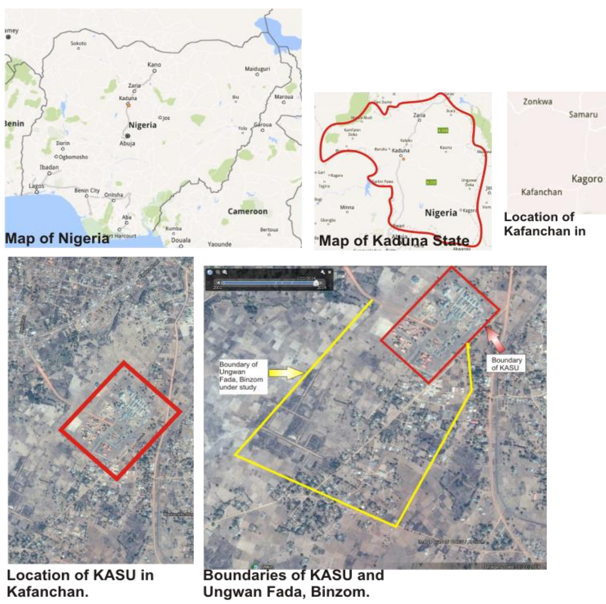


Figure 1: Satellite image of the location of KASU and Binzom, highlighting KASU and UngwanFada, Binzom, January 2014. Source: Adopted from Google Earth

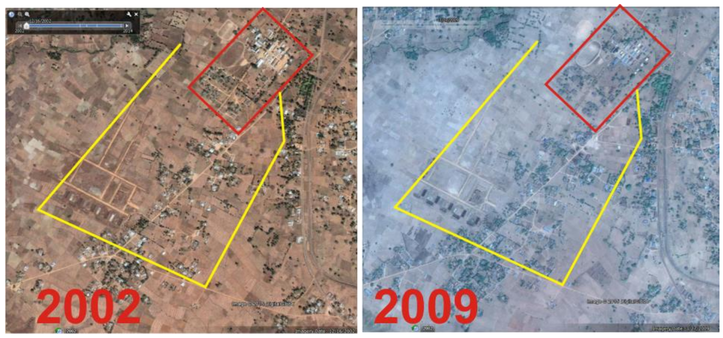


Figure 2: Satellite images of UngwanFada, 2002 and 2009. Source: Adopted from Google Earth.

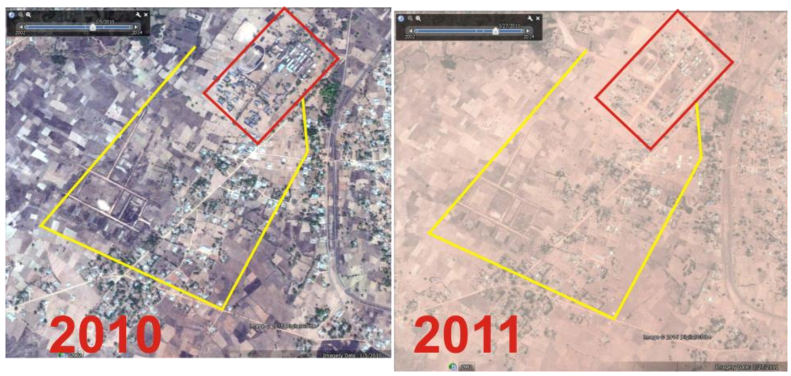


Figure 3: Satellite images of UngwanFada, 2010 and 2011. Source: Adopted from Google Earth.

An increase in population inevitably leads to an increased demand for land and landed property, this result in uncontrolled, unorganized developments, further leading to neighborhoods/communities without basic infrastructure facilities (Agbola and Elijah, 2009).The data presented in Table 1.0 was derived from a survey of staff and students of the university carried out in October to November, 2015. The figures show the student population has a much higher impact on Binzom community in terms of housing demand. This may be due to the fact that some of the staff live off campus, and the university has staff quarters consisting of 13 units of 4 bedroom houses, 4 units of 3 bedroom houses, 12 units of 2 bedroom houses, and 32 units of single rooms.

These facilities as at the time of carrying out this research were already filled to capacity, a situation which indicates that new/future staff of the university will have to seek off campus accommodation. A total population of 39.4% of KASU, Kafanchan campus no doubt represents a significant influence to the development of Binzom and other surrounding communities. This figure is set to increase exponentially every year with new intake of students and staff and also with the introduction of new academic programs. This will therefore have a direct effect on Binzom community, leading to further infrastructural developments (especially student hostels) in response to the increased demand for accommodation.

Unearned Increment in Binzom

Investigations from interviews with people of Binzom community revealed that there was a sudden demand of land and landed property in Binzom, following the development of the university, this lead to a spike in the cost of land, and it has been on a steady increase each year since, as shown in Table 2.0.This unearned increment-due to the population of the university in need of housing, has brought about a rise in the cost of land and rent in Binzom, and surrounding communities, without any corresponding developments or improvements to justify such increments.

Indigenous land owners are taking advantage of the unearned increment and are selling their farmlands, which is mainly used for the development of student hostels. Investigations revealed that the funds acquired from the sale of such lands is used by the indigenous Binzom community members to develop new hostels or convert old buildings/compounds into hostel accommodation for students, and this is done with little or no professional supervision.

Table 2.0: Increasing cost of land in Binzom

Year	Cost of Land (in Naira)
2011	100,000 to 150,000
2012	150,000 to 350,000
2013	400,000 to 500,000
2014	550,000 to 600,000
2015	600,000 to 650,000

Source: Authors Field work. (2015)

The farm lands are currently being carved up and converted to layouts of residential plots of 15meters by 30meters. These layouts are done without proper or professional design, planning and without any control, they are also commonly characterized by narrow access roads in between the plots.

A Changing Built Environment

The buildings in Binzom and other surrounding communities mostly consisted of traditional compound houses characterized by a cluster of single rooms surrounding a central courtyard or yard; each compound is usually separated from the next by farmlands belonging to the families in the compounds. The buildings are mostly old and built with mud bricks, sandcrete blocks or a combination of both, and roofed with thatched or zinc roofs. There are signs of conversion of some of these traditional compounds with modern building materials, likely following an increased in the family size, and or income. Figure 5 shows the location of various infrastructural developments in Binzom from 2013 to 2015 alone, the selected survey samples for this study are highlighted in yellow.

Following a sudden and increasing demand for accommodation by staff and mostly students of KASU Kafanchan, some existing traditional family compounds have been partially or completely converted to mini student hostels, and even whole houses have been remodeled for the purpose of providing accommodation for students.

It is evident that a rapid sprawl of informally planned buildings has begun in Binzom, and as stated by Tonkiss (2013) there are risks associated with such rapid unplanned development such as loss of rural land, pressures on infrastructure, clean water, congestion, overcrowding, and substandard housing.

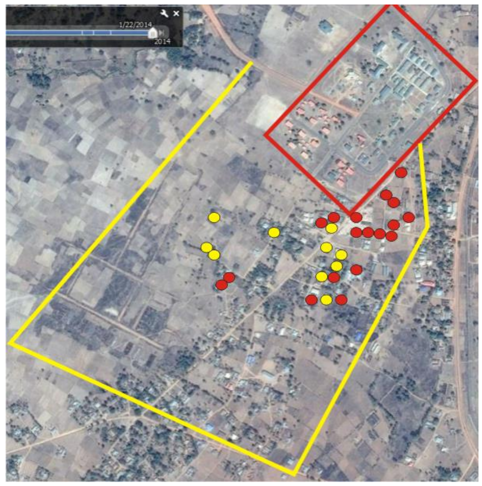


Figure 4: Infrastructural developments in Binzom for student hostels in yellow and red, selected surveys in yellow. Source: Adopted from Google Earth

SURVEY OF INFRASTRUCTURAL DEVELOPMENTS IN BINZOM

Assessment Criteria

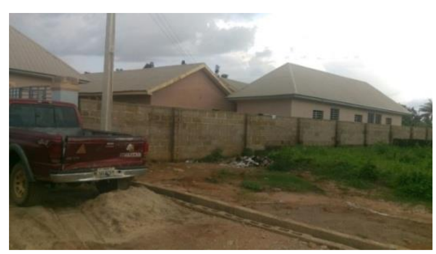
Case studies were conducted on some of the off campus student accommodations available in Binzom, with the aim establish the pattern/categories of infrastructural developments. Therefore, the following variables were used in assessing the buildings:-

a. Category of development: This category includes new buildings, renovated, or redeveloped buildings. These are defined as follows:
   i. New building: A project term describing a building designed and constructed from scratch rather than alteration, remodeling or refurbishment (Davies and Jokiniemi, 2008).
   ii. Renovation/Refurbishment: Remedial work, repair work, the action of repairing or remodeling a building or a space within a building to meet current requirements (Davies and Jokiniemi, 2008).
   iii. Adaptive re-use: The extensive alteration of an existing building so that it will serve a new or modified purpose (Cyril, 2006).
   iv. Extension: A wing or structure added to an existing building (Cyril, 2006).
b. Location category: The general location of the cases studies is Binzom, however this has further been categorized into new plots of land that were previously farm lands, and plots of land in already existing residential areas.
c. Capacity/Number of rooms: Number of apartments in the property
d. Size of the land: This category refers to the total area of the plot of land in square meters, and number of plots.

e. Facilities: This refers to the provision of sanitary and kitchen facilities in the apartment, categorized as:-
   i. Fully en-suite room: Consisting of a room, kitchenette, and bathroom.
   ii. Semi en-suite room: Consisting of a room and kitchenette only, or a room and bathroom only.
   iii. Single room: Consisting of only a bedroom.
f. Construction date/period

The data presented in Table 3.0 and 4.0 were collected through field surveys designed to highlight the student housing developments in Binzom since the inception of KASU.

Table 3.0: Buidling Survey 1-5

	BUILDING SURVEY 1 -		
	ITEM	**REMARKS**	 Figure 5: Case study 1, a new mini estate of 11 fully en-suite rooms. Source: Authors Field Work.
1	Type of development	New	
2	Location category	Converted farmland	
3	Number of rooms	11	
4	Facilities	Fully en-suite rooms	
5	Size of plot	900 m^2 (30m x 30m)	
6	Construction date	2014 to 2015 completed	
	BUILDING SURVEY 2 -		
	ITEM	**REMARKS**	 Figure 6: Case study 2, a converted 3 bedroom, for student hostels. Source: Authors Field Work.
1	Type of development	Adaptive re-use	
2	Location category	Existing residential land	
3	Number of rooms	11	
4	Facilities	Fully en-suite rooms	
5	Size of plot	525 m^2 (35m x 15m)	
6	Construction date	2015 completed	
	BUILDING SURVEY 3 -		
	ITEM	**REMARKS**	 Figure 7: Case study 3, an extension to an existing building. Source: Authors Field Work.
1	Type of development	Extension	
2	Location category	Existing residential land	
3	Number of rooms	3	
4	Facilities	Fully en-suite rooms	
5	Size of plot	900 m^2 (30m x 30m)	
6	Construction date	2015 completed	

	BUILDING SURVEY 4 -	
	ITEM	**REMARKS**
1	Type of development	New
2	Location category	Converted farmland
3	Number of rooms	8
4	Facilities	Fully en-suite rooms
5	Size of plot	450 m^2 (30m x 15m)
6	Construction date	2015 on going

Figure 7: Case study 4, a new building of 8 fully en-suite. Source: Authors field work

	BUILDING SURVEY 5 -	
	ITEM	**REMARKS**
1	Type of development	New
2	Location category	Converted farmland
3	Number of rooms	6
4	Facilities	Fully en-suite rooms
5	Size of plot	450 m^2 (30m x15m)
6	Construction date	2015

Figure 8: Case study 5, ongoing project of 6 fully en-suite rooms on a farm land.

Source: Authors Fieldwork (2015)

Table 4.0: Building Survey 6-10

	BUILDING SURVEY 6 -	
	ITEM	**REMARKS**
1	Type of development	Extension
2	Location category	Converted farmland
3	Number of rooms	10
4	Facilities	Fully en-suite rooms
5	Size of plot	450 m^2 (30m x 15m)
6	Construction date	2015On going

Figure 10: Case study 6, a new mini estate of 10 fully en-suite apartments on a farmland. Source: Authors Field Work.

	BUILDING SURVEY 7 -	
	ITEM	**REMARKS**
1	Type of development	New
2	Location category	Existing residential land
3	Number of rooms	10
4	Facilities	Fully en-suite rooms
5	Size of plot	450 m^2 (30m x 15m)
6	Construction date	2014

Figure 11: Case study 7, a compound of 10 fully en-suite rooms, in a residential area. Source: Authors Field Work.

	BUILDING SURVEY 8 -	
	ITEM	**REMARKS**

1	Type of development	New	 Figure 12: Case study 8, a compound of 16 single rooms, residential area. Source: Authors Field Work.
2	Location category	Existing residential land	
3	Number of rooms	16	
4	Facilities	Single rooms	
5	Size of plot	297 m^2 (27m x 11m)	
6	Construction date	2014	
	BUILDING SURVEY 9-		 Figure 13: Case study 9, a compound of 8 single rooms, extension to an existing compound.
	ITEM	**REMARKS**	
1	Type of development	Extension	
2	Location category	Existing residential land	
3	Number of rooms	8	
4	Facilities	Single rooms	
5	Size of plot	240 m^2 (20m x 12m)	
6	Construction date	2015	
	BUILDING SURVEY 10 -		 Figure 14: Case study 10, a compound of 8 single rooms, extension to an existing compound.
	ITEM	**REMARKS**	
1	Type of development	Adaptive re-use	
2	Location category	Existing residential land/building	
3	Number of rooms	14	
4	Facilities	Single rooms	
5	Size of plot	750 m^2 (25m x 30m)	
6	Construction date	2015 On going	

Source: Authors Fieldwork (2015)

FINDINGS AND DISCUSSION OF RESULTS

The following observations have so far been made:-

1. Increased pressure on the host community for housing: The number of students of KASU living in Binzom, has no doubt increased the population of the small community. This student population seeking accommodation will continue to increase every year as new students and staff, and also new academic programmes are introduced to the university. It is evident that the population is growing at a faster pace than the community can absorb.
2. Change of Land use: Before KASU Kafanchan campus was setup, Binzom was a rural community characterised by small family compounds separated by farmlands, and small clusters of buildings. This rural setting has since changed to accommodate housing demands; farmlands are currently being converted to residential layouts, as the land owners and farmers are eager to dispose of their lands, carving out as many plots as possible from any available piece of land. These layouts are usually done without professional survey or planning, and are characterised by narrow roads, this situation if left unchecked will no doubt lead to the development of rural slums. The rapid loss of agricultural land will no doubt have other socio-economic effects in the long run, asthe

previous subsistence farmers embrace a new but doubtfully sustainable means of making quick money.

3. Unearned increment: There has been a spike in the cost of land, landed property, and rents in Binzom, since the inception of the university, without any justifiable corresponding developments or improvements to the land and property. Before the coming of KASU Kafanchan campus, a piece of land measuring 15m x 30m was being sold for between 100,000 to 150,000 naira, by the time the university took off, the price of the land went up to between 400,000 and 500,000 naira as at 2014. Today the same parcel of land is being sold for 550,000 to 600,000 naira.
4. Changing built environment: Farmlands and old mud houses have since given way to new buildings. The prevalent new building types are characterised by single room apartments some with built in bathrooms and kitchens, some without any conveniences, the rooms are mostly not larger than 15 square meters, often with little or no cross ventilation. Some of the buildings are built with substandard building materials and construction techniques, often professionals are not involved. The standards or quality of accommodation provided is a far cry from decent.
5. Redevelopment of old buildings: The local land owners and farmers are not left out in the rapid infrastructural development going on in Binzum, funds acquired from the sale of land is being used to renovate or redevelop old mud buildings into single room apartments that characterizes student flats. The old rural landscape of mud houses with rusted zinc or thatched roofs, has given way to cement sand plastered mud walls, new and coloured zinc sheets, something the locals are proud of and fondly refer to as 'modern buildings'.
6. Increase in the density of inhabitants per plot of land: Binzom is characterised by individual family compounds separated by large expanses of farmland around them, the new developments of residential layouts, and mini-estates now has about 8,12, and even 16 rooms per plot of land (450 m^2) depending on the size of individual rooms, these rooms usually have multiple occupants. This development will no doubt lead to the eventual emergence of high density rural slums as private developers make brisk business.
7. Waste generation: There is an increase in the generation of garbage from student hostels, which is usually gathered in heaps outside the compounds and set on fire. This has created not only an eye sore but also introduced health risks.
8. Water and energy consumption: Investigations have revealed that there has been an increase in the demand/usage of electricity and water. According to staff of Kaduna Electric working in the area, the small transformer serving the community has experienced overloading in recent times. The wells that usually supply water to compounds are also becoming inadequate in meeting demands.
9. Inadequateresources and lengthy processes involved in layout planning and approvals on the part of the Kaduna State Urban Planning and Development Authority (KASUPDA), has led to the negation of KASUPDA in the urban development process by developers. This may be due to the fact that there are no government funded basic infrastructure and amenities including roads, water, electricity distribution facilities (Electric poles, power lines, and transformers).Thereby creating a situation where people feel that the government has no legal entitlement in their community, as a result the regulatory agency

lacks the will to enforce and exercise legal control over development activities in the community.

CONCLUSION

The presence of an institution within any community is doubt a positive development, however this development shouldn't be allowed to degenerate the hitherto peaceful setting of the community as it makes it transition from rural to semi-urban. The current situation in which 39.4% of the population of KASU living in Binzom has already brought about significant changes to the community, this will no doubt continue with the growth of the university.

The activities taking place today and their resulting negative effects provide a view into the eventual future outlook of Binzom, and by extension the surrounding communities serving as host to the university, it is therefore imperative that early and pre-emptive action be taken by the relevant authorities, community members and new land owners to mitigate against unsustainable development.

It can therefore be concluded that if the long term effects of unsustainable spatial development continue in Binzom, the community will inevitably degenerate into a slum.Adequate development control is therefore required to ensure that layouts and their access roads are designed and developed to professional planning standards. The rapid transformation if left unchecked will likely lead to the development of a high density rural slum. As Binzom becomes increasingly urbanized it is clear that the hitherto adequate amenities such as electricity, water supply, become inadequate due to increased demand; and the methods of waste disposal (solid and liquid) becomes unsustainable.

Effective means of providing student housing through various forms of Public Private Partnership (PPP) should be adopted, as this will help reduce the population impact of KASU on Binzom and surrounding communities, and increase the pace at which student hostels are developed. PPP schemes such as, the Build Operate Transfer (BOT) form of development can be adopted by the government, whereby the government provides the land for private developers at low cost to build hostels, and operate for a period of time before handing over to the government. This would no doubt speed up the provision of accommodation to meet up with the ever rising student population.

REFERENCES

"Adaptive re-use, extension". In Cyril M.H. (Ed). (2006). Dictionary of architecture and construction (4th ed). U.S.A: McGraw Hill.Doi:1036/0071452370

Abebe, F. K. (2011). Modelling informal settlement growth in Dar es Salaam, Tanzania University of Twente Faculty of Geo-information and Earth Observation ITC, Enschede. Cited in Negera, D. S. (2012). Identifying and classifying slum development stages from spatial data. Unpublished master's thesis. Netherlands/Enschede:University of Twente.Retrieved URL: https://www.itc.nl/library/papers_2012/msc/upm/dinsasori.pdf on November 30, 2015, 6:59:10 PM.

Agbola, T., Elijah M. A. (2009).Urbanization, Slum Development and Security of Tenure. Cited in De Shebiniin et al. (eds.). (2009). The Challenges of Meeting Millennium Development Goal 7 in Metropolitan. Lagos, Nigeria. Urban Population-Environment Dynamics in the Developing World: Case Studies and Lessons Learned. Paris: Committee for International Cooperation in National Research in Demography (CICRED) (316 pages) 77-106. Retrieved from http://www.ciesin.columbia.edu/repository/pern/papers/urban_pde_intro.pdf on November 30, 2015, 6:51:11 PM.

Atanur, G. (2011). The effects of urban expansion on cultural landscapes – Case study of Bursa. Scientific Research and Essays Vol. 6(20), pp. 4185-4194, 19 September, 2011. DOI: 10.5897/SRE10.1062

Cities Alliance for Cities Without Slums. (2000). About Slum Upgrading.2011, from http://www.citiesalliance.org/ca/About-slum-upgrading. Cited in Negera, D. S. (2012). Identifying and classifying slum development stages from spatial data. Unpublished master's thesis. Netherlands/Enschede:University of Twente. Retrieved URL: https://www.itc.nl/library/papers_2012/msc/upm/dinsasori.pdf on November 30, 2015, 6:59:10 PM.

Centre for Global Education (2002). *Rich World, Poor World: A Guide to Global Development*downloaded at www.cgdev.org/files/2844_file_EDUCATON1.pdf. Cited in Gyasi, S. N., Kwesi, F. B. (2013).An empirical evaluation of student accommodation.European Journal of Business and Social Sciences, Vol. 12, pp164-177, March 2013. ISSN: 2235-767X. Retrieved from http://www.ejbss.com/recent.aspx on November 30, 2015.

Fanni, Z. (2008). How can traditional small cities contribute to sustainable development? Journal of Geography and Regional Planning Vol. 1(6), pp. 116-121, September, 2008

Retrieved from http://www.academicjournals.org/JGRP ISSN 2070-1845 December 02, 2015, 11:40:19 AM.

Gyasi, S. N., Kwesi, F. B. (2013). An empirical evaluation of student accommodation.European Journal of Business and Social Sciences, Vol. 12, pp164-177, March 2013. ISSN: 2235-767X. Retrieved from http://www.ejbss.com/recent.aspx on November 30, 2015.

Heimlich RE, Anderson WD (2001). Development at the Urban Fringe and Beyond: Impacts on Agriculture and Rural Land. 803 Economic Research Service, US Dept. Agric., Wash. DC. p. 80.Cited in Ujoh, F., Kwabe, I.D., Ifatimehin, O.O. (2009).Understanding urban sprawl in the Federal Capital City, Abuja: Towards sustainable urbanization in Nigeria. Journal of Geography and Regional Planning Vol. 3(5), pp. 106-113, May 2010. Retrieved from http://www.academicjournals.org/JGRP on December 02, 2015, 11:40:32 AM. ISSN 2070-1845

Horan, E., Craven,R. G. (2014). Sustainable Urban Development and Liveability. How can Melbourne Retain its title as the World's Most Liveable City and Strive for Sustainability at the Same Time? *European Journal of Sustainable Development* (2014), **3**, 4, 61-70. ISSN: 2239-5938.Doi: 10.14207/ejsd.2014.v3n4p61

Nsiah-gyabaah (2003).Urbanization, environmental degradation and food security in Africa. Paper presented at the Open Meeting of the Global Environmental Change Research Community, in Montreal, Canada, 16-18 October 2003. Retrieved November 30, 2015, fromhttp://sedac.ciesin.columbia.edu/openmtg/docs/Nsiah-Gyabaah.pdfon November 30, 2015, 6:55:51 PM.

Negera, D. S. (2012). Identifying and classifying slum development stages from spatial data. Unpublished master's thesis. Netherlands/Enschede:University of Twente. Retrieved URL: https://www.itc.nl/library/papers_2012/msc/upm/dinsasori.pdf on November 30, 2015, 6:59:10 PM.

Niebergall, S., Loew, A, &Mauser, W. (2008). Integrative Assessment oof informal Settlements Using VHR Remote Sensing Data: The Delhi Case Study. Cited in Negera, D. S. (2012). Identifying and classifying slum development stages from spatial data. Unpublished master's thesis. Netherlands/Enschede:University of Twente. Retrieved URL: https://www.itc.nl/library/papers_2012/msc/upm/dinsasori.pdf on November 30, 2015, 6:59:10 PM.

"New building, Renovation". In Davies, N., Jokiniemi, E. (2008). Dictionary of architecture and building construction. U.S.A: Architectural press, Elsevier Ltd.ISBN:978-0-7506-8502-3

Rena, C., Delaney, A. (2012). Trends in undergraduate housing: Process and product. Planning for Higher Education V41N1/1 October-December 2012.Retrieved from http://www.demographicperspectives.com/Demographic%20Perspectives_Planning%20in%20Higher%20Education_V41N1_Trends%20in%20Undergraduate%20Housing_Process%20and%20Product.pdf on November 30, 2015, 7:07:51 PM.

Sarah L. S., Eric D. L. (2010). Student preferences in housing: Survey data analysis: preferred unit style and cost. The SCION GROUP.Retrieved from http://thesciongroup.com/wp-content/uploads/2012/01/housing_preferences.pdf on November 30, 2015. 7:09:43 PM.

Sharma, Y. (2012). Fast pace of higher education enrolment growth predicted to slow, *Universityworld news Issue* No: 213, available at http://www.universityworldnews.com/article.php?story=2012031308172724. Cited in Gyasi, S. N., Kwesi, F. B. (2013).An empirical evaluation of student accommodation.European Journal of Business and Social Sciences, Vol. 12, pp164-177, March 2013.ISSN: 2235-767X. Retrieved from http://www.ejbss.com/recent.aspx on November 30, 2015.

Tonkiss, F. (2013). Cities by Design: The social Life of Urban Form. Polity Press 65 bridge street Cambridge CB21, UK. ISBN13:978-0-7456-4897-2. Pp2, 25, 28, 34,143)

Toyobo A.E., Muili A.B. &Adetinji M.A. (2011).The relevance of infrastructural facilities to rural housing development in Lagelu local government, Oyo state, Nigeria. Academic Journals,Vol. 9(3)pp29-30, November, 2014. ISSN:1993-8225 doi:10.5897/INGOJ2011.027

United Nations (1971). Integrated Approach to Rural Development in Africa U.N New York. Cited in Toyobo A.E., Muili A.B. &Adetinji M.A. (2011).The relevance of infrastructural facilities to rural housing development in Lagelu local government, Oyo state, Nigeria. Academic Journals,Vol. 9(3)pp29-30, November, 2014. ISSN:1993-8225 doi:10.5897/INGOJ2011.027

Ujoh, F., Kwabe, I.D., Ifatimehin, O.O. (2009).Understanding urban sprawl in the Federal Capital City, Abuja: Towards sustainable urbanization in Nigeria. Journal of Geography and Regional Planning Vol. 3(5), pp. 106-113, May 2010. Retrieved from http://www.academicjournals.org/JGRP on December 02, 2015, 11:40:32 AM. ISSN 2070-1845

Urbanization. (n.d) In Wikipedia. Retrieved December 2, 2015, from https://en.m.wikipedia.org/wiki/Urbanization

ASSESSMENT OF THE IMPLICATIONS OF URBAN GROWTH IN SULEJA BETWEEN 1987 AND 2014

Adeleye, B. M.[1], Sulyman, A.O.[1], Medayese, S.O[1], Ayangbile, O. A[2] & Popoola, A[2]
[1]Department of Urban and Regional Planning, Federal University of Technology, Minna, Nigeria
[2]Department of Urban and Regional Planning, University Of Ibadan, Ibadan Oyo State, Nigeria

Cities in developing countries are often characterized by uncoordinated growth. Accompanying this growth are various problems which include traffic congestion, emergence of slum, flooding, uncollected solid waste and poor sanitation. These problems pose a critical challenge to cities in developing countries. Suleja which is one of the most urbanized local governments in Niger State and also proximate to Abuja the Federal Capital Territory is experiencing the identified problems.This study therefore examines the extent and implications of urban growth in Suleja between 1987 and 2014. Spatial analysis of the city for the period understudy (1987 - 2014) and implication of the growth on the residents and environment were determined.Primary and secondary data as well as Geospatial techniques were used for the study.Two sets of satellite imageries were used for the study that is,Thematic Mapper for 1987 and Enhance Thematic Mapper for 1997, 2007 and 2014. The findings of the geo-spatial analysis were corroborated with the findings of the primary and secondary data sources.The analysis reveals that Built-up area in Suleja increased from 10.91km^2 in 1987 to 46.25km^2 in 2014. While the 35% of the building plans submitted for approval to Niger State Urban Development board, Suleja are approved annually. The study also revealed that the pollution level of Suleja which was consequential to the increase in growth recorded a high value of 15.97 ppm for CO, 0.67 ppm for NO_2 and 1.33 ppm for SO_4.The study recommends that the planning and management of Suleja should be based on inclusive planning approach more so, infrastructure should be systematically expanded at a rate equal to the rate of the urban growth in Suleja.

Keywords: Pollution, Slum, Solid waste, Spatial growth, and Urban growth

banji230@yahoo.com

Adeleye et. al. (2016). **ASSESSMENT OF THE IMPLICATIONS OF URBAN GROWTH IN SULEJA BETWEEN 1 987 AND 2014** Sustainable Built Environment and Climate change; The challenges of Post 2015 Development Agenda. Schoo l of Environmental Technology Conference, SETIC, 2016

INTRODUCTION

In less developed countries of the world before 1950 the pace of urbanization was very slow, however, after this period the rate of urban growth increased substantially (McCatty, 2014). Most of the world's urban centres are rapidly urbanizing at an alarming rate this assertion was proven by Donk (2006), who believes that the world is increasingly becoming urbanized and the rate at which city populations and urban centres grows is an indication of the pace of social and economic change. In recent times rural-urban drift has led to an increase in urban growth in most developing countries. This growth is attributed to the "Push" of the rural areas and the "Pull" of urban centres (Aluko, 2010). The push and pull in this regard are with respect to the population, which can be traced to the effects of regional imbalances (Oyeleye, 2013) in other words regional imbalance and urban drift has led to increase in population in urban centres. According to Tibaijuka (2006), it has been estimated that one third of the world's population lived in cities In 1976 and 30 years later (2006), this population rose to one-half of the entire humankind and by the target year for the Millennium Development Goals (MDGs); cities in the world are estimated to grow to two third that is, 6 billion people by 2050 (UN- Habitat 2006).

Africa is presently ranked among the least urbanized continent of the world, it is, however, prominent for its highest rates of urbanization. According to the United Nation's projection, it is expected that 61% of the world population will be urban by 2030 and over half the population in Africa will be urban by 2020 (UN, 2004; Ajala, 2005). Jiboye (2005), Osasona et al (2007) opined that, this phenomenal growth anticipated for cities can be attributed to the incidence of globalization, industrialization and population explosion. Urban growth can be refer to the rate of growth of an urban population or a growth that makes intensive use of land for the location of buildings and impermeable surfaces (Oyeleye, 2013). On the other hand Ioannides, et al (2008) referred to urban growth as the process of growth and decline of economic agglomerations. UNICEF (2012), in her report defined urban growth as an absolute increase in the number of people who live in towns and cities, and believes that the pace of urban population growth depends on the natural increase of the urban population and the population gained by urban areas through both net rural-urban migration and the reclassification of rural settlements into cities and towns.

The effects of this population changes in African cities in particular has produced miseries that are often difficult to understand because most of the African primate cities including those in Nigeria are faced with the problem of deteriorating physical and living conditions. The deterioration manifests itself in form of slums, urban sprawl and squatters' settlements, increasing traffic congestion, flooding and erosion and deteriorating infrastructures (Olurin 2003 and Olujimi 2009). Urbanization has enormous negative consequences in Nigeria and other developing countries, Population increase as index of urbanization in Nigeria is driven by rural-urban migration and not by natural increase (Oyeleye, 2013). Many scholars see rural-urban migration in urbanization process as the genesis of urban problems in different part of the world (Wahab, 1990; Agbola, 2004; Olujimi 2009). In order to achieve sustainable urban planning in our cities, it is imperative for planners to monitor the ongoing changes in land use/land cover pattern of an area over a period of time. Against this background, every bit of the available land will be used in most rational and best possible way so as to ensure orderly development.

Aim and Objectives of the Study

This study aims at examining the nature and consequences of urban growth in Suleja with a view to achieving sustainable development. In executing this study, the trend of physical growth of Suleja between 1987-2014 was analysed and the implications of the growth on the residents and the environment was examined.

Nature of Urban Growth in Nigeria

Urban growth and physical expansion of urban settlements is not peculiar to Nigerian states alone, but a global phenomenon which has occurred significantly all over the world. In recent times, urban growth has had an intense drive in the third world regions (Aina, 1992 as cited by Abiodun et al., 2011). This assertion is also supported by the UN (2012) who professed that the population of the world is expected to be concentrated in the third world countries whose population is projected to increase from 2.7 billion in 2011 to 5.1 billion by the year 2050. Over the years, population growth in Nigeria has been growing at an alarming rate and Olujimi (2009) opined that the Urban population growth in Nigeria in the last thirty years is 5.8 percentage per annum and this is amongst the highest urban growth rate in the world. The rate of urban growth in Nigeria can be tied to three major processes which are natural increase in the population; rural-urban migration and city annexation into the surrounding rural areas (Agbola, 2006).

It is noteworthy that urban growth processes in Nigeria and most developing countries are expanding without significant urban planning. Celik et al. (2009) noted that physical manifestations of rapid urbanization in third world countries like Nigeria are often chaotic and shows far-reaching demographic, social and economic transformations. Regrettably, the opportunities tied to urbanization in these countries are lost due to inadequate resources, basic infrastructure, services and well-conceived planning (Celik et al., 2009). These occurrences are responsible for millions of people in Nigeria, living in environment overwhelmed by slums, filth and squalor having grossly inadequate social amenities (Bankole and Bakare, 2011). The nature of urban growth experienced in Nigeria is evident in the conversion of land from nonurban area to an urban area, or expansion of urban areas into adjoining neighbourhoods, agricultural land, forest area, wetland and other nonurban lands.

Ndabula et al., (2014) opined that urban expansion in itself may not be a problem, but rather the nature and patterns of the urban growth, which may be characterized based on urban land use pattern and its associated impact on the urban spatial form, the rate of land conversion and land use intensity. The concept of urban growth includes spreading outwards of a city and its suburbs to its outskirts, auto-dependent development on rural land, excessive, ineffective urban space consumption, poor distribution of open spaces, scattered development away from the central city and existing infrastructure (Hasse and Lathrop, 2003).

Methodology

The longitudinal design method was adopted in this study. Data for the study was generated from two main primary sources and secondary sources. Since this study involved change detection, the use of imageries taken at different times were adopted. Data for the secondary sources were obtained from journals and other materials from the internet; Solid waste data were obtained from Niger State Environmental Protection Agency, lists of building plan approvals were obtained from Niger State Urban Development Board while crime reports were obtained from the Nigerian Police Force Suleja. Four sets of satellite images for Suleja for 1987, 1997, 2007 and 2014. All the imageries are the American Land-sat series Thematic Mapper (TM) and Enhance Thematic Mapper (ETM^+). All the satellite imageries were obtained from the National Centre for Remote Sensing, Plateau State (table1. 1). Data for the primary sources were acquired from Oral interview and the use of "Rasi 700" gas meter which was used to measure the level of Pollution in Suleja.

Table 1.1: Image Properties

S/No	Image Year	Path and Row	Data Set	Image Captured Date
1	Suleja 1987	P189 R53	TM	21/12/1987
2	Suleja 1997	P189 R53	ETM^+	27/12/1997
3	Suleja 2007	P189 R53	ETM^+	09/12/2007
4	Suleja 2014	P189 R53	ETM^+	04/3/2014

Source: Fieldwork, 2014

The data generated were processed; tabulated and analysed using the Statistical Package for Social Science (IMB SPSS) ver.20. The software package used for images analysis was the Integrated Land Water Information System (ILWIS 3.3 Academic). The ILWIS Academic was used for Image Classification and Post Processing. A supervised classification was carried out on all the imageries using three parameters which are, Built-up Area, Bare Surface and Vegetation. Geospatial techniques were employed in determining the spatial growth of Suleja between 1987 and 2014. In order to make this research scientific, four imageries of ten years intervals were processed that is, Thematic Mapper for 1987, the Enhance Thematic Mapper for 1997, 2007 and 2014.

The images obtained were "sub-set" on ILWIS 3.3 Academic so as to determine the Area of interest which is Suleja. Band combination of 4, 3, 2 were used to develop a "false colour composite" for the study area. The 4, 3, 2 bands have a potential of being used for urban studies, on this colour composite Vegetation appears in shades of red, urban areas in cyan blue, soils vary from dark to light browns. "Training sets" were created on all the imageries and these "Training sets" include: Built-up area, Vegetation and Bare Surface. These training sets were subjected to a supervised (full Gaussian) maximum likelihood classification; this was done using the "classifier" tool on the operation list of ILWIS 3.3 Academic software.

Study Area

Suleja Local Government Area (fig 1) lies between latitude 9º6'13.8'' and 9º17'49.35'' north of the equator and longitude 7º6'58.6' and 7º12'18.41' east of Greenwich Meridians. Suleja local government has a population of 216,578 in 2006 (NPC, 2006). In the year 2014, the population figure increased to 278,735 (projected figure).

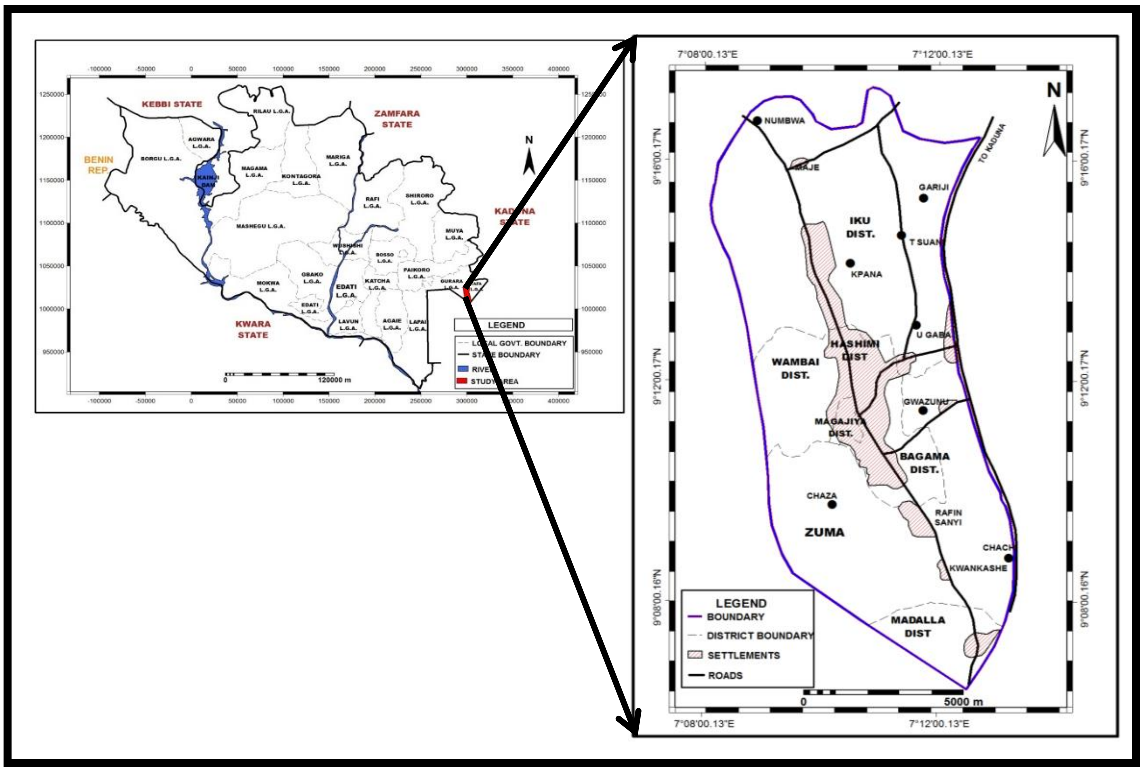


Figure 1: Administrative Map of Suleja highlighted in Map of Niger
Source: Department of URP FUT Minna.

Discussion and Findings

In analysing the images, three classes of landuse landcover were identified in Suleja, these classes are Built-up areas, Bare Surfaces and Vegetation. The built-up areas are represented in red colour, while bare surfaces and vegetation are represented in Grey and Green colour respectively (fig 2).

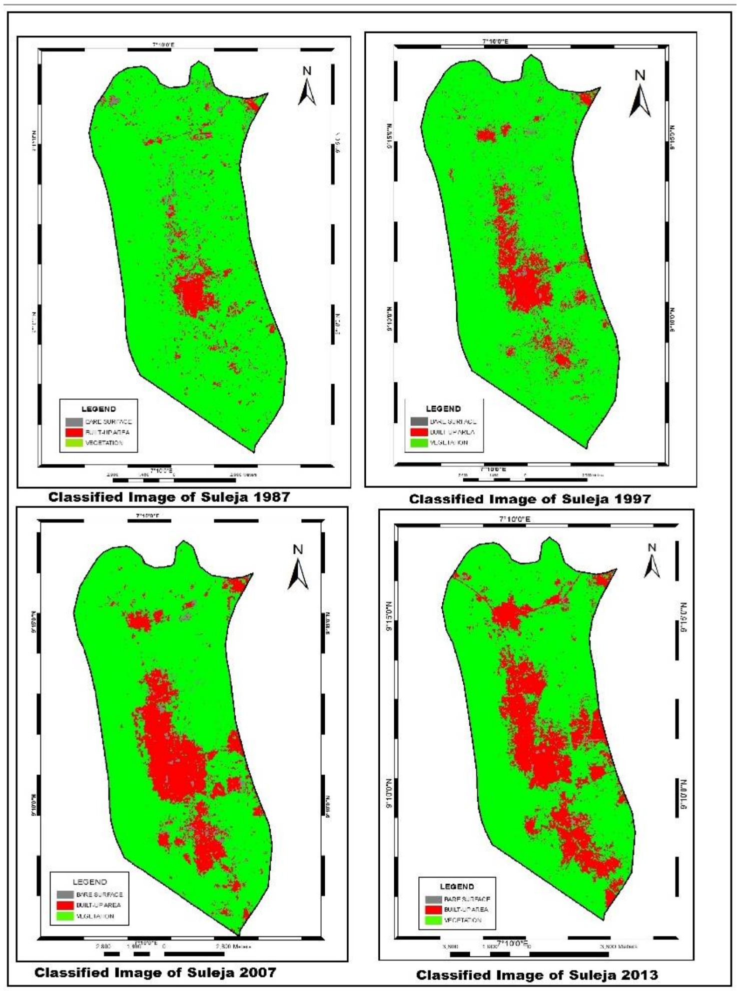


Fig 2: Composite Map for Suleja
Source: Author's Field Survey, 2014.

Table 1 shows the landuse landcover of Suleja in 1987, the table (table 1) reveals that the study area was forested in 1987 with vegetated area covering a total of 194.20 km^2 (91.77%) of the total land use. Built-up area and Bare Surface covers a land area of 10.91Km^2 (5.16%) and 6.51Km^2 (3.07%) respectively. Built up area increased from 10.91km^2 (5.16%) in 1987 to 17.46 km^2 (8.25%) in 1997. This increase led to a slight decrease in vegetated area from 194.20 km^2 (91.77%) in 1987 to 190.56 km^2 (90.60%) in 1997. Bare surface also decreased in the year 1997 with a total land area of 3.57 km^2 (1.69%). All these changes can be attributed to increase in human activities and increase in population (table 1).

In 2007 (table 1), there was a drastic increase in the size of built-up area in the study area. The built-up area increased to 30.52 km^2 (14.42%) as against 17.46 km^2 recorded in 1997. The Niger State Urban Development Board attributed the increase in growth to the influx of people moving into Suleja from Abuja as a result of "mass" demolition done within that period (2007) by Federal Capital Development Authority, Abuja. Increase in human activities in Suleja also gave rise to decrease in vegetation and bare surface in 2007. Vegetated area decreased to 178.15 km^2 (84.16%) while Bare Surface also decreased to 3.02

km^2 (1.43%) as against 190.56 km^2 (90.60%) and 3.57 km^2 (1.69%) recorded for vegetation and bare surface respectively in 1997.

Table 1 shows that the study area witnessed a considerable increase in socio-economic activities. The built-up area increase from 30.52Km^2 (2007) to 46.25 Km^2 in 2014, due to increase in human activities in Suleja more vegetal cover and Bare Surfaces were lost. The vegetal cover decreased from 178.15km^2 in 2007 to 164.02km^2 in 2013 as Bare Surface also decreased from 3.02km^2 in 2007 to 1.41km^2 in 2013. The change in landuse landcover (table 1) in this year can be attributed to increase in Population of Suleja. Between 1987 and 2014 the changes in built-up areas were progressive.

Table 1: Land use/Land Cover Change (1987-2014)

Sample Set	Land cover Area (Km^2)							
	1987	**%**	**1997**	**%**	**2007**	**%**	**2014**	**%**
Bare Surface	6.51	3.07	3.57	1.67	3.02	1.43	1.41	0.67
Built-up Area	10.91	5.16	17.46	8.25	30.52	14.42	46.25	21.85
Vegetation	194.20	91.77	190.59	90.07	178.15	84.16	164.02	77.48
Total	211.62	100	211.62	100	211.69	100	211.68	100

Source: Author's Field Survey, 2014.

Extent of Change between 1987 and 2014

The magnitude of change (table 2) from 1987-1997 is calculated by subtracting the area of each Landuses Landcover type for the year 1987 from 1997 that is, B-A. The annual frequency of change (D) is determined by dividing the magnitude of change of each of the Landuse landcover category by the number of years between the period, that is, 10 years for 1987 -1997, 10 years for 1997 to 2007 and 7 years for 2007 – 2014. The percentage of change (E) is calculated by dividing the magnitude of change C of each Landuse Landcover category by the figure of the base year that is, 1987 then multiplying the result by 100. This same process is done for the periods 1997 to 2007 and 2007 to 2014 where 1997 and 2007 are the reference year respectively. The results of the analysis show a tremendous change in the Landuse Landcover of the study area during the 27 years period from 1997-2014. It is noticed that the percentage change in the proportions of some Landuse sample sets increased while others decreased.

Table 2 also reveals that Bare Surface between 1987 and 1997 recorded an annual frequency of change of -0.29Km^2 with a percentage of change -45.16; this implies that 0.29km^2 is converted into built-up areas annually. This period (1987 - 1997) also recorded a decrease in vegetal cover. The analysis unveils that 0.36 km^2 of vegetal cover are lost annually due to human activities. Built-up area within this period (1987 -1997) gained a total of 0.66 km^2 annually. The dynamics indicate that there was an increase in spatial growth between 1987 and 1997.

Table 2: Extend and percentage of change between 1987 and 1997

Sample Set	A Year 1987 (KM^2)	B Year 1997 (KM^2)	C Magnitude of change (B-A)	D Annual Frequency of Change C/10	E Percentage of change C/A x100
Bare Surface	6.51	3.57	- 2.94	- 0.29	- 45.16
Built-up Area	10.91	17.46	6.55	0.66	60.04
Vegetation	194.20	190.59	- 3.61	- 0.36	-1.86
Total	211.62	211.62	0	0.01	13.02

Source: Author's Field Survey, 2014.

Table 3 shows a further decrease in the size of Bare Surface and Vegetation. The analysis reveals a magnitude of change of - 0.55km^2 for Bare Surface and - 12.44km^2 for vegetation. This magnitude of change reveals that a total of 0.06 km^2 and 1.24 km^2 are loss annually for both Bare Surface and Vegetation respectively. This trend also reveals a 1.24km^2 of vegetal cover are cleared annually for urban expansion. This period (1997- 2007) shows an increase in built up area with a magnitude of change of 13.06 km^2 and a percentage of change of 74.80%. The analysis also shows that a total 1.31km^2 of disturbed vegetation and Bare Surface are added to the built-up areas. The increase in Built-up area between 1997 and 2007 can be attributed to the influx of people into Suleja.

Table 3: Extend and percentage of change between 1997 and 2007

Sample Set	A Year 1997 (KM^2)	B Year 2007 (KM^2)	C Magnitude of change (B-A)	D Annual Frequency of Change C/10	E Percentage of change C/A x100
Bare Surface	3.57	3.02	- 0.55	- 0.06	- 15.41
Built-up Area	17.46	30.52	13.06	1.31	74.80
Vegetation	190.59	178.15	- 12.44	-1.24	- 6.53
Total	211.62	211.69	0.07	0.01	52.86

Source: Author's Field Survey, 2014.

The magnitude of change of naturally vegetated area between 2007 and 2014 was -14.13km^2, (table 4) with an annual frequency of change of -2.36 km^2 which implies that a total of 2.36km^2 of vegetal cover are loss annually due to increase in human activities in the study area. There was also a decrease in Bare Surface, as 0.27km^2 are loss annually with a magnitude of change of -1.61km^2 and a percentage of change of -53.31. This period (2007 - 2014) also shows an increase in Built-up Area, which can be attributed to the residents' quest for space for development and the influx of people coming into the study area in search of economic opportunities. The magnitude of change for Built-up area for this period was 15.73km^2 with a percentage change of 51.54%. 2.25km^2 is added to the Built-up area annually.

Table 4: Extend and percentage of change between 2007 and 2014

Sample set	A Year 2007 (KM^2)	B Year2013 (KM^2)	C Magnitude of change (B-A)	D Annual Frequency of Change C/7	E Percentage of change C/A x100
Bare Surface	3.02	1.41	- 1.61	- 0.23	- 53.31
Built-up Area	30.52	46.25	15.73	2.25	51.54
Vegetation	178.15	164.02	-14.13	- 2.02	- 7.93
Total	211.69	211.68	- 0.01	- 0.01	-9.7

Source: Author's Field Survey, 2014.

The rate in crime was progressive between 2006 and 2014. The study reveals that a total of 905 cases were reported in the last 8 years in Suleja. The highest numbers of cases reported were in 2008 (31) and 2011 (124). The Nigerian Police Force in 2008 attributed the high crime rate recorded during that period to the influx of people from Abuja, a resultant effect of the Abuja mass demolition by the FCDA while that of 2011 was attributed to the Suleja Madalla bombing in which 113 people were arrested. As the population of the study area grew in 2013, 122 cases were reported and a total of 156 people were apprehended. This figure (156) marked the highest number of people apprehended in Suleja in the last eight years. 967 persons were apprehended in all the crimes committed in Suleja, 896 of which are males while 71 are females. This indicates that males are more involved in crime than their female counterpart. The prevalent crime record can be attributed to the spatial growth of Suleja, unemployment coupled with inadequate security arrangement for the city. Global standard for the ratio of a police to a person is 1:50 but in Nigeria, especially in a growing city like Suleja the ratio range between 1:600-1000. This gross shortfall encourages criminal activities to grow.

Environmental problems experienced in Suleja are Flooding, Erosion, Uncollected Waste and land Degradation. Fig 4.16 reveals that, 2.2% of the respondents are faced with the problem of flooding, 21.2% of the respondents are faced with the problem of Erosion. 57.6% and 19.1% of the respondents believed that uncollected waste and land Degradation respectively, are more pronounced in their area. The study reveals that Suleja has prevalent cases of uncollected waste and this occurrence can be attributed to increase urban growth. Table 5 shows that 62,928 cubic meters were collected in the year 2009. In the year 2010 123,120 cubic meters of solid waste were collected, 184,680 cubic meters, 247,152 cubic meters and 308,940 cubic meters were collected for the year 2011, 2012 and 2013 respectively. The increase in cubic meters of solid waste collected in the study area can be attributed to increase in population. A total of 926, 820 solid waste was collected between 2009 and 2014. The Niger Environmental Protection Agency believes that these statistics does not give a true record of waste collection in Suleja because lots of solid waste are left uncollected daily.

Table 5: Volume of Waste Generated in Suleja per Population between 2009 and 2013

Year	Population	Volume of Solid Waste Generated (m^3)
2009	238,040	62,928
2010	245,664	123,120
2011	253,526	184,680
2012	261,626	247,152
2013	270,008	308,940
Total	**1,268,864**	**926,820**

Source: Author's Compilation, 2014.

Hypothesis:

H_0: the volume of waste generated in Suleja does not vary significantly with the annual population

H_1: the volume of waste generated in Suleja is directly proportional to increase in annual population

Based on the available data on the volume of solid waste generated between the five years period of 2009 and 2014, attempt was made to correlate the annual volumes of generated solid waste with the population figure for the corresponding years (table 6). The goal is to investigate if the volume of waste generated annually increases as the annual population increases. The result, as summarised in table 7, shows a perfect positive (1.0) correlation coefficient, which is significant at 99% confidence level. Hence, the null hypothesis is rejected and the alternative hypothesis is accepted. This shows that, the volume of waste generated in Suleja is, actually, directly proportional to the annual population increase. The observed pattern is, therefore, real and not attributable to chance occurrence.

Table 6: Correlation between Volume of Waste Generated and Annual Population

		Population	Volume of Solid Waste Generated (m3)
Population	Pearson Correlation	1	1.000**
	Sig. (1-tailed)		.000
	N	5	5
Volume of Solid Waste Generated (m3)	Pearson Correlation	1.000**	1
	Sig. (1-tailed)	.000	
	N	5	5

***. Correlation is significant at the 0.01 level (1-tailed).*

Source: Derived from Table 5

The Rasi 700 gas meter was used in collecting data on the quantity of Co, No_2 and So_2 concurrently and the emission level of Suleja 2014 was deduced.

Table 7: Level of Gas Emission in Suleja between 2012 and 2014.

	Standard	2012	2014
Gases	**Unit (PPM)**	**Unit (PPM)**	**Unit (PPM)**
CO	10	13.48	15.97
NO_2	0.04 -0.06	0.073	0.67
SO_2	0.01	0.0163	1.33

Author's Compilation 2014

Table 7 reveals the level of gas emission in Suleja in 2012, after the mean emission of the were recorded CO constitutes 13.48ppm, while No_2 and So_2 reads 0.073ppm and 0.0163ppm respectively (Gazali *et al*., 2013). The level of gas emission increased in 2014, 15.97ppm was recorded for CO, 0.0133ppm was recorded for SO_2 and 0.67ppm was recorded for NO_2. The value recorded in 2014 were higher than the stipulated value by the NESREA which state 10ppm for CO, 0.04 -0.06ppm for NO_2 and 0.01ppm for SO_2 (FEPA, 1999). The High pollution values can be attributed to urban growth and large concentration of Motorcycles.

Ineffective development control as a result of urban growth has led to emergency of Slum in Suleja between 1987 and 2014. According to the Niger State Urban Development Board only 35% of the building plans submitted to the Ministry are approved. The Board (NSUDB) noted that developers frequently go ahead with their development without having their plans approved and this contravention by developers often defaces Suleja. Table 8 shows the numbers of building plans approved between 1993 and 2013.

Table 8: Building plans approved from 1993 to 2013 in Suleja

Year	No. of Applications	No. of Plans Approved	No. Of Plans not Approved
1993	145	51	94
1994	150	53	97
1995	136	48	98
1996	90	32	58
1997	117	41	76
1998	134	47	87
1999	135	47	88
2000	79	28	51
2001	140	49	91
2002	108	38	70
2003	81	28	53
2004	82	29	53
2005	99	35	64
2006	174	61	113
2007	171	60	111
2008	227	79	148
2009	181	63	118
2010	129	45	84
2011	119	42	77
2012	79	28	51
2013	80	28	52
TOTAL	2656	932	1734

Source: NSUDB, 2014.

The number of building plans approved yearly, does not reflect the true population of Suleja. More so, the inability of the Niger State urban Development board to approve more than 35% of the applications made yearly has encouraged the erection of illegal buildings, contravention and chaotic planning in Suleja.

Conclusion

This study has effectively examined the implications of urban growth in Suleja between 1987-2014. It is important to note that crime, uncollected waste, pollution, land degradation, and slum emergence are consequential to urban growth in Suleja within the period under study. To accurately determine the extent of growth in Suleja within the 27 year study period, remote sensing tool was employed. This tool (remote sensing) provides an important catalyst in understanding of the way that urban areas grow and change over time.

Recommendations

On the basis of the findings of the study, recommendations are made to ameliorate the implications of urban growth in Suleja. Recommendations made are:

- The Niger State Government should partner with the National Centre for Remote Sensing and the Federal University of Technology, Minna for the training and capacity building of the staff of the Niger State Urban Development Board so as to bordering their knowledge in monitoring urban growth.
- The Niger State Urban development should give more attention to development control so as to check the emergence of unlawful development. More so, the process of building plan approval should be made less cumbersome by the planning board so as to encourage developers.
- The planning and management of Suleja should be based on the concept of Environmental Planning and Management (EPM). This is a bottom-up and community driven planning and management system, promoted by UN-Habitat.

REFERENCES

Abiodun, O. E., Olaleye, J. B., Dokai, A. N. and Odunaiya, A. K. 2011. Land Use Change Analyses in Lagos State From 1984 to 2005. FIG Working week 2011. Bridging the Gap between Cultures. Marrakech, Morocco, 18-22 May 2011

Agbola, T. 2004. “Readings in Urban and Regional Planning” Published by Macmillan Nigeria Limited, Ibadan, Oyo State, Nigeria. Pp. 179

Ajala O.A. 2005. Environmental Impact of Urbanization: The challenges to urban governance in Nigeria. In Fadare et al. (Eds.).Proceedings of the Conference on Globalization, Culture and the Nigerian Built Environment. Vol. II. Ile-Ife, Nigeria.

Aluko, O.E. 2010. “The Impact of Urbanization on Housing Development: The Lagos Experience, Nigeria” *Ethiopian Journal of Environmental Studies and Management* Vol. 3, No. 3

Bankole, M. O. and Bakare, H. O. 2011. Dynamics of urban land use changes with remote sensing: Case of Ibadan, Nigeria. *Journal of Geography and Regional Planning* Vol. 4(11), pp. 632-643, 4 October, 2011.

Celik, A. P., Zyman, R. and Mahdi, R. (eds.), (2009): Sustainable Urbanization in the Information Age ST/ESA/ PAD/SER.E/137, Department of Economic and Social Affairs Division for Public Administration and Development Management United Nations New York, New York

Donk, V.M. 2006. Positive Urban Futures in Sub-Saharan African: HIV/AIDS and the Need for a Broader Conceptualisation (ABC). Environment and Urbanisation, 18(1): 155-177.

Federal Environmental Protection Agency (FEPA), 1999. National Guidelines and standards for industries Effluents, Gaseous Emissions and Hazardous waste Management in Nigeria.

Gazali S. A. and Kazeem A. S. 2013. Contributions of CO, NO2 and SO2 from automobile emission to environmental problems in Niger state, Nigeria. *International Journal of Environmental Sciences*. Volume 3, No 5, 2013.

Hasse J.E., and Lathrop, R. G., 2003. Land Resources Impact indicator of Urban Sprawl. *Applied Geography* 23:159-175.

Ioannides, Y. M., Overman, H. G., Rossi-Hansberg, E. and Schmidheiny, K. 2008. The effect of information and communication technologies on urban structure, Economic Policy, 23, 201-242.

Jiboye A.D. 2005. Globalization and the Urban Growth process in Nigeria. In Fadare et al. (Eds.). Proceedings of the Conference on Globalization, Culture and the Nigerian Built Environment. Vol. II. Ile-Ife, Nigeria.

McCatty, M. 2004. The Process of Rural-Urban Migration in Developing Countries. An Honours essay submitted to Carleton University in fulfillment of the requirements for the course ECON 4908, as credit toward the degree of Bachelor of Arts with Honours in Economics.

National Population Commission (NPC). 2006. Provisional Census result. Federal Government of Nigeria. Abuja.

Ndabula, C., Jidauna, G. G., Averik, P. D., Oyatayo, T. K., Abaje, I.B., and Ali, A. Y., 2014. Characterization of sprawling in Kaduna metropolitan area. *American Journal of Environmental Protection* 2014; 3(3): 131-137

Olotuah, A.O. and Adesiji, O.S. 2005. "Housing Poverty, Slum Formation and Deviant Behaviour" Federal University of Technology, Akure, Nigeria and 61 Glimpsing Green, Erith Kent, DA 18 4HB London.

Olujimi, J. 2009. Evolving a Planning Strategy for Managing Urban Sprawl in Nigeria. *Journal of Human Ecology*, 25(3): 201-208

Olurin, T. A. 2003. Gender Participation and the Environmental Planning and Management (EPM) Process: A Case Study of Water Supply in Bodija Market, Ibadan. Journal of the Nigerian Institute of Town Planners, XV1: 1 – 18.

Osasona C., Ogunshakin L. and Jiboye A. 2007. ―The African Woman's right to security through sanitation. From the dwelling unit to the neighbourhood. Conference proceeding on *Right to Live in Africa*. Trieste, 9 – 10 November.

Oyeleye, O. I., 2013. Challenges of Urbanization and Urban Growth in Nigeria. *American Journal of Sustainable Cities and Society* issue 2, Vol. 1

Tibaijuka, A. K. 2006. A Message from the Executive Director. Habitat Debate, 12(2): 12. Traditional States of Nigeria 2013. World Statesmen. Retrieved 2014-09-05

UNICEF 2012. The State Of The World's Children. www.unicef.org accessed April 2014.

United Nations (2012): World Urbanization Prospects The 2011 Revision Highlights ESA/P/WP/224 Department of Economic and Social Affairs Population Division United Nations New York.

Wahab, K. 1990. "Urban Housing Conditions" Urban Housing in Nigeria, A.G. Onibokun (Ed.); Ibadan: Nigerian Institute of Social and Economic Research.

USERS PERCEPTION ON LANDSCAPE FEATURES OF OFFICE BUILDINGS IN ABUJA NIGERIA

ADEDOKUN Adebayo John, ADEDAYO Olatunde Folaranmi,
ADEBAYO Oluwatoyin Abiodun and ANUNOBI Anthony Ikechukwu
Department of Architecture, Federal University of Technology, Minna, Niger state.

The provision of landscape elements in buildings can dampen the movement of air and as such affect air flow rate and patterns within buildings. There is a great need to reduce energy consumption in office buildings due to escalating environmental problems such as Urban Heat Island effect and global warming. The safeguarding and enhancing sustaining building is important planning objective, with the use of landscape. Sustainable of office building design is one major challenge for Architects and Built Environment professionals in an attempt to sustainable environment. The environmental and economic benefits of trees have been studied relative to a variety of interests including their influence on office buildings value in Abuja. This study investigates the effect of trees and landscaping on office buildings, based on a comparison of 22 office buildings in Abuja area. Data that describe the quantity, functionality, and quality of landscaping were gathered from each of the buildings including landscape maturity, the percentage of ground cover (trees, turf, pavement), and functional attributes (building shade, noise buffer, space definition, recreation, visual screen, and aesthetics). The problem with majority of the offices provided in Abuja is open space and undefined area within and around the buildings. This paper examined user's perception on landscape features of office buildings in Abuja Nigeria. The research method adopted for this study is a mix method approach with the use of observation schedule and structure questionnaire. The data obtained was collated and entered into SPSS package and was analyzed using the non-parametric tools. The result was collated using chats while plates were used to show graphical details observed from the field. The result showed that very little attention are been paid to the issues of landscape elements in office building designs in Abuja and that attention has been focused on the aesthetic aspects of office designs. These papers conclude that there is need to develop a home grown approach towards design offices that responds to establish ways of conserving and enhancing the benefits of existing hedgerows (closely planted trees), trees, woodlands (vegetation), streams, wetland areas and other natural features. The paper recommends the use of landscape features (elements) to enhance, safeguard and sustaining of office buildings in Abuja Nigeria.

Keywords: *Buildings, Landscape Features, Environment, Office Design, Sustainable*

tripleaj2002@yahoo.co.uk

INTRODUCTION

The control of airflow is one of the most subtle and yet an inexpensive concern of the office buildings. According to Peters (1971) was among the first to report that shade trees contributed 19% to the total appraised value of a 2.8 ha parcel. Landscaping features form an integral part of the built environment, office buildings and contribute immensely to enhance passive performance of buildings. Bernatzky (1978) identified benefits of urban green structures as cooling hot air by evapo-transpiration, shading the ground and walls, reducing the radiant temperature, control of wind velocity and direction, filtering dust and noise.

Landscaping is any activity that modifies the visible features of an area of land including but not limited to:

a. Living elements such s flora or fauna; or what is commonly referred to as ‘gardening’, the art and craft of growing plants with a goal of creating a beautiful environment with the landscape.

b. Natural elements such as landforms, terrain shape and elevation or bodies of water.

c. Human elements such as structures, buildings, fences or other material objects created and/or installed by humans.

d. Abstract elements such as weather and lighting conditions.

According to Richard (2007), the effective of airflow in a space is to remove the pollute air and ensure thermal comfort to the occupant. Landscaping is the combination of both elements of art and science to create a functional, aesthetically pleasing extension of indoor living to the outdoors. It requires good observation and design skills. A variety of benefits and costs associated with urban forests and landscape trees have been explored (Dwyer et al. 1992; Nowak 1993; McPherson et al. 1999). A good landscaper understands the elements of nature and construction and blends them accordingly.

The aim of the paper is to examined user’s perception on landscape features influence on surrounding of office buildings in Abuja Nigeria. It is expected that findings of this study will guide designers to make informed decisions regarding the choice and placement of landscaping features to direct air movement into office buildings.

PRINCIPLE OF LANDSCAPE DESIGN:

One initial purpose of landscape design is to blend man's technology (house or building) into the natural surroundings. To work toward a desirable landscape design, the landscaper must have a working knowledge of architectural elements and design principles. The landscaper must consider the proposed use for the site. Other considerations are the layout of the terrain, climate and soil conditions, and costs. Once this information is known, the landscape architect proceeds to actual design.

ELEMENTS OF LANDSCAPE DESIGN:

Elements of art include but are not limited to color, line, form, texture and scale. These elements are never independent of each other.

1. **Color**: is used to convey emotion and influences the mood and character of the overall landscape design or parts of the design. Color variation can best be explained by use of a color wheel (Figure 1.1). Primary colors are red, blue and yellow. Orange, green and violet are called secondary colors because they are combinations of two primary colors. Tertiary colors are the fusion of one primary and one secondary color.

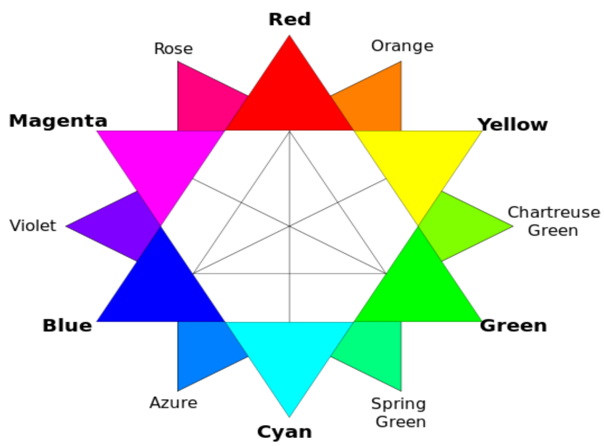


Figure 1:The colour wheel.

Source: *Concepts of Arts,1973*

2. **Line**: This is used to create order by directing eye movement or flow. The concept and creation of line depends upon the purpose of the design and existing patterns. In the overall landscape, line is inferred by bed arrangement and the way these beds fit or flow together. Lines may be used to draw attention to an object, divide a space, group related objects together, or separate unrelated objects in landscape design.

3. **Form:** Form is closely related to line. Line is considered usually in terms of Form is basically the shape of a plant and structure of its branching pattern.

Figure 2:The Relativity Of Form.

Source: *Concepts of Arts,1973*

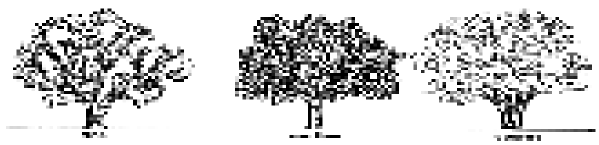


Figure 3: The relativity of texture

Source: Concepts of Arts,1973

4. **Scale:** refers to the size of an object or objects in relation to the surroundings.

Size refers to definite measurements while scale describes the size relationship between adjacent objects. The size of plantings and buildings compared on the human scale must be considered.

Figure 4 **:**Scale And The Environment

Source : Concept of Art , 1973

5. **Texture:** is the surface quality of an object than can be seen or felt. Surfaces in landscape include buildings, walks, patios, groundcovers and plants. The texture of plants differs as the relationships between the leaves, twigs and branches differ (Figure 2.3). Coarse, medium or fine could be used to describe texture but so could smooth, rough, glossy or dull.

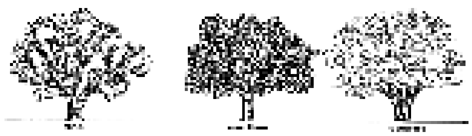


Figure 5: The elativity of Texture

Source: Concepts of Arts,1973

LANDSCAPE ELEMENTS IN RESPECT TO OFFICE BUILDINGS

Landscape features are the raw material from which landscapes both functionally and visually are made. It is necessary to consider the physical, cultural and ecological features.

Classification of Landscaping

i. Natural landscape**:** this is the original characteristics of land forms and has to do with natural features like trees, water bodies (streams, lakes, ponds, and rivers), and stone formations. It is informal and regulatory in nature.

ii. Artificial landscape: this is also referred to as man-made landscape to suit desired conditions. It is formal in nature and is not regulated. Landscaping is the combination of both elements of art and science to create a functional, aesthetically pleasing extension of indoor living to the outdoors. It requires good observation and design skills. A good landscaper understands the elements of nature and construction and blends them accordingly.

The landscape architect's plan takes into account proportion and scale. The plan also takes advantage of natural land formations, such as hills or pools, or alters them. He also considers contrasts in shady masses and open, sunny spaces, especially in relation to the climate. Planting may be designed according to season so that different parts of a garden bloom at different times. A successful plan also requires knowledge of plant characteristics, needs, and limitations. Other elements in a landscape architect's plan may be fountains, streams, and pools; sculpture and benches; walls, walks, and terraces; and small structures such as gazebos, kiosks, and trellises.

RELEVANCE OF LANDSCAPING TO THE OFFICE BUILDING

There is various relevance of landscape to the design project. These include:

Ecological services;
Trees provide ecological services that include:

Reduced air pollution

Reduced energy consumption.

Trees reduce air pollution by trapping particulate matter in their leafy canopies and by absorbing noxious pollution into their leaves. The particulate matter is eventually washed away with rain. Absorbed pollutants are incorporated into the soil after leaf fall where they are broken down by microbes. These actions reduce human health problems related to air pollution.

At night, when the earth radiates heat back into space, temperatures often drop to the cooling or dew point, when water vapor, some of which is produced by trees during the daytime, condenses. This releases latent heat back into the atmosphere. When groups of trees intercept sunlight and use it for photosynthesis, they shade roads, buildings, and other structures, and they help reduce energy consumption.

SocialBenefits:
Social benefits of landscaping include;

i. Increase job satisfaction for staffs that can look outside their window and see trees. This results in a happier nature while at work thereby increasing their productivity (Miller 1997).

ii. Faster recovery time for hospital patients who have a view of trees out of their window than patients who did not (Ulrich 1984).

iii. Improve child development and enhances cognitive development (Wells 2000).

Aesthetic value:

Landscaping is also used for its aesthetic value as it beautifies an environment and the presence of trees tend to increase the property value up to 20% especially when there are trees that have been in existence for some time.

RESEARCH METHOD

The research method adopted for the study was mix method approach with the use of observation schedule and interview guide. The study covered selected office buildings in Abuja. A sample size of 5 staff was selected in each studied building leading to a total of 120 respondents as shown in table 1.0. Observation and structure questionnaires were conducted in the building and respondents were randomly selected. The data was analyzed using descriptive statistics in SPSS version 21. Cross tabulation was used to determine the relationships between selected variables. The results are presented in charts and tables while plates are used to describe existing situations.

Sample Size

The field study was conducted in twelve (12) different locations in Abuja. The table 1.0 below shown the areas, number and sample size administer.

Table 1.0: Showing the location and sample size.

No.	Number of Offices	Locations	Sample Size	Total Number
1	2	Jabi	5	10
2	2	Area 1	5	10
3	3	Area 10	5	15
4	2	Area 11	5	10
5	2	Berger	5	10
6	2	Banex	5	10
7	2	Mabushi	5	10
8	2	Wuse II	5	10
9	2	Zone 6	5	10
10	3	Utako District	5	15
		Total number of questionnaires administer		**120**

The table 1.0 above was used to discuss and explain the result of data gathered during the field study. Federal Ministry of Lands and Urban Development, Mabuchi, Silla Zeker building No. 29, Adebayo Adediji Crescent Utako District, Abuja, Goaba plaza Utako, Abuja and Federal Ministry of Works, Land and Housing, Mabushi, Abuja. The field study was also conducted in three different days for each location, respectively.

DISCUSSION OF RESULTS

USE OF LANDSCAPE FEATURES IN OFFICE BUILDINGS

Landscape element in office buildings helps to control the use of the spaces, walls opening and landscaping to regulate the amount of air and direct sun light into the buildings. Also, to adjust the orientation and characters of the buildings towards achieving effectiveness, convenience, efficiency and total value within the space provided in the buildings.

The table below shows the data gotten from the observation and interview with the users of the selected office buildings in Abuja city. The interview was sub-divided in 6 different segments, which are using of sun shading devices, the use of windows types in office buildings, the use of court yard in office buildings, the use of indoor plants in office buildings, the use of soft landscaping and proposed change in office design in response to climate change in Abuja.

Use of Landscape Features

Under the use of landscape features, three different questions were asked from the users. From the table below show the result of the total number of responded users and total percentage. The percentage is show in chart.

Use of Court Yard in Office Buildings

Under the use of court yard in office buildings, three different questions were asked from the users. From the table below show the result of the total number of responded users and total percentage. The percentage is show in chart.

The use of court yard

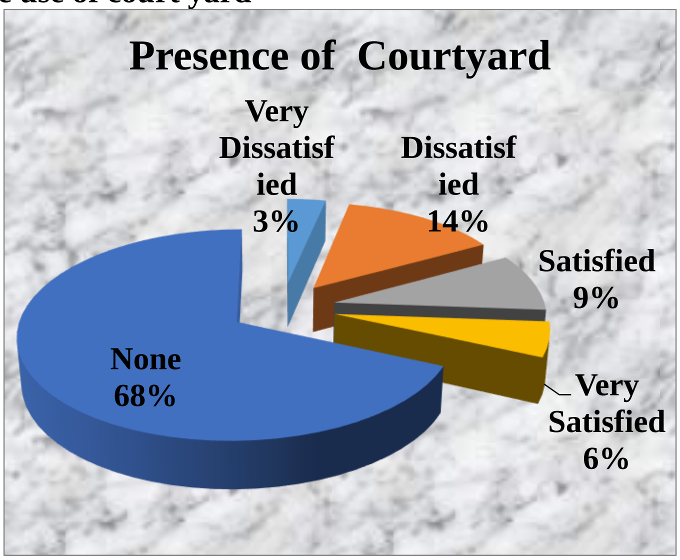


Figure 7.0: Level satisfaction with court yard size.
Source: Author Field Survey 2015.

From above chart, shows that users are more satisfied with court yard within the buildings to provide air circulation. The data gather show that 15% building have court yard and the users are satisfied with it. While 17% buildings do not have court yard and the users are not satisfied. And 68% buildings have no court yard and also the users prefer their building should have court yard.

Use of Indoor Plants in Office Buildings

Under the use of indoor plants in office buildings, two different questions were asked from the users. From the table below show the result of the total number of responded users and total percentage. The percentage is show in chart.

Indoor plants in office buildings.

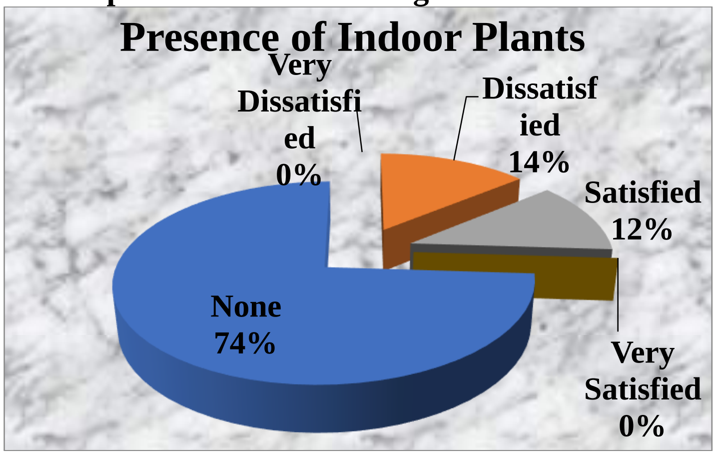


Figure 10.0: Level of satisfaction with indoor plants in office buildings
Source: Author Field Survey 2015.

It shows that, the use of indoor plants enhance office buildings. The use of indoor plants helps to regulate the temperature of the building and also increase the output of the users.

Use Landscaping Elements in Office Buildings

Under the use of landscaping elements in office buildings, two different questions were asked from the users. From the table below show the result of the total number of responded users and total percentage. The percentage is show in chart.

Landscape around the building

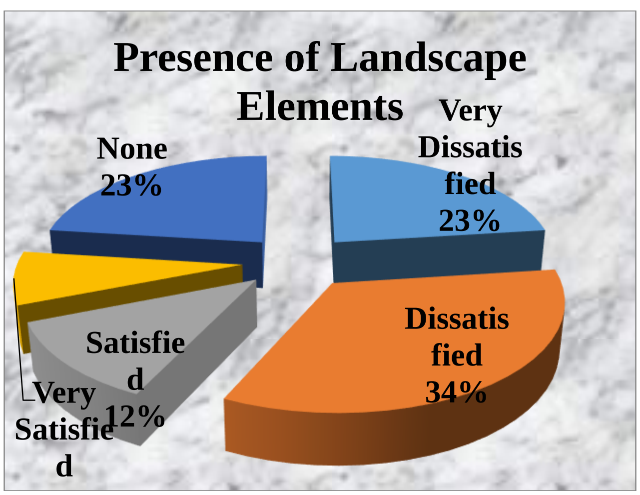


Figure 12.0: Level of satisfaction with landscape around the buildings.
Source: Author Field Survey 2015.

From above Chart, **57%** of the users are mostly not satisfied with the landscape elements not use in the buildings, while **20%** are really satisfied without the landscape. And **23%** offices building in Abuja have no landscape around. The results above show that, the use of landscaping elements is highly necessary in office design, to enhance the building and also it helps to regulate the temperature within and around the buildings. Plate 1.0 below show landscape around the office building.

Plate 1.0**:** 3D remodel of the building and surrounding showing soft and hard landscaping and the wall opening. Source: Author, 2015.

Plate 2.0**:** Surrounding of the building showing little landscaping and the wall opening. (The researcher observed that few or no green area and few trees around the building).

Source: Author Field Survey 2015.

From above Chart, **57%** of the users are mostly not satisfied with the landscape elements not use in the buildings, while **20%** are really satisfied without the landscape. And **23%** offices building in Abuja have no landscape around. The results above show that, the use of landscaping elements is highly necessary in office design, to enhance the building and also it helps to regulate the temperature within and around the buildings.

PROPOSED CHANGES IN OFFICE BUILDING IN REGARD TO LANDSCAPE FEATURES

Below chart figure 14 – figure 19; show the response of the users in Abuja office buildings, if the items 1 to 5 can be included in new proposed office design planning.

Data from the user response in Abuja.

Use of court yard in office buildings.

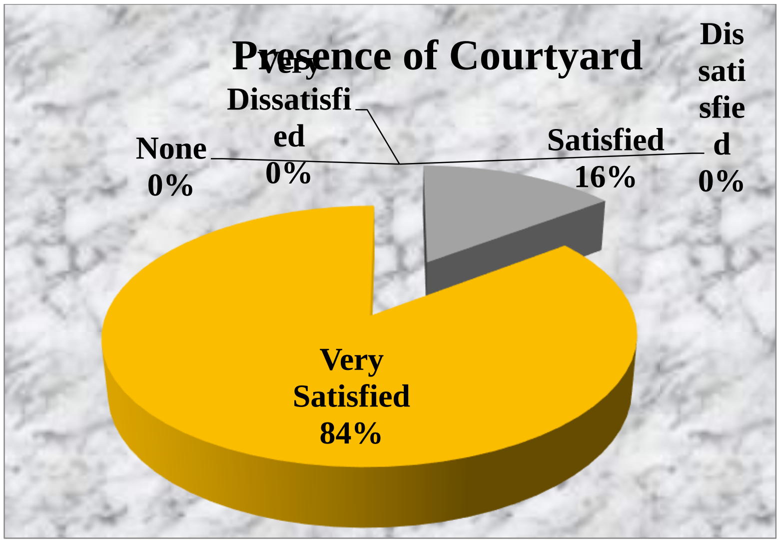


Figure 16.0: Level of satisfaction with court yard..
Source: Author Field Survey 2015.

The above chart show the use of court yard in office buildings is useful also. The court yard provide a friendly environment to the users and also help to regulate the temperature within the office buildings to reduce the amount of heat within the offices. From the chart above, 84**%** are **Very Satisfied** if the use of court yard is introduce in office buildings design and their response show the change in climate will not affect the functions of office building. While **16%**, also show **Satisfaction.**

Use of indoor plants in Office buildings.

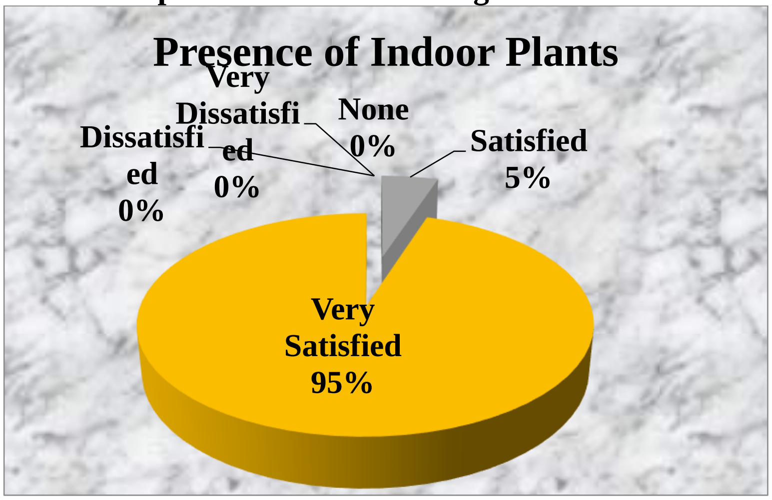


Figure 17.0: Level of satisfaction with indoor plants in office buildings.
Source: Author Field Survey 2015.

From the chart above: Show that the use of indoor plants in office building will be useful to also regulate the temperature within and around the offices. **95%** are **Very Satisfied** if an indoor plant is introduced within the design. The responses of the users show that change in climate will not affect the functions of office building design. While **5%**, also show **Satisfaction** of the indoor plants in the office buildings is provided. The results above show that, the use of indoor plants is highly necessary in office design, to enhance the building and it functionality.

Use of landscape elements in office buildings.

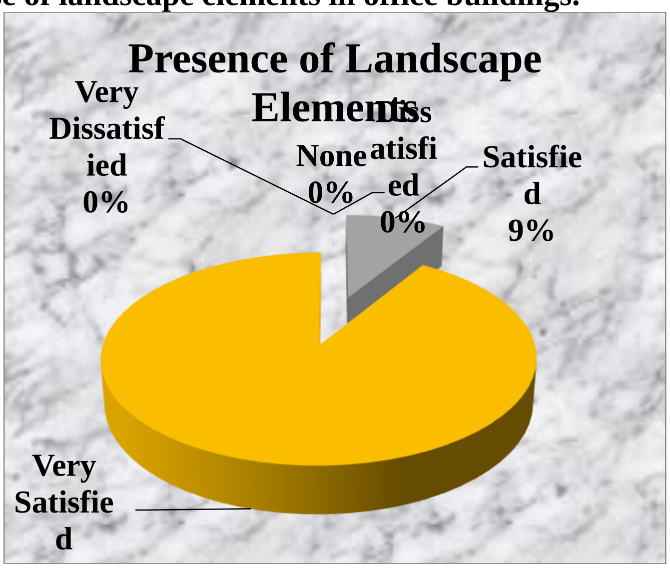


Figure 18.0: Level of satisfaction with landscape elements in office buildings.
Source: Author Field Survey 2015.

From the chart above: Show that from the proposed change in office design planning, **91%** will be **Very Satisfied** if landscape elements is included right from the design stage and their response show the change in climate will not affect the functions of office building design. While **9%** are, also show **Satisfaction** of the landscape elements in the office buildings. The results above show that, the use of landscaping elements is highly necessary in office design, to enhance the building and it functionality.

The plate 2 shows the kind of indoor plants in Silla Zeker Building No. 29, Adebayo Adediji Crescent Utako District, Abuja.

Plate 3.0: Surrounding of the building showing hard landscaping and the wall opening. (The researcher observed that no green area and trees around the building).

Source: Author Field Survey 2015.

3D Model of the same existing building showing Indoor plants in plate 2 below.

Plate 4.0**:** 3D remodel of the building and surrounding showing soft and hard landscaping and the wall opening. Source: Author, 2015.

Plate 5.0**:** 3D remodel of the building and surrounding showing soft and hard landscaping and the wall opening.
Source: Author, 2015.

Plate 6.0**:** 3D remodel of the building and surrounding showing soft and hard landscaping and the wall opening.
Source: Author, 2015.

The plate 3.0 shows the existing of the office building without landscape. While plate 4.0 – 5.0 show the proposed 3D landscape of the same existing office building. And plate 6.0 shows the landscape around the office building in Abuja.

It was observed that landscape elements are essential to office buildings, because it enhanced, safeguarded and sustained office building.

CONCLUSION AND RECOMMENDATIONS

The most significant conclusion which can be drawn from this study is that more users prefer the use of landscape features at the design stage for sustainable office buildings. Landscaping shows that it has a positive effect on people in general but most importantly, on office users. It is of both aesthetic and economical value as it not only beautifies an environment but it also help the users within the office to relax.Landscape elements are one of the greatest challenges facing buildings, mankind, and major challenge for both Architects and Built Environment professionals in an attempt to sustain buildings. Buildings meeting the challenges of change in climate effects in Abuja and cities in Nigeria, therefore requires both mitigation and adaptation strategies. Architects and Built Environment professions have vitals roles to play in regard to sustaining office buildings.

It is therefore important to take measures like the use of court yard, indoor plants and landscape elements in office buildings to regulate this factor.

Changing in office buildings with the use of landscape features in Abuja will enhance the functions, efficiency and effectiveness of the buildings and the users' inputs and outputs. The study has identified the use of court yard, indoor plants and landscape elements will help safeguard, enhance and sustain office buildings in Abuja. Architects and Build Environmental professionals should adopt the using of landscaping elements, is very important in buildings, both in court yard, indoor plants to serves as cooling system within and around the buildings.

REFERENCES

Abdul Razak, S. (2003). Possibilities of using void to improve natural cross ventilation in high-rise low cost residential building. PhD Thesis. University of Technology Malaysia.

Adunola, A.O. (2011), Adaptive Thermal Comfort in Residential Buildings in Ibadan Metropolis. Unpublished PhD Thesis, Obafemi Awolowo University, Ile-Ife, Nigeria.

African Development Bank et al, *Poverty and Climate Change: Reducing the Vulnerability of Poor through Adaptation*. Paper presented at the 8th Conference of parties to the United Nations Framework Convention on Climate Change, New Delhi, 2002.

Ajibola K (2001). Design for comfort in Nigeria – A Bioclimatic Approach. Oxford U.K, Pergamon, J. Renewable Energy, 23:57-76.

Al-Azzawi, S. (1996), Daily Impact of Climate on the Pattern of Urban Family Life; Indigenous Courtyard Houses of Baghdad, In Sayigh, A.A.M. (ed.) , Proceedings of the World Renewable Energy Congress, Pergamon Press, Oxford, U.K.

Anderson, L.M., and H.K. Cordell. (1988). Influence of trees on residential property values in Athens, Georgia (USA): A survey based on actual sales prices. Landscape Urban Plann. 15:153–164.

Beckett, K.P., P. Freer-Smith, and G. Taylor. (2000). Effective tree species for local air-quality management. J. Arboric. 26:12–19.

Bernatzsky, A. (1978). Atmospheric Ecology and Preservation. Elsevier, Amsterdam

Bollinger, C., K.R. Ihlanfeldt, and D.R. Bowes. (1998). Spatial variation in office rents within the Atlanta region. Urban Stud. 35(7):1097–1118.

Clapp, J.M. (1980). The intrametropolitan location of office activities. J. Region. Sci. 20:387–399.

Council of Tree and Landscape Appraisers. (2000). Guide for Plant Appraisal (9th ed.). International Society of Arboriculture. Champaign, IL. 143 pp.

Des Rosiers, F., M. Theriault, and P. Villeneuve. (2000). Sorting out access and neighbourhood factors in hedonic price modeling. J. Property. Invest. Fin. 18(3):291–315.

Doxiadis CA (1996). *How Can We Learn About Man and His Settlement s in Rapport(Ed)* The Mutual Interaction of People and Their Built Environment. A Cross-cultural Perspective.The Hague. Mouton, pp. 23-42.

Dwyer, J.F., E.G. McPherson, H.W. Schroeder, and R.W. Rowntree. (1992). Assessing the benefits and costs of the urban forest. J. Arboric. 18:227–234.

Ikpo, J. I. (2009). Maintainability indices for public building design. *Journal of Building Appraisal (200) 4, 321-327* Faculty of environmental Design and Management, Department of building, Obafemi Awolowo University, Ile-Ife, Osun State, Nigeris.pdf.November 22th, 2015.

Jackson ARW & Jackson JM (1997). Environmental Science – The National Environment and Human Impact, Addison Wesley, Edinburgh, Longman (Publisher) Ltd, First Edition, pp. 89-132.

Lawal AF (2008). Assessment of Public Building Designs for Energy Conservation in Southwestern Nigeria, Unpublished Ph. D. Thesis, Technology Planning and Development Unit, Faculty of Technology, Obafemi Awolowo University, Ile-Ife. Nigeria.

Markus K, Morris E (1980). Buildings, Climate and Energy. London, Pitman Publication. pp. 56-67.

McPherson, E.G. J.R. Simpson, P.J. Peper, and Q. Xiao. (1999). Benefit–cost analysis of Modesto's urban forest. J. Arboric. 25:235–248.

Noor Hanita, A. M., Abdul Razak, S., Amira, M. (2005). Social and cultural aspects of open spaces: A study on selected typologies in Kuala Lumpur City. Proceedings of International Seminar: Cultural of Living, Yogjakarta.

Nowak, D.J. (1993). Compensatory value of an urban forest: An application of the tree-value formula. J. Arboric. 19:173–177.

Ogunsote O. O.. & Prucnal-Ogunsote B. (2003). Choice of a thermal index for architectural design with climate in Nigeria. Department of Architecture, Federal University of Technology, Akure. Nigeria. 4, 5-9.

Ogunsote, O. O. (1991). Notes on computerized storage of climatological data for the architect. *Climate and human settlements – integrating climate into urban planning and building design in Africa*. UnitedNations Enviroonment Programme, Nairobi, Kenya.

Peters, L. (1971). Shade and ornamental tree evaluation. J. For. 69:411–413.

Richard, A. (2007, May). Natural Ventilation in Passive Design. Environment Design Guide

Roaf, S., Fuentes, M. and Thomas, S. (2007). Ecohouse: A Design Guide (3rd Edition ed.). Elsevier, Oxford, UK.

INTEGRATION OF RECREATIONAL SPACES IN HOTEL BUILDINGS TO IMPROVE USER COMFORT IN MINNA, NIGER STATE.

ABUBAKAR, Olaitan Abdulrazak
Department of Architecture, Federal University of Technology, Minna, Niger State, Nigeria,

Hotel buildings are designed to provide hospitality and comfort to its users at all levels. This is normally achieved basically by the provision of accommodations and the integration of other services and functions that meets the need and also aid the general comfort and well being of hotel users. The poor integration of recreational spaces within hotel building or in an hotel environment is one amongst other problems that has affected the standard of services as well as the level of comfort derived by hotel users in Nigeria. This research aims to evaluate this problem by the examination of the users perception on the recreational spaces as provided or to be provided in hotel buildings in minna, Niger state. In order to achieve this, a well designed questionnaire and observation schedule was used to get firsthand information from hotel users on whether or not hotel owners in Minna, Niger State have successfully satisfy their recreational needs in terms of the provision of recreational facilities in selected hotel buildings. The research shows that although, all the selected hotels provides for one or two forms of passive recreation, but the active recreation have been neglected because only few of them provided for active recreation. The results also reveals that majority of the respondents are not satisfied with the recreational facilities provided, but were okay with the positions of the recreational spaces. Therefore, it is recommended that more variety of recreational spaces should be integrated into hotels buildings in Minna, with keen attention to the active forms of recreation, in order to promote the comfort of users.

Keywords: *Comfort, Hospitality, Hotel-Buildings, Integration, Recreation.*

textzone3@yahoo.com

ABUBAKAR, Olaitan Abdulrazak (2016). **INTEGRATION OF RECREATIONAL SPACES IN HOTEL BUILDINGS TO IMPROVE USER COMFORT IN MINNA, NIGER STATE.** Sustainable Built Environment and Climate change; The challenges of Post 2015 Development Agenda. School of Environmental Technology Conference, SETIC, 2016

1. INTROUCTION

According to World Tourism Organization, hotel is an establishment that is structured to provide paid accommodation for lodging on a temporary or short term basis with or without ancillary services (services such as recreation, entertainment, food and drinks).

According to Adeoye 1998, hotel rooms consist only a few set of furniture like a ward-robe, a bed and small table without other supporting services during the early times, but these have been replaced in recent times by luxurious and more modern facilities such as air conditioned, en suites bathrooms, executive rooms and presidential rooms. Ezeigbo 1998 also states that new features are now included in hotel services such as internet services, television sets, telephones and breakfast serve in bed, and mini bar and snacks. These emergence and inclusion of various other facilities and services brought about the different classification of hotel around the world today Hamilton, 2000. Bigger and higher class hotels provides spaces like; gymnasium, spa, sauna, swimming pools, conferences, casino, restaurant and cinema. From the statements above, it can be deduced that although hotels were initially established to just provide temporary lodging, but it has since risen to provide other wide range of services in order to meet the rising need of customers among which recreation is part of. Jones 1997 also added that Recreational spaces in Hotels are generally known to enhance the general functionality as well as increase the range of services provided. He further states that the integration of recreational spaces in hotel systems will help to promote the activity of leisure. The need to treat or integrate recreational activities (both active and passive) as an essential function in hotels is to offer wide range of service as well as aiding the human biology and psychology, because recreation is the expenditure of time with intent to gain some refreshment. It is a break from monotony and a diversion from the daily routine. By the integration of recreational spaces in hotels, Oak (2010) confirms that it will provide a positive change from the stereotypical lifestyle and involves an active participation in some entertaining activity. Also, McPeek & Chee affirms in 2011 that the recreational contents of an hotel as additional to the other services provided, must be adequately equipped, organized and arranged, accessible and attractive so that it has the practical value which will satisfy the recreational needs of the user. The significance of recreation in medical terms is creating of the optimal conditions for rest, refreshment and recovery that will help to regenerate the disorders that must have occurred due to the various forms of fatigue and other negative influence (Oak , 2010).

This paper strives to determine the extent at which recreational spaces have been integrated into the hotel buildings in Minna, Niger State Nigeria, by the proper assessment of selected hotel buildings within Minna.

2. HOSPITALITY AND RECREATION

2.1 Hospitality

Chon and Sparrow (2000), confirms that the term hospitality was originally derived from the Latin word “HOSPE” meaning host or guest and "hospitium" which also means chamber for guest, inn or quarter. Broadly speaking, Hospitality is the act of showing kindness in welcoming and looking after the basic needs of guests or strangers, mainly with regards to accommodation, food and drink (Murray and Benny, 2009). A reasonable explanation of

Hospitality is simply the relationship between a guest and a host. Therefore, Hospitality Industry refers to the companies or bodies which provides services such as accommodation and/or food and/or drink to travelers who are away from home and in need of such services (Murray et al, 2009). In recent times according to Benny et al, 2009, The scope of Hospitality is such that it does not only cover for the provision of lodging and food but other related tourism operation such as travel guides and theme parks. And also suggestion was made to merge the hospitality and tourism into a single industry.

The figures below illustrates the scope and relationship between Hospitality and Tourism:

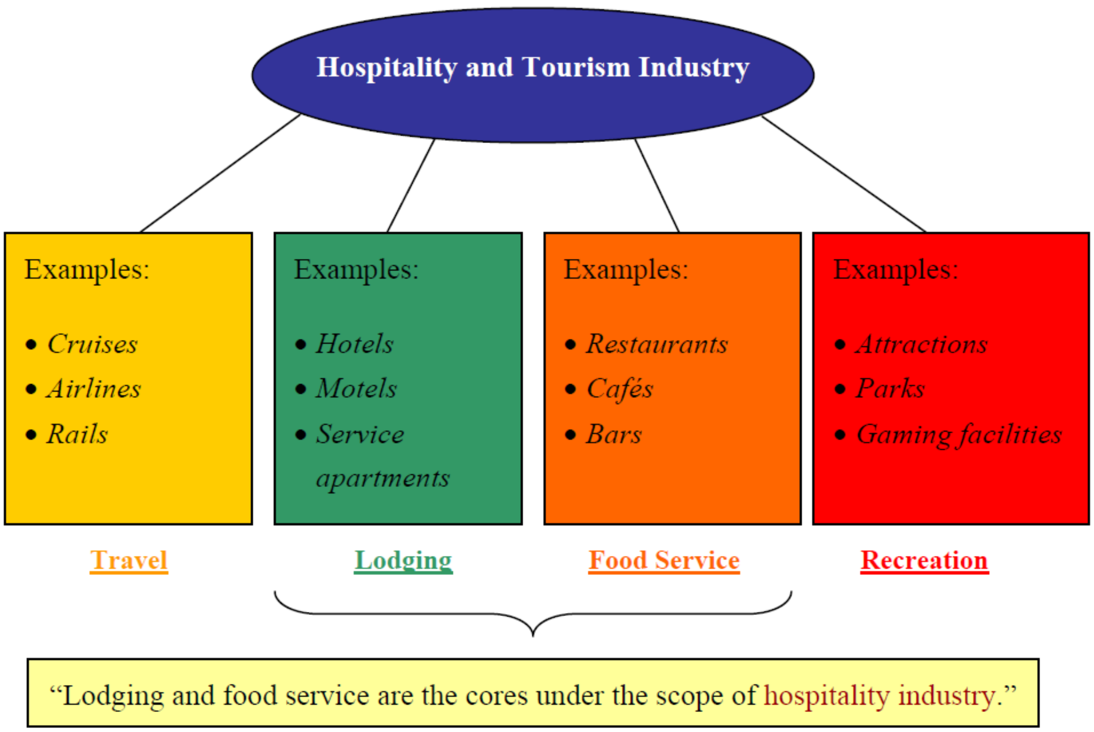


Fig 1.1: *Illustrating the Scope of Hospitality and Tourism Industry*

Source: *Introduction to Hospitality, 2009.*

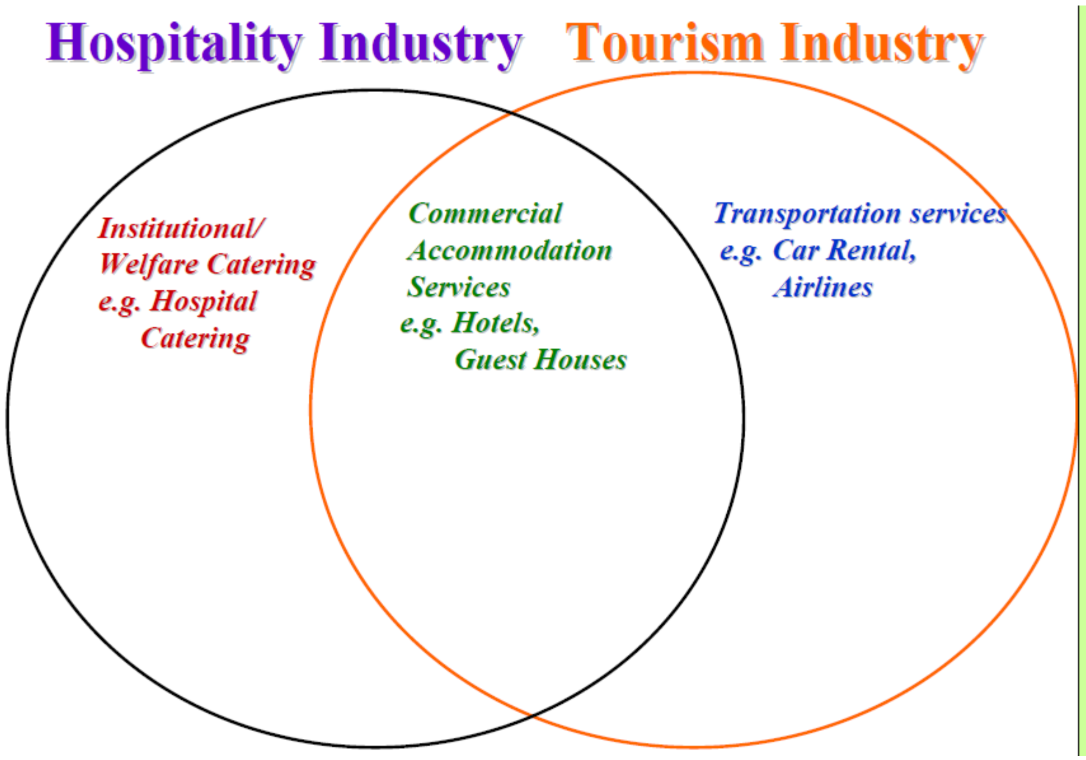


Fig 1.2: *Illustrating the Relationship between Hospitality and Tourism Industry*

Source: *Introduction to Hospitality, 2009.*

2.1.1 Hotel

Hotels generally are referred to as any establishment that provides lodging Paid on a short-term basis. According to Murray 2009, hotels are business establishment built by the owner for offering basic services like sleeping accommodation, and/or Meals and/or Drinks to people that presents themselves, who are able and willing to pay a reasonable sum for the services and facilities provided and who is in a fit state to be received. He added that the facilities provided in hotels may range from a basic bed and storage for Clothing, to luxury features like swimming pool, business center, childcare, conference facilities and other social function services.

Types of hotels

According to Hamilton (2000), different types of hotels offer different kinds and ranges of services to their guests and will be run differently to meet their guests' needs. For example;

Airport hotels- are designed especially to provide travelers with a place to eat and sleep. They offer a mix of facilities and amenities. Therefore they are hotels mainly cater for people en-route (traveling) for business or pleasure;

Casino hotels- these type of hotels provides for services like gambling operations and live entertainment centers which is the major revenue centers for the hotel.(Mackenzie, 2009).

Other types of hotels includes;

Spa hotels, City center hotel, Resort hotels, Conference/convention hotels, guest houses, highway hotels/motels, all-suites hotels, boutique hotels...

Classification of hotels

According to Ayeni, Kufoniyi, and J.O. Akinyede, (2003), Hotels all over the world are classified in different ways based on certain factors which include the following:

(a) Classification based on Location- Here, it includes:

Urban, suburban, Rural, Island, Airport, Resort, Tourism centre (near attractions), Business centre

(b) Classification based on form of ownership - Hotels that are owned independently, hotel chain, franchise, syndicate owned

(c) Classification based on facilities boating

golf, conventions, ski, condominiums, business centers, cable television, in house movies, room service menu

(d) Classification based on type of client

Business people, Community, Tourist, Traveler, Holiday maker, Family

(e) Classification based on standard

First class, Luxury, Good, Medium, Small

(f) Classification based on amenities (eg. 1, 2, 3, 4, 5 stars)

(G) Size Number of Beds or Bedrooms.

The most widely accepted form of classification is based on amenities (the rating system). Where hotels are rated in stars. Hotels can be classified into a one star, two star, three star, four star and five star hotels. There are also six and seven star hotels around the world but not in Nigeria, Ayeni, Kufoniyi, and J.O. Akinyede, (2003).

2.2 Recreation

Recreation is from two Latin words- '*Re*', meaning to do again and '*Creare*', meaning to create. Recreation is a renewing experience, a different and refreshing change from daily routine and work day experience (Fadamiro, 2003). Recreation is the expenditure of time with intent to gain some refreshment. It is a break from monotony and a diversion from the daily routine. It is a positive change from the stereotypical lifestyle and involves an active participation in some entertaining activity (Oak, 2010). Recreational activities involve an element of enjoyment and happiness obtained from engaging in something one likes. Different recreational activities serve as the sources of immense pleasure and provide relaxation to one's mind and body. Boniface and Cooper (1987) and Roberts (2001) agree that recreations are the varieties of activities we choose to undertake during leisure time. Recreation, therefore, are pursuits taken-up during leisure time other than those to which people have a high commitment. Recreation also, is a means of escaping from work boredom and/or a body renewal in preparation for routine and necessary work. Recreational activities give us an opportunity to spend time with our near ones and ourselves. They give us an opportunity to meet new people, make new friends and socialize. Some of the recreational activities help us in developing leadership qualities and interpersonal skills. Aside work to meet the basic needs of man (i.e. hunger, warmth and safety), recreation and leisure are regarded as one of the basic human needs as sources of pleasure, relaxation and excitement (Fadamiro, 2003). Recreational activities are divided into two major classes namely: Passive Recreation and Active Recreation.

2.1.1 Recreation Space

This refers to the purpose-built venues, within which recreation facilities are provided, either by the public or private sector. In the urban areas, building coverage may be up to 100%; in the rural areas, sites dedicated to recreation uses may have a lower coverage.

Recreational spaces can either be active or passive; active recreational space is also referred to as core activities while passive is regarded as non – activities.

3. STUDY AREA AND METHODOLOGY

3.1 Study Area.

Minna which became Niger state capital in 1976 is the preferred study area within which Hotels that provide for active recreational spaces are selected for observation. Minna is a city of estimated population 304,113 (Nigerian Population Census 2007), located the in North Central part of Nigeria. It is located on latitude 9°36′50″ North of the Equator and longitude 6°33′24″ East of the Greenwich Meridian. Niger state make up about 8% of the total Nigerian land mass and is150 km away from the Capital city of Abuja, with Minna one of its major cities.

Although, there are fifty-two (52) registered hotels in minna, twelve of them were assessed making about 25% of the total number. it is worthy to state that only five of them provides for active recreation. These hotels includes Golden Palace Guest Inn., Nasfah Hotels, Hydro Hotels, Shiroro Hotels and Aloevera Hotels. it is also observed that the active recreation facilities provided in Shiroro Hotels are no longer functional as they are in a very bad-state. The research areas visited includes;

Golden Palace Guest Inn.

Nasfah Hotels

Hydro Hotels

Aloevera Hotels

Doko Hotels

Akana Hotels

Dogon-Koli Hotels

Shiroro Hotels

Brighter Suites

Yanah

Falana Hotels

Gurara Hotels

3.2 Methodology

This research was carried out to examine how or how much of Recreational activities/ spaces have been provided in selected hotels in Minna, Niger State, Nigeria. As stated above, the research was conducted in twelve randomly selected hotels in Minna, amongst which only Four of them provides for active recreation, all other only provides for passive forms of recreation. A cross-sectional research was carried out in these twelve hotel buildings in 2015. Data were collected from the field using observation schedule, questionnaires, photographs and oral interviews. The observation schedule was used to collect data of the Active and Passive Recreational spaces that are provided in these Hotels. This observation schedule was used to determine the percentage difference in the number of active and passive recreational activities that have been provided.

The questionnaire however were used to get the hotel users perception on the recreation spaces that are provided and not provided in these research areas. In administering questionnaires, a purposive sampling method was used to ensure the four hotel buildings that provides for active recreation were selected, while a simple random sampling method was employed in selecting the remaining hotel samples from others. A total of 120 questionnaires were administered across the 12 selected hotels among which a total of 87 questionnaires were returned out of the 120 that were in the course of this research. 84 out of the 87 that were retrieved was valid which represents 70% of the administered questionnaires. The questionnaire that was used in collating data from the respondents consisted of questions from two different sections (sections A and B). The Section-A was designed to collect data on the Basic information of the respondent, this includes questions that gives information about the sex, age, marital status, occupation, purpose of visit to hotels, criteria for selection of hotels to visit and how often they visit an hotel. The Section-B of the questionnaire collects data on questions such as perception of recreation, how often they recreate, level of satisfaction on the position of the recreation as well as the type of recreational spaces provided in the research areas. Quantitative and qualitative data were able to be collected in the course of the field work. The quantitative data obtained from the questionnaires were analyzed using a descriptive statistical tool.

4. *DATA PRESENTATION AND DISCUSSION*

4.1 Data Presentation

4.1.1 Research Areas that Provides for Active Recreational

The chart below shows that only 33% of the of the sample size provides for both active and passive recreation while the larger 67% provides for only passive recreation. This means that passive recreation are given more attention than the active recreation.

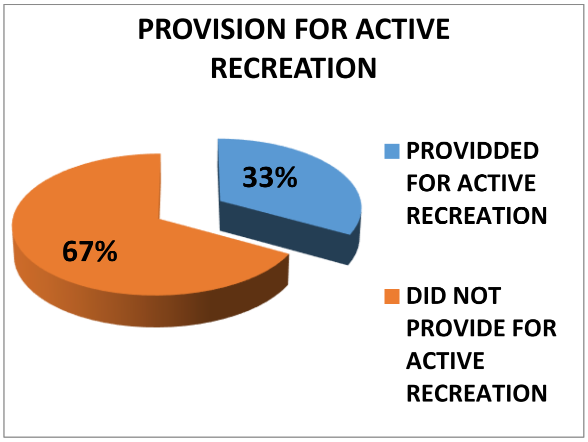


Fig1: *Showing the Percentage difference in the Provision for Active Recreation in Research Areas*

Source: *Researchers Field Work, 2015*

4.1.2 Research Areas that provides for Active Recreational Spaces.

The table below shows only the research areas that provides for active recreational spaces.

Table 1*: Showing the Research Areas that provides for Active Recreation, and the Spaces as Provided.*

RESEARCH AREAS THAT PROVIDES FOR ACTIVE RECREATION	**ACTIVE RECREATIONAL SPACES PROVIDED**				
	SWIMMING POOL	GYM	LAWN-TENNIS COURT	BADMINTON COURT	TABLE GAMES
Golden Palace	✓	✓	✓	●	●
Nasfah Hotel	✓	✓	●	✓	●
Hydro Hotel	✓	✓	✓	✓	●
Aloevera Hotel	✓	✓	●	●	✓

Source: *Researchers Field Work, 2015*

4.1.3 Percentage Difference Between Active and Passive Recreational Spaces Provided in Research Areas

The table below shows the difference in percentage between the number of active and passive recreation as provided in the research areas. It explains that only 24% and 76% represents active and passive recreation spaces that were provided respectively.

Table 2*: Showing the Percentage difference between Active and Passive Recreation Provided in Research Areas*

RESEARCH AREAS	**RECREATIONAL SPACES PROVIDED**		
	NUMBER OF ACTIVE RECREATIONAL SPACES	**NUMBER OF PASSIVE RECREATIONAL SPACES**	**TOTAL**
GOLDEN PALACE	3	5	8
DOKO	0	3	3
AKANA	0	2	2
HYDRO	4	5	9
ALOE-VERA	3	5	8
DOGON-KOLI	0	4	4
SHIRORO	0	5	5
BRIGHTER	0	3	3
YANAH	0	2	2
FALANA	0	2	2
GURARA	0	3	3
NASFAH	4	5	9
TOTAL	**14 (24%)**	**44 (76%)**	**58 (100%)**

Source: *Researchers Field Work, 2015*

4.1.4 Section-A: Sex:

The chart below shows that majority of the respondents 77% are Male against the 23% which are Female. This explains that the male visits the hotel more often than the female in the research area.

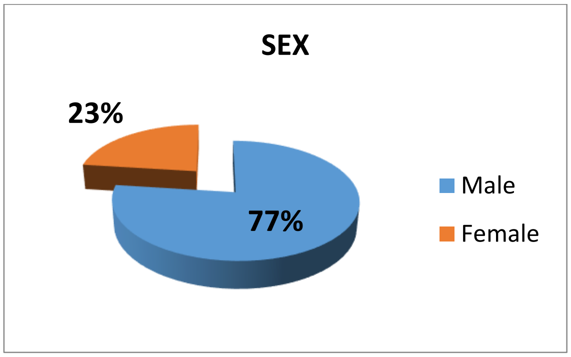


Fig2: *Illustrating Sex Frequency of Respondents.*

Source: *Researchers Field Work, 2015*

Marital Status: Table 3 below shows that most of the respondent are married with the highest percent of 67%, while single and divorced carries 29% and 4% respectively.

Table 3: *Showing the Frequency for Marital Status of Respondents*

Status	**Frequency**	**Percentage (%)**
Single	24	29
Divorced	3	4
Married	57	67
Widowed	0	0
Total	**84**	**100**

Source: *Researchers Field Work, 2015*

Employment Status: The statistics below shows that 37% of the respondents are self employed, 33% are in the public sector, while 30% falls in the private sector.

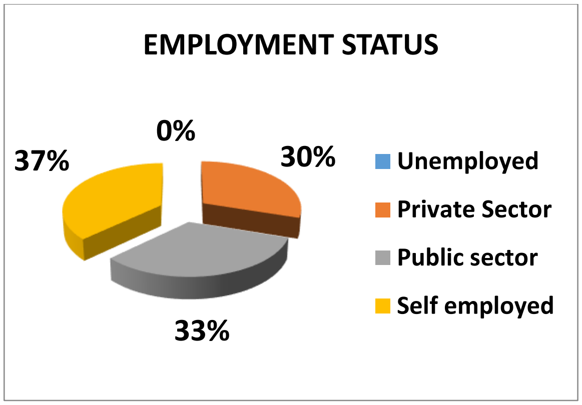


***Fig3:** Showing the Education Attainment of Respondents*

***Source:** Researchers Field Work, 2015*

Purpose: . The stat below explains that the purpose of visit to hotels between the respondents differs, as 35% of the respondents visits for pleasure, 29% for business purposes, while 26% and 10% visit hotels for recreation and other purposes respectively.

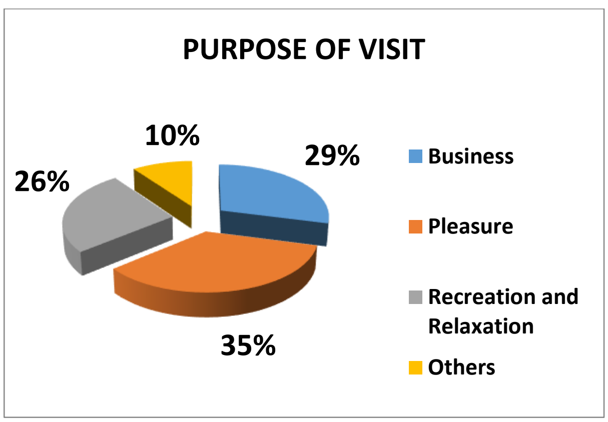


***Fig4:** Showing the Frequency for Purpose of Visit to Hotels*

***Source:** Researchers Field Work, 2015*

How often do you visit Hotels?: The table below shows how often hotel users (respondents) visit the hotels. It shows that majority of the respondents visits twice a month with a percentage of 44% of the total.

Table 4: *Showing the Frequency for how often the Respondents visit Hotels*

How often?	Frequency	Percentage (%)
Weekly	9	11
Monthly	20	24
Bi-Monthly	37	44
Tri-Monthly	18	21
Total	**84**	**100**

Source: *Researchers Field Work, 2015*

Criteria for Selection of Hotel?: The chart below shows that the criteria for the selection of choice of hotel to visit differs across hotel users (respondents). Majority of the respondents with a percentage of 49% makes their choice based on the facilities that are provided in the hotels. other criteria like services, proximity and others makes 19%, 26% and 6% of the total.

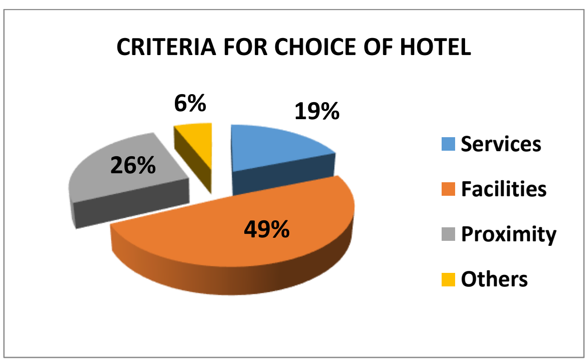


Fig5: *Showing the Frequency for Criteria for choice of Hotel*

Source: *Researchers Field Work, 2015*

4.1.5 Section-B:

How often do you Recreate?: The table below shows that majority of the respondents recreates twice a month with a percentage of 37% of the total, those that recreates weekly takes 23% of the total. Others that recreates once a year, twice a month and twice a year takes 13%, 20% and 7% respectively.

Table 5*: Showing Sex Frequency of how often they Recreate*

How often?	Frequency	Percentage (%)
Weekly	19	23
Monthly	31	37
Bi-Monthly	17	20
Once a Year	11	13
Twice a Year	6	7
Total	**84**	**100**

Source: *Researchers Field Work, 2015*

Mode of Recreation?: The chart below explains that most of the respondents prefers the passive means of recreation with 57% while those that prefer the active form of recreation over the passive take the remaining 43% of the total. Little wonder Majority of the research areas provides only for the passive form of recreation.

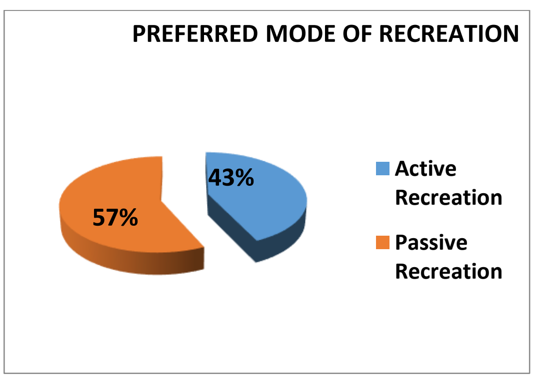


Fig6: *Showing Sex Frequency of preferred mode of Recreation*

Source: *Researchers Field Work, 2015*

Level of Satisfaction on the Recreational facilities Provided?: In addition to the stats explained above, the respondents were asked to rate their level of satisfaction on the facilities in terms of recreation provided in the research areas. As shown in the chart below, 50% of the respondents were not satisfied with the recreational facilities provided, 34% of them were satisfied with them while 16 of the respondents were indifference.

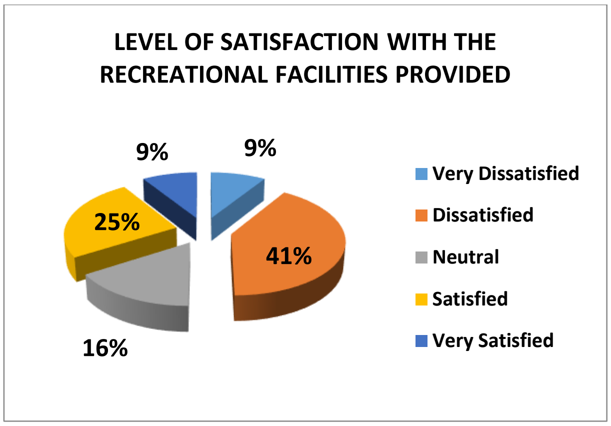


Fig7: *Showing level of Satisfaction with the Recreational facilities provided*

Source: *Researchers Field Work, 2015.*

Level of Satisfaction on the Position of the Recreational facilities Provided?: Similarly, the respondents also were asked to rate their level of satisfaction on the positioning of these recreational facilities that have been provided in the research areas. From the chart below, it can be seen that 23% of the respondents were not satisfied with the positions of the recreational facilities provided. While 22% of the respondents were indifferent, a whopping 55% of the respondents were satisfied with the positioning.

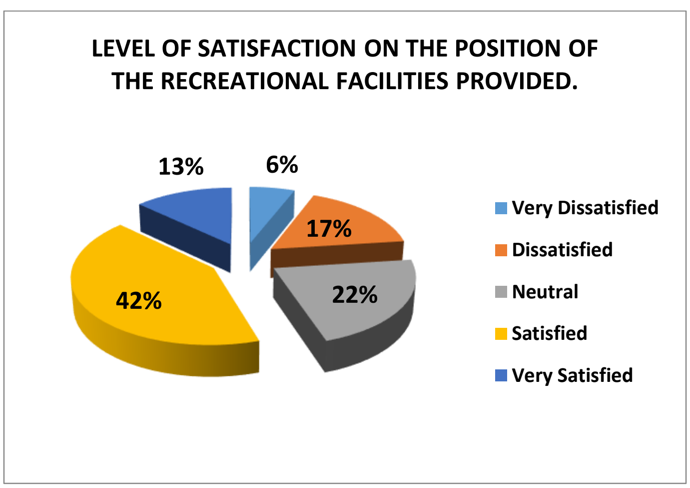


Fig8: *Showing level of Satisfaction with the positioning of the Recreational facilities provided*

Source: *Researchers Field Work, 2015*

4.2 Deductions

From the data presented in the tables and charts above, the following deductions can be made:

i. It is evident that most Hotels in Minna have generally neglected active recreation as only four hotels out of the selected twelve hotels have provided for one or two form of active recreation. That is only about 33% of selected hotels and about 8% of all the hotels in Minna.

ii. Also, as required by hotel users in Minna, most of the recreational spaces provided are passive. Although, it is observed that most of the passive recreational spaces provided are those generate more income to the hotel owners like the Restaurant, Conference halls, Bars, Lounges etc while the likes of Parks, Garden, Sit-out are less provided.

iii. In addition, it is also evident that the recreational space provided in these hotels do not satisfy the taste of it users in terms of equipments and machines as 41% of respondents express their dissatisfaction. Therefore more recreational facilities should be provided to serve it users

iv. It is also observed the most of the recreational spaces provided for are either outdoor for active recreation or separate building for the passive recreation. This is to aid users that visit the hotel only to recreate.

5. CONCLUSION AND RECOMMENDATIONS

This Research has been able to assess the recreation spaces (both active and passive) into their Hotel buildings. It is observed that active recreation were not integrated into most of the hotel buildings in Minna as only few hotels provides for active recreation. Hence, this paper concludes that hotels in Minna should strive to promote users comfort through the provision of adequate facilities and different forms of recreational activities especially the active recreation spaces.

In order to achieve this, the following suggestions are made;

i. A standard should be set for the hotels in terms of the recreational facilities to be provided in hotel buildings. This is to enable easy and adequately rating of hotels.

ii. Also, facilities such as recreational spaces should always be provided to meet to need of it users and comfort them. Therefore, the recreational spaces provided should be adequately equipped so that the spaces can be functional.

iii. The positions of these recreational activities should be easily accessible for both hotel users and other users.

6. REFERENCES

Akogun, J.F. {2006}. *Community Knowledge and Use of Existing Recreational Facilities in Bida, Niger State, Nigeria.* An Unpublished Master's Thesis, University of Ado-Ekiti, Ado- Ekiti, Nigeria.

Ayeni, O.O., Kufoniyi, O. and J.O. Akinyede (2003). "Towards a National Geospatial Information Policy for Nigeria", Proceeding of the Technical Session of the 38th

Annual General Conference and Meeting of Nigeria Institution of Surveyors, Lokoja, Kogi State, Nigeria, pp.21.
Baud-Bovy, M. and Lawson, F. (1998). *Tourism and Recreation: A Hand Book of Planning and Design.* England: Architectural Press.
Boniface, B.G. and Cooper, C.P. (1987). *The Geography of Travel and Tourism (4th ed.).*England: Heinemann.
California State Parks (2005). *The Health and Social Benefits of Recreation*. Sacramento, CA: California State Parks Planning Division.
Fadamiro, J.A. (2003). *Recreation and Parks Design*. Nigeria: Department of Architecture, Federal University of Technology, Akure, Nigeria.
Hamilton R (2000). “Hotels and Our Society: Classification and Types” Longman Press
Ibru G. M (2004). Nigerian: The promise of tourism. GSI published limited road, Lagos Nigeria.
McPeek, C., & Chee E. (2011). "*Physical Activity as a Luxury”:* African American Women’s Attitudes Toward Physical Activity. Retrieved: 4/10/2015 from http://wjn.sagepub.com/content/34/3/317
Murray M. & Benny C. (2009). "*Introduction to Hospitality”:* Tourism and Hospitality Studies.
National Bureau of Statistics (2011). Federal Republic of Nigeria 2006 Population Census. Retrieved:6/10/2015 from http://www.nigerianstat.gov.ng/nbsapps/connections/pop2006.pdf
Nigeria Tourism Development Corporation (1989). National Hotel Classification, Grading Exercise and Other Serviced Accommodations in Nigeria.
Oak, M. (2010). List of Different Recreational Activities. Retrieved: 26/10/2015 from http://www.buzzle.com/articles/list-of-different-recreational-activities.html
Queensland Government (2009), *‘‘*What is Outdoor Recreation*?"* Retrieved: 27/10/2015 from http://www.qorf.org.au/01_cms/details.asp?ID=686
Roberts, I. (2001). *Advanced Leisure and Recreation*. Oxford: Heinemann.
WTO Commission for Africa, 2003: Specific Program of Activities to Promote Tourism Development in Sub-Saharan Africa

THE IMPACT OF HOUSING TRANSFORMATION ON THE QUALITY OF THE ENVIRONMENT OF RESIDENTIAL BUILDINGS IN GOVERNMENT ESTATES IN SOUTH WESTERN NIGERIA.

Victor Olufemi Adegbehingbe,
Federal University of Technology, Akure, Nigeria

Housing transformation activities on the quality of environment of residential building has affected all factors of the built-environment and has elicited grave concern from the professional and non-professional alike. This paper examines and evaluates the impact of housing transformation activities on the Quality of Environment of residential buildings in three housing estates in South-Western Nigeria, were data were selected , with a view to identify the factors for the phenomenon, and examining the trend of the transformation . The use of questionnaire, personal interview of some design professional involved in the management of the selected study estates were carried out. Analysis were carried out through the use of simple frequency table and Chi-Square test. The study reveals that a large percentage (49.4%) indicated that transformers are enhancing the quality of the environment and also providing infrastructure to the neighborhood and provision of service area in the stud area. The study concluded that in reducing the need for housing transformation in the study estates design professional should rely on functional architectural design, provision of service areas within the estates are involvement of end users. Flexibility should be brought into design of residential buildings on government estates to accommodate extension as phase construction in order to meet future demands of owners. Findings revealed that housing transformation activities resulted into reduction in environmental qualities of the study estates and that the housing transformation activities results in both positive and negative impact and these were adequately appreciated and addressed. This paper recommendations include the improvement and enforcement of environmental protection laws, which are already in place, enforcement of planning laws, the need to increase the number of staff of the planning approval authority in the housing corporation responsible for the management of the estates under study, need to educate the occupants of the study estates on the negative influence of indiscriminate housing transformation on the quality of residential environment.

Keywords: Built-environment, environmental quality, Government Estates, housing transformation, residential building.

victoradegbehin22@gmail.com

voadegbehingbe@futa.edu.ng

Victor Olufemi Adegbehingbe (2016). **THE IMPACT OF HOUSING TRANSFORMATION ON THE QUALIT Y OF THE ENVIRONMENT OF RESIDENTIAL BUILDINGS IN GOVERNMENT ESTATES IN SOUTH W ESTERN NIGERIA** Sustainable Built Environment and Climate change; The challenges of Post 2015 Development Agenda. School of Environmental Technology Conference, SETIC, 2016

INTRODUCTION

Nigerian government at various levels could not meet the housing need of the people (Nigerian housing policy 2004). Even the few ones provided could not meet the expectation of the occupants (Tipple, 2004). Some facilities needed where not provided and some not needed were provided (FG, 2001, Olotuah, 2006). This has made the residential estates to be haphazardly developed to the detriment of the users (Agbola, 1998). This brought about unplanned environment, which made the resident estates physically and functionally not alien with the existing physical regulations. Furthermore, most of the physical transformation activities taking place on the residential estates were not officially approve by planning authorities. Thus, leading to continous destruction of unauthorized extensions by appropriate planning authorities. Lots of money earlier used in carrying out these physical transformation were lost (Nwuzi, 1995). Many of the transformed buildings were converted to various usages, such as hotel accommodation and guest houses, thereby attracting social and security problems to he studied estates. Makachia (2005) asserted in a study that the environment generated are often wanting in emerging space and land use conflicts.

The deficit in housing in Nigeria has driven many inhabitants in few states that provided formal housing estates to carryout housing transformation of their dwellings. According to Makachia (2005), housing transformation are understood as modifications, firstly, of the existing design product by the expansion of plinth area, addition of spaces laterally and vertically or by adding spatial units like rooms, alcoves, corridors, etc. Secondly, Makachia (2005) viewed housing transformation as quantitatively re-organizing the disposition of the provided spaces through relocating, resizing of opening space and/or the exterior environment. Housing transformations presume that the architect made no provision for the phenomenon at conception and design stage. Mai and Shubana (2006) reiterate that residential housing transformation is an 'inevitable response to changing needs occasioned by socio-economics of survival'. Tipple (1991) defines housing transformation as 'an alteration or extension involving construction activity and using materials and technology in use in the locality'.Shaban Sheuya (2004) remarks that: "The transformation of public owned housing creates some definitional problems. Before the government owned houses are transformed they are formal. After extensions have been made, they no longer conform to the building standards and regulations. At this stage, the houses comprise of an older part that is formal and the extensions or alterations that are informal. How do we then categorize this formal/informal hybrid in traditional settlements planning practice?.

In its own definition of what constitute informal settlements, the UNCHS (1996) put forward two principles, which are fundamental to the perception of informal settlements namely:

(1) That houses in question are either illegally built and

(2) Few services (roads, sewerage, water, storm water drainage, electricity and telephones) and few community/municipal facilities (clinics, schools), if any, are built in the immediate neighborhood.

Sheuya (2003) thereby highlights the issue of illegality as used in the UNCHS (1996) definition of informal settlements. To Sheuya, illegality must be further defined and this to him means:

"Without formal permission from the authorities or (and in many cases in addition) it sits on land, which has not been properly purchased through the normal system and zoned for residential development".

According to Cunningham, Popkin and Burt (2005), while the United States department of Housing and Urban development (HUD) determined in their transformation of the public housing system(in the HOPE VI program), the mixed-income housing and family's relocation was embarked upon. In this HUD's HOPE VI program, which included the "improving the living environment for residents of severely distressed public housing'' and '' provision of housing that will avoid or decrease the concentration of very low income families'' a definition of 'hard to house' group among the low income families was defined. Cunningham, Popkin and Burt (2005) report that the strict screening requirements (which was devoid of those with criminal background checks, drug test, or work requirements gave the 'hard to house' families as those such as grandparents caring for grandchildren, families with disabled members, very large households and multiple-barrier families coping with an array of difficult problems.

Mai and Shubana (2006) postulate that a major impact of globalization particularly in the third world cities like Abuja is the migration of skilled and unskilled labour to the urban centres. While Lo and Young (1998) were of the view that such globalization opens new markets at national and international level that further accelerated rural- urban migration, which compounds an acute accommodation shortage for the migrants. In meeting this enormous housing demand, ''a number of traditional dwellings have been transformed in many cities and peri-urban settlements with no exceptions'' (Mai, ibid).

Positive effects of Residential Housing Transformation

Wu (2003) postulates that the evolution of urban space has its historical continuity which means that the new layer is built upon the existing urban fabric. As a result, the urban space in post-reform China is composed by overlapped layers built in different historical periods. He believes that real estate development in China evolves through various objectives. From the overwhelming necessity to ease housing shortage, rather than the transition from a planned to market economy; or the drive by globalization and foreign investment, there has been a strong local dimension of real estate development. That China has a change in the real estate development have enormous implication for urban spatial structures. At same point in time in the China example, there were times when decline profit rate in the production sphere has driven both banks and enterprises to seek outlets for a higher profit in real estate (Wu, 2003). Wu further supports the positivism notion by asserting that "starting from power decentralization and redistribution of economic benefits, the process has been characterized by (1) some resources have been transferred outside of state control (where private and foreign investments emerged) and (2) some resources have been decentralized from the central to local governments.

For Chinese cities, Dowall (1994) remarks that the introduction of land prices would provide capital for relocation of factories and thus redevelopment of industrial land. Andrusz et al (1996) report on the changes in urban spaces in East European cities. Landman(2006) is of the opinion that due to the diverse needs of African cities, adoption of wide range of planning trends and design concepts from the international basket of concepts and approaches including the concepts of the compacts city, New Urbanism, Pragmatism, Decentralization and Priority Zones have emerged. These are incorporated within a combination of two competing approaches, namely a people-centred approach focused on developmental planning and a market-driven approach that focused on global competitive (Adebayo 2002, Farvacque-Vitkovic and Godin 1998). The African development process is taking the shapes of the development of a city form characterized by higher density inner city enclaves and lower density peripheral or satellite urban outposts (Jenkins and Wilkinson, 2002). In addition or the advantaged neighborhoods developed during the periods of colonization- where the shining neighbourhoods are characterized by well-developed spaces for the elites, protected by a range of electronics surveillance systems, gated fences and walls' which were privately developed infrastructures and services delivery systems(Jenkins and Wilkinson,2002).

As in the Gbagyi housing pattern in response to the influx of the urban poor migrants into the Nigerian Federal Capital, Abuja, housing transformation became an inevitable response to the changing needs occasioned by socio-economics of survival (Mai and Shamsuddin 2006). The four Gbagyi housing transformation themes – behavioural, spatial, cultural and socio-economic were manifested in one way or another in the last three decades (1976 – 2006).

According to Mai and Shamsuddin (2006), the Gbagyi examples were characterized by five kinds of transformations namely:

1. Conversion of reception to bedrooms for rent;
2 Conversion of rooms adjacent to streets to shops;
3 Extension of dwellings to meet increased family needs;
4 Modifications of spaces to cater for socio-cultural demands of privacy; and
5 Face lifting of dwelling as a status symbol.

Courtyard housing has survived transformation in the Gbagyi case, it simply indicates that the retention of core values were possible when peripheral values were lost to urbanization and acculturation (Rapoport, 1982).

Unlike the situation in Iran; Mirmoghtadaee (2009) reports that the physical characteristics of houses have been transformed profoundly. Inward-looking courtyard houses changed to outward-looking residential complexes with a shared courtyard…..the physical changes took place simultaneously with social transformations. Patri-archial extended families which were formerly the dominant household model in Iranian traditional society were replaced by independent nuclear families.

Thomson and Meijer (2007) are of the view that as in the case throughout Western Europe, the Dutch housing stock is ageing. After the unprecedented mass construction following World War II, the addition of new dwellings has dropped to less than one percent (1%) annually. Though the Dutch housing stock is still relatively young – over three quarter of the stock was produced in the about 50 years after W.W II and two-third in the past 30years. The ageing process is coming up. Based on the actual replacement rate of less than 0.25% annually, the minimum necessary life span of a dwelling has to be at least some 400 years''.

Based upon the Thomsen and Meije (2007) findings in Netherlands, the three major explanatory aspects of the problematic segments in the housing programmes were building quality/age, location and the owner's solvency. Jelili et al (2006) observe in Ogbomoso, Nigeria that these are the perceived advantages in redeveloped properties in the high-density areas of the city with the feeling that redevelopment usually goes with enhanced value and change of use. The residents perceived the redeveloped properties to have more significant socio-economic value. The aesthetic values of such redeveloped properties were also enhanced.

Negative Consequencies of Residential Housing Transformation

Jelili et al (2006) postulated that the perceived enhanced value brought by redevelopment in the studied area does not differ significantly among the high-density areas. To physical planners, this alone does not translate to viability and environmental sustainability of such redevelopment. Therefore, they are of the opinion that the increased density brought about by multistoried buildings and inadequate setbacks among other planning guidelines or development control standards and insufficient infrastructure in several locations of these redeveloped buildings may make them less suitable where they are located. However, inmost cases such developments are aberrations to physical planning interests. Jelili et al (2006) further remarked that the proportion of commercial properties that increased appreciably from 21.95% before redevelopment to 47.56% after redevelopment while residential use decreased from 31.7% to 28.05%. Besides this, Jelili et al (2006) also observed that there was incompatible use of redeveloped properties (usually turned to commercial uses). Furthermore there is the undesirable increasing density or land use intensity brought about by building on open spaces or redevelopment of bungalows and compound houses into multistoried buildings.

Mai and Shamsuddin(2006) believe that there is profound change in the way of life at Gbagyi, Abuja. Here mobile life of the city provides for impersonal contacts where respect for marriage is unsuitable to the social environment. A new kind of Gbagyi association is now formed, which is devoid of family lineage. It emphasizes camaraderie, mutual assistance and recreation (Mai and Shamsuddin, 2006). Due to culture change the Gbagyi custom of cooperation in tilling the soil as an obligation of kinship and marriage rather than wage earner/employer was severed. Moreover, marriage in Gbagyi culture was a collective family responsibility, but today it has become more of an individual arrangement between the prospective spouses, instead of their kinsmen providing the bride price that serves to cement family groups.

RESEARCH DESIGN

The study was carried out in the three oldest estates in three states out of the six states that made up of South –western Nigeria. The three states and housing estates are: Ijapo Estates, Akure, Ondo State, Old Bodija Estates in Ibadan, Oyo State and Ikeja GRA, in Lagos, Lagos State, using close ended questionnaire. The survey sought to identify factors responsible for physical transformation activities that were carried out by occupants of the study estates.

This was supported by preliminary site observation, and informal discussions with occupants of the residential buildings.

In the research, a total number of 474 questionnaires were retrieved and analysed in the study are. Among the variables examined are:

- Cost of transformation
- Duration of transformation
- Reaction to physical transformation activities in the neighbourhood
- Effect of physical transformation on the environment
- Mode of transformation
- Mode of constructions.

The population of this study was the household heads that transformed their buildings in the three study estates in Akure, Ibadan and Lagos.

Table 1 shows the percentage of distribution of questionnaires in the study areas.

S/NO	Housing Estate	Town/State	No of Respondent Retrieved and Analysed
1	Ikeja Housing Estate	Ikeja, Lagos State	133
2	Old Bodija Housing Estate	Ibadan, Oyo State	201
3	Ijapo Housing Estate	Akure, Ondo State	140
	Total		474

Source: Adegbehingbe, 2011

The numbers of questionnaire administered on transformed buildings were presented in table 1.

Figure 1: Map of South-West-Nigeria showing States where study areas are located.

RESEARCH METHOD

Simple random sampling was used to select houses and streets in the selected housing estates. Systematic sampling was employed to select the household heads that were interviewed on selected streets. Data for the research were collected with the use of interview schedules, observations and structured questionnaires administered on 474 transformers and 87 design professionals. Analyses were carried out through the use of simple frequency tables and chi-square test. For statistical analysis, this study primarily relied on the data collected on a recently completed Ph.D research on "The Analysis of Physical Transformation of Residential Buildings in Government Estates in South-Western Nigeria."

Three housing estates namely Ikeja Government Reservation Area (GRA), Lagos, Old Bodija Housing Estate, Ibadan and Ijapo Housing Estate, Akure are the estates studied, in which 474 households that transformed their buildings were interviewed. This is made up of Ikeja GRA (133), old Bodija (201) and Ijapo (140). Design Professionals (87) in charge of the management of the study estates were also interviewed.

FINDINGS AND DISCUSSION OF RESULTS

Housing Transformation Activities on quality of the residential environment

On whether housing transformers are enhancing the quality of the environment and also providing infrastructure to the neighborhood, a very large percentage (49.4%) indicated that transformers are providing these. This is an indication that infrastructure were not provided initially on the study estate. The Home based enterprises (HBE) in the study area are provision shops and hairdressing / barbing shops(31.6%). These imply that there is no provision of service areas in the study area. Apart from residential purpose, the most common use for transformed building is office accommodation (47.7%) while frontage rooms are the most common external area affected by transformation (58.9%) and wall partitioning are the most common internal area affected by transformation (92.2%) while area gained through transformation are between 31 and 40 sq meter.

On the issue of problems encountered during transformation process, thus enhancing the quality of the residential environment , 39.7% were of the opinion that the delay of approval of drawings while 20.7% ,said lack of cash flow were most prominent during transformation process. Major reasons why occupants embarked on physical transformation are to generate more income for the family (41.6%), provide comfortable conditions, safety and security elements that were lacking in the buildings.

The study reveals that majority of cost of transformation were either less than N250,000 or above One million Naira (Nigerian Currency), and majority of transformation took less than one year to complete. Majority of respondents in the study estates agreed that physical transformation activities were providing infrastructures which government could not provide. Old Bodija record 43.8%, Ikeja 46.6% and Ijapo 60%. While a lot of respondents were indifference to these activities in their neighbourhoods, Old Bodija record (49.0%), Ijapo (32.3%) and Ijapo (32.9%) respectively.

Majority of residents in Old Bodija were of the opinion that the physical transformation activities were of no effect on the quality of environment with 37.8% rated the effect to be middle. The majority of respondents in Ikeja and Ijapo estates graded the effect to be middle. This confirm Falade's (1988) assertion that there is the need for adequate knowledge of the concept of effective environmental management in a community for such study.

Physical Status of Transformed Buildings-enhancing positive effect on quality of residential environment.

The variables examined included: the age of transformed buildings, transformed spaces, home based enterprises (HBES), Uses for transformed buildings and external area affected by transformation.

Age of Transformed Building

The frequency distribution presented in Table 1.0 indicated that about 88.5% of the buildings transformed are below 30 years old and 19.6% are below 10years . 44.7% of the transformed buildings are between 10-20 years and 24.2% are between 21-30 years. This indicated that buildings below 10 years will not be spurred by dilapidation, thus enhancing positive effect on quality of residential environment, while those between 21-30 years had earlier been transformed. Those between 10-20 years are in higher number since they were being transformed for the first time. Table 2.0 further revealed that building transformation is best carried out where such structures are between 10 and 30 years of age. While old buildings (31 years and above) had been remodeled earlier on, the newer buildings (10 years and below) may also need some remodeling. Analysis of Variance (ANOVA) however showed that the distribution of transformed building into age classes differed significantly across the study area ($P<0.05$).

Table 1.0 : Age of Transformed building

Building Age	Transformers	
	Frequency	% of respondents
Below 10yrs	89	19.6
10 -20yrs	203	44.7
21 - 30yrs	110	24.2
31 - 40yrs	32	7.0
41 - 50yrs	8	1.8
Above 50yrs	32	2.7
Total	474	100

Source: Adegbehingbe (2011)

From the mean separation using Duncan multiple range test (DMRT) presented in Table 2.0., building age class 10- 20 years was quite distinct from every other class but there were some measure of similarities between below 10 and 10-20 years age classes, together with 41-50 years and 50 years and above building age classes.

Table 2.0 : Mean Separation for respondents distribution to the age of transformed buildings

Building age	Mean of % respondents ± SE
Below 10	20.50 ± 6.29^{a}
10 - 20 years	47.50 ± 4.8^{c}
21 - 30years	21.23 ± 7.29^{a}
31 - 40years	6.96 ± 3.53^{ab}
41 - 50years	1.76 ± 1.11^{b}
Above 50years	2.10 ± 1.72^{b}

Means sharing the same superscript in column are not significant

Data on transformed Spaces

This study analysed the data on space added to each transformed building after moving into the building, thus enhancing the quality of the environment. Table 3.0 indicated that most transformed spaces are the living rooms and dining area (32.7%). This is followed by the living, dinning, kitchen, garages and stores/ shop (24.05%). This demonstrated that transformers responded to the inadequacies of the original design.

Table 3.0 : Transformed Spaces

Transformed Spaces	Transformers	
	Frequency	% of respondents
Living room and dining room	155	32.70
Living room, dining room and kitchen	54	11.39
Living, dinning, children, guest room and kitchen	42	8.86
Living, dinning, kitchen a Garages	42	8.86
Living, dinning, kitchen, Garages & stores / shop	114	24.05
Others	71	14.9
Total	474	100

Source: Adegbehingbe (2011)

Effect of Physical Transformation Activities on the Environment

The researcher observed that a lot of transformation activities took place or were taking place during the survey. The respondents were asked to grade the effects of these activities on the environment on their neighbourhood. The responses obtained were compared with other estate. Majority of the respondents in ikeja and Ijapo estates grade the effect to be middle, (Ikeja 40.6%, Ijapo 48.6%). The table below shows the results of the majority of those residing in Old Bodija are of opinion that the physical transformation activities are of no effect on the environment (37.8%) while substantial grade the effect as middle (37%). This confirms Falade's (1998) assertion that, there is need for adequate knowledge of the concept of effective environment management in a community for such studies.

Table 4: effect on Environment

S/N	**Effect on Environment**	**Ikeja**		**Old Bodija**		**Ijapo**	
		Freq	%	Freq	%	Freq	%
1	None	15	11.3	76	37.8	38	27.1
2	Low	23	17.3	13	6.5	24	17.1
3	Middle	54	40.6	75	37.3	68	48.6
4	High	4.1	30.8	37	18.4	10	7.1
	Total	133	100	201	100	140	100

Source: Adegbehingbe, 2011

Home Based Enterprises

On the issue of the home based enterprises, Table 5.0 shows that the provision shop, hair dressing and barbing salon (31.6%) were the most frequently provided home based enterprises in their residential buildings. Substantial occupants (20.3%) are engaged in other Home Based Enterprises (HBE) that cannot be classified. These indicated that the common enterprises engaged by transformers are those that will enable neighbours to purchase home needs and those providing employments opportunity . This indicated that these studied estates required some service delivery enterprises, thus confirming Arimah (1999), Tipple (2000), Sheuya (2004) and Mai (2006).

Table 5.0: Home Based Enterprises

Home Based Enterprises	Transformers	
	Frequency	% of respondents
Provision shop and hair dressing/ barbing shop	150	31.6
Provision shop, hairdressing / barbing shop & livestock keeping	83	17.5
Provision, Hairdressing/barbing shop & livestock keeping & tailoring	22	4.6
Provision shop/pertinent medicine store, stationeries / barbing shop	57	12.0
Shop, stationeries / photocopies and restaurant	66	13.9
Others	96	20.3
Total	474	100

Source: Adegbehingbe (2011)

Other uses for Transformed Building

Apart from residential purposes, further analysis of frequency as shown in Table 6.0, indicated that majority of other uses of transformed building (47.7%) are for office accommodation, followed by shopping complex (11.0%) This indicated inadequacy of the layout plan of the study estates. Table 7.0 presented the result of the Analysis of Variance on the respondents‘ view to others uses for which buildings were transformed while Table 8.0 presented the follow-up test using Duncan Multiple Range Test (DMRT). It was shown that there is significant difference (P<0.05) in the respondents‘ view to uses in which transformed buildings within the studied estates are being put into.

Table 6.0 : Other uses for Transformed building

Other uses for transformed Building	Transformers	
	Frequency	% of respondents
Office Accommodation	226	47.7
Warehouse	27	5.7
Place of worship	41	8.6
School accommodation	33	7.0
Hotel accommodation	24	5.1
Shopping	52	11.0
Worship	25	5.3
Total	474	100

Source: Adegbehingbe (2011)

Table 7.0 : ANOVA for the respondents' view to other uses for transformed buildings

Source of Variation	Sum of Squares	df	Mean Square	F	Sig.
Building uses	3676.712	7	525.245	13.057	0.000
Error	643.647	16	40.228		
Total	4320.358	23			

External Area Affected by Transformation

The study analysed the external area affected through transformation. The Table 9 highlighted that the frontage rooms (58.9%) and the backyard rooms (18.1%) were the main external areas affected by transformation, thus enhancing the quality of residential environment. The original houses provided in the study areas are of low standard design. However one of the most interesting features arising out of this study was that transformers were able to produce various designs out of the original uniform design and the frontage rooms are mostly affected, thus enhancing the quality of the residential environment. The respondents that transformed their buildings have superimposed a variety of house size upon these more or less uniform cancas. The result of the one way ANOVA for respondents view to external transformation presented in Table 10 shows that the distribution of respondents to the type of external areas affected through transformation differed significantly (P<0.05) in the study area. From Table 11 showing the follow-up test using Duncan Multiple Range Test (DMRT), respondents' distributions to each of frontage rooms and backyard room were distinct from other external areas while their distributions to others were not significantly different.

Table 9 : External Affected by transformation

External Area	Transformers	
	Frequency	% of respondents
Frontage rooms	279	58.9
Backyard rooms	86	18.1
Side rooms	36	7.6
Upper floor room	22	4.6
Frontage roof / floor	29	6.1
Others	22	4.6
Total	474	100

Source: Adegbehingbe (2011)

Table 10: ANOVA for the respondents' view to the external areas affected by transformation

Source of Variation	Sum of	df	Mean	F	Sig.
External Area	7167.236	5	1433.447	52.437	0.00 0
Error	328.040	12	27.337		
Total	7495.276	17			

Source: Adegbehingbe (2011)

Table 11: Follow-up test (DMRT) for respondents' view to the external areas affected by transformation

Type of external areas	Mean ± SE of % respondents
Frontage room	59.86 ± 4.09^{a}
Backyard room	18.70 ± 3.88^{b}
Side room	7.40 ± 2.25^{c}
Upper floor room	4.30 ± 1.62^{c}
Frontage room/floor	5.93 ± 2.31^{c}
Others	3.83 ± 3.11^{c}

Means sharing the same superscript in column are not significant

RECOMMENDATIONS AND CONCLUSION

Residential buildings in government estates in Nigeria are often transformed by addition of structures or modification of existing spaces since these buildings do not in most cases conform with the expectations of occupants. Residential buildings were often built without consultations with the end – users who usually indulge in transforming their houses(Adegbehingbe2011). This study carried out the analysis of physical housing transformation of residential buildings in selected government estates in south-western, Nigeria in which the socio-economic characteristics of occupants that transformed their buildings were compared with those that did not transform(Adegbehingbe & Fadamiro 2007) . It analysed factors that influence user's decision to transform occupied buildings in the study areas. It examines physical status of transformed building and compared transformation activities and process in the studied areas. It examines how to reduce the need for housing transformation by addressing the causative agents.

It has been established that original owners of the buildings who are civil servants were being displaced by those who were self employed and had access to more fund and even purchased the buildings. The study has been able to established that sex has no effect on building transformation but marital status has great influence; this study has clearly shown that occupants of the residential buildings transformed their houses mainly to provide comfortable conditions safety and security elements that were lacking in the buildings.

Lack of provision of service areas within the study area is evident from this study and it accounts for numerous home-based enterprises in the study area.

Furthermore, it was observed that transformed building was being used for purposes other than residential. These transformed buildings were used for other purposes due to non-functional architectural designs and inadequacies noted in layout plans.

The occupants of the three study estates, identified the same reason for transforming their building, which is to generate more income, increase in family size and satisfying shopping needs. Most of these reasons can be eliminated to a certain extend by involving end users, functional architectural design and provision of service areas within the study areas.

Occupants of residential buildings transformed their buildings due to inadequacy in the design of the original building on the study area, and no cases of abandoned transformed buildings due to the fact that the transformers usually made sure that they have access to enough fund before embarking on transformation of their buildings. The study concluded that in reducing the need for housing transformation in the study estates, design professionals will rely on functional architectural design, provision of service areas within the estates, and involvement of end users.

Flexibility should be brought into design of residential building on government estates to accommodate extension as phase construction in order to meet the future demand of owners.

Due to non-approval of application for alternation and extension on time, transformer usually embarked on unguided transformation. This will be drastically reduced if approval can be communicated within a practicable time limit and this will also avoid undue transformation.

No doubt the policy recommendations will go a long way in ensuring proper, guided physical housing transformation in the three study areas, in Nigeria and developing countries in general.

REFERENCES

Adebayo A. (2002). Viewpoint *cities* 19(5) 351-355

Adegbehingbe. V.O (2011). Analysis of Physical Transformation of Residential Building in selected Government Estates in South Western, Nigeria. Unpublished Ph.D Thesis, Federal University of Technology, Akure. Nigeria. 145-154.

Adegbehingbe, V.O &Fadamiro, J.A. (2006). Sustainability of built environment on Nigeria: self-help transformation of public housing option. *A Conference Proceedings of International Conference in the Built Environment in the 21st Century (ICIBE 2007) Kuala Lumpur*, Malaysia, 13-15 June.

Adegbehingbe, V.O. Fadamiro J.A & Ogunsote O.O (2010). *Reducing the need for HousingTransformation in South-Western, Nigeria by Addressing the Causative Agent*. Preceedings of the 1st International Conference, School of Environmental Technology, The Federal University of Technology, Akure, Nigeria, 25-27 October.

Andrusz G. (1996). *Structural Change and Boundary Instability*. Fn Andrusz .G, Harloe M & Szeleny I (eds) Cities After Socialization. Urban and Regional Change and Conflict in Post Socialist Societies.

Cheema, R (2008). *Transforming Lagos into Africa's Models Megacity*. Eko Hotels and Suites, Victoria Island Lagos.

Dowell, D.E. (1994) Urban Residential Redevelopment in the People's Republic of China. Urban Studies, 31 (9) 1497-1516.

Farvacque, V. C & Godin L. (1998). *The Future of African cities*: *challenges and priorities for urban development*. The world bank: Washington D.C.

Jellili, M.O & Adedibu A.A (2006). Land Use Classification and Informal Sector Question in Ogbomosho, Nigeria. Journal of Human Ecology 20(4) 283-387.

Jenkins P. &Wikinson P (2002). "Assessing the growth impact of the global economy on urban development in Southern African cities: Case studies in Maputo and Cape town *in cities* 11(1) 33-47.

Landman, Karima (2006). Socio-Spatial transformation in Africa. A framework to map the process and guide the planning of future cities. Paper delivered at the conference *planning Africa 2006* – Capetown, 22-24 March.

Lo, F & Young Y. (1998*). Globalisation and the world of large cities*, New York, NY, United Nations Publications.

Mai, M. M.(2006). *Transformation of Vernacular Housing Pattern in Peri-Urban Abuja-Nigeria due to informal Urbanism, 1976-2006.*'Unpublished PhD thesis, Universiti Teknologi, Malaysia.

Mai, M. M & Shubana S. (2006).Urbanisation and globalization of Gbagyi Housing transformation *Faculty of Built environment, University Teknologi Malaysia Malaysia.*

Makachia P.A,(2005) Influence of house form on dweller- initiated transformation in urban housing.IAHS World congress on housing, 33rd, Pretoria, South Africa.

Mirmoghtadace, Mahta (2009). Process of Housing Transformation in Iran.*Journal of Construction in Developing countries* vol. 14, No 1. Pp 69-80.

Morah, E.U (1993). Why Nigeria obtained the new capital that it did. An analysis of officials disposition in housing development *International review of Administrative Science* (59) 251-275

Mosha, A.C (2001). Africa's future, *Forum for Applied Research and Public Policy*.Summer. 28-33.

Popkin Susan, Cunningham Mary I.C and Burt Martha (2006). *Public Housing Transformation and the Hard to House, Housing Policy Debate*, 16(4).

Rapoport, A. (1982). *The Meaning of the Built Environment. A nonverbal communication approach.* Bevery Hills, Sage.

Sheuya, S.A. (2004*). Housing Transformations and Urban Livelihoods in informal Settlement*.The Case of Daresalam, Tanzania.*SPRING Research Series*. No 45, Dortmund, 34-75.

Thompson, A & Meijer F (2007). *Sustainable Housing Transformation Quality and Improvement Strategies of Ageing Private Housing Stock in the Netherlands*. A Paper presented at the ENHR international conference on sustainable regeneration and maintenance (20) 25-28.

Tipple, A.G. (1991).*Self Help Transformation in Low Cost Housing*.*An Introductory Study*. CARDO in Association with the International Urban Press, Newcastle Upon Tyne.55-76.

Tipple, A.G. (2000). *Extending Themselves: User Initiated Transformation of Government built housing in developing Countries* Liver pool University Press, Liverpool.20-48.

United National Centre for Human Settlements (1996). An urbanizing world: global report on human settlements. Oxford university Press, Nairobi.

Wu fulong, (2003). Globalisation, Place Promotion and Urban Development in Shangari *Journal of Urban Affairs 25(1)55-78.*

ASSESSMENT OF NEIGHBOURHOOD INFRASTRUCTURE CONDITIONS IN MINNA, NIGERIA

Popoola, Naomi Ijadunola
Department of Estate Management and Valuation Federal University of Technology, Minna,

Infrastructure provision is very vital in the overall development of any society; yet it remains a major challenge confronting many cities. Its availability in term of quantity and quality is an important yardstick in the assessment of the quality of the environment. Infrastructure in the context of this study is the physical infrastructure which are the general neighbourhood facilities supporting the existing houses. Hence this study assessed the conditions of infrastructure within the Peripheral residential neighbourhoods in Minna, Nigeria. Data for the study were sought from both primary and secondary sources. A sample size of 600 was drawn out of the total 18, 387 households in the sampled neighbourhoods using estimation method. Estimation rate of 50% and precision range of ±4 were adopted in determining the sample size. Systematic random sampling method was adopted in the administration of the questionnaires while infrastructure conditions were assessed using eleven (11) variables which were rated on 5 point likert scale and summed up to determine the 'perfect condition' score. A summation of all scores by a particular neighbourhood was divided by the perfect condition score, to determine infrastructure quality index number. The rating scale ranges from 0 -1 (Very Poor= 0.00-0.19; Poor 0.20-0.49; Fair 0.50-0.74; Good 0.75-0.94 and Excellent= 0.95-1.00). Quantitative and descriptive methods were used in analyzing data. Results of analysis revealed that infrastructure conditions in the neighbourhoods are fair; with infrastructure indices ranging from 0.52 to 0.65. This implies that, infrastructure provided within the sampled residential neighbourhoods are not adequately meeting the household present demands due to their deplorable conditions. The study recommended government and community interventions in the refurbishing and provisions of necessary infrastructure needed to support development and for the enhancement of quality environment.

***Keywords**: Environmental Quality, Infrastructure Condition And Peri-Urban Neighbourhoods.*

naomipopoola@futminna.edu.ng
naomi.popoola@yahooo.com

POPOOLA, NAOMI IJADUNOLA (2016). **ASSESSMENT OF NEIGHBOURHOOD INFRASTRUCTURE CONDITIONS IN MINNA, NIGERIA** Sustainable Built Environment and Climate change; The challenges of Post 2015 Development Agenda. School of Environmental Technology Conference, SETIC, 2016

INTRODUCTION

The presence and quality of infrastructure is now widely appreciated by the government and populace due to the challenges of unprecedented rates of urbanization. Even though many studies have highlighted the importance of infrastructure for growth and development, many of the developing worlds are still plagued by deteriorating and inadequate infrastructure (Holly, 2014). Infrastructure is important in the improvement of living standards of citizens and in the attainment of a well functioning economy (Arunma, 2010).

Availability of infrastructure is important and of equal importance is also the adequacy of the infrastructure provided. Adequate infrastructure in term of quantity and quality for urban needs helps in prolonging the useful life of the infrastructure and enhances environmental quality. Jacoby (2000) observed that infrastructure increases assets values. This encourages investment due to increase in initial capital invested. Quality infrastructure ensures the delivery of goods and services that promote economic growth and contribute to quality of life, including social well-being, health and safety, and the sustainable conservation of the environment (Holly, 2014). The availability of infrastructure facilities is therefore very critical to the economic, industrial, technological and social development of any country (Arunma, 2010).

However, access to infrastructural facilities is relatively very low most especially in the developing countries (Holly, 2014). Nigeria is not exempted from these problems of infrastructure availability and adequacy. Otegbulu (2014) rightly observed that infrastructure provision and quality have remained a major challenge and as a result, there has been a general public outcry over the poor conditions of the urban infrastructure in Nigeria. This has been attributed to high cost of providing urban infrastructure, inadequate budgeting by the government, poor national maintenance policy, undue political interference, public attitude to urban infrastructure, unwillingness of government to liberalize policies towards urban infrastructural services, corruption in the public sector of the economy and poor conditions of services in the public services (Iseh, 2003; Udoka, 2013).

UN-Habitat (2003) observed that cities attract new migrants each year who, together with the increasing native population, will continue to compound the problems of urban congestion and hampering of local authorities attempts to improving basic infrastructure and delivery of essential services. Minna the capital of Niger State is experiencing growth that is unplanned and uncontrolled, most especially at the peripherals. The most visible evidence of this development is the large and rapidly growing informal and squatter settlements at the peripheral areas without increase in the provision of supporting infrastructure such as roads, security, water supply and waste disposal facilities amongst others.

This study assessed the conditions of infrastructure within the Peripheral residential neighbourhoods in Minna, Nigeria. This knowledge will help planners in decisions relating to planning, development and management of urban fringes.

Concept of infrastructure

There is no standard definition of infrastructure across economic studies (Gianpiero, 2009). It was viewed in the World Development Report, (1994) as an umbrella term for many activities referred to as "*social overhead capital*". The report viewed infrastructure as including services from public utilities, public works and transport sectors such as power, telecommunications, piped water supply, sanitation and sewerage, solid waste collection and disposal, and piped gas, roads and major dam and canal works for irrigation and drainage, urban and interurban railways, urban transport, ports and waterways and airports (World Bank, 1994). Infrastructure is defined as the physical framework of facilities through which goods and services are provided to the public (Deepika, 2002). Infrastructure is a heterogeneous term and it includes physical structures of various types used by many industries as inputs to the production of goods and services (Chan, Forwood, Roper, and Sayers, 2009). This description encompasses social infrastructure (schools and hospitals) and economic infrastructure (network utilities such as energy, water, transport and digital communications (Stewart, 2010).

Presence of infrastructure is a major determinant of economic growth while lack of it hinders sustainable growth and poverty reduction (Sahoo, Dash and Nataraj, 2010). Infrastructure can deliver major benefits in economic growth, poverty alleviation, and environmental sustainability, but only when it provides services that respond to effective demand and does so efficiently (World Bank, 1994). The role of infrastructure in economic development has been well explored and documented in literature (Jacoby, 2000; Deepika, 2002; Sahoo and Dash, 2009). However, the challenges of providing adequate infrastructure to cater for the needs of the teeming urban populace remains evident across the globe, most especially in developing countries. This probably is due to the fact that, Infrastructure provision is dominated by the public sector and requires huge capital investments. This makes it difficult for planners to match the availability of supply of infrastructure with demand at all times (World Bank, 1994).

Infrastructure is an indispensable asset in nation's integration and development. Its adequacies in term of quantity and quality are an important yardstick in the assessment of the quality of the environment. There is therefore the need to give it utmost attention in urban planning and management for the achievement of sustainable living and working environment.

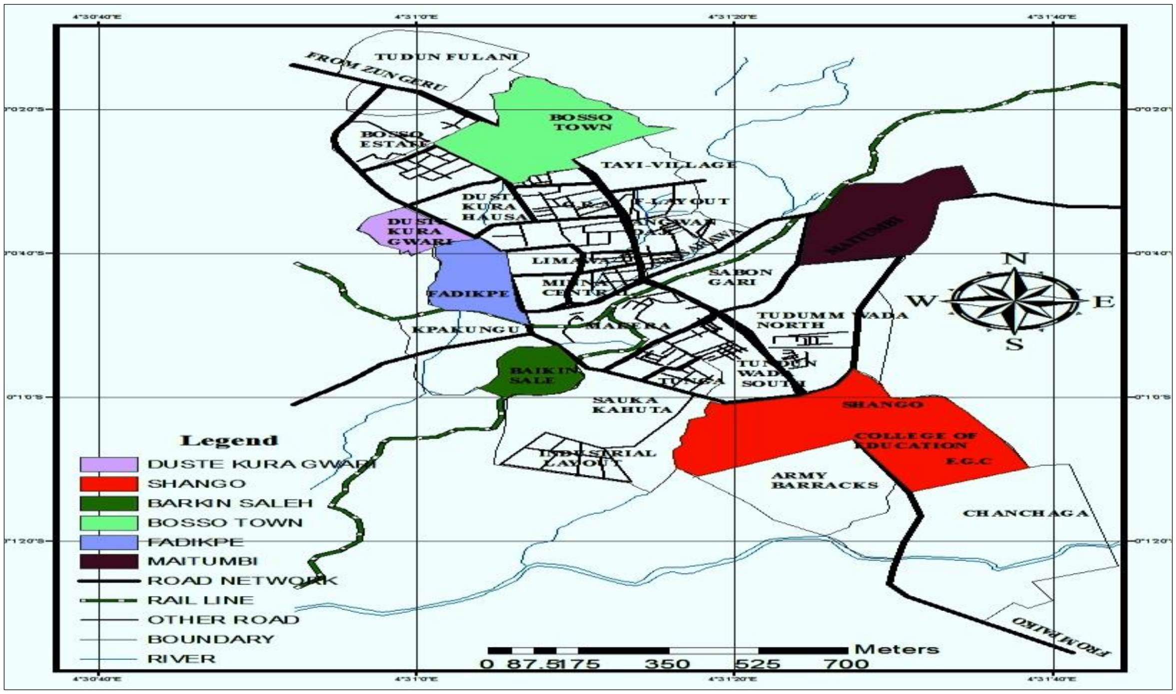


Figure 3. Delineated Boundaries of Sampled Neighbourhoods.
Source: Adapted from Minna Street Map, 2014

Methodology

Cluster sampling technique was adopted in the section of sample areas for the study. The peripheral residential neighbourhoods were zoned into three namely; South-West peripheral, North-West peripheral and North-East peripheral zones with each zone representing a cluster. Two neighbourhoods were randomly selected within each cluster (zone) to ensure equal representation from each zone. The selected neighbourhoods formed the sample areas for this study and they include Barkin-Sale and Shango from the South-Western zone while Fadikpe and Dutsen-kura (Gwari) were selected in the North-Western zone and the North-Eastern zone has Bosso and Maitumbi. A sample size of 600 was drawn out of the total 18,387 households in the sampled neighbourhoods using Adams *et al.*(2007) simplified formula;

$$n_0 = Z^2_{\alpha/2} \times \frac{P(1 - P)}{d^2}$$

Where:

N= population size (18387)

n_0= sample size

Z = standardized normal value (1.96)

α =level of significance (95%)

p = estimate rate expressed as decimal (50% = 0.5)

d = precision range expressed as decimal

Estimation rate and precision range of 50% and ±4 respectively were adopted in determining the sample size. The sample size was distributed proportionally amongst selected neighbourhoods while systematic random sampling technique was adopted in the administration of copies of questionnaire.

infrastructure conditions were assessed using eleven (11) variables; namely, Water sources, frequency of water supply, power sources, drainage type, drainage conditions, condition of access road, waste disposal system, sewage disposal methods, general sanitary conditions and neighbourhood security (Table 1). Variables used were rated on 5 point likert scale and summed up to determine the 'perfect condition' score. A summation of all scores by a particular neighbourhood was divided by the total possible score, that is, the "perfect score" to get the infrastructure quality index number. AAPPA- Australian Association of Higher Education Facilities Officers, (2000) condition rating was adopted in rating conditions of infrastructure. The rating scale ranges from 0 -1 (Very Poor= 0.00-0.19; Poor 0.20-0.49; Fair 0.50-0.74; Good 0.75-0.94 and Excellent= 0.95-1.00). Data analysis was conducted using descriptive (mean; percentages) while results were presented using tables and figures.

Table 1: Variables used in Infrastructure Condition rating and assessment

S/N	**Facilities/ Component**	**Type/ Weight (Rating)**					**Remark**
		5	**4**	**3**	**2**	**1**	
1	**Water source**	Pipe borne	Borehole	Well	Stream	Canal	
2	**Water frequency**	Excellent	Good	Fair	Poor	V. Poor	***EA***
3	**Power source**	PHCN	Inverter	Generator	Lamp	Candle	
4	**Power frequency**	Excellent	Good	Fair	Poor	V. Poor	***EA***
5	**Drainage type**	Precast (covered)	Precast-uncovered	Plastered block	Unplaster block	Open gutter	
6	**Drainage condition**	Excellent	Good	Fair	Poor	V. Poor	***EA***
7	**Access road condition**	Excellent	Good	Fair	Poor	V. Poor	***EA***
8	**Waste disposal method**	Excellent	Good	Fair	Poor	V. Poor	***EA***
9	**Sewage disposal**	Excellent	Good	Fair	Poor	V. Poor	***EA***
10	**Security**	Excellent	Good	Fair	Poor	V. Poor	***EA***
11	**General sanitary condition of neighbourhood**	Excellent	Good	Fair	Poor	V. Poor	***EA***

*NB: Expertise Assessment (EA)

Source: Author, 2014

4.0 Results of Findings and Analysis

4.1. Infrastructure Conditions Assessment in the Sampled Peri-urban Neighborhoods.

Physical observation during field work revealed availability of basic infrastructure, though some are in deplorable conditions. Conditions of infrastructure examined are summarized below:

1.Water supply :Major source of water is the public mains of which water supply not frequent and has failed completely in some neighbourhoods due to broken and obsolete pipes. However not all houses are connected to the water mains due to high cost of connection and irregularity in water supply. Majority of houses in Bosso and Maitumbi are not connected to public water mains (2.87 and 2.62 respectively), residents of the neighbourhoods relied more on secondary sources of water such as; borehole, well or employ the services of water vendors (Table 2).

2. Power source: major source of electricity is from the nation's power grid. Majority of the houses in the selected neighbourhoods are connected to the power grid but power supply has been very irregular. This condition is more evidence in Shango, Bosso and Maitumbi with condition mean scores of 2.78, 2.92 and 2.87 respectively. This made some houses resort to the use of alternative sources of power such as power generator set, rechargeable lamp, candle and lantern.

3. Drainage: not all neighbourhoods are provided with drainage. Mean scores for drainages ranges between 1.27 and 1.76 across sampled neighbourhoods. However, some major roads in Bosso neighbourhood have very good precast drainages; though some are blocked with waste deposition. Where drainages are not available, residents employ open gutter in disposing waste water (Plate I and II). These made the drainage conditions to rate very poorly on the assessment scale (Table 2).

Plate I: waste deposit in drainage in Barkin Sale, Minna.
Source: Author, 2016

Plate II: Open gutter in Maitumbi, Minna.
Source: Author, 2014

4. Access road: Access road conditions were poor across neighbourhoods with mean scores of between 2.04 and 2.57. Most access roads within neighbourhoods are untarred and washed-off in some cases. Access roads within neighbourhoods are in deplorable conditions across the sampled neighbourhoods and worse in Maitumbi (Table 2).

5. Waste disposal: Waste within neighbourhoods was disposed by government or private operatives for a fee. However, some waste bins are seen filled and littering the environment due to delay in evacuating wastes by government and private operatives. Waste disposal methods was generally poor across neighbourhoods (2.00 -2.57). Some residents dispose their waste in uncompleted buildings or in water canals which has great implications on health and general conditions of the environment.

A

B

Plate III (a & b): Waste deposited in an uncompleted building & Drainage in Barkin-sale, Minna
Source: Author, 2016.

6. Sewage disposal: mode of sewage disposal rated fair on the assessment scale in Dutsen-kura and Fadikpe neighbourhoods (3.11 and 3.47 respectively). These two neighbourhoods depended more on government evacuation vehicles while the other four neighbourhoods employed some other means such as disposing directly within neighbourhoods (Table 2).

7. Neighborhood security: all the sampled neighbourhoods have at least one (1) Police out-post, though not evenly distributed within the neighbourhood. In order to support the efforts of the government in providing security in the neighbourhoods, residents employed services of private/ local guards and dogs amongst others. However, security breaches were high in Bosso, Barkin-sale and Shango with mean scores of 2.69, 2.93 and 2.98 respectively (Table 2).

8. General Sanitary Condition: the overall environmental conditions of Dutsen-kura and Fadikpe rated fairly on the assessment scale (3.26 and 3.37 respectively). General condition of the environment in the other neighbourhoods rated poor 2.43 – 2.83). The environmental condition as observed in the neighbourhoods has implications on health, housing quality and value.

Table 2: Mean Scores and Index for Infrastructure Condition Rating in Minna Peri-Urban Neighbourhoods

S/N	Neighbourhoods	N	WS	WF	PS	PF	DG	DG.C	AC.C	WD	SWG	STY	GNS	INDEX
1	**Dutsen-kura**	**47**	3.62	3.00	4.87	3.36	1.64	2.52	2.19	2.57	3.11	3.26	3.19	**0.61**
2	**Fadikpe**	**30**	4.07	3.43	4.90	3.17	1.73	2.83	2.57	2.57	3.47	3.37	3.47	**0.65**
3	**Barkin-sale**	**42**	3.57	3.33	5.00	3.29	1.76	2.60	2.19	2.48	2.86	2.93	2.86	**0.60**
4	**Shango**	**45**	3.96	3.11	4.98	2.78	1.27	2.27	2.04	2.00	2.47	2.98	2.82	**0.56**
5	**Bosso**	**310**	2.87	2.76	4.90	2.92	1.48	1.95	2.21	2.00	2.37	2.69	2.43	**0.52**
6	**Maitumbi**	**126**	2.62	2.94	4.99	2.87	1.45	2.30	2.33	2.42	2.69	3.03	2.53	**0.55**
	TOTAL	**600**										**Average Index**		**0.58**

NB: WS=water source, WF=water frequency, PS=power source, DG=drainage type, DG.C=drainage condition, AC.C=access road condition, WD=waste disposal, SWG=sewage, STY=security, GNS=general sanitary condition.

Source: Author, 2015.

Condition Rating Indices

Very poor	0.00 – 0.19
Poor	0.20 – 0.49
Fair	0.50 – 0.74
Good	0.75 – 0.94
Very good	0.95 – 1.00

Mean Scores Rating

Excellent	4.60 – 5.00
Good	4.00 – 4.59
Fair	3.00 – 3.99
Poor	2.00 – 2.99
Very poor	0.00 - 1.99

4.2. Overall Infrastructure Conditions in the Sampled Residential Neighbourhoods

Infrastructural conditions also rated fairly on condition scale, with condition index scores ranging from 0.52 to 0.65. Conditions of infrastructure in Bosso, Maitumbi and Shango neighbourhoods are the worst amongst sampled neighbourhoods with condition index scores of 0.52, 0.55 and 0.56 respectively. Conditions of infrastructure in Fadikpe, Dutsen-kura and Barkin-sale rated better than the first three neighbourhoods mentioned with condition index scores of 0.65, 0.61 and 0.60 respectively (Table 3).

Table 3: Infrastructure Quality Indices in Minna Residential Neighbourhoods

S/N	Neighbourhoods	N	INDEX
1	Dutsen-kura	47	0.61
2	Fadikpe	30	0.65
3	Barkin-sale	42	0.60
4	Shango	45	0.56
5	Bosso	310	0.52
6	Maitumbi	126	0.55
	TOTAL	600	0.58

Source: Author, 2015.

Although the infrastructure assessed rated fairly on the assessment scale, some are in a very bad condition and incapable of meeting the needs of the increasing housing and population in the neighbourhoods. According to Agbola and Agunbiade (2009), continuous housing development not well supported by good infrastructure can lead to slum formation.

Conclusion and Recommendations

The research has assessed the conditions of infrastructure in some selected residential neighbourhood in Minna, Nigeria and observed that the neighbourhoods were characterized by; inadequate infrastructure to cater for household's need, obsolete infrastructure resulting to service failure due to poor maintenance culture on the part of the government and the community.

The study therefore recommends refurbishment of existing infrastructure and provision of new ones in order to enhance the neighbourhood's environmental quality. The study also recommends community participation in infrastructure provision and maintenance in order to compliment the efforts of government.

References

Agbola, T. & Agunbiade, E. M. (2009). Urbanization, Slum Development and Security Of Tenure: The Challenges Of Meeting Millennium Development Goal 7 In Metropolitan Lagos, Nigeria. In: Sherbiniin, A., A. Rahman, A. Barbieri, J.C. Fotso, & Y. Zhu (eds). *Urban Population-Environment Dynamics in the Developing World: Case Studies and Lessons Learned*. Paris: Committee for International Cooperation in National Research in Demography (CICRED).

Arunma, O. (2010). Capital Market as a Long term Option for Financing Infrastructure Development. A paper presented at the Central Bank of Nigeria Infrastructure Finance Conference held at the Sheraton Hotel and Towers, Abuja. December 6th and 7th.

Australian Association of Higher Education Facilities Officers (AAPPA) (2000). *Guideline for Strategic Asset Management, SAM – How to Undertake A Facility Audit*, 1st Edition. Australia: AAPPA

Chan, C., Forwood, D., H. Roper, and C. Sayers (2009) 'Public Infrastructure Financing: An International Perspective', Productivity Commission Staff Working Paper.

Deepika, G. (2002): Impact of Infrastructure on Productivity: Case of Indian Registered Manufacturing Centre for Development Economics. Working Paper No. 106.

Gianpiero, T. (2009): Public infrastructure: definition, classification and measurement issues. Online at http://mpra.ub.uni-muenchen.de/12990/ MPRA Paper No. 12990, posted 25. January 2009 06:11 UTC.

Holly K. W. (2014). Financing Sustainable Infrastructure. *International Development Finance Club (IDFC) Volumes I &II.*

Iseh, F. (2003,) The state of urban infrastructure in Nigeria. Atlantis Books, Ibadan. Nigeria.

Jacoby, H.. (2000). Access to Rural Markets and the Benefits of Rural Roads. *The Economic Journal, 110*.

Otegbulu, A.C. (2014), 'Urban Infrastructure Condition and Neighbourhood Sustainability: A Contingent Valuation Approach'. Ethiopian Journal of Environmental Studies & Management, Vol.7 (2) 160.

Sahoo, P. and Dash, R. K. (2009), Infrastructure Development and Economic Growth in India. *Journal of the Asia Pacific Economy*. Rutledge, 14(4) 351-365.

Sahoo, P., Dash, R. K. and Nataraj, G. (2010), Infrastructure Development and Economic Growth in China. Institute of Developing Economies (IDE), JETRO, JAPAN. Discussion Paper No. 261.

Stewart, J. (2010,) Public and Private Financing of Infrastructure- 'The UK National Infrastructure Plan 2010', European Investment Bank Papers.

Udoka, I. S. (2013), The Imperatives of the Provision of Infrastructure and Improved Property Values in Nigeria. *Mediterranean Journal of Social Sciences*. 4 (15). 21-33.

World Bank, (1994), World Development Report - Infrastructure for Development. Oxford University Press, New York.

STRATEGIES FOR IMPROVING INFORMAL INTERACTION IN STUDY OF SCHOOL OF ENVIRONMENTAL TECHNOLOGY, FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA, USING ISOVIST VISIBILITY GRAPHS

Oyetola, S.A, Zubairu, S.N, Adedayo, O.F, Alonge, O, & Eri, P,O
Department of Architecture, Federal University of Technology, Minna

This paper discusses the concept of an *isovist*, derived from architectural literature, and shows how isovists can help architects understand visibility and its importance in a physical environment. An isovist is defined as the set of all points visible in all directions from a given vantage point in space. The overlap between two or more isovists locations can be used to assess reciprocal visibility and thereby assist in the design of offices, commonly utilized spaces and even office/staff allocations. This work illustrates the value of isovists for architectural design using field data from a faculty building in the Federal University of Technology, Minna. The paper also shows how an isovist analysis can be used to propose alternative design solutions at design and even post-design stage. The as-built plan of the school of Environmental Technology (S.E.T) building, Federal University of Technology (F.U.T), Minna was developed using AUTOCAD 2014 software and analysed with DepthmapX; using isovist visibility graphs: a space syntax tool to reveal the relative connectivity and visual integration of the designed spaces with interesting results. The paper also proposed probable alterations to the present design of the S.E.T building thereby revealing higher levels of connectivity and integration. The analysed as-built plans which showed average (av.) connectivity of 3775.22 and average (av.) visual integration values of 10.8 were seen to have increased positively after alterations, to 3830.45 and 11.1 respectively. The paper recommended that this method be adopted in the analysis of proposals especially in environments that require its users to provide productive outcomes through face-to-face interactions.

Keywords: Connectivity, integration, isovist, space syntax, physical environment,

steveoyetola@gmail.com

Oyetola et. al. (2016**). STRATEGIES FOR IMPROVING INFORMAL INTERACTION IN STUDY OF SCHOOL OF ENVIRONMENTAL TECHNOLOGY, FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA, USING ISOVIST VISIBILITY GRAPHS** Sustainable Built Environment and Climate change; The challenges of Post 2015 Development Agenda. School of Environmental Technology Conference, SETIC, 2016

Introduction

Majority of work carried out in offices are termed as knowledge work. Most people imagine knowledge work to be scientists sitting behind their desks trying to discover new and innovative ideas. It is however acceptable that knowledge work is cognitive because it requires employees their own individual insight, memory and analytical prowess in order to develop and create new ideas. (Herwagen, Kampschroer, Powel, & Loftness, 2004). However, besides the cognitive dimension of knowledge work, it also has a social dimension which involves interactions and collaborations between co-workers. This is predominantly caused by the level of task complexity which encourages employees to interact and collaborate together to optimise the quality of work (Schon, 1991). For example, these days it is virtually impossible for a sole employee to possess all the knowledge and skills required to develop high tech trains and airplanes, it is more effective to combine knowledge and skills of several employees. In situations where researchers are highly specialised especially those working in the University, the feedback from colleagues on ones work can greatly improve the quality, reliability and usability of the individuals work outcome.

Interactions between employees are facilitated by the social networks that they participate in, which are maintained through formal and informal interactions. Observational research conducted by Allen (1977) showed that employees in the office mainly communicated through brief but frequent face-to-face contact (Brill, Wideman & BOSTI Associates, 2001). They concluded that most of these contacts were not planned but happened spontaneously a people walked from their workstations to other places in the office, like dispensing machines, copiers and even toilets. The prevalence of face-to-face interactions resulting in shared knowledge becomes an important asset in any knowledge organisation; whether this knowledge is at a factual level (that is, knowing on what tasks a colleague is currently working on), or on a social-emotional level (that is, knowing if the colleague is experiencing difficulties and needs help). The shared knowledge gained through face-to-face interactions enable employees to be aware of their colleagues and even what activities they are currently engaged in (Gutwin & Greenberg, 2001). By increasing the level of shared knowledge through face-to-face interactions the available potential in a group of employees can be used more efficiently (Peponis, Bafna, Bajaj, Bromberg, Congdon, Rashid, Warmels, Zhang & Zimring, 2007). Face-to-face interaction leads to higher levels of shared information which resultantly leads to a better use of cognitive potential in an organisation. Therefore, for organisations where knowledge is an outcome, the sharing of knowledge between employees is of utmost importance. This paper therefore reiterates the importance that informal interaction has in office environments and highlights design strategies for improving this type of interaction using isovist visibility graphs; a space syntax tool. The analysis was carried out on the school of Environmental Technology, a faculty office building in the Federal University of Technology, Minna

Office Layout and Face-To-Face Interaction

It is a well-known fact that the arrangement of physical space, such as offices, hallways, stairwells and common areas in a building can influence the frequency of informal interaction amongst employees of that space (Kraut, Fish, Root & Chalfonte, 1990). It has also been observed that when employees are separated by same distance, visual barriers like walls and stairways reduce opportunities to make eye contact with one another and initiate interaction. (Festinger, Schacter & Back, 1950). According to Peponis *et al*, (2007), the office layout can improve shared knowledge by stimulating face-to-face interactions. Their studies also showed that three (3) variables can be considered when discussing office layout and its relationship to face-to-face interaction:

- **Distance between employees**

  This is very important because, the larger the distance the more physical effort an employee has to make to reach a co-worker. Research by Allen (1971) showed that chances for spontaneous interactions between co-workers reduced to virtually zero after a distance of thirty metres unless of course there is a specific purpose for the contact. Therefore, in order to support face-to-face contact this distance has to be considered in the design of office layouts.

- **Visibility of Employees**

  The further an employee is seated from an active traffic path, the less likely he/she will be seen by a colleague who is passing by. Backhouse & Drew (1992) found that employees who are walking through an office hallway will scan the faces and postures of co-workers to see if they are available for conversation. This therefore means that high transparency within the workplace influences the possibility that employees can detect potential conversation partners thereby increasing chances for spontaneous and face-to-face interactions (Wolfeld, 2010).

- **Integration of the office**

  This can simply be understood as the location of a particular office in reference to all other offices, the higher the centrality of an office, the better (Serrato, 2002). A more integrated office can enhance the possibility for spontaneous face-to-face interaction because of a higher traffic of employees.

Space Syntax – Isovist Visibility Graph

The three variables by which office layouts can influence face-to-face interactions can be researched using space syntax analysis. Space syntax analysis is a set of descriptive techniques first represented by Hillier and Hanson in their book, The Social Logic of Space in 1984. Its basic premise is that it is possible to determine certain underlying structures of space that are linked to observable patterns of behaviour (Peponis and Wineman, 2001). One of those relationships between space and behaviour is the observation that spaces that are accessible also have a higher probability to be used for movement. This means that the distribution of movement is a function of spatial configuration. This means that employees will use a hallway that is more accessible to reach a destination than one that is not. It is also important to note that is more accessible hallway will lead to co-presence between employees which will ultimately result in spontaneous face-to-face interaction.

Space syntax analyses 2D building maps as input which are then broken down into components like rooms and then analysed with algorithms and finally represented as maps, graphs or data form showing the characteristics of a particular place. An Isovist is the set of all points visible in all directions from a given vantage point in space with respect to an environment. An isovist visibility graph shows how visible each point in a space is, to all other points in that space. (Figure 1). The graph is developed after each isovist is calculated for each square and the visibility of each square is determined by overlapping all generated isovists. In Figure 1, the red represents the most visible spaces therefore most integrated whereas the blue shows the least visible and least integrated spaces. Other shades of colours represent various levels of intermediate visibility and integration. Isovist graphs can be useful for positioning public spaces, offices that requires its employees to interact often, placing public displays (notice boards) and even determining effects of design (at design and post design stages). For example, locating a water dispenser at point "a" will increase possibilities of chance encounters by employees at offices located at "d" and "c" in Figure 1.

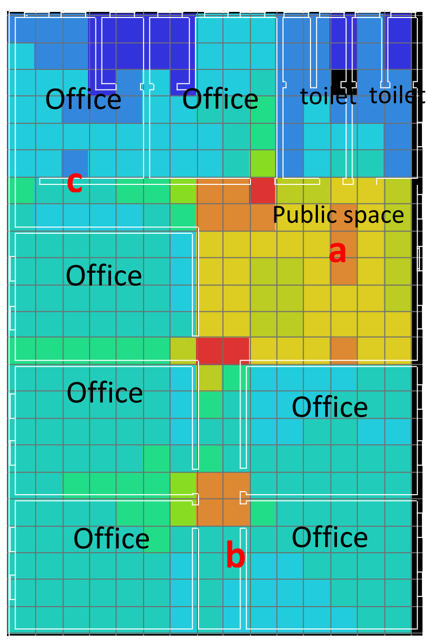


Figure 1. Isovist visibility graph of a floor plan
Source: Author Fieldwork, 2016

Research Methodology

The School of Environmental Technology, Federal University of Technology, Minna was purposely selected for the survey. The as-built plan of the School of Environmental Technology, F.U.T Minna was produced using AUTOCAD 2014 software. The generated plan was then imputed into the Depthmap X software for visual analysis (Figure 2). The imputed plan (map) is then broken down into a system of grids and analysed. The software then creates an array of isovists that depicts areas of integration and overall accessibility of the space. The average connectivity and visual integration (using the isovists created) were then obtained and were compared to similar data obtained from proposed alterations to the school of environmental technology, Minna.

Analysis of Results

The level of integration denoted by the darker shades of red show spaces within the building that are highly integrated as opposed to the darker shades of blue which show low integration. These red spaces provide possible and probable scenarios for interaction within the complex. It also shows the possible effects with office allocation within the building; offices closer to the visible areas (red) will have a higher probability for chance encounters. Offices where integration is low will reduce the level of possible interactions amongst staff; these spaces can be proposed for work that requires a high level of concentration work. This can be seen in the existing modelled plan; offices at the wings are secluded from the network. The part of the building labelled “B” in figure 2 has offices for professorial cadres of staff which is also poorly integrated with the rest of the building. This will have implications on communication with these select cadres of staff. This portion of the building was chosen for this study because it was constructed as an addition to the existing structure in 2011. The average visual integration of the existing S.E.T building is 10.8107 and its average connectivity is 3775.22. These values were analysed and calculated for the whole building structure. These values can be seen in table 1.

Table 1: Showing average integration and average connectivity in as-built s.e.t. Plan

Attribute	Minimum	Average	Maximum
Connectivity	12	3775.22	8108
Point First Moment	24623.4	1.16881e+008	3.30841e+008
Point Second Moment	4.428e+007	5.08216e+012	1.91603e+013
Visual Entropy	0.922017	1.46287	1.71491
Visual Integration [HH]	3.60055	10.8107	16.4804
Visual Integration [P-value]	0.310473	0.932202	1.4211
Visual Integration [Tekl]	0.8306	0.918388	0.963995
Visual Mean Depth	1.70314	2.21969	4.21842
Visual Node Count	18461	18461	18461
Visual Relativised Entropy	1.84726	2.24871	3.53085

Source: Authors Field work, 2015

Offices at wing. These offices are highly segregated and therefore suitable for concentration work

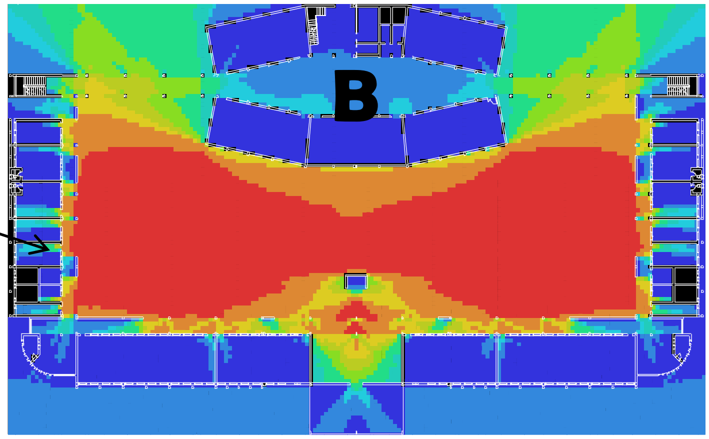


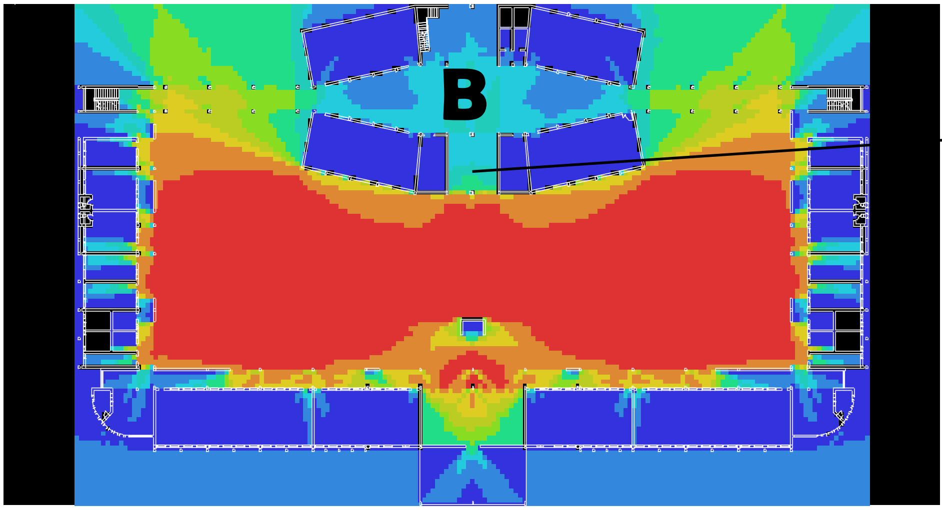
Figure 2: Visual graph analysis showing level of integration in S.E.T.
Source: Author's field work, 2015

Figure 3 shows slight improvements to levels of integration and connectivity when "B" part of the building is altered. The average integration and average connectivity in Table 2 can be seen to have increased to 11.1253 and 3830.45 respectively.

Table 2: Showing average integration and average connectivity In altered s.e.t. Plan

Attribute	Minimum	Average	Maximum
Connectivity	10	3830.45	8132
Point First Moment	21693.1	1.183e+008	3.32145e+008
Point Second Moment	4.104e+007	5.12199e+012	1.93594e+013
Visual Entropy	0.882556	1.43029	1.7075
Visual Integration [HH]	3.60683	11.1253	16.843
Visual Integration [P-value]	0.310716	0.95841	1.45097
Visual Integration [Tekl]	0.830778	0.921114	0.966145
Visual Mean Depth	1.68867	2.18329	4.21592
Visual Node Count	18605	18605	18605
Visual Relativised Entropy	1.84979	2.25132	3.55375

Source: Authors Field work, 2015



(introduced access)

Alteration made to the latter wing can be seen to positively increase levels on integration

Figure 3: Visual graph analysis showing level of integration in altered plan of S.E.T.
Source: Author's field work, 2015

This shows that slight alterations can either positively or negatively affect the buildings initial visual integration and connectivity values, thereby affecting the levels of chance encounters/ face-to-face contacts. A prior analysis of the design before construction would have corrected and increased the integration and connectivity levels thereby increasing interaction and ultimately improving knowledge work productivity.

CONCLUSION

In this paper we have shown how isovists can assist architects to understand how the spatial characteristics of a work environment and the positioning of offices and public areas within that environment affect reciprocal visibility among collocated individuals. Isovist analyses can be used to assess the ideal location of a public areas or, certain office type (especially those that require its employees to acquire knowledge through high levels of interaction) within a physical environment, such that either opportunities for interaction or needs for privacy are maximized (some offices require high levels of work with least amount of distractions).

The application of isovists has certain limitations. For example, isovists assume equal visual access in 360 degrees and do not take people's customary line of sight from a given point into account. A detailed analysis require time spent looking in each direction. In addition, the relationship between individuals at different locations are not considered especially when discussing subject behavior as visibility is likely to have different consequences depending on type of tasks.

Reference

Allen, T.J. (1977) *Managing the Flow of Technology: Technology transfer and the Dissemination of Technical information within R&D Organizations.* Cambridge: MIT Press

Backhouse, A. & Drew, P. (1992) *The design implications of social interaction in a workplace setting. Environment and Planning B:* Planning and design, 19, pp. 573-584.

Brill, M., Weidemann, S. & BOSTI Associates (2001). *Disproving widespread myths about Workplace design.* Jasper: Kimball International.

Festinger, L., Schacter, S., & Back, K. (1950). *Social pressures in informal groups: A study of human factors in housing.* Palo Alto, CA: Stanford University press

Gutwin, C., & Greenberg, S. (2001). *A descriptive framework of workspace awareness for real time groupware. CSCW'01.* Dordrecht: Kluwer

Heerwagen, J. H., Kampschroer, K., Powell, K.M. & Loftness, V. (2004) *Collaborative knowledge work environments. Building & Information,* 32 (6), pp. 510-528

Kraut, R.E., Fish, R., Root, R., & Chalfonte, B. (1990). *Informal communication in organisations : Form, Function and Technology.* In S. Oskamp & S. Spacapan (Eds.), Human reactions to technology: Claremont symposium on applied social psychology (pp. 1454-199). Beverly Hills, CA: Sage publications

Peponis, J., Bafna, S., Bajaj, R., Bromberg, J., Congdon C., Rashid, M., Warmels, S., Zhang, Y., Zimring, C. (2007). *Designing Space to Support Knowledge Work.* Environment and Behavior, 39 (6), 815-840.

Peponis, J., & Wineman, J. (2001). *Spatial structure of environment and behavior,* in R.B. Bechtel & A. Churchman: handbook of environment.

Serrato, M.G. (2002). *Building based communication research. Gedownload op 11 maart 2011 van http://www.tradelineinc.com*

Schon, D. A. (1991) *The reflective practitioner.* Alderschot: Ashgate Publishing

Wolfeld, L.R. (2010). *Effects of office layout on job satisfaction, productivity and Organisational commitment as transmitted through face-to-face Interactions*. Colonial academic alliance ungergraduate research journal, 1 (1), article 8.

CONCEPTUAL ISSUES ON CLIMATE CHANGE AND SUSTAINABLE DEVELOPMENT

LANDSCAPING FOR PASSIVE SECURITY AND ADAPTATION FOR CLIMATE IN CHURCH ENVIRONMENT NIGER STATE, NIGERIA

AILOYAFEN Dorcas, ADEDAYO Olatunde Folaranmi & ADEBAYO Oluwatoyin Abiodun
Department Of Architecture, Federal University of Technology, Minna.

Nigeria is faced with several risks ranging from problems of climate change to security challenges and this is not limited to a specific aspect of the built environment as all buildings and environment are affected. The places of worship are greatly affected in terms of security which affects the disposition of Christians during worship at churches. Many of the studied churches were seen to have made use of landscape elements but these went placed with the aim of using them to deter intrusion as in the case of security but rather for beautifying the church. The challenge for architects and church administrator is how to cope with challenges of security and climate change. This paper examines landscaping as a catalyst for deterring intrusion of threats passively and enhancing climate adaptation in church environment in Nigeria. The research method adopted for this study is the descriptive survey method by collecting qualitative and quantitative data. The results were analyzed using descriptive tools in SPSS and are presented in tables and charts while the pictures are presented in plates. The study reveals that it is possible to achieve passive security and solve some climatic challenges in church environment using soft landscape elements. The paper is concluded by determining the aspects of the building where the architect can infuse the specific landscape elements to achieve the aim of the paper. It further states the type of landscape elements that could be used to achieve the aim of the study hence developing a responsive building design scheme.

Keywords: Adaptation, Building, Climate change, Security, Soft landscaping

emmado004@gmail.com

***AILOYAFEN, D. et al** (2016). **LANDSCAPING FOR PASSIVE SECURITY AND ADAPTATION FOR CLIMATE IN CHURCH ENVIRONMENT NIGER STATE, NIGERIA** Sustainable Built Environment and Climate change; The challenges of Post 2015 Development Agenda. School of Environmental Technology Conference, SETIC, 2016

INTRODUCTION

Climate change manifestations are wide ranging and irrefutable. These changes are at least in part a result of human activities. Climate change is recognized as one of the greatest and most serious environmental challenges the world is confronted with in the 21st century to the point that the global warming and climate changes issues top the agenda at global level (Anver, 2000). These changes are set to continue regardless of future greenhouse gas emissions because of the cumulative impacts of the emission that have arisen since the outset of industrialization. Most countries of the world today are experiencing extreme weather conditions and climate change associated natural disasters which scientists have concluded to be induced mostly by the activities of man (Atilola, 2012). High frequency of formation of cyclonic storm surges, high density rainfall along with changing precipitation patterns and prolonged droughts, hurricanes along with related landslides and wildfires are some of the extreme weather events in various parts of the world (IPCC, 1996, Ahmad *et al,* 2000). IPCC publication in 2007 concludes that:

- CO_2 levels are at their highest for 650,000 years
- Climate change is unequivocally happening
- There is a 90% chance that this is the result of human activity
- Man has 10-15 years left to put in place serious measures to start reducing emissions

Barnet and Adger (2007) observe that climate change is increasingly being called a security problem because there is concern that climate change may increase the risk of violent conflict. The underlying proposition is that climate change is likely to undermine human security by reducing the natural resource base and limiting access to existing natural resources which are central to sustainable livelihoods, especially in developing countries. Nigeria, like other developing countries which is a low emitter of energy is made to adapt to the expected impacts of the anticipated climate change (Oni and Akingbohungbe, 2013), thereby posing a threat to the country. Not only is Nigeria faced with the challenge of climate change but also other security challenges.

Security has to do with freedom from danger, anxiety and fear; a situation that shows that a country is not exposed to sabotage or external attack (Amadu, 1989). UN (2010) defines security as a degree of protection to safeguard a country, group of people, person and properties from danger, destruction, attack and crime. Insecurity concept connotes different things ranging from danger, hazard, uncertainty, lack of protection to lack of safety. According to Beland (2005) insecurity is a state of fear or anxiety due to absence or lack of protection. Achumba, Ighomereho, & Akpan-Robaro, (2013) defines insecurity from two perspectives. First and foremost, it is defined as the state of being open or subject to danger or threat of danger, where danger is the condition of being susceptible to harm or injury. Secondly, it is seen as the state of being exposed to risk or anxiety, where anxiety is a vague unpleasant emotion that is experienced in anticipation of some misfortune. These definitions of insecurity underscore a major point that those affected by insecurity are not only uncertain or unaware of what would happen but they are also vulnerable to the threats and dangers when they occur. For this paper, insecurity is defined as the breach of peace and security regardless of the cause or source which contributes to conflicts that leads to the loss of lives and properties. The concept of security is related to the concept of safety, continuity and reliability. Security takes into consideration the actions of people planning to cause an attack. The Institute of Open Methodologies (2006) defines building security as the degree to which a building, its facilities and users are protected from a potential threat that can cause any form of damage to the building and its users. Building security is beyond installing high technology electronic systems in a building to identify intruders but it is first of all a process of planning and designing from the concept stage how to hinder of delay attacks.

In Nigeria today, terrorism has become a fundamental source of insecurity with primary base generally located in religious fanaticism and intolerance in Northern Nigeria (Achumba, Ighomereho & Akpan-Robaro, 2013). The effect of terrorist activities such as suicide bombings, kidnappings, destruction of lives, public infrastructure, private and entrepreneurial investments, the climate of fear, panic and confusion and a heated and ungovernable polity has continued to make Nigeria an unsuitable bride for foreign investments. This not only poses a threat to the budding democracy in place, it also may endanger efforts to achieve industrial development in the country. To face this challenge headlong, a multi-stakeholder imperative has become inevitable.

Public places like churches, mosques, markets and other places of large gatherings have being the target of terrorists. Nonetheless the threats, churches and other public buildings can be planned in such a manner as to tackle the challenges of insecurity by the implementation of security design strategies. Having viewed the challenges, this research is aimed at finding out how landscape can be used to aid passive security design and at the same time be a means of adapting to the climate change in Minna, Niger state.

Climate Change in Nigeria

Climate change is a pattern of change affecting global or regional climate as measured by such things as average temperature and rainfall, or an alteration in frequency of extreme weather conditions. This variation may be caused by both natural processes and human activity. Climate change has been majorly blamed upon human activities which result in increased release of green house gases and widespread deforestation both of which alter the balance of atmospheric gases in favors of the green house gases (GHGs) (Fawehinmi, 2007). Nature in itself was made to take care of balancing the ecosystem in a suitable manner but that is without the activities of human activities. Therefore for the existence of man to continue on the earth surface, man must in wisdom utilize the natural resources in the most prudent and sustainable manner.

Recently, the issue of global climate change due to the greenhouse effects, including global warming and sea level rise have been a subject of scientific discussions and public debate. Developing countries like Nigeria contribute to the greenhouse emissions, though insignificant as compared to the contribution of the developed countries. Regardless of the contribution, climate change will have significant impacts locally, regionally and globally, thereby, creating problems for sustainable development and resource management. Indeed climate change and sea level rise would compound the serious problems of sustainability of the environment and management of resources, as well as the currently serious problems in population consumption patterns and characteristics in many parts of Africa and other developing countries (Fatile, Adejobi, 2012).

Developing countries like Nigeria are least prepared for the impact of global warming. Global warming is real and evidence abounds in the country. Although the country has been lucky not to have experienced major climate-change-induced natural disasters, the effect of climate change is evidenced by rise in sea level and erosion along the nation's coastline; the weather pattern which is no longer distinct in the country, the very hot weather conditions high precipitations which have led to flooding, ruining crops in parts of the country creating food scarcity, the latest being Jigawa State; gully erosion has sacked many communities especially in Edo and Anambra States; as a result of persistent drought, the Lake Chad has almost dried up, while there had been persistent desert encroachment in the north.(Olaniyi, Funmilayo, Olutimehin,2014).

Adaptation of Man to Climate Change

Adaptation means that measures should be taken to reduce the adverse impact of global warming on human life and the environment. Some of the options that are available include: changing the cropping patterns; stopping further development on wetlands, flood plains, and close to sea level; developing crops that are resistant to drought, heat and salt; strengthening public health and environmental engineering defense against diseases; designing and building new water projects for flood control and drought management; construction of dykes and storm surge barrier against sea level rise (Holdren, 2010). On the other hand, adaptation involves coping with climatic change, taking measures to reduce the negative effects, or exploit the positive ones by making appropriate adjustments. Adapting landscapes and places to the changes is an urgent challenge for all those that have a role to play in the management of the built and natural environment.

Insecurity in Nigeria

One of the most fundamental source of insecurity in Nigeria today is terrorism which has its primary source of support generally situated in religious fanaticism and intolerance particularly in Islam dominated states in Nigeria (Achumba, *et al*. 2013). Terrorism which is a global phenomenon where no one is safe was defined by Sampson and Onuoha (2011) as "the premeditated use or threat of use of violence by an individual or group to cause fear, destruction or death, especially against unarmed targets, property or infrastructure in a state, intended to compel those in authority to respond to the demands and expectations of the individual or group behind such violent acts".

Nigeria amongst other countries has witnessed great level of insecurity in recent times. This has made national security threat to be a major issue for the government and has prompted huge allocation of the national budget to security. According to Hammar, (2008) a renowned expert on church safety, security and legal matters,*"Most churches are safe places. While incidents of shootings on church property are shocking, they are rare. But because of the "open access" policy of most churches, they remain easy targets for violent acts. While such acts cannot be prevented, there are steps that church leaders can take to manage the risk."* In order to reduce the incidence of crime, the Federal Government has embarked on criminalization of terrorism by passing the Anti-Terrorism Act in 2011, installation of Computer-Based Closed Circuit Television Cameras (CCTV), in some parts of the country, enhancement of surveillance as well as investigation of criminal related offences, heightening of physical security measures around the country aimed at deterring or disrupting potential attacks, strengthening of security agencies through the provision of security facilities and the development and broadcast of security tips in mass media (Azazi, 2011). Notwithstanding these efforts, the insecurity state in some part of the Nigeria is still high and seems insurmountable. The need for security in church buildings is becoming more relevant than ever as a result of the increasing number of attacks experienced. The primary goal of a security design approach is to minimize the loss of life of the building's occupants. The most effective way to achieve this goal is with a comprehensive and coordinated, multidisciplinary approach to address security in the earliest phases of site selection and/or the design process. Table 1.0 shows churches that were attacked in the Northern part of Nigeria between 2011 and 2012 and the number of casualties recorded. From table 1.0, it would be observed that many lives were lost as a result of the various attacks on the mentioned churches; people sustained various degrees of injuries as well as assets lost. From the states affected, Madalla which is in Niger state was also affected. Madalla which is a busy and large settlement within Niger state was one of the targeted churches having the highest death record. Plate 1 show that the car was detonated very close to the church building and as such had great impact on the building and the worshippers in it. It would be advised that the state capital of Niger state, Minna should put in place measures which can help to hinder the intrusion of terrorists thereby preventing their attacks or reducing the effects of their attacks.

Table 1.0: List of Major Attacks on Churches in Northern Nigeria from 2011-2012

S/No	Date of attack	State	Location of attack	Impact
1	25th Dec, 2011	NIGER	Christmas Day Bombing in Madalla	50 people Killed
2	6th Jan, 2012	ADAMAWA	Christ Apostolic Church was attacked and Igbo people were also killed in Mubi in the same state	37 people killed
3	8th April, 2012	KADUNA	Easter Day Church Bombing	38 people Killed
4	17th Jun, 2012	KADUNA	Multiple attacks on churches	12 people killed and 80 injured
5	7th August, 2012	KOGI	Deeper Life Church attack	19 people killed

Source: Adapted from Ewetan and Urhie (2014)

Plate 1: The bomb effect on the building of St Theresa church at Madalla

Plates 1 shows St Theresa Catholic church at Madalla, Niger state which was bombed on 25th December, 2011 (Christmas day). The plate gives a pictorial view of the effect of the explosion on the building and the vehicles. As observed there were no restrictions as to a clear car park, which led to the close range of parked cars to the building. Although a tree was within the the premise, it is observed that this landscape element was not planted with the aim of deterring intrusion upon property and so was not used as a security measure.

Physical Security Control Measures and Landscaping

According to Home Land Security 2009, to reduce the risks of direct contact and physical attacks against a facility, the physical security measures are mostly useful. These may occur in passive or active forms. Integrating protective measures in design minimizes the impact of mean attacks on a building immensely. The passive measures for a functioning security system according to a study by National Capital Planning Commission, (NCPC 2002), is a permanent protective measure provided by both site and structure that involves the effective use of Engineering and Architecture to achieve improved security by eliminating potential security threats in public buildings. In other words, passive security measures are necessary in public buildings so as to eliminate potential security threats perpetrated by man-portable improvised explosive devices (MPIEDs) and vehicle-borne improvised explosive devices (VBIEDs).

According to the physical security design manual for VA facilities (2007), passive measures are static elements such as static bollards, raised concrete planters, fences and trees of sufficient girth, standoff zone distance, integrated in the design from the inception stage. These are barriers that offer important benefits to physical security posture. They first and foremost create a psychological deterrent for anyone thinking of an unauthorized entry. Soft landscape can be used to soften and enhance the appearance of perimeter fences and other security elements (FEMA 430, 2007). They could also be used as perimeter fence in the form of thorny hedges and dense hedgerows. However the application and choice of the soft landscape as a security measure, it is important to note that plantings must ensure they do not block important sight lines or create hiding places. In other words, plants near buildings should be high to keep sight lines open. Low planting adjacent to buildings may be admissible, but its height and density should not provide hiding places for people or packages or isolated areas that are not easily observed.

RESEARCH METHOD

Data for the study was obtained using observation schedule purposefully structured to provide sufficient and relevant information for the analysis of the study. The paper is majorly aimed at providing information as to the provision of landscape for climate adaptation as well as a means to mitigate the state of security in churches within Minna, Niger state in lieu of design implementations to improve them. The selection of the study sample was spread amongst Orthodox and Pentecostal churches within the 9 zones as regionalized by the Christian Association of Nigeria (CAN) using Stratified Random sampling method. A total number of 54 churches were studied out of the 177 registered with the Christian Association of Nigeria (CAN) with 6 churches from each zone, evenly spread between the Orthodox and Pentecostal by studying 3 each at every zone. Zones where the number of registered Pentecostal churches are not up to 3, the Orthodox churches available was used to fill in so as to study 6 different church buildings within the zone. The data was collated, sorted based on the zones and entered into the SPSS for analysis purposes while results are being presented in tables and charts, pictures presented in plates to further buttress explanations within the result discussions.

Table 2.0: List of Studied Churches in Minna, Niger State

S/No	Zone	Type of church	Name of church
1	Minna Central West	Orthodox	St Michael catholic church St Peter's Anglican cathedral 1st ECWA church
		Pentecostal	Redeemed Christian church of God C & S Headquarters New Life for All
2	Minna Central East	Orthodox	1st Baptist church St Andrew Anglican church The Apostolic Church 1st Gospel Baptist church
		Pentecostal	Kingdom hall of Jehovah witness The Living Word of Hope
3	Tunga East	Orthodox	5th ECWA church COCIN church Presbyterian church
		Pentecostal	Living Faith Foursquare Gospel church The Lord's Chosen
4	Tunga West	Orthodox	Our Lady of Fatima catholic church 2nd ECWA Yoruba section The Apostolic Church
		Pentecostal	Ever Increasing Faith Bible church Redeemed Christian church of God The Redeemed Evang. Mission (TREM)
5	Maitumbi	Orthodox	ECWA church St John's catholic church Christ Apostolic church
		Pentecostal	Mountain of Fire and Miracles Living Faith Church Assembly of God
6	Kpakungu	Orthodox	C & S Ona-Iwa Mimo Christ Apostolic church St Mary's Catholic church
		Pentecostal	Agape Love Chapel Terbanacle of Mercy Chapel Redeemed Church of God
7	Dutsen Kura	Orthodox	ECWA church Sacred Heart Catholic Church C & S No. 3

		Pentecostal	Redeemed Christian Church of God Gospel faith mission Deeper life

Source: Author's Fieldwork (2015)

Table 2.0b: List of Studied Churches in Minna, Niger State

S/No	Zone	Type of church	Name of church
8	**Sauka Kahouta/ Barkin Sale**	**Orthodox**	**ECWA no. 4** **Covenant Baptist church** **C.A.C Ile Anu**
		Pentecostal	Mountain of fire and miracles Living Faith church Deeper Life church
9	Tayi village	Orthodox	C.A.C Kauna Baptist church COCIN ECWA
		Pentecostal	EYN church Redeemed church

Source: Author's Fieldwork (2015)

FINDINGS AND DISCUSSION OF RESULTS

The analysis of the data obtained through observation schedule was done and presented in tables and plates below. The churches were zoned for less cumbersome data presentation and analysing the soft landscape elements thereby seeking to address its adoption in churches within Minna as a security measure as well as a means to mitigate the climate change and its effect on man.

Table 3.0: Presence of Elevated Planters in the Studied Churches

Church zone	Presence of elevated planters	
	Yes	**No**
Minna Central West	0	6
Minna Cenral East	0	6
Tunga East	0	6
Tunga West	0	6
Maitumbi	0	6
Kpakungu	0	6
Dutsen Kura	1	5
Sauka Kahouta/Barkin sale	0	6
Tayi Village	0	6
Total	**1**	**53**

Source: Researcher's Fieldwork (2015)

The result presented in table 3.0 shows that a majority of the churches in Minna do not consider the use of elevated planters as an important security measure. This gives rise to an area which the Architect and the church administrator need to introduce to church designs as it can help as a security measure and at same time the plantings can help as an adaptive measure toward climate change in the country. Planters help to add to the beautification of the church and soften hard lines by helping to blend security into the overall site design. Soft landscapes can help to de-emphasize hardened security measures as seen in plate 2.0 below where RCCG Tunga West planted some flowers all in a bid to de-emphasize the presence of the "concrete-filled-drums" which are placed as security measures. Elevated planters are mostly used to direct traffic and in some cases do have reinforced bollards within them, thereby hindering vehicular access. Elevated planters can function as hardened security barriers. When reinforced and rightly placed, serve two purposes, providing both security and an attractive landscape element.

Table 4.0: Type of Soft Landscape Provided

Church zone	Type of Soft Landscape Provided			
	Shrubs	**Flowers**	**Trees**	**None**
Minna Central West	0	1	2	3
Minna Cenral East	0	3	3	0
Tunga East	0	1	2	3
Tunga West	0	1	4	1
Maitumbi	0	1	0	5
Kpakungu	1	0	1	4
Dutsen Kura	0	0	2	4
Sauka Kahouta/Barkin sale	0	0	1	5
Tayi Village	0	0	0	6
Total	**1**	**7**	**15**	**31**

Source: Researcher's Fieldwork (2015)

From table 4.0, it can be deduced that 23 churches have soft landscape within the church premises while 31 churches do not which is approximately 57% of churches studied. Out of the 43% that have some soft landscape planted within the church premise, a very few were seen to have used these plants to direct traffic, restrict vehicular movement and deter intrusion while some others used it to soften the hard physical security elements. Most of the churches that planted soft landscape within were basically for beautification of the church. Credit should be given to churches like RCCG at Tunga West as seen in plate 2 having used soft landscape to soften the hard effect of bollards, amongst some other churches for having purposefully utilized soft landscape as security measures. St Michael Catholic Cathedral as seen in plate 3 for using landscape elements to direct vehicular and pedestrian movement.

Plate 2: RCCG at Tunga West showing use of soft landscape to soften and enhance the appearance of perimeter fences and other security elements.
Source: Researchers field work (2015)

Plate 3: Soft landscape use to direct traffic within church site at St Michael Catholic Cathedral, Minna Central West.
Source: Researchers field work (2015)

Existing or carefully selected trees, plants, flowers are some of the soft landscape elements that can contribute to safety, comfort, traffic direction and restriction as against the case of St Theresa Catholic church shown in plate 1 which didn't have plants restricting vehicle parking and direction of traffic. These landscape elements also add to the aesthetics of the environment as seen in plate 3. By so doing, the plants which are also used for mitigating to climate change and it effects by their emission of oxygen into the atmosphere and intake of the CO_2 which is excess in the air and causing ozone depletion.

Dense planting, trees, heavy objects, such as large sculptural objects, massive boulders, concrete forms with unassailable slopes can be used in a similar way to bollards to prevent vehicles from passing, while allowing the passage of pedestrians and bicycles. To ensure that such barriers can effectively reduce the threat level, engineering design and/or evaluation is necessary. For example existing dense thickets of mature trees can be incorporated into a perimeter system. Landscape design uses a palette of living materials that respond to seasonal changes in climate and change in size and mass over time. The choice of appropriate plantings for the purpose of security is an important task. Plantings for security often suffer harsh environmental conditions like limited watering, compacted soils and runoff of chemicals from roads and sidewalks. These conditions are usually not healthy for plants and as such when a living landscape is installed with security function; it needs be well maintained to support its health and effectiveness.

Security and Landscape Design in churches

In addition to considering the building(s) footprint in new churches construction, it is advisable to integrate the natural site characteristics with the placement of the building(s) and the other site features such as roads, parking areas, walks, and other site amenities. Churches need to incorporate in the security design solutions natural environment to enhance the security and aesthetics. Landscaping that are environmentally sensitive, conserve resources, address social issues as well as marry form and function all in an aesthetically pleasing approach should be encouraged as these are said to be sustainable in nature and at the same time help address security challenges when properly handled by professionals. The implementation of sustainable design principles and security requirements should be mutually inclusive in church designs. A variety of site features and amenities from the landscape architectural palette can be used to provide the required level of security. The manipulation of landforms, integration of water features, elevated planters, vegetation, changes in elevation of paved areas, fences, a wide range of street furniture, site elements and amenities can all be strategically implemented to enhance security. These can be used to restrict and control pedestrian and vehicular circulation and access as well as prevent unwanted surveillance. These elements when placed rightly can improve the security level in the form of informal surveillance and makes undesirable activity stand out in a much more obvious way.

CONCLUSION

From the data analyzed above, it can be concluded that most of the churches in Minna, Niger state do not fully employ soft landscape as a security design measure and as a result do not help in the adaptation to climate change as well as being prone to the attacks of intruders. Security concerns have made the integration of building architecture and site design increasingly critical. The close collaboration of architect, security specialist, and structural engineer can result in both responsive and inspirational designs. Indeed, there is a growing recognition that site security measures and design excellence, need not be mutually exclusive. The widespread use of anything precast concrete placed almost everywhere in our valued landscape has resulted in an unpleasant aesthetic environment. The topography and land characteristics of the surrounding area can have both negative and positive implications. The presence of natural physical barriers such as water features, dense vegetation, and rough terrain can help provide access control. The incorporation of water features, planting, and grading to create new topographic landforms in the site design can enhance a site's security where these features do not naturally occur. The topography and climate characteristics can affect the performance of chemical and biological weapons. As wind moves through the landscape, topography and objects in its path have an effect on wind patterns.

Landscaping should be considered when evaluating how a site is observed from outside its boundaries as well as how the surrounding area is observed from the site.

- Clear sight lines that allow security personnel and security devices to monitor the site and area beyond should be observed
- The modification of vegetation and topographical factors by the landscape architect which can enhance their security value and even turn a negative situation into a positive security attribute as landscape elements could be used to restrict, or channel, and constitute a continuous barrier around the site and at the same time serve a means to adapting to climate changes in the environment.

REFERENCES

Achumba, I. C., Ighomereho, O. S., & Akpan-Robaro, M. O. M. (2013). Security Challenges in Nigeria and the Implications for Business Activities and Sustainable Development. *Journal of Economics and Sustainable Development*, 4(2), 79-99.

Adeleke, K. (2008): Climate Change in Architecture and the National Development Agenda III. Seminar

Adeleke, O.O (2011): Mitigating the Effects Of Climate Change Through Sustainable Building Environment Agenda Iv. Seminar Proceedings Organized By Architects Registration Council Of Nigeria, April, 2011.

Amadu, I.M. (1989), "Education and Nationalism in Nigeria: A Religious Perspective. *Religion and State: The Experience,* Ibadan Gilbert, Grace and Gabriel Association

Atilola, O (2012): Climate Change And The Environment: Issues And Geo-Information Challenges. Knowing To Manage The Territory, Protecting The Environment, Evaluate The Cultural Heritage. Rome, Italy, 6-10 May 2012

Azazi, A. (2011). "Responding to the Emerging Trends of Terrorism in Nigeria", *5th Policing Executive Forum Conference Proceedings* Organized by CLEEN Foundation. Lagos

Barnet, J and Adger, W. (2007). "Climate change, human security and violent Conflict": *Geographical journal on Climate change.*vol.27(3);36-47.

Beland, D. (2005). The Political Construction of Collective Insecurity: From Moral Panic to BlameAvoidance and Organized Irresponsibility. *Center for European Studies, Working Paper Series 126.*

Brian M. Harrell, CPP (2010), "Security Challenges for Houses of Worship." *Journal of Physical Security 4(2), 1-9*; North American Electric Reliability Corporation (NERC)

Climate Adaptation: Seizing the challenge. (2014). World Economic Forum, Geneva, Switzerland. .http://wef_gac_climatechange_adaptationseizingchallenge_report_2014.pdf

Ewetan, O.O , Urhie E. (2014). "Insecurity and Socio-Economic Development in Nigeria." *Journal of Sustainable Development Studies* Volume 5, Number 1, 2014, 40-63

Ezeabasili, A.C.C, Okonkwo, A.U (2013). Climate change impacts on the built environment in Nigeria. African research review. An international multidisciplinary journal ethiopa. Vol7(4), serial no 32: 288-303. Doi: http://dx.doi.org/10.4314/afrrev.7i4.18

Fatile, J.O, Adejobi, O.S (2012) "Climate Change, Environment and Conflicts in Nigeria." *British Journal of Arts and Social Sciences* ISSN: 2046-9578, Vol.6 No.1 (2012) British Journal Publishing, Inc. 2012 http://www.bjournal.co.uk/BJASS.aspx

FEMA (2007) Site and Urban Design for Security. Guidance Against Potential Terrorist Attacks. U.S Department of Homeland Security.

Hammar, R. (2008) "Does Your Church Need a Security Guard?" *Church Law and Tax Report* March/April 2008, p. 1.

Ibrahim A.M. and Azubuike A.S. (2014), "A Review on the Security Challenges in Northern Nigeria and its Implications for Business Survival and Sustainable Development". J*ournal. of Management and Corporate Governance*, Vol. 6, No. 2, Pp. 46 – 54.

Intergovernmental Panel on Climate Change (IPCC, 1990); First Assessment Report. UNEP: IPCC (2007): Climate Change 2007; The Scientific Basis: Contribution Of Working Group I To The Third Assessment Report Of The Intergovernmental Panel On Climate Change Cambridge University Press.

Martin, C., Campillo, G., Meirovich, H. , Navarrete, J. (2013) Climate Change Mitigation & Adaptation through Publically-Assisted Housing: *Theoretical Framework for the IDB's Regional Policy Dialogue on Climate Change*. Inter-American Development Bank. Technical note no. Idb-tn-593

Mennonite mutual insurance company (2013). Guns in Churches: Addressing church security needs.www.mennonitemutual.com

National Capital Planning Commission. (2002). *The National Capital Urban Design and Security Plan*. Washington, DC.

Odjugo, P.A.O. (2010): General Overview of Climate Change in Nigeria. *Journal of Geography and Regional planning*, Vol 3, No. 6.

Olaniyi O.A, Funmilayo O.A, Olutimehin I.O, (2014) Review of climate change and its effect on Nigeria ecosystem. *International Journal of Environment and Pollution Research* Vol.2,No.3, pp.70-81, December 2014. Review of climate change and its effect on Nigeria ecosystem; Published by European Centre for Research Training and Development UK (www.eajournals.org)

Oni, O.F, & Akingbohungbe, O.D,(2013). Climate Change and Architectural Practice in Nigeria. *Journal of Environment and Earth Science.* Vol 3. No. 4

Physical Security Design Manual for VA Facilities (2007). Life Safety Protected Facilities. Department of Veterans Affairs, Washington, DC 20420

Risk management series: site and urban design for security: guidance against potential terrorist attacks; FEMA 430/ 2007

Sampson, I. T., & Onuoha, F. C. (2011). "Forcing the Horse to Drink or Making it Realise its Thirst"? *Understanding the Enactment of Anti-Terrorism Legislation (ATL) in Nigeria*. Perspectives on Terrorism, 5(3-4).

Susanne C. M (2010) Communicating climate change: history, challenges, process and future directions. wires.wiley.com/climatechange. Volume 1, January/February 2010. John Wiley & Sons, Ltd.

UN Habitat (2011). Cities and Climate Change: Global Report on Human Settlements 2011. United Nations Human Settlements Program.

United Nations (UN, 2010). Sustainable Development: From Brundtland to Rio 2012, Background Paper prepared for consideration by the High Level Panel on Global Sustainability at its first meeting, 19 September. New York.

Ushe M.U (2012), "Religious conflicts and education in Nigeria: Implications for national security", *International Journal of Educational Research and Development* Vol. 1(2), pp. 011-022 School of Arts and Social Sciences, National Open University of Nigeria, Lagos, Nigeria.

RETROFITTING FACULTY BUILDING WITH EXTERNAL BALCONIES FOR ADAPTATION TO CLIMATE CHANGE

ONWUKA, Bridget Nneoma, YUSUFF, Taiwo Qasim & ADEDAYO, Olatunde Folaranmi
Department of Architecture, Federal University of Technology, Minna, Niger State, Nigeria.

Evidences of climate change include change in temperature, rainfall, heat, and wind patterns. These have affected the behaviour of man and his responses to the environment particularly the built environment. The growing nature of our cities and the overall effect on the office building environment has ensured that the present office buildings in many Nigerian universities cannot respond to the changing climate. A major problem with the present faculty office buildings is the amount of heat gain by the building and the uncomfortable interior environment it generates hence requiring a lot of energy to keep it cool. There is need to seek alternative ways of making the building respond to the climate change. The aim of this study is to examine ways of retrofitting existing faculty buildings in tertiary institutions to respond to the climate challenges. The research method adopted would be a qualitative method with the use of Observation schedule. Six tertiary institutions in Niger State would be selected for this study and the data generated will be analysed using non-parametric statistical tools in SPSS. The results will be presented in tables, chats and plates. In conclusion the paper would recommend the retrofitting of balconies to faculty buildings as a way of improving the climatic response.

Keywords: ***buildings, climate change, faculty, retrofitting, offices***

talk2aee@gmail.com

INTRODUCTION

There are new concepts in adapting buildings to climate change, through the introduction of green buildings and sustainable designs. These methods are usually achievable with new buildings while the old buildings have to be retrofitted to cope with the challenges. Many faculty buildings in tertiary buildings date back to when climate issues were not as problematic as the 21st century. It is understood and certain that the earth has been undergoing a process that has resulted to physical changes and this change has direct impact on the climate condition, temperature, rainfall, snow, and wind patterns. Climate change awareness has been recognized globally as every part on earth is experiencing distinctive effects. In this regards, controlling and tackling climate change is begun by identifying the indigenous effect in a particular locality. There are two main contributing factors to the growing impact of climate change. There are:

Human factors

The introduction of industrialization which brought about industries, automobiles, and mining which in one way or the other operate by burning fuels which releases gases. These gaseous emissions over the years deplete the ozone layer causing increase in climate change. The most common and major contributor is gotten from burning of fossil fuels, the result of this action produces carbon dioxide gas to the atmosphere. The gas affects the earth's energy balance by altering the inflowing of solar radiation to the earth and the discharge of infrared which is also thermal radiation. This thermal radiation trapped in the earth's atmosphere leads to warming of the earth's surface.

Since the emergence of industrialization in the 1750's the overall earth's climates temperature has been found to be increasingly warmer. The following gases are related to human activity:

> **Carbon dioxide:** This comes from burning of fossils fuel in areas such as transportation, heating buildings, manufacturing of cement and mining.
>
> **Methane:** this gas is on the increase due to human activities in agriculture, natural gas distributions and landfills.
>
> **Nitrous oxide:** this is also emitted into the earth's atmosphere from fertilizers, burning of fuels and also natural soil processes and sea also releases N_2O.
>
> **Halocarbon gas:** The main use of this gas is as a refrigerating agent in industries and factories and also for other industrial processes.

Climate Change and the Global Awareness

There is increase awareness of climate change all over the world. Some major research concerns based on their physical impacts include population. It is shown that the increase in population of the earth has a direct influence on the effects of climate change (Swim, Clayton, & Howard 2011). Population includes;

- Consideration of population size
- Distribution of population
- Population density

Population size more effect on the environment as there are more people to limited resources in this case, to carter for the increase in population. There are more human activities and these causes it to be considered utmostly. The size of population in the world has grown exponentially over 100years. There are over 6.6 billion humans on the planet (US Census Bureau, 2015). So when considering population size per capital emission the potential of population growth and size on climate change is much greater in countries with high per capita emissions (international Energy Agency, 2007). With more population requires higher energy demand and this has resulted to countries such as United States of America emitting CO_2 25times higher than Africa currently (Carr, Suter & Barbieri, 2006).

Effects and Results of Climate Change

The potential occurrence of a natural or human-induced physical event or trend or physical impact that may cause loss of life, injury or other health impacts, as well as damage and loss to property, infrastructure, livelihoods, service provision, ecosystems and environmental resources. In many regions, changing precipitation or melting snow and ice are altering the hydrological systems, having huge impacts on quality and quantity of water sources. Melting glaciers are in constant shrinkage causing rise water level in some parts of the world. (Artic Climate Impact Assessment, 2015).

Aquatic live has been affected by the climate change with warmer water thereby causing shift in migrating patterns, abundance and species interactions in response to on-going climate change (Parker, Ketch & O'Reilly, 1997). In the case of agriculture, based on research as wide range of regions and crops production have been affected negatively with the recent occurrence in drought and heat wave. Crops such as rice and soybeans have been most affected because regions where they are mostly cultivated are hugely affected by the effects of climate change. Other impacts from recent climate-related extremes such as heat waves, drought, floods, cyclones and wildfires, reveal significant vulnerability and exposure of some ecosystems, the resulting effects of climate change to earth are: (Wang, Swail & Zwers, 2006).

Architecture and Climate Change

Refurbishment and retrofitting measures afford the opportunity to improve the energy efficiency of existing building. The various benefits that can be accrued from good buildings, adapting building design for climate change is about managing the unavoidable while there is debate around what level of adaptation is needed. There is a growing awareness that design practices need to take into account predictions of increased risk and intensity of extreme events. Architects in designing for climate change adaptation must acknowledge that the nature of the weather events is unlikely to remain the same throughout a buildings lifetime. Adaptation measures cannot prevent the significances of climate change.it can reduce to a great extent the risk of the influence (Parry, 2009).

An urban forest, especially trees, shrubs and green areas provides the micro climate service of reducing a city‘s carbon impact in two major ways, directly by carbon uptake from the atmosphere and long-term storage in wood, and indirectly by reducing a city‘s energy use. All plants take up CO2 from the atmosphere and convert the carbon into their living tissues. Unlike grasses and other herbaceous plants, however, only shrubs and trees store carbon in woody tissue for decades to centuries, and so keep enough CO2 out of atmospheric circulation over a sufficient time frame to reduce the rate of climate change.

Risk	Possible Effects
Rising temperature	Impact on external surfaces; thermal performance of building
More intense rainfall	Greater intensity of runoff; issues of structural integrity; drainage; opportunities for capturing rainfall
More frequent / intense cyclones	Greater strain on building material fixtures, claddings and fasteners; greater wind loading requirements
More frequent flooding	Sea level rise leading to coastal and inland flooding; more coastal salt spray; water damage to building contents; contamination from sewage, soil and mud; undermining of foundations
More fire events	Total or partial fire damage; smoke and water damage
More hail storms	Impact damage (mostly roofs, guttering, windows) and subsequent rain/moisture penetration
Increased humidity	Mould; condensation; decreased thermal performance of building
Decreased humidity	Higher risk of fire

Plate i showing effects of climate change on buildings
Source: environmentdesignguide.com.au

Approaching the course of retrofitting could be achieved through different approaches. Anticipatory (Proactive) adaptation is an approach that takes place before the actual effect of climate change is experienced. Such adaptation or approach is a pre-emptive measure to prevent or to minimise possible climate change. It weighs up the vulnerability of natural and man-made systems as well as the costs and benefits of action versus inaction. Planned Adaptation is a conscious policy decision based on an awareness that conditions have changed or are about to change and that action required to return to or achieve a desirable state. This approach is used in developed countries in the world. Some planned approaches include tree planting and reforestation. A post adaptation is called reactive adaptation where an adaptation that takes after impacts of climate change has been experiences, for instance when new building regulations follow a severe flooding event. It is very important to avoid this adaptation after the impact has been felt and damages done, it could also be very expensive to manage. The final adaptation is autonomous (spontaneous) adaptation**,** this is an adaptation that does not constitute a conscious response to climatic stimuli but is triggered by ecological changes in natural systems and by market or welfare changes in human systems (Mark & Deo, 2011).

Climate Change and Faculty Buildings in Niger state

There has been obvious impact on the micro climate in Niger state with registered reduction in minimum temperature, humidity, and rainfall. The relative humidity represents the amount of water vapour existing in the atmosphere in a specific zone. Niger state has recorded up to 21°C as at the early 90's but currently Niger state has recorded 24°C as its minimum temperature. This information then proves that it's getting warmer gradually, and due to these effects of climate change, humans have changed pattern of living because the weather is warmer now, there are reoccurring illnesses causing people to remodel their residential spaces (Ayinde, Muchie & Olatunji, 2011).

Niger state has a total of 16 tertiary institutions distributed across the state with most of the institutions established as far as in the early 1970's. this would give an idea of the style of architecture apapted during the construction of the faculty buildings. With no obvious considerations for future changes, most faculty buildings provide no flexible characteristics to the changing trend in climate. Faculty buildings located in this state also feel its own deep effects on the progressing climate change as most tertiary institutions were built without the consideration of futuristic situations. Heat trapping in buildings occurs when the heat absorbed into the building during the day from the sun remains in the building space thereby increasing the internal temperature. Building elements used in faculty buildings in Niger state such as concrete roof decking, high level windows, and poor orientation contribute immensely to heat trapping within the building (Ayinde, Muchie & Olatunji, 2011).

RESEARCH METHOD

An Observation Schedule was used as research instruments to gather the required data from selected tertiary institutions in Niger State. Each institution studied represents the various categories of established tertiary institutions in Niger state. The data from the observation schedule was used to interpret results observed in the course of the study. The observation study was carried out on offices of faculty building and its effectiveness over time and the level of satisfaction it has given its users. The administration of the research instruments was carried out using 2015

Postgraduate students of the Department of Architecture who were selected and trained and were assigned to the different institutions. The observation schedule was collated and sorted out before it was keyed into the SPSS software version 21 for analysis. The descriptive tools of cross-tabulation and frequency were used to analyse the data and the results were transferred to Microsoft-Excel package where the generated tables were used to develop the charts and graphs.

Table 1: Institutions Studied

Name of Institution
State Polytechnic Zungeru
Ibrahim Badamosi Babangida University, Lapai
College of Education Minna
Federal Polytechnic Bida
College of Nursing Bida

Source: Authors' fieldwork, 2016

FINDINGS AND DISCUSSION OF RESULTS

Retrofitting in Modern Architecture

Retrofitting can best be understood as remodelling and adding more features to improve its efficiency. In architecture, retrofitting is a constant practice as the desires of users change. In fig1 it can be seen that most faculty buildings of tertiary institutions in Niger state were not built for some other purposes and later adopted to be used as an educational institute. Although over time more buildings were added resulting to in the results shown in fig 1 as there is 0% of the building in Ibrahim Badamosi Babangida University, while in fig 2 it further buttresses the point by showing that the same tertiary institution has a well-planned out relaxation spaces using balconies for its users. Plate 1 shows the use of balconies surrounding a courtyard with planted green landscape to provide users of the building with easy circulation, an open airy space with landscape to absorb some of the carbon dioxide. The use of balconies also retreats the interior space from direct sunlight or driving rain, this then prevents the offices from direct heating of the sun.

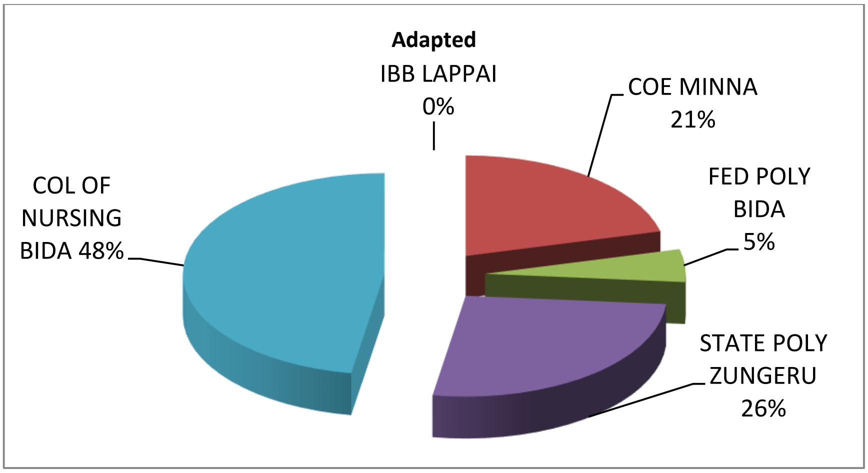


Fig 1. Institutions with adapted buildings Source: Author's fieldwork (2015)

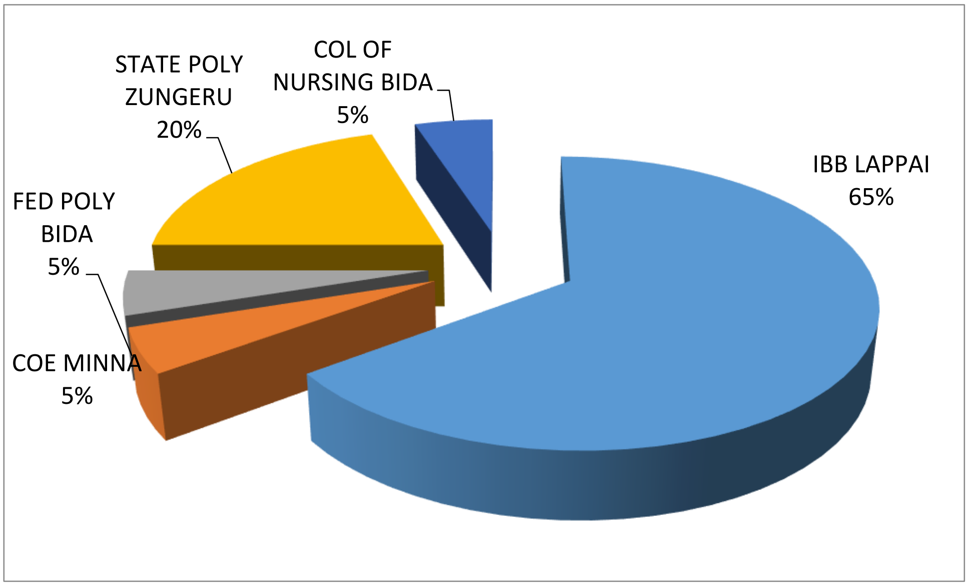


Fig 2 showing institution with relaxation spaces Source: Author's fieldwork (2015)


Plate ii showing combination of balconies and landscaping at IBB University Lappai

Building Elements in Faculty Buildings

With the current trends in climate change it is necessary to consider the building flexibility in design, this is to allow for unexpected decisions to most possible changes in climate conditions. This may include no-regret strategies that bring benefits even in the absence of future climate change. Designers should also be in the loop of current research that involves the locality of the brief. This is to enable the designer proffer adequate materials to suit the current climate change evolution preparing the building for the predicted hazards. Passive design strategies have the double benefit of countering increasing temperatures without underestimating mitigation efforts. The majors of passive design are:

- Thermal Mass
- Insulation
- External shading
- Cross ventilation

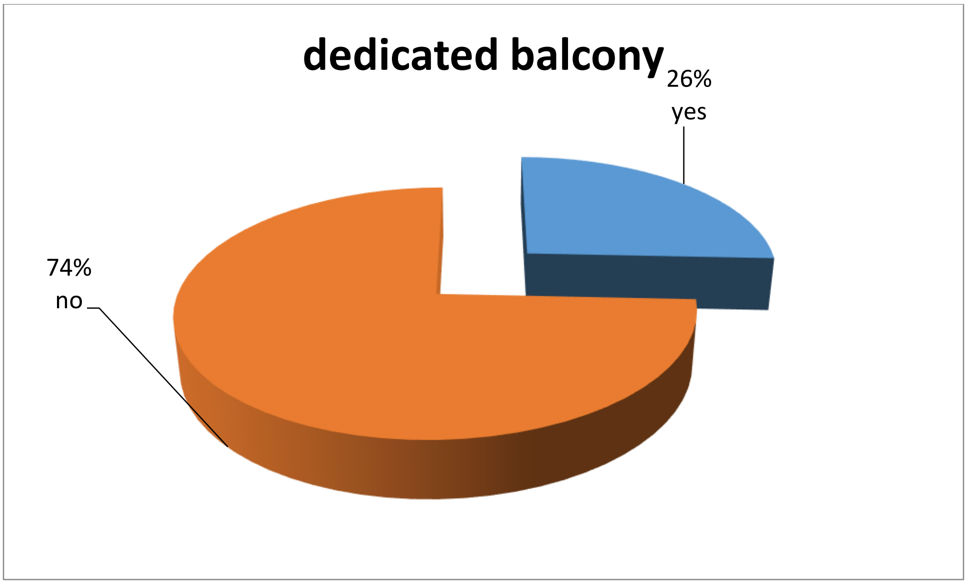


Fig 3 showing presence of balconies among all institutions Source: Author's fieldwork (2015)

Offices of tertiary institutions according to fig 3 have put away with considerations in the further warming of the climate. As for this, use of balconies which are spaces for multiple uses and provide airier spaces for staff to make use of are disregarded and misused or converted to storage places. Retrofitting on old buildings of faculty buildings and considering the above listed majors of passive design can go long way in providing a more conducive environment for staff to work in with the age of the institutions studied table 2 shows the years most of the faculty buildings were built and relating this with the report of change in the local climate. Restructuring the initial design with better façade and also reducing the amount of energy consumption in the building by a reasonable percentage.

Table 2: Institutions with their Year of Establishment

Name of Institution	**Year Established**
State Polytechnic Zungeru	1977
Ibrahim Badamosi Babangida University, Lapai	2005
College of Education Minna	1975
Federal Polytechnic Bida	1978
College of Nursing Bida	1976

Source: Authors' fieldwork, 2016

Retrofitting for Comfort

Since fig 1 has shown that most faculty offices were adopted and this gives room for retrofitting these buildings to provide enough comfort for staff who are its direct users. Balconies can be used to adapt to the rising temperature of Niger state by retrofitting the current existing build. Also in fig 4 and 5 shows the need expand on office space by retrofitting, because these small spaces plays major negative impact on both the physical and mental health of the staff. The adaptation of balconies would create a wider spatial impression and also give a better looking façade to the old buildings and supported with other building elements. Redesigning office spaces to adapt to climate change by changing the building elements in terms expanding windows and introducing wider spaces and shading devices puts the users in comfortable positions. In other words, a planned adaptation approach retrofits faculty buildings to protect the functionality of the faculty buildings in these tertiary buildings against the rising effects of climate change.

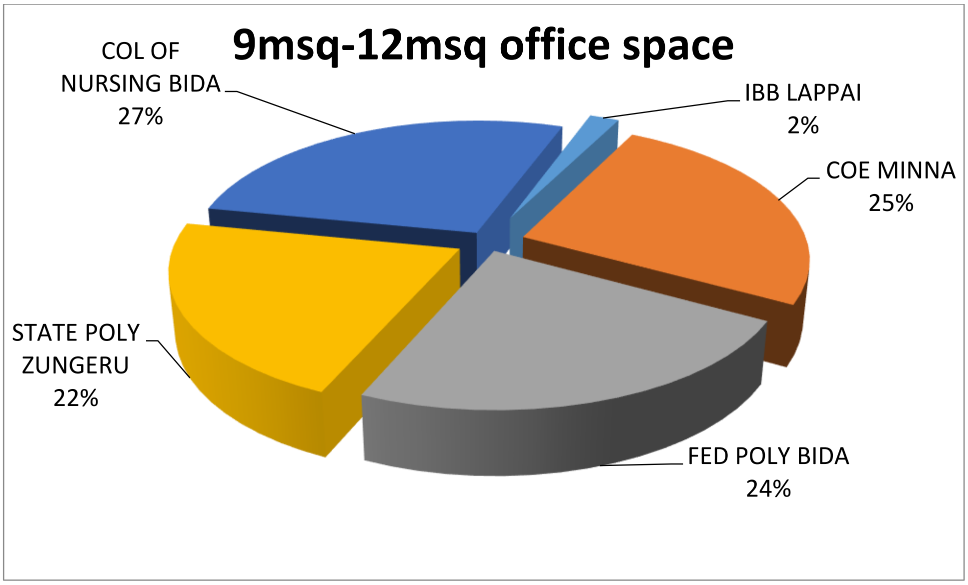


Fig 4 showing distribution of office spaces Source: Author's fieldwork (2015)

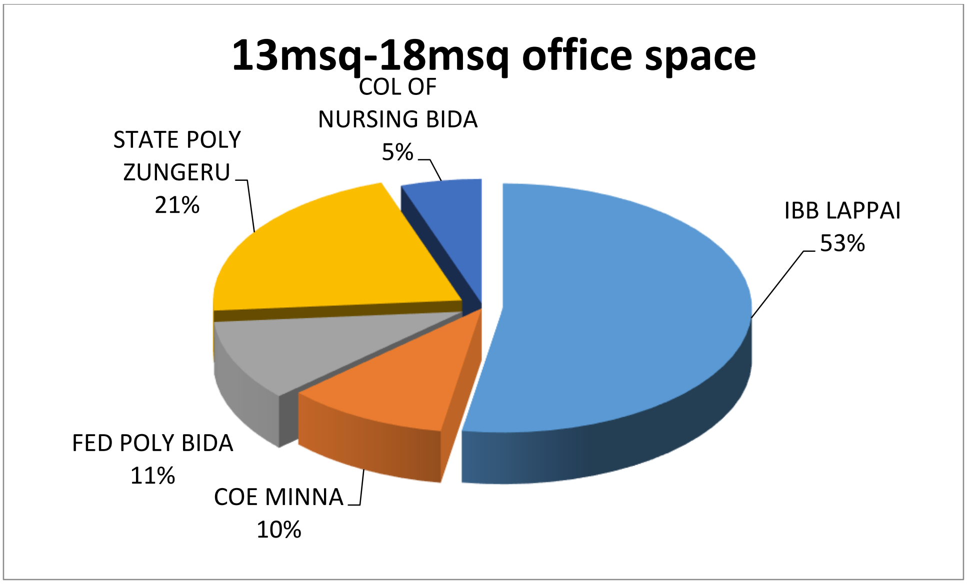


Fig 5 showing distribution of office spaces Source: Author's fieldwork (2015)

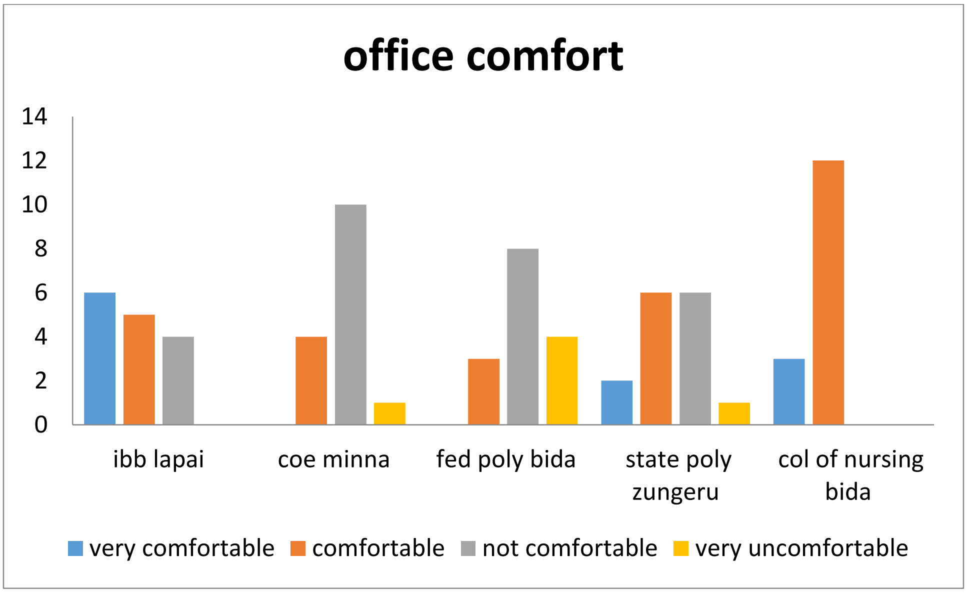


Fig 6 showing presence of balconies in faculty offices Source: Author's fieldwork (2015) v

Plate iii showing balcony in a faculty building of State Polytechnic Zungeru

CONCLUSION

From all the findings of the research carried out above, it can be concluded that there is a progressive warming of the earth and Niger state is not excluded. Though Niger state is in Nigeria, it is experiencing its own part of climate change because this has affected different aspects of its habitation.

With the fast growing population of students and staff, the general expansions on the institutions have failed to acknowledge perception of staff towards their office spaces. Architecture today has provided diverse means of adjusting buildings by remodelling them to suit its users. Therefore situation such as the effect of climate change should be a driving factor to improve on existing building spaces.

Faculty buildings in tertiary institutions of Niger state are mostly old buildings that were built for other purposes but were later adopted for other purposes. The condition of staff offices leaves staff in very tiny spaces to work in as the years are rolling by the weather get hotter and unbearable for staff to work in. According to this study, the weather would get hotter and more extreme with no structural adaptation measures by these faculty buildings to combat the effects, buildings would become more and more uncomfortable for users.

REFERENCES

Arctic Climate Impact Assessment. (2005). "*Arctic Climate Impact Assessment*. Cambridge University Press". 1042 pp. Bernier N and Thompson KR 2006. *Predicting the frequency of storm surges and extreme sea levels in the northwest Atlantic*. J. Geophys. Res. 111, C10009.10/29/2005.

Ayinde, O. E., Muchie, M. and Olatunji, G. B. (2011). "Effect of Climate Change on Agricultural Productivity in Nigeria: A Cointegration Model Approach" *Journal of Human Ecology* 189-194

Consultative Group on International Agricultural Research, CGIAR (2009), *Climate, Agriculture and Food Security: a Strategy for Change.* http//:www.cgiar.org

Khanal, R.C. (2009), "Climate Change and Organic Agriculture" *The Journal of Agriculture and Environment*, 10,100-110.

Parkes G.S, Ketch L.A and O´Reilly C.T.O. (1997). "Storm surge events in the Maritimes". Proceedings, 1997 Canadian Coastal Conference, 21--24 May 1997, Guelph, Ontario. Can. Coast. Sci. and Eng. Assoc. pp. 115--129.

Parry, M, Arnell, N, Berry, P, Dodman, D, Fankhauser,S, Hope, C, Kovats, S, Nicholls, R, Satterthwaite,D, Tiffin, R, Wheeler, T, (2009). "*Assessing the Costs of Adaptation to Climate Change": A review of the UNFCCC and other recent estimates*, International Institute for Environment and Development and Grantham Institute for Climate Change, London

Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M.Tignor and H.L. IPCC, (2007). "*Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* Miller (eds.)". Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Swim, J. K., Clayton S., and Howard, G.S., (2011). "*Human Behavioural Contributions to Climate Change. Psychological and contextual drivers. American Psychological Association"*. Vol. 66 (251-264).

Wang X.L, Swail V.R and Zwiers F.W., (2006). "Climatology and Changes of Extra-tropical Cyclone Activity": Comparison of ERA--40 with NCEP–NCAR Reanalysis for 1958– 2001. J. Climate 19: 3145–3166.

SOIL CARBON DIOXIDEEFFLUX IN THREE DIFFERENT CANOPY DENSITIES OF TROPICAL FOREST, PENINSULAR MALAYSIA

MANDE Kato Hosea*[1] AHMAD Abdullah Makmom[2], AHMAD Zaharin Aris[3], AHMAD Ainuddin Nuruddin[4], SULEMAN, Ezekiel Nghai[5]

[1]Air Pollution & Ecophysiology Laboratory, Department of Environmental Science, Faculty of Environmental Studies, Universiti Putra Malaysia, 43400 UPM Serdang, Selangor, Malaysia.
[2]Department of Environmental Sciences, Faculty of Environmental Studies, Universiti Putra Malaysia, 43400 UPM Serdang, Selangor Darul Ehsan, Malaysia.
[3]Environmental Forensics Research Centre, Faculty of Environmental Studies, Universiti Putra Malaysia, 43400 UPM Serdang, Selangor Darul Ehsan, Malaysia.
[4]Institute of Tropical Forest and Forest Product University Putra Malaysia 43400 UPM, Serdang, , Selangor Darul Ehsan, Malaysia.
[5]Department of Architecture, Kaduna State University P.M.B 2339 Kaduna, Nigeria.

Soil CO_2 efflux has been identified as playing a key role in the forest carbon balance, hence, it is essential to understand soil CO_2 efflux in different stand densities and carbon cycles. The aim of this paper was to determine the influence of environmental and biological factors on soil CO_2 efflux under different forest canopy densities. The selection of the experimental plots was based on stand density, which strongly affects the estimation of soil CO_2 efflux as well as the environmental and predictor factors. A detailed study of soil CO_2 efflux, its environmental and predictors factors were conducted in three different forest canopy densities with the same physical-geographical environmental conditions in the 30 years Dipterrocarp Ayer-Hitam research forest of Universiti Putra Malaysia. Three compartments based on Leaf Area Index (LAI) of dense, open and moderate canopy sites were studied. Measurements of soil CO_2 effluxes were conducted using a continuous open flow chambers technique connected to a multi gas-handling unit and infrared CO_2/H_2O gas analyser. One-way ANOVA and the multiple linear regressions indicated the impact of environmental variables and biological processes on soil CO_2 efflux across the different canopy densities. Soil CO_2 effluxes ranged from 114.31-467.57mg/m^{-2}/h^{-1} ($P<0.001$), 76.26-459.84mg/m^{-2}/h^{-1} ($P<0.001$) and 98.18-510mg/m^{-2}/h^{-1}($P<0.001$) in dense, open and moderate canopies, respectively, with the highest CO_2 emission from the moderate forest canopy. Generally, high soil moisture and soil temperature signify the most influential factors controlling soil CO_2 efflux. As predicting variables, soil organic carbon (SOC), total organic carbon (TOC), litter fall carbon and nitrogen (C&N), soil moisture content and porosity (bulk density) account for the spatial and temporal variation in soil CO_2 efflux. These explain the impact and significant contribution of the environmental factors and biological processes on soil CO_2 efflux across the 30-year *Dipterocarp* canopy densities.

Keywords: *Canopy density, Carbon budget, Forest ecosystems, Leaf Area Index, Litter fall, Soil CO_2 efflux.*

mandebo10@yahoo.com

Mande et. al. (2016). **SOIL CARBON DIOXIDEEFFLUX IN THREE DIFFERENT CANOPY DENSI TIES OF TROPICAL FOREST, PENINSULAR MALAYSIA** Sustainable Built Environment and Climate change; The challenges of Post 2015 Development Agenda. School of Environmental Technology Conference, SETIC, 2016

INTRODUCTION

Global climatic change occur as a result of the increase in greenhouse gas contributed by the terrestrial carbon budget (Schlesinger & Andrew, 2000; Dufresne *et al*., 2002), whereas global warming can trigger soil CO_2 efflux into the atmosphere to compensate the carbon update by photosynthesis (Piao *et al*., 2005), which resulted from high amount of carbon in the soil of the terrestrial ecosystem (Dupouey *et al*., 1999; Luyssaert *et al*., 2010). However, any change in the environmental variability will affect the autotrophic and heterotrophic respiration by roots and soil organism, thereby increasing the soil CO_2 efflux, (Luo & Zhou, 2006; Pangle & Seiler, 2002; Gough & Seiler, 2004).

Soil CO_2 efflux has been recognised as a major factor for climate change, and evaluating the capacity of forest ecosystems for different stand canopy densities, tree species, age and forest management activities is paramount. In addition, assessing their contributing impact on the atmospheric carbon balance influence global climate change and predicting future occurrences is vital (Wang *et al*., 2006; Lee & Jose, 2003; Pypker & Fredeen, 2003).

Kim *et al*. (2009), and Litton *et al*. (2003) reported that the management of forest activities, such as deforestation, thinning, land use and fire, have increased soil CO_2 efflux, which is found to be much related to the succession *Dipterocarp* forest canopy density of the Ayer-Hitam research forest for tropical rainforest ecosystems, Peninsular Malaysia. The forest ecosystem has been recognised as as a sink for CO_2, because of its high productivity, which is a good mitigation factor for climate change (Goodale *et al*., 2002; Nabuurs *et al*., 2003). A study of carbon dynamics under different forest canopy densities is paramount in understanding global carbon cycles (Linderner & Karjalainen, 2007; Jandl *et al*., 2007).

The determination of soil CO_2 efflux in relation to major environmental factors is vital to ascertain the controlling factors and the corresponding CO_2 efflux from the soil via the forest into the atmosphere. This process can be used for calculating the percentage of CO_2 emitting into the atmospheric carbon pool, notwithstanding the challenges in estimating the soil CO_2 efflux into the atmosphere and its percentage because of the spatial heterogeneity and temporal variability of the carbon stock, as this is linked to the dynamic carbon stock in the soil (WBGU 1998; IPCC 2000; Schimel 1995). Although various studies have examined soil respiration and environmental factors under different climatic and vegetation conditions using different techniques (Davidson & Janssens, 2006; Hibbard *et al*., 2005), there is much to be explored in the converted and logged tropical rainforest ecosystem in terms of soil CO_2 efflux. Even though, Lulie *et al*. (2005), Wan *et al*. (2003), Adachi (2005) and Rahman *et al*. (2005) reported that the 30-year old succession

Depterocarp forest is under threat from further logging in years to come, the studies on soil respiration and related factors are limited. The soil CO_2 efflux of the tropical rainforest is an important issue on both the regional and the global scale.

MATERIALS AND METHODS

Site Description

An extensive field experiment was performed throughout the months of October 2012 and February 2013 (monsoon period) in the dense, open and moderate forest densities of 30-year *Dipterocarp* forest canopy of the Ayer-Hitam forest reserve. The reserve has a land mass of 1248 hectares, and is located 15-233m above sea level with a slope slant of 10-20% in the multimedia and super corridor area. The reserve is a research and extension forest for Universiti Putra Malaysia. The study area is approximately 45km from Kuala Lumpur; (Paiman *et al*., 2007).

The objective of this study was to determine the influence of the environmental factors on soil CO_2 efflux under different forest canopy densities in the tropical rainforest ecosystem and also to use an efficient constructed technique and model to estimate the rate, spatial and temporal variation in soil CO_2 efflux across the different forest canopy stand densities.

The reserve experiences equatorial climatic conditions with a temperature of 22.7^{o}C and relative humidity of 59-96%, with an average of 83%, (Pius, 2000). The soil is classified as belonging to the Serdang-Kedah series with a combination of local alluvium colluvium resulting from metamorphic rock, (Pius 2000). Three 50m square experimental areas were established, within 1500m of each other. Soil CO_2 efflux, soil temperature, soil moisture, litter fall and soil sampling were randomly collected at 27 sampling points for each of the three forest canopy densities. The LAI was measured using a sunfleck ceptometer (AccuPAR model sf-80, Decagon, Pullman, WA) (Bolstand & Gower, 1990).

Land use history

The Ayer Hitam forest was logged during the period of 1936-1951 and several rehabilitation activities have since been undertaken to improve the forest ecosystem, which is based on the Malaysian uniform system (MUS) with a post-F inventory carried out in 1995 to ascertain the resources of the forest reserved, (Paiman *et al*., 2007).

Soil CO_2 flux measurement

Soil CO_2 efflux was measured each day from 0800 hours to 1700 hours from 1 November 2012 to 31 February 2013, using two continuous open flow chambers of 64cm in height and 50cm width, with a volume of 3250cm^3 and enclosed soil surface area of 2500cm^2. The ambient air was directed into the chamber from a constructed ambient air stabilizer via tubing. The chamber was made up of a flow fan for the mixture of CO_2 and a 3cm thick closed foam gasket was placed between the chamber base and the soil collar to prevent leakage.

The chambers were connected to a multi gas-handler (WA 161 model), which provides a channel to regulate the flow of CO_2 from various chambers to a flow meter connected to a CO_2/H_2O gas analyser (Li-Cor 6262). A standard calibration (zero setting) of CO_2 and H_2O was carried out using silica gel and soda. Soil collars were randomly inserted 3cm into the soil for 24 hours before the commencement of measurement for the soil pressure to stabilize in order to attain equilibrium. The measurement lasted for 9 hours each day and the CO_2 efflux was recorded every 5secs over a period of 5min in each chamber, from which an average was calculated to estimate the CO_2 concentration over 5min for each chamber. The total soil CO_2 efflux was estimated based on the derived equation:

$$R_s = \sum \frac{(CO_{2_{chamber}} - CO_{2_{ambient}})}{A\ x\ T} = g\ CO_2 m^{-2} s^{-1} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots [1]$$

Where:

R_s is the soil CO_2 efflux ($gCO_2m^{-2}s^{-1}$), $CO_{2chamber}$ and $CO_{2ambient}$ are the CO_2 concentrations of the chamber and ambient air stabilizer, respectively, and A is the surface area of the chamber with T as the time.

Soil temperature, soil moisture, litter fall, bulk density, soil organic carbon (SOC), total organic carbon (TOC), soil pH, soil moisture content, carbon (C) and nitrogen (N) contents in litter fall were measured to establish the linear relationship with soil CO_2 efflux.

Soil Temperature and Moisture

Soil temperature and soil moisture were measured at a depth of 5cm at intervals of 5min concurrently with each soil CO_2 chamber reading using soil temperature and moisture probes (Watchdog data logger model 125 spectrum technology and Delmorst model KS-D1), respectively.

Soil Sampling and Analysis

Soil samples were taken randomly at sampling points of each plot from a depth of 0-100cm. The soil samples were weighed, air dried and oven dried at 105ºC for 48 hours. The soil moistures content was determined using ISRIC (1993) based on the following equation:

Moisture content in wt% (w/w)

$$Moist\ (wt\%) = \left[\frac{(A-B)}{(B - tare\ tin)}\right] x\ 100 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots [2]$$

With a corresponding moisture correction factor (mcf) for analytical results as:

Moist correction factor=(100 + %moist)/100

A=air dry soil, B=oven dry soil.

The bulk density determination was done in accordance with the method of soil analysis part 1 [1986] using the formula:

$$Bulk\ density\ (mgm^{-3}) = {}^{g}/_{v} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.. [3]$$

Where:

g=oven dry mass of the sieved soil (g), v=sample volume (ml).

Soil Organic Carbon (SOC) was estimated using the following equation;

$$M = {}^{10}/_{Vblank} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.. \ldots\ldots\ldots\ldots\ldots\ldots\ldots.. \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.. [4]$$

$$\%oxidizable\ organic\ carbon\ ({}^{w}/_{w}) = {}^{[V\ blank - V\ sample]}/_{Wt}\ x\ 0.3\ x\ mass \ldots\ldots [5]$$

$$\%total\ organic\ carbon\ ({}^{w}/_{w}) = 1.334\ x\ \%\ oxidazable\ organic\ carbon \ldots\ldots.. \ldots\ldots [6]$$

$$\%organic\ matter\ ({}^{w}/_{w}) = 1.724\ x\ \%total\ organic\ carbon \ldots\ldots\ldots. \ldots\ldots\ldots\ldots\ldots\ldots\ldots. [7]$$

Where:

M = molarities of ferrous ammonium sulphate solution (app 0.5ml)

V blank = volume of ferrous ammonium sulphate solution required to titrate the blank (ml)

= Volume of ferrous ammonium sulphate solution required to titrate the sample (ml)

wt = weight of air dry soil (g)

0.3 = 3 x 10^{-3} x 100 where 3 is the equivalent weight of C.

Total organic carbon (TOC) was determined by the Walkley-Black method using a correction factor of 1.33 (Sollins *et al*., 1999) as it is appropriate for moisture analyses because of its simplicity.

$$Toc\ (\%c) = M\ x\ \left[{}^{(V1 - V2)}/_{S}\right] x\ 0.39\ x\ mcf \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad [8]$$

Where:

M = molarities of ferrous sulphate solution (from blank titration)

V1 ml ferrous sulphate solution required for blank

V2 ml ferrous sulphate solution required for S = weight of air dry sample in grams

mcf = 3 (equivalent weight of carbon) corrected factor.

Organic Carbon Input by Litter Fall and Leaf Area Index (LAI)

To ascertain the input of litter fall to soil carbon a 1m x 1m litter trap with $1mm^2$ mesh net to avoid decomposition was placed 1m above the forest floor with three litter traps placed on each plot site. The litter was collected at intervals of 14 days for a period of four months (1st October 2012 to 28th February 2013). They were weighed and air dried in the laboratory and oven dried at 70^0C for at least 48 hours, before weighing and separating into leaves, twigs, fruits and miscellaneous components. Carbon and Nitrogen were determined using a TruMac CNS Macro Analyser (LecoCorp). The different canopy densities of the three plot sites were determined based on leaf Area Index (LAI). A sunfleck ceptometer (AccuPAR model sf-80, Decagon, Pullman, WA) (Bolstand & Gower, 1990) was used for determining the canopy leaf distribution (dense, open and moderate canopy densities) and the LAI was determined as an instant measurement. Readings were taken in each forest stand density, in each of the four cardinal directions with the positioning of the ceptometer placed horizontally 1m above ground level (Bolstand & Gower, 1990).

Statistical Analysis

An equation was developed to estimate the total amount of soil CO_2 contributed in the forest carbon budget from each stand canopy density based on the measurement of soil CO_2 efflux, soil temperature and soil moisture. SPSS software (SPSS Inc., Chicago, Illinois, USA) version 20 was used for the repeated measures analysis using one-way analysis of variance (ANOVA) to present the means ±, standard deviation of [n] and significant differences of soil CO_2 efflux across the three different forest canopy densities of the forest ecosystem.

Descriptive Statistics explain the normality of data distribution and relationship of soil CO_2 and environmental parameters respectively. Partial Correlation shows the relationship between the bivariates when the third variable is held constant.

The multi linear regression model was employed to ascertain the impact of the environmental variables on soil CO_2 efflux. The techniques were used for both predictive and explanatory purpose with the experimental and non-experimental design which can be represented in the equation below:

$$Y_i = \beta_0 + \beta_1 X_{i1} + \beta_2 X_{i2} + \ldots \ldots + \beta_p X_{ip} + \epsilon_i \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots . \ldots \ldots \ldots . [9]$$

Where:

Thus,- Y_i is the i^{th} observation of the dependent variable,- X_{ij} is the i^{th} observation of the j^{th} independent variable,- $j = 1, 2, ..., p$. The values β_j represent the parameters to be estimated, and ε_i is the i^{th} independent identically distributed normal error.

RESULTS

Soil CO_2 efflux

Soil CO_2 efflux in the dense canopy forest ranged from 114.31-467.57mg/m^{-2}/h^{-1} (Table 1), low emission was recorded between 0800hrs and 1100hrs while there was a pronounced increment between 1300hrs and 1500hrs. The mean soil CO_2 efflux recorded was 317.3263mg/m^{-2}/h$^{-1.}$ The Soil temperature, moisture and water potential maintained a high rate throughout the period of measurement, 25-27^{o}c, 24.4-26.42% and 97-98% respectively. The open canopy displayed a range of soil CO_2 efflux from 76.26-459.84mg/m^{-2}/h^{-1}and a means of 245.9130mg/m^{-2}/h^{-1} (Table 1). The peak of emission was observed at 11.50am to 2.30pm whereas soil temperature, moisture and water potential increased with time by 25.20^{o}C to 26.80^{o}C, 25.01 to 26.42 and 97.40 to 97.80%, respectively. The moderate canopy flux increased from 98.18-510.03mg/m^{-2}/h^{-1} with a mean of 291.9368mg/m^{-2}/h^{-1}

(Table 1) while the soil temperature, moisture and water potential increased from 24.80 to 26.50°C, 23.52 to 26.60% and 97.70 to 97.80% respectively.

Table 1: Descriptive statistics of soil CO_2 efflux microgram /mole/hour ($mg/m^{-2}/h^{-1}$)

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Dense Forest Canopy CO2	216	317.3263	108.34415	7.37189	302.7959	331.8568	114.31	467.57
Open Forest Canopy CO2	216	245.9130	93.86495	6.38670	233.3244	258.5016	76.26	459.84
Moderate Forest Canopy CO2	216	291.9368	114.53467	7.79310	276.5761	307.2974	98.18	510.03
Total	648	285.0587	109.83040	4.31455	276.5865	293.5309	76.26	510.03

Bulk density, soil moisture content, soil pH, SOC and TOC

The soil bulk density for the dense canopy increased with depth but slit twist at the 80cm and 100cm depth (Fig 1), while open canopy soil bulk density fluctuated along the various depths (Fig 1). The fluctuation of bulk density was also recorded in the moderate canopy (Fig 1.0). The physiochemical parameters recorded from the soil sample analysis showed the soil pH in the three forest ecosystems to be moderately slightly acidic, with pH 5.77, pH5.6, pH 5.67pH (Table 2) for the dense canopy, open canopy and moderate canopy respectively. While the SOC in the top soil of 10cm was found to be higher in the moderate canopy, followed by the dense and open canopy with 4.924%, 4.223% and 1.408%, respectively (Table 2; Fig 2), the TOC varies across the three forest ecosystems with 1.4%, 2.3% and 4.6% for the dense, open and moderate canopies, respectively (Table 2.0; Fig 2.0). The soil moisture content showed a higher H_2O content for the moderate canopy, followed by the open canopy and very low in the dense canopy with 37.39% and 22.26% and 1.58%, respectively (Table 2), and a correction factor of 1.37, 1.22 and 1.02 for the moderate, open and dense canopies, respectively (Table 2).

Table 2: Analysis of soil sample and litter fall.

SAMPLE PLOTS	SOC %	TOC %	pH	Soil moisture content %	Moisture correction factor	Litter falls	
						Carbon %	Nitrogen %
Moderate Canopy	4.925	4.6	5.67	37.39	1.37	47.92	1.29
Dense Canopy	4.224	1.4	5.77	1.58	1.02	49.05	1.31
Open Canopy	1.408	2.3	5.67	22.26	1.22	48.10	1.19

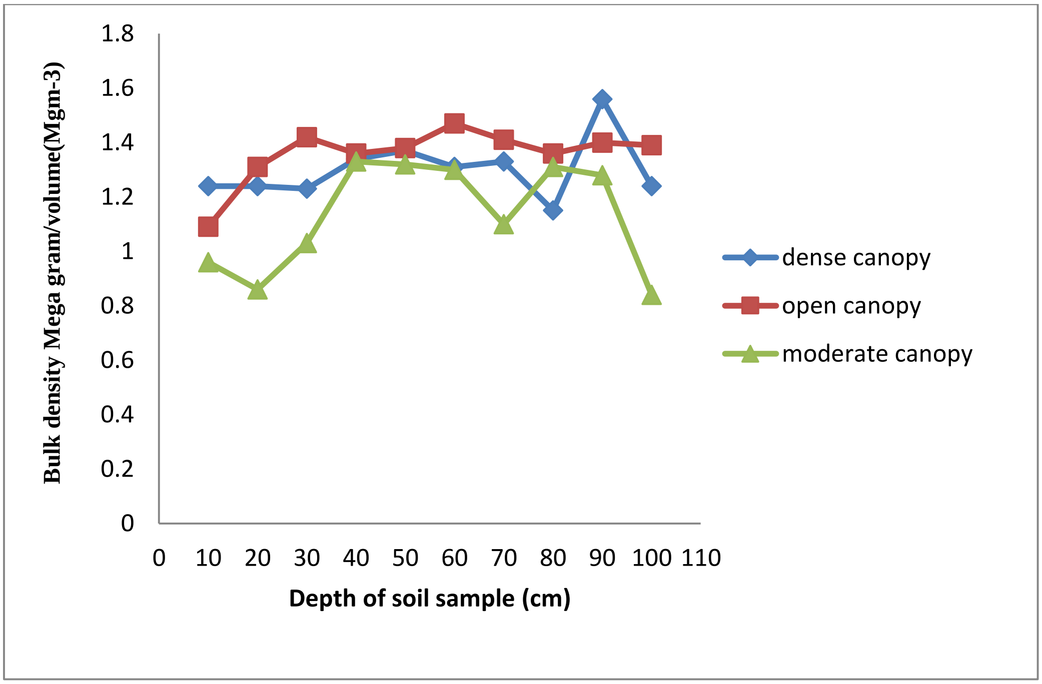


Figure 1: Earth Bulk Density

Litter Fall (Carbon and Nitrogen) Input

Consideration of the soil CO_2 efflux spatial and temporal variation rate in relation to several biophysical and environmental conditions in terms of litter fall, and C and N concentration, was previously reported by Saiz *et al*, (2006). In this study the percentage contributions of C and N within the three different canopy stand densities were high, with carbon found to be 49.05%, 48.09% and 47.92% for dense, open and moderate canopy stand densities respectively. In addition, the nitrogen was 1.3%, 1.29% and 1.19% for the dense, moderate and open canopy stand densities, respectively (Table 2).

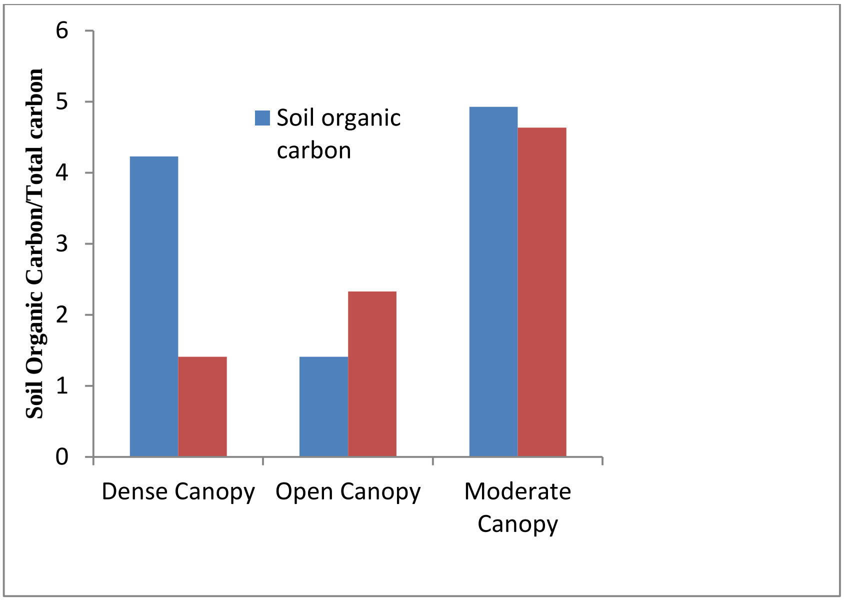


Figure 2: Soil Organic Carbon and Total Organic Carbon

Soil moisture, soil temperature and water potential input

The spatial and temporal variations of the soil CO_2 effluxes were well explained using the multiple regression model, which showed the high impact of soil moisture, temperature and water potential at 0.142, 0.192 and -0.132, respectively in the dense canopy (Table 3), while in the open canopy showed an impact for 0.022, -0.066 and 0.286 of soil moisture temperature and water potential respectively (Table 4). The moderate canopy showed a beta coefficient of -0.176, 0.165 and 0.048 for soil moisture, temperature and water potential, respectively (Table 5.0). Correlation using Bivariate Guilford's rule of thumb indicated a relationship between soil CO_2 efflux and soil moisture, water potential and temperature (Table 6).

Table 3: Dense canopy estimates of coefficient of the model of environmental parameters in degree Celsius and percentage (^{0}C and %)for soil temperature, soil moisture and water potential

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
	B	Std. Error	Beta			Tolerance	VIF
(Constant)	11358.177	7344.355		1.547	.123		
DST	34.793	12.131	.192	2.868	.005	996	1.004
DMT	23.776	13.254	.142	1.794	.000	.712	1.404
DWT	-128.646	77.153	-.132	-1.667	.000	.712	1.404

a. Dependent Variable: Dense Forest CO_2. DST=Dense Forest soil Temperature, DMT=Dense Forest soil Moisture, DWT=Dense forest water potential.

Table 4: Open canopy estimates of coefficient of the model of environmental parameters in degree Celsius and percentage (^{0}Cand %) for soil temperature soil moisture and Water potential

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	-17233.366	4519.239		-3.813	.000		
	OST	10.096	12.039	.066	.839	.003	.696	1.436
	OMT	-2.599	9.303	-.022	-.279	.000	.686	1.458
	OWP	177.096	48.833	.286	3.627	.000	.687	1.455

a. Dependent Variable: Open Forest CO2. OST=Open forest soil Temperature, OMT=Open forest temperature, OWT=Open forest water potential.

Table 5.0: Moderate canopy estimates of coefficient of the model of environmental parameters in degree Celsius and percentage (^{0}C and %) for soil temperature, soil moisture and water potential

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	-488.941	8081.594		-.061	.952		
	MST	33.966	14.022	.165	2.422	.016	.958	1.044
	Mmt	-236.371	89.818	-.176	-2.632	.005	.993	1.007
	MWP	56.557	79.135	.048	.715	.018	.964	1.037

a. Dependent Variable: Moderate ForestCO2. MST=Moderate forest soil temperature, MmT= Moderate soil moisture, MWP=Moderate forest water potential.

Table 6: Correlations statistics of environmental parameters under study (soil temperature, soil moisture and Water potential).

	OpenCanopiesCO2	Moderate Canopies CO2	Dense Canopies Soil Tempt	Open Canopies Soil Tempt	Moderate Canopies Soil Tempt	Dense Canopies Soil Moisture	Open Canopies Soil Moisture	Moderate canopies Soil Moisture
DenseCanopiesCO2								
OpenCanopies CO2								
Moderate Canopies CO2	.016 .814							
DenseCanopiesSoil Tempt	-.078 .569	.159 .242						
OpenCanopies SoilTempt	.267* .030	.241 .052	.820** .000					
Moderate Canopies SoilTemp	.269* .022	.248* .034	.869** .000	.871** .000				
DenseCanopiesSoil Moisture	.094 .491	.305* .022	.054 .693	.358** .007	.174 .200			
OpenCanopies SoilMoist	.215 .083	.258* .036	.747** .000	.982** .000	.836** .000	.455** .000		
Moderate canopiesSoilMoisture	.105 .377	.266* .023	.852** .000	.865** .000	.667** .000	.239 .076	.868** .000	
	 .455	.596 .664	.786 .423	.863 .643	.943 .864	.864 .743	.324 .534	
DenseCanopies waterPotential	.745	.342 .532	.845 .764	.974 .873	.924 .856	.975 .875	.845 .745	
	.546	.845 .083	.533 .765	.741 .875	923 .892	.459 .634	.845 .867	
OpenCanopy waterPotential	.843							
	.654							
Moderate Canopies waterPotential	.567							

*. Correlation is significant at the 0.05 level (2-tailed). **. Correlation is significant at the 0.01 level (2-tailed).

DISCUSSION

Soil CO_2 efflux

The ANOVA statistical analysis revealed good significant differences in soil CO_2 effluxes across the three forest canopy densities with a significant level of $p<0.001$. A post Hoc Test (Tukey/Scheff/Bonferroni) indicated a significant difference at the $p<0.001$ level. The normal Q-Q plot of distribution showed that all observed values in the three ecosystems fall along the straight line and the box plot showed no outlier data, giving a good distribution of data with skewness (Fig 3.

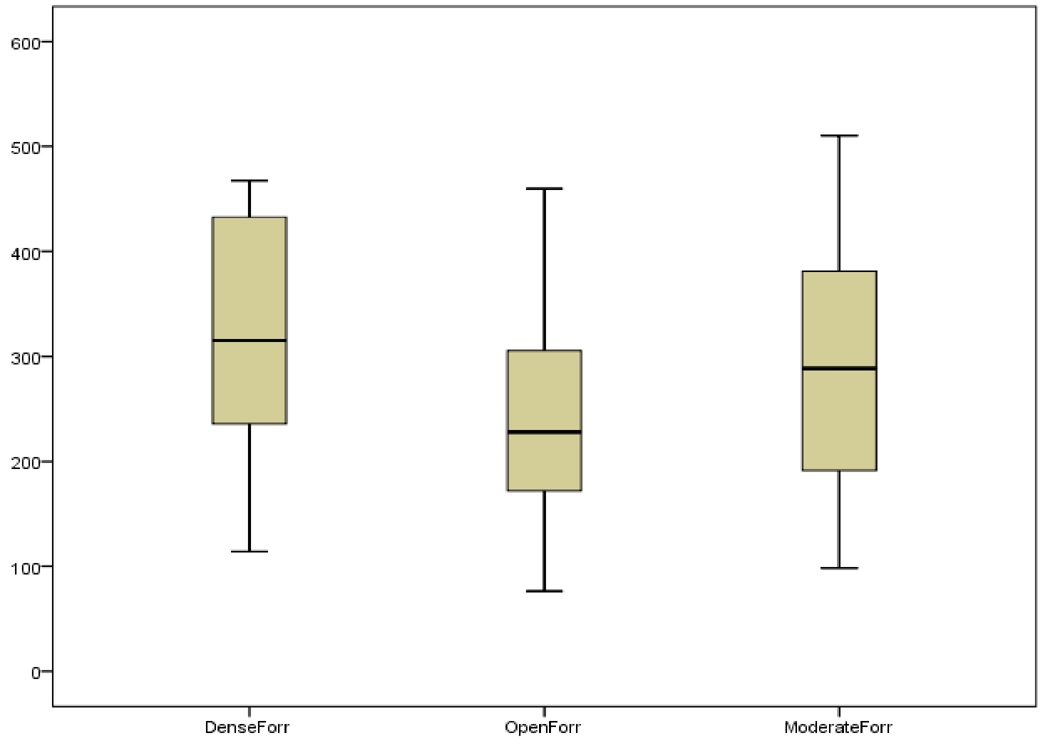


Figure 3: Box and whisker plot of environmental parameters

The dense forest canopy soil CO_2 emission range from 114.31-467.57mg/m^{-2}/h^{-1} related to 299.6-443.1mg/m^{-2}/h^{-1} for the sparse *ulmus pulima* woodland of China (Jin *et al*., 2008) while the lowest emission was recorded in the open canopy with a range of 76.26mg-459.84/m^{-2}/h^{-1} which is relatively higher than the onion filed in Japan, 11-307mg/m^{-2}/h^{-1} (Hu *et al*., 2003). The highest amount of soil CO_2 efflux was found in the moderate canopy with a reading of 98.18-510.03mg/m^{-2}/h^{-1} which is within the range of the canopy field woodland of China ranging from 305.5-730.8mg/m^{-2}/h^{-1} (Jin *et al*., 2008).

Controlling factors and their Effect on soil CO_2 efflux

To establish the relationship between the soil CO_2 efflux, soil moisture and temperature, statistical correlation (Guild fort rule of thumb) was employed, which indicated that an increase in the soil moisture, temperature and water potential will cause an increase in soil CO_2 efflux. The multiple linear regression model was used. The classical assumption for linear regression comprises the check and collinearity diagnostic, which showed that none of the conditional index models for the three different forest canopy densities was above the threshold limit of 30.0. In addition none of the tolerance values were less than 0.10 indicating no multi collinearity problem among the variables of the models. With this condition met, it is reasonable to conclude that the estimated multiple linear regression model can be used to explain the impact of soil temperature and moisture on soil CO_2 efflux. As depicting in Table 3, the largest beta coefficients in the dense canopy are soil moisture with 0.142, temperature with 0.192 and water potential with -0.132. The open canopy beta coefficient indicated the higher impact of soil temperature at 0.066 and low water potential at 0.286 and moisture occurring at -0.022 (Table 4), while the beta coefficient in the moderate canopy showed that the soil temperature and water potential was significantly higher with 0.165, 0.046, respectively and lower soil moisture at -.176 (Table 5). The soil temperature was found to have a high impact on both the open and moderate canopies compared to the soil moisture and water potential, however, the soil moisture had a greater impact than the soil temperature in the dense canopy, which accounts for the most spatial and temporal variations in soil CO_2, therefore suggesting that the environmental variables are the controlling factor.

Effect of Soil properties on soil CO_2 efflux

The results from the study area, as characterised by the soil CO_2 efflux rate, in response to the increase in soil organic carbon (SOC), total organic carbon (TOC), carbon (C), nitrogen (N), soil moisture content and moderately slightly acidity, as reported by Ming Xu (2001) and Joshi (1994). This suggests that the soil CO_2 rate is based on the protein provided in the microbial activity and roots (Tewery *et al*., 1982). As observed, the highest soil CO_2 efflux was from the moderate canopy with 275.38-1184 μmolCO_2 m^{-2} s^{-1}, which can be attributed to the high percentage of SOC (4.925%), TOC (4.6%), C (47.92%), N (1.29%) and soil moisture content of 37.39. The dense canopy was found to be the next in the emission level with soil CO_2 efflux of 256.03 to 1038.12 μmolCO_2 m^{-2} s^{-1} and SOC, TOC, C and N, with a

4.223%, 1.58%, 49.05% and 1.31%, respectively. The open canopy displaced the lowest soil emission, as the reading was found to be 118.83 to 1129.49 μmolCO_2 m^{-2} $s^{-1}$and 2.328, 22.26%, 48.10% and 1.19% for TOC, SOC, C and N, respectively. The bulk density in the forest ecosystem was observed to increase with the depth indicating the important role played by the pore spaces for microbial activity (Elliot et al., 1980; Doran et al., 1990). This important component in the carbon cycle plays a key role as a contributing factor and predictor variable of spatial heterogeneity for soil CO_2 efflux. The soil CO_2 efflux rate estimated at the three ecosystems based on the canopy densities are within the range emitted by a 39-years larch stand in Korea, (Choosing Kim, 2006) but greater than the soil forest of Hokkaido Japan, (Ronggui et al., 2001) and paddy ecosystem in China, (Ren et al., 2007). The highest amount of soil CO_2 efflux observed in the moderate canopy is much related to the high amount of soil moisture content and the role of microbial activity due to the presence of SOC, TOC and litter fall in the moderately acidic soil and soil pore spaces. The dense canopy swas found to be second in the emission level and much related to the SOC, TOC, litter fall and soil moisture content. The open canopy with less canopy density and litter input gave raise to low amount of SOC and TOC, thereby emitting low soil CO_2 efflux.

Contribution of litter fall (C and N)

The high percentage of C and N in litter fall is attributed to the canopy stand densities in relation to the soil CO_2 efflux in each study plot area as also cited by Curiel *et al*. (2005) in the deciduous forest scenario; however, although this study was not conducted in a deciduous forest, all the microbial activity in respect of the forest type are all based on the availability of C and N. A significant difference in litter fall in terms of C and N input in the three different canopy densities was recorded but there was not much relationship to the soil respiration found in order of the canopy stand densities, but lignin and microbial activities were assumed to be responsible for the entire CO_2 efflux scenario. The total Soil CO_2 efflux rate in the moderate canopy density was found to be the highest in the study area but litter fall in terms of C and N input place it third and second respectively, with the dense canopy density being second in soil CO_2 efflux but highest in C and N input from litter fall. The open canopy density was found to be the lowest in soil CO_2 efflux but second and third in C and N input from litter fall. This result suggests the significant role played by litter fall among the three canopy densities which is a major predictor in explaining the variation in soil respiration of the different canopy stand densities, as explained by Davidson et al. (2002), and Hibbard *et al*. (2005).

CONCLUSION

The total amount of soil CO_2 efflux from each forest canopy density, as was computed in the derived equation (1), showed that the moderate canopy forest ecosystem displayed the highest rate of CO_2 efflux at 39.772$gCO_2m^2s^{-1}$ with the dense canopy emitting 29.818 $gCO_2m^2s^{-1}$ and open canopy displaying 99.630 $gCO_2m^2s^{-1}$. This showed that the interaction among the soil CO_2 efflux and soil temperature, soil moisture, total organic carbon (TOC), soil organic carbon (SOC), litter fall, soil pH and bulk density had a strong influence and impact on the soil CO_2 emission rate, as was explained by the multiple linear regression model, correlation and descriptive statistical analysis. Therefore the beta coefficient relationship suggests that the environmental factors have considerable influence on soil CO_2 efflux while the contributing and predicting factors from soil are the microbial activities, lignin and root respiration influence by litter fall, which increases the amount of minerals in the soil. Therefore, the soil temperature and moisture, as well as soil properties, are better predictors of the soil CO_2 efflux rate. Hence, it is concluded that the environmental variability and biological processes dominate soil CO_2 efflux in any ecosystem, which should be taken into cognisance in determining and improving the estimation soil CO_2 efflux. In addition, the design of the field experiment and technique involved are of paramount importance. It is important to note that the results were obtained in the tropical rainforest of the monsoon period of the peninsula, which could have an influence on the environmental and biological process, and might differ from other seasons and ecosystems. Nevertheless, the results will help to improve the estimation of soil CO_2 efflux for various ecosystems under different stand densities as influenced by the environmental and predictor factors in the tropical forests of Malaysia.

Acknowledgements

We would like to thank a number of laboratory staff of the faculty of Environmental Studies UPM for their support: Mr Rashid Haron, Mr Shamsuddin Johan, Mr Abd Gafar Talip, Mr Ahmad Ithanin Bengan, Mr Mohd Nasil Idril and Mr Zainodin Abdul Wahab. We acknowledge the support of the Ayer-Hitam forest staff, rangers, security and the staff of the Faculty of Forestry, Universiti Putra Malaysia. Lastly we also acknowledge the contribution of John Dilling for the proof reading.

REFERENCES

Adachi, M., Bekku, Y. S., Konuma, A., Kadir, W. R., Okuda, T. & Koizuma, H. (2005): Require and sample size for estimating soil respiration rate in large areas of two tropical forest s of two types of plantation in Malaysia. For. Ecol. and Manage. 210,455-459.

Amat, R. Y., Mohd, S., Mohamad, K. & Noramzidy, R. (2001): Preliminary inventory of non-wood resources in ayer Hitam forest reserve, Selangor. Pertanika Journal of Tropical Agric. Science. 24 (1), 7-10.

Bolstand, P. V. & Gower, S.T. (1990): Estimation of leaf area index in fourteen southern Wisconsin forest stands using a potable radiometer. Tree physiol. 7, 115-124.

Choonsig, K. (2006): Carbon storage, Litterfall and Soil CO_2 Efflux of a Larch (*Larix leptolepis*) Stand. Integrative Biosciences. 10, 191-196.

Curiel, Y., Janssen, I. A., Carrara, A. & Ceulemans, R. (2004): Annual Q10 of soil respiration reflects plant phonological patterns as well as temperature sensitivity. Global Change Biol. 10, 161-169.

Davidson, E. A. & Janssens, I. A. (2006): Temperature sensitivity of soil carbon decomposition and feedbacks to climate change. Nature. 440, 165-173.

Dufresne, J. l., Friendlingstein, P., Berthelot, M., Bopp, L., Ciais, P., Fairheas, L., Le treut, H. & Monfrag, P. (2002): On the magnitude of positive feedback between future climate change and the carbon cycle. Geophys. Res. Lett. 29, 1397-1405.

Dupouey, J.L., Pignard, G., Badeau, V., Thimonier, A., Doˆte, J.F., Nepveu, G., Berge`s, L., Augusto, L., Belkacem, S. & Nys, C. (1999): Stocks et flux de carbonedans les foreˆtsfranc¸aises. C R AcadAgricFr. 85,293–310.

Goodale, C.L., Apps, M.J., Birdsey, R.A., Field, C.B., Heath, L.S., Houghton, R.A., Jenkins, J.C., Kohlmaier, G.H., Kurz, W., Liu, S., Nabuurs, G.J., Nilsson, S. & Shvidenko, A.Z. (2002): Forest carbon sinks in the northern hemisphere. Ecol.Appl. 12, 891–899.

Hibbard, K. A., Law, B. E., Reichstein, M. & Sulzman, J. (2005): An analysis of soil respiration across northern hemisphere temperate ecosystems. Biogeochemistry. 73, 29-70.

Hul R., Hatano, R., Kusa, K. & Sawamoto, T. (2003): Soil Respiration and Net Ecosystem Production in an Onion Field in Central Hokkaido, Japan *Soil Sci. Plant Nutr.,* 50 (I), 27 – 33

IPCC. (2000): Land use, land-use change, and forestry. Special report of the intergovernmental panel on climate change, Cambridge University Press, Cambridge.

Jandl, R., Vesterdal, L., Olsson, M., Bens, O., Badeck, F. & Rock, J. (2007): Carbon sequestration and forest management. CAB Rev: Perspect Agric. Vet Sci. Nutr Nat Resour. 2,1–16.

Jin, H. M., Sun, O. J. & Liu, J. Z. K. (2008): Dynamics of soil respiration in sparse Ulmus pumila woodland under semi-arid climate. Ecol Res 24: 731–739

Kim, C., Son, Y., Lee, W.K., Jeong, J. & Noh, N. J. (2009): Influences of forest tending works on carbon distribution and cycling in a pinusdensiflora s.et. z stand in Korea. For. Ecol. Manage. 257, 1420-1426.

Lee, K. H. & Jose, S. (2003): Soil respiration, fine root respiration, fine root production, and microbial biomass in cottonwood and loblolly along a nitrogen fertilization gradient. For. Ecol. Manage. 185,263-273.
Lindner, M. & Karjalainen, T. (2007): Carbon inventory methods and carbon mitigation potentials of forests in Europe: a short review of recent progress. Eur J. For. Res. 126,149–156.
Litton, C. M., Ryan, M. G., Knigh, D. H. & Stahl, P. (2003): Soil surface carbon dioxide efflux and microbial biomass in related to tree density 13years after a stand replacing fire in a lodge pole pine ecosystem . Global change Biol. 9,680-696.
Lulie, M., Ryusuke, H. & Kah, J. G. (2005): Soil CO_2 flux from three ecosystems in tropical peatland of Sarawak, Malaysia. Tellus. 57B, 1-11.
Luo, Y. & Zhou, X. (2006): Soil respiration and the environment 1st ed. San Diego (CA)
Academic Press San Diego.
Luyssaert, S., Ciais, P., Piao, S.L., Schulze, E.D., Jung, M., Zaehle, S., Schelhaas, M.J., Reichstein, M., Churkina, G., Papale, D., Abril, G., Beer, C., Grace, J., Loustau, D., Matteucci, G., Magnani, F., Nabuurs, G.J., Verbeeck, H., Sulkava, M., Van der Werf, G.R. & Janssens, I.A. (2010): The European carbon balance. Part 3: forests. Glob Chang Biol. 16,1429–1450.
Nam, R., Minako, A., Yuichioo, Y., Toshinori, O., Hiroshi, K. (2003): Soil organic carbon dynamic of different land use in southeast Asia; Progress Report of NIES-FRIM-UPM, Joint Research Project on Tropical Ecology Biodiversity. 1-4.
Pangle, R. E., Seiler, J., 2000. Influence of seedling roots, environmental factors and soil characteristics on soil CO_2 efflux rates in a 2 year old loblolly pine (*pinus taedal*) plantation in the Virginia piedmont. Environ. Poll. 116,S85-S96.
Paiman, B., Amat, R. Y., 2007. Ayer Hitam forest reserve community, multimedia supper corridor community heritage. 1st ed. Universiti Putra press Serdang.
Rahman, K., Azizi, R., NurSupardi, Md. N., Kaoru, N., Takuja, K., Yojiro, M. & Tamon, Y. (2005): Estimating root biomass based on the excavation of whole root system in a primary dipterocarp forest of Pasoh forest reserve peninsular Malaysia. Progress Report of NIES-FRIM-UPM, Joint Research Project on Tropical Ecology Biodiversity : 14-19.
Ren, X., Wang, Q., Tong, C., Wu, J., Wang, K., Zhu, Y., Lin, Z., Watanabe, M. & Tang, G. (2007). Estimation of soil respiration in a paddy ecosystem in the subtropical region of China. Chinese Science Bulletin. vol. 52.no. 19,2722-2730.
Ronggui, H., Ryusuke, H., Kanako, K. & Takuji, S. (2004): Soil Respiration and Net Ecosystem Production in an Onion Field in Central Hokkaido, Japan Soil Sci. Plant Nutr.,50 (I), 27 -33.

Saiz, G., Green, C., Butterbach-Bahl, K., Kiese, R., Vitabile, V. & Farrell, E.P. (2006): Seasonal and spatial variability of soil respiration in four Sitka Spruce stands. Plant soil. 287, 161-176.

Schimel, D.S. (1995): Terrestrial ecosystems and the carbon cycle. Glob Chang Biol. 1,77–91.

Schlesinger, N. H. & Andrews, J. A. (2000): Soil respiration and the global carbon cycle. Biogeochemistry. 48,7-20.

Sollins, P., Glassman, C., Paul, E.A., Swanston, C., Lajtha, K., Heil, J.W., Elliott, E.T., Robertson, P. G. (1999): Soil carbon and nitrogen: pools and fractions. Standard soil methods for long-term ecological research. Oxford University Press UK. 89–105.

Wang, C. K., Yang, J. Y. & Zhang, Q. Z. (2006): Soil respiration in the six temperate forest in China. Globe change Biol. 12, 2103-2114.

WBGU. (1998): The accounting of biological sinks and sources under the Kyoto Protocol—a step forwards or backwards for global environmental protection? German Advisory Council on Global Change, Bremerhaven.

SUSTAINABLE BUS TERMINAL DESIGN WITH ADAPTATION TO CLIMATE CHANGE.

ABBA Mark Terlumun & A.I. Anunobi
Department of Architecture, Federal University of Technology, Minna, Niger State, Nigeria.

The adaptation to climate change in every aspect of living today has encouraged the perspective and changed the approach employed in addressing different situations. In developed countries, buildings are built to withstand the constant change in climatic conditions therefore making them sustainable. Sustainable design would then be the ideology of designing public buildings, commercial and even residential buildings to adapt to climate change. Climate change is universal and as such Nigeria is not an exception to its effect. Public buildings like bus terminals are structures that are constantly used in Nigeria, because it's the major form of transportation, as a result of this every state in the country has over five bus terminals registered in the state. The designing of bus terminals to adapt to climate change through sustainable measures is one that can be addressed and achieved architecturally. This research assessed the different measures of adopting sustainable design in bus terminals to suit the current climate change. An observation schedule was employed to gather data and spss17 was also used to analyze the data, illustrations and graphics were presented using Microsoft excel. This research would finally show that the measures for sustainable design in bus terminal using available techniques was not considered in the designing of bus terminals, therefore it is necessary to strictly implement sustainable design measures to curtail the frequent climatic change situations in the designing of bus terminals.

***Keywords**: Bus terminal, Climate change, Design, Sustainable design*

abbamark@yahoo.com

ABBA M. T. & Anunobi, A.I. (2016). **SUSTAINABLE BUS TERMINAL DESIGN WITH ADAPTATION TO CLIMATE CHANGE.** Sustainable Built Environment and Climate change; The challenges of Post 2015 Development Agenda. School of Environmental Technology Conference, SETIC, 2016

INTRODUCTION

A bus terminal is a structure where city or intercity buses stop to pick up and drop off passengers. It is a designated place where a bus or coach starts or ends its scheduled route. The design of bus terminals in Nigeria has been neglected so much that only spaces are allocated within a metropolis and regarded as terminals, thereby allowing for every possible exposure of its users. The Niger state Transport authority was established to manage transportation within the state, providing its terminals in all major cities in Niger state, and stations in smaller settlements. Climate change refers to a change in the state of the climate that can be identified by changes in the mean and/or the variability of its properties and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forcing such as modulations of the solar cycles, volcanic eruptions, and persistent anthropogenic changes in the composition of the atmosphere or in land use. Framework Convention on Climate Change (UNFCCC) 2013, in its Article 1, defines climate change as: 'a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods.

The California Academy of Sciences, San Francisco, California, is a sustainable building designed by Renzo Piano

Climate change is anticipated to have wide-ranging effects on buildings and the future sustainability of the Earth due to adverse ecological, social and economic impacts (Stern 2006; McMullen and Jabbour 2009).. The driving force in these eco threatening events is an increase in the Earth's temperature as a result of human activities, for example the release of greenhouse gases, industrialization and changes in landscape characteristics due to an increasingly growing population of the world.

The International government Panel on Climate Change (IPCC) projects a global mean temperature increase of 1.1°C to 6.4°C by 2100, which is likely to affect climatic factor such as storms and floods, and lead to a rise in sea level due to the thermal expansion of the oceans and the melting of ice sheets and glaciers, therefore affecting the landscape, environmental factors and human existence. We must begin to proffer solutions to avoid and tackle these growing endemic to provide sustainable housing for future generation.

Sustainable design is the philosophy of designing physical objects, the built environment, and services to comply with principles of social, economic, and ecological sustainability. It is the designing of structures to adapt to the constant climatic change in our environment today such as greenhouse effects, flood etc. This research paper is using observation schedule to assess availability of sustainable design consideration provided with bus terminals. Observation Schedule is a valuable method of obtaining information of a building and other end users by careful assessment of instruments provided for a purpose which the research is being carried out. Such evaluations provides useful information that can be used either to highlight the satisfaction, or any problems that can be tackled within the project under study, or to provide data that can be used to improve the process and design of future bus terminals and other buildings. The aim of this research is to determine the different measures of adopting sustainable design in bus terminals to suit the current climate change.

AVAILABILITY OF SUSTAINABLE DESIGN

There are many forces responsible for shaping the Earth's climate. Operating and interacting at different scales in time and geographic space, these include (McMullen and Jabbour 2008): variations in radiation emitted from the sun (e.g., sun spot activity), the cyclical behaviour of the Earth's orbit and axis, changes in the gas composition of the atmosphere, volcanism, uplifting and wearing away of land surfaces, shifting distribution of landmasses and oceans caused by plate tectonics, and changes in the characteristics of the Earth's land surface. Evidence indicates that the Earth is currently going through an accelerated period of global warming. Increases in anthropogenic emissions of gases (e.g., carbon dioxide, methane) into the atmosphere, and an enhanced greenhouse effect, are considered to be the major driving force behind the accelerated global warming that has taken place over the last century (IPCC 2007a,b). Since the introduction of the United Nations Framework Convention on Climate Change in 1994 few countries have been able to reduce gas emissions according to targets of the Kyoto Protocol.

Trends for the states and provinces associated with the Gulf of Maine indicate an increase in GHG emissions over the last decade (Environment Canada 2008;

Regional Greenhouse Gas Initiative 2009). Which interactively affect changing climate and increasing variability at the regional and local these include: The changing thermal properties of the Earth's atmosphere, which contributes to changes (a general increase) in global moisture content and atmospheric water balance (McMullen and Jabbour 2009). Changes to the global distribution of heat flows and atmospheric circulation patterns. The differential heating and cooling patterns will influence major regional air flow systems (e.g., the jet stream, North Atlantic Oscillation, Arctic Oscillation) and ocean currents (the Deep Sea Circulation System, Gulf Stream, the Nova Scotian Current etc.), which dictate continental weather patterns over the Entire world. It is thought that this could cause an increase in the intensity of storms in the northern hemisphere, as well as a possible northward shift of storm tracks, Melting of ice sheets, glaciers and warming of ocean waters. The ice caps lock up some 2% of the Earth's water and melting will change the volume, temperature and salinity of the oceans. Observations have shown that since 1979 the Arctic perennial sea ice cover has been declining at 9.6 % per decade (Arctic Climate Impact Assessment 2005). In 2005, the Arctic sea ice extent dropped to 2.05 million sq. miles, the lowest extent yet recorded in the satellite record. The IPCC (2007c) estimates that, since 1993, thermal expansion of the oceans due to rising sea temperature contributed about 57% to sea level rise, while melting of ice caps and glaciers contributed about 28% and losses from the polar ice sheets contributed 15%. Land movement and land subsidence, which is a manifestation of the Earth crust's long-term response to the end of the last ice age, referred to as 'glacial iso static adjustment' (Peltier 2004). In the Gulf of Maine, subsidence rates are not uniform and are estimated to be from 0 cm to 20 cm/century.

The world commission on environment and Development defined "Sustainability" as meeting the need of the present without compromising the ability of future generations to meet their own need. Sustainability proffers solutions to the future of our world, designing buildings (residential, commercial, and public) to withstand the adverse climate change. The metrological department in Nigeria has in recent years predicted flood in some states and the effect of these on our environment. The changes are a frequent occurrence in our lives that we must begin to look at ways to tackle them architecturally and in construction to prevent future problems if there ever is a serious natural occurrence befalling Niger state. The goal of sustainable design is to find architectural solutions that guarantee the well-being and coexistence of these constituent groups.

SUSTAINABLE DESIGN AND CLIMATE CHANGE ADAPTATION

The overarching goal of sustainable design and climate change adaptation approach is to ensure that sustainability considerations are addressed throughout the project planning and design process, with attention to construction and operation stages, including on-going maintenance and subsequent renovations in bus terminals – in short, throughout the project life cycle. At the same time, adaptation must be considered now and incorporated into both near-term and long-term facility plans. To achieve sustainable design and adaptation goals and meet requirements, there must be collaboration of the federal government, and state government, close coordination across all planning and design disciplines, including maintenance and operations considerations, which is essential. Low-impact materials chosen in the construction of bus terminals such as non-toxic, sustainably produced or recycled materials which require little energy to process. Energy efficiency, use manufacturing processes and produce products which require less energy. Emotionally durable design reducing consumption and waste of resources by increasing the durability of relationships between people and products, through design for reuse and recycling. Products, processes, and systems should be designed for performance in a commercial 'afterlife.

SOLUTIONS TO CLIMATE CHANGE IN TERMINALS.

The UN-HABITAT state of world's cities 2008/2009 Harmonious cities report recognised physical planning as one of the factors to consider in the process of sustainable urban development. Physical planning includes but not limited to building alone, however construction is a major problem being addressed by many governments of developing countries of which Nigeria is one. When sustainable development is mentioned in many forums, it is often viewed from the proper use of natural resources or the consumption of energy. It is also viewed as how the activities that man carries out affects his environment be it physical or human. According to Hadjri and Onyango (2007), sustainability covers broad range of issues affecting social, economic, cultural and even judicial aspect of life. These issues from the definition affects the nature and type of structures being provided because they are all linked directly to man and his behavior. According to azevedo, Macieland Rego (2007) where it quoted burnt land report WCED of 1987, sustainable development is development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs. It can be deduced from this view that sustainability is not a permanent event and that it is expected to meet the current needs of the people. Buildings which are essential needs for humans and is a part of physical planning should be examined from the method of construction, material and design to determine the sustainability of such building schemes. In Nigeria, many of the research into sustainable development with respect to buildings is often examined with regards to construction method and the materials used for the construction. (See Adedeji, 2005). The reason for the examination of these aspects of building provision in Nigeria is probably due to the need to ensure that the cost of providing sustainable buildings is reduced. In many other countries, sustainable development is examined from the energy consumption by the building and its users (see Gilkinson and Sexton (2007), Azevedo et al(2007), tipple (1994), Noguchi

(2005). It can be observed from the issues examined by these researchers that the aim is to provide building structures that are sustainable within their environment while adapting to climate change. It implies therefore that to have a sustainable building, the design should be sustainable within its environment be it physical or human environments.

RESEARCH METHODOLOGY

This research paper is based on a descriptive approach in which data gathering was done through observation schedule and case study approach. Bus terminals in Niger state was assessed to know the activities and facilities present in each of them and the extent to which sustainable design considerations were taken. The primary data was gotten to determine the extent of the impact of climate change on the terminals. The case studies taken include: Niger state transport authority bus terminals in, Minna, Kontagora, Bida, Lapai, Mokwa, New wuse, New bussa, Suleja and Wushishi. This study was carried out on bus terminals in Niger state. An observation schedule was employed to gather data and spss17 was used to analyze the data, illustrations and graphics were presented using Microsoft excel. To evaluate sustainable design with adaptation to climate change in Niger state, personal observations by the author, using a check list of possible sustainable measures of some selected terminals in the state. Observing the building materials, orientation, height of the building and other related measures in cocktailing climate change.

The study area is the capital of Niger state which lies on longitude 9^{o} 33North and latitude 6^{o} 33 East on geographical bed of undifferentiated basement, which has25 local government area. The sample for this research were all taken from Niger state transport authority bus terminals and a few National Union of Road Transport Workers controlled terminals in Niger state. There are three senatorial zone in Niger state and three samples will be taken from each zone, for the purpose of this research.

This map shows Niger state

There are 25 local government areas in Niger state, and there are three senatorial zones with an average of 8 local government area in each zone. But for this research, studies were carried out on Niger State Transport Authority Terminals in three major cities in each of the senatorial zone and National union of Road Transport Workers Terminals because not all local government areas have terminals but stations. They have been selected and are listed below according to zone.

DISCUSSION OF RESULT

The discussion of results covers the materials used in construction of the bus terminals by the architects and their knowledge of the sustainable materials and climate change. The materials used in these facilities by the developer are also discussed while the appearances of some of the facilities are presented in plates to give a view of the facilities available to commuters when they make use of the bus terminals.

Durability of Materials used in the construction of the Bus terminals

The average percentage use of bus terminal in comparison with material used is shown in plate 1 and 2, where the percentage of the materials used is not sustainable and not eco-friendly. This implies that the bus terminals can be considered as not being sustainable and that the facilities provided within the bus terminal will definitely give in to climatic change in the future to come. The group that makes the remaining percentage of sustainable is almost negligible. It can be concluded that the motor parks are in constant use all through the year and this affects the maintenance level of the facilities within the bus terminals.

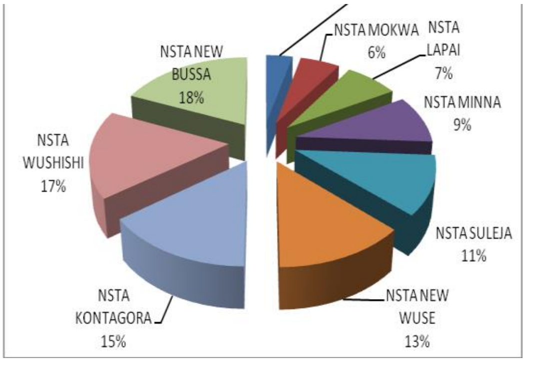


Plate 1. NSTA bus terminal, Minna showing the terminal building and percentage of usage by passengers. Source: Authors' field work, 2015.

Sustainable Design with Consideration to Climate Change.

Sustainable design standards and project design guides are also increasingly available and are vigorously being developed by a wide array of private organizations and individuals such as use of low-impact materials, Energy efficient building materials, Biomimicry: "redesigning industrial systems on biological lines. There is also a large body of new methods emerging from the rapid development of what has become known as 'sustainability science' promoted by a wide variety of educational and governmental institutional buildings examples are material used, orientation of building to mention a few. There is little or no consideration given to the design of terminals within the state with regards to climate change and a thought for the future but instead rigid structures are put in place with mostly open spaces regarded as terminals. Sustainable terminal designs must be implemented to be Energy efficient.

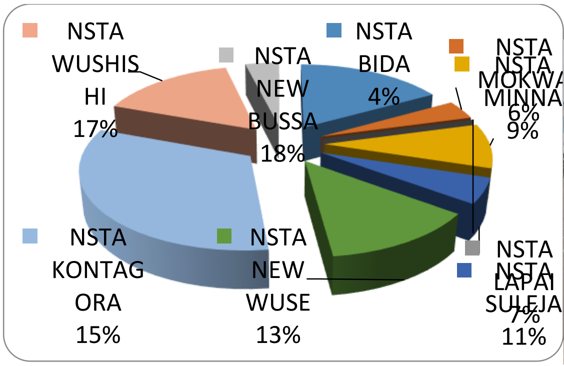


Plate 2. Showing usage of sustainable design considerations while constructing bus terminals. Source: Authors' field work, 2015.

OBSERVATION SCHEDULE FINDINGS

It was observed during the survey that the bus terminals had different facilities available to the passengers such as terminal building, Administrative building, Mosque, Service Bay, corner shops. The quality of these facilities vary hence they are categorized. It can be observed that the conditions of the buildings in the terminals where available are poor as many of them are not properly maintained and constructed poorly. The floors were dirty while many had broken or cracked ceiling boards. In the case of a terminal building only two of the terminals had these facilities particularly in terms of being good enough; though there were no permanent seats at the Kure New Market Motor Park, plastic seats and benches were not usually provided.

Karu New Market Motor Park

It was observed that facilities in bus terminals where they were available were not in good conditions. The three terminals that had good structures were maintained by either the State government, Private Company or the Local government and the people responsible for it usually collected the toll and also had responsibility to keep it maintained.

It was also observed that the level of maintenance in the different bus terminals varied; NSTA bus terminals had the fairly poor environment while other privately owned terminals were least maintenance. The management of the bus terminals determined the type of schedule put in place for their maintenance. The terminals operated by the State government and a private company had better maintenance. The other bus terminals were operated by the different transport unions. It was also observed that the terminals that were purpose built such had better facilities than the others which evolved overtime and had little or no planning design in place.

CONCLUSIONS

It has been discussed that a bus terminals falls under public buildings and its design and construction should be such that it takes into account the sustainability and climate change considerations because this affects the success of such facilities. The research has shown that the bus terminals have not met the need to adapt to climate change and therefore being a sustainably designed building and hence it can be implied that the terminals in Niger state are inadequate and require major transformation. While some of the problems highlighted by the observations can be solved by administrative means others require the renovation and redesign of parts or the entire bus terminal to reflect the desires of the present and future users.

RECOMMENDATIONS

The paper concludes by making the following recommendations with the view that it would help improve the quality of the motor parks.

1. There should be maintenance evaluation of the bus terminals with a view to determine the state of the buildings in relation to climate change so as to determine the type of remodeling to be carried out within them.

2. Bus terminals should be constructed using sustainable materials that have the durability to withstand adverse climate conditions and the designs of such terminals should not be the open air type as it seen in parts of the state’s terminals

3. There should be provision of good building structures within the terminals, designed and constructed to the quality of the type found in international terminals and provided with uninterrupted power/water supply, in other words are self sufficient.

4. Other facilities provided for in these bus terminals should be properly spaced to ensure proper arrangement and orderly.

5. A service company or service unit should be engaged to maintain the bus terminals in terms of maintenance of the facilities should be highly trained.

REFERENCE

Arctic Climate Impact Assessment. 2005. Arctic Climate Impact Assessment. Cambridge University Press. 1042 pp.

Adedeji, Y.M.D (2005). Sustainable Low-Cost Housing Technologies in Cities: Accelerated Construction initiatives Option. Journal of Land Use and Development Studies, 1(1).

Adesanya, A.O. & Adeniji, S.A., (1998). “Sustaining urban public transport in Nigeria: critical issues and remedies” in Freeman & Jamet (eds.) Urban Transport Policy. Balkema, Rotterdam, 775-781.

Azevedo,N.J.D. Maciel silva, P.M.W. & Rego Silva, J.J. (2007). Definition of indicators for sustainable social housing: in search of a model. XX XV IAHS World congress on Housing Science.

Bernier N and Thompson KR 2006. Predicting the frequency of storm surges and extreme sea levels in the northwest Atlantic. J. Geophys. Res. 111, C10009, doi: 10.1029/2005JC003168.

Environment Canada. 2008. Canada’s Greenhouse Gas Emissions: Understanding the Trends, 1990--2006. Environment Canada Gatineau. http://www.ec.gc.ca/pdb/ghg/inventory_report/2008_trends/2008_trends_eng.pdf (accessed March 2008).

Environment Canada 2008; Regional Greenhouse Gas Initiative 2009). Trends, 1990--2006. Environment Canada Gatineau. http://www.ec.gc.ca/pdb/ghg/inventory_report/2008_trends/2008_trends_eng.pdf (accessed March 2008).

Framework Convention on Climate Change (UNFCCC) 2013

Gilkinson, N. & Sexton. M. (2007). Delivering Sustainable Homes; Meeting Requirements: A Research Agenda. XX XV IAHS World congress on Housing Science

Hadjri, K. & ONyango J. (2007). Dubai Revised: Are New Planned Communities more Sustainable? XX XV IAHS World Congress on Housing Science – Melbourne.

Intergovernmental Panel on Climate Change (IPCC). 2007a. Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the IPCC. IPCC, Geneva.

Intergovernmental Panel on Climate Change (IPCC). 2007b. Climate Change 2007: Mitigation of Climate Change. Contribution of Working Group 111 to the Fourth Assessment Report of the IPCC. IPCC, Geneva.

Intergovernmental Panel on Climate Change (IPCC). 2007c. Climate Change 2007: Impacts,

Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the IPCC. IPCC, Geneva.

Iseki, H., Ringler, A., Taylor, B.D., Miller, M., & Smart, M. (2007). Evaluating Transit Stops and Stations from the Perspective of Transit Users.

McCabe GJ, Clark MP and Serreze MC. 2001. Trends in Northern Hemisphere Surface Cyclone Frequency and Intensity. J. Climate 14: 2763–2768.

McMullen CP and Jabbour J (eds). 2009. Climate Change Science Compendium. UN Environmental Programme, Geneva. 72 pp.

Noguchi, M. (2005). Japanese Manufacturers' Cost-Performers' Marketing Strategy for the Delivery of Solar Photovoltaic homes. Retrieved from http://canmetenergy-canmetenergie.nrcan-mcan.gc.ca on 11th December 2015, 20:09pm

Lyndon, H. and Todd, A.L. (2006). Evaluating New Start Transit Program Performance Comparing Rail and Bus. Victoria Transport Policy Institute Canada.

Ogbazi, J.U. (1992). Urban Transportation Planning. Principle and Practice of Urban and Regional Planning in Nigeria. Mekslink Publishers Nigeria, Awka. pp. 64-72.

Stern N (2006). The Stern Review: Economics of Climate Change. Cambridge University Press. ISBN -13: 9780521700801. 700pp

Tipple, A.G. (1994), The Need for New Urban Housing in Sub-Saharan Africa: Problem or Opportunity. *African Affairs*, 93(373), 587-608. Retrieved from http://www.jstor.org/stable/723668 on 27th November, 2015. 13:22pm

UN-HABITAT 2008/2009 State of the world cities harmonious report retrieved from http/www.unhabitat.org October 2015.

Wang XL, Swail VR and Zwiers FW. 2006. Climatology and Changes of Extratropical Cyclone Activity: Comparison of ERA--40 with NCEP–NCAR Reanalysis for 1958–2001. J. Climate 19: 3145–3166.

W.R. Peltier, 2004. Global Glacial Isostasy and the surface of the Ice-Age: The ICE – 5G (VM2) pp. 111-149

INVESTIGATION OF THE EFFECT OF SEA LEVEL VARIATION ON VERTICAL REFERENCE FRAMES BASED ON A DESIGNED EXPERIMENT

ODUMOSU, J. O[1]; IDOWU, T. O[2]; ADESINA, E. A[1]; AJAYI, O. G[1]; IBRAHIM, P[1].

(1) Department of Surveying and Geoinformatics, Federal University of Technology, Minna.
(2)Department of Surveying and Geoinformatics, Federal University of Technology, Akure.

The Mean Sea level as a result of its "near-coincidence" with the equipotential surface of the geoid is universally adopted as a reference surface for the physical realization of the vertical reference system. Unfortunately, the effect of climate change has continued to alter the value of the mean sea level across the globe by as much as 10mm per annum at certain locations. The Gauss-Markov functional model has been used in this study to determine the effect of Sea Level variation on sea-related physical heights along the ZTT-control series in Lagos state using the different International Association of Geodesy (IAG) standard geo-potential values as representative indicators of sea level rise. Results obtained show very minimal effect of MSL variation on the VRF with a standard deviation of ∓ 0.000000000015 m

Keywords: *Climate Change, functional Models, GNSS Levelling, Height Systems, Vertical Reference Frames (VRF).*

joseph.odumosu@futminna.edu.ng

Odumosu et.al. (2016). **AN INVESTIGATION OF THE EFFECT OF SEA LEVEL VARIATION ON VERTICAL REFERENCE FRAMES BASED ON A DESIGNED EXPERIMENT** Sustainable Built Environment and Climate change; The challenges of Post 2015 Development Agenda. School of Environmental Technology Conference, SETIC, 2016

INTRODUCTION

Most environmental hazards (such as flooding, erosion, air-pollution, earthquakes, e.t.c) are spatially related phenomena that have tendencies of spreading into neighboring environments depending on the spatial characteristics of its immediate surroundings; the most significant characteristic that determines the extent and nature of such spread being the terrain undulation. Terrain undulation refers to the height variation of an area of land, depicting the low and high lands in the area with reference to a reference measurement surface. Diverse reference surfaces for height measurement have been adopted over the years by several countries (Rizos, 2015b) some of which include the Mean High Water Neaps (MHWN), Mean High Water Level (MHWL), Mean High Water Springs (MHWS), Mean Sea Level (MSL), e.t.c (Figure 1).

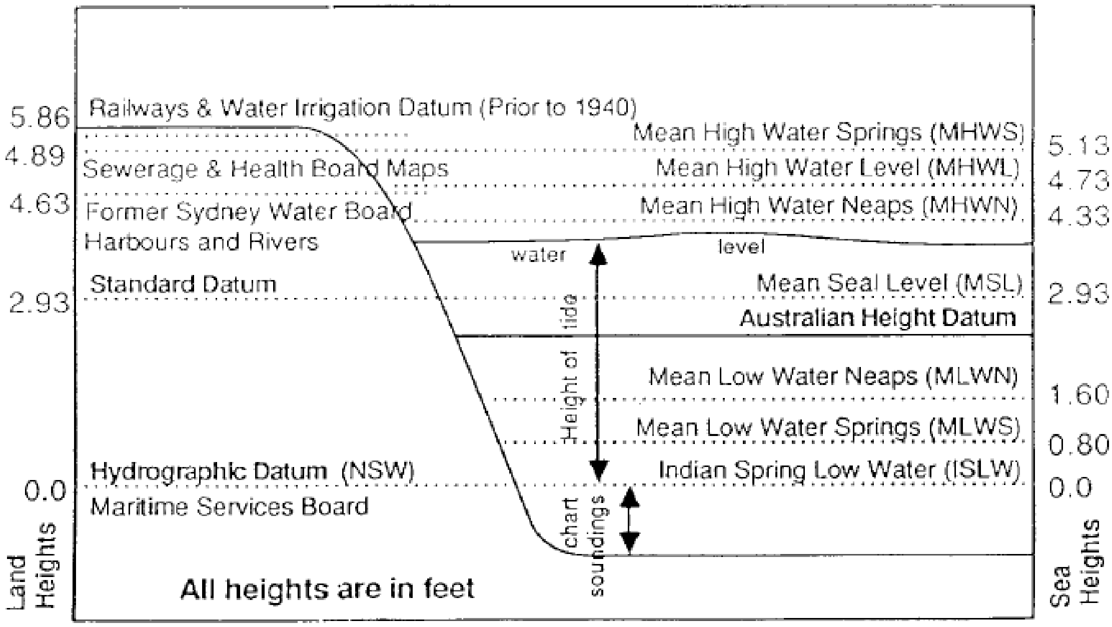


Figure 1: Some vertical datums used for height definition: An example of Sydney (Rizos, 2015b)

However, the “near-coincidence” of the MSL with the geoid has over the years popularized the adoption of sea-related heights (Tide Guage Datums) for the realization of several national vertical reference frames (Torge, 2001; Agren, 2015). This practice of relating heights to sea level are generally prominent because of it is practically easy to achieve and also due to the vast presence of the global oceans. Good as it may be, time dependence of the MSL (MSL Variation) due to climate change, non-parallelism of the equipotential surface and inconsistence in the exact definition of the zero reference level (Fotopulous, 2003; Rizos, 2015(a & b)) makes sea dependent heights a rather unstable choice for height definition. To overcome these problems vertical reference frames across the world should be tied to the geoid.

The geoid is best defined as the equi-potential surface of the earth's gravity field which nearly coincides with the surface of the MSL of the global oceans and is everywhere perpendicular to the plumbline (Listings,1873). The Mean Sea Level is defined as the average level of the global oceans taken over a period of 19.6 years (Ojinaka, 2007). Reference systems are introduced in order to model geodetic observations as a function of unknown parameters of interest. The coordinate systems are defined in terms of orientation, metrics, and curvature i.e they are three-dimensional in principle (Heitz 1988, Torge, 2001). A reference system defines the origin and the orientation of fundamental planes or axes of the system. It also includes the underlying fundamental mathematical and physical models (Seeber, 2003). Therefore, a Reference system could simply be described a set of parameters and idealized theoretical descriptions/model for an intended real world positioning system. On the other hand, a reference frame means the practical realization of a reference system through observations. It consists of a set of identifiable fiducial points on the sky (e.g. stars, quasars) or on Earth's surface (e.g. fundamental stations) (Torge, 2001; Seeber, 2003; Rizos, 2015a)

Since climate change has cause the position of the MSL to change over the years, the implication of maintaining a vertical reference Framework that is MSL dependent is that heights within the framework may lose positional integrity over time and might need to be re-observed. This research looks at the effects of MSL variation on Lagos vertical Reference Frame work from the geodetic perspective by taking advantage of the direct relationship between heights and earth surface potentials.

PHYSICAL HEIGHTS FROM A GEODETIC PERSPECTIVE

Height is the distance of a point above a specified surface of constant potential; the distance measured along the direction of gravity (Meyer et al, 2005, Odumosu et al, 2015). This can be mathematically expressed as equation 1:

$$H = {(W_0 - W_P)}/{g} \qquad (1)$$

Where:

g = gravity Vector

W_0 = Potential at Reference Point

W_P = Potential at Observation Point

But g and W are inter-dependent as shown in equation 2

$$g = \nabla W = grad\ W \quad (2)$$

Now, we can show that potential depends only on positions (equations 3 – 5)

$$W = V + \phi \quad (3)$$

Where:

V = Gravitational Potential

ϕ = Centrifugal Potential

$$\therefore W = G \iiint_v \frac{\rho}{l} dv + \frac{1}{2} w^2(x^2 + y^2) \quad (4)$$

$$\oint W = - \oint g.dn = 0 \quad (5)$$

To avoid path dependence, spirit leveled height differences are converted to potential differences as given by Argen, 2015 (equation 6 - 7) and shown in Figure 2.

$$dW = W_B - W_A = -\int_A^B g.dn \approx \sum_A^B g.\delta n \quad (6)$$

$$\therefore H_A = {}^{C_A}\!/_{g_A} \quad (7)$$

Where $C_A = W_0 - W_A$

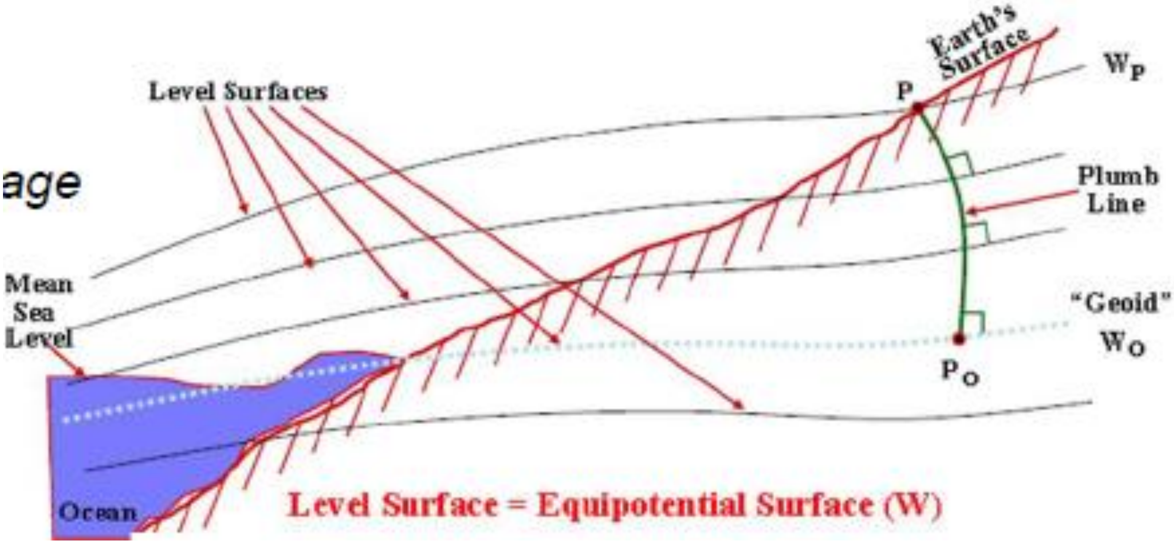


Figure 2: Definition of Height from gravimetric perspective (Argen, 2015)

EFFECT OF SEA LEVEL RISE ON VERTICAL REFERENCE FRAME

The changes in sea Level with time results in a shift in the origin of the Vertical Reference Frame (VRF) since the equipotential surface used as the zero height reference will change in position (Kotsakis, 2012). Although, this effect might be constant at the origin (δW_0), its effect on individual points within the frame work will vary due to the non-parallelism of the equipotential surfaces (equation 8):

$$H_t - H_i = \frac{\delta W_0}{g_t} - \frac{\delta g}{\delta H} \cdot \frac{\delta W_0{}^2}{2g_t{}^3} + \ldots\ldots \qquad (8)$$

From Equations 7 and 8 therefore, a change in the MSL results in a change in the adopted equipotential surface (Sanchez, 2013). This by implication changes the value of our reference potential (W_0) as shown in Figure 3.

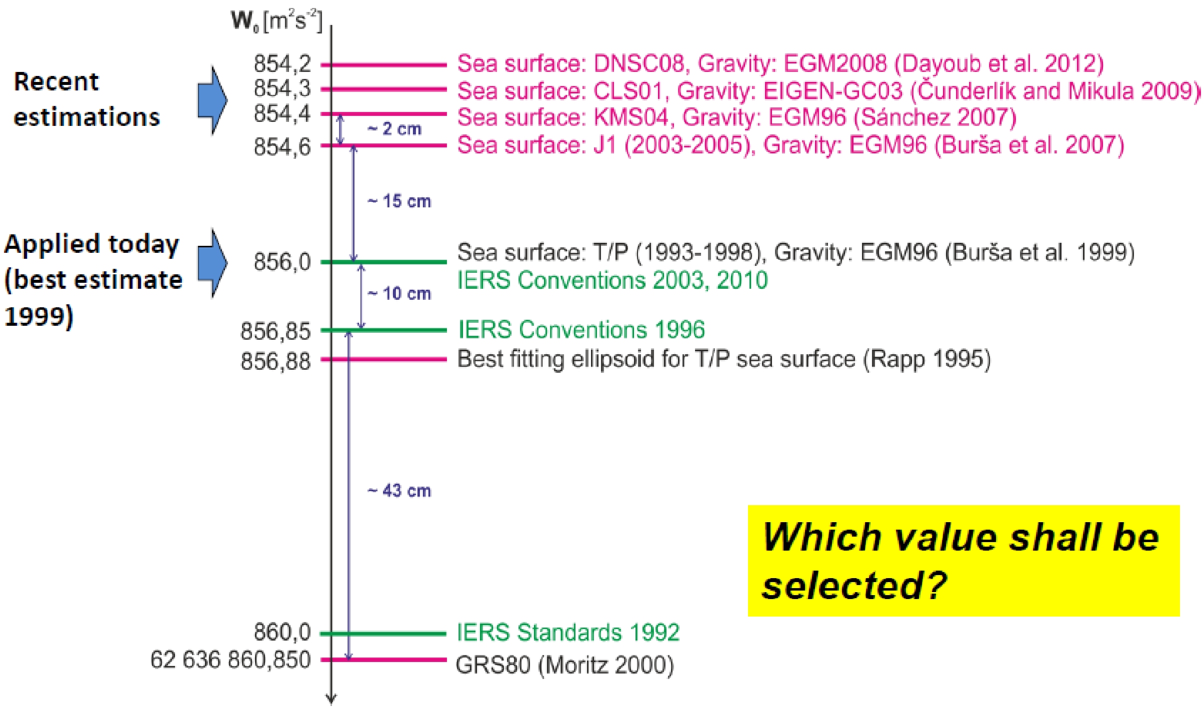


Figure 3: Some examples of W_0 values (Sanchez, 2013)

METHODOLOGY / MODEL FORMULATION

Due to lack of absolute gravity data for the study area, actual gravity is replaced in equations 7 and 8 with normal gravity since normal gravity potential accounts for approximately 99.9995% of the total potential (Jekeli, 2007). Therefore, equation 7 is re-written as equation 9

$$H_A = {(W_0 - W_A)}/{\gamma_A} \qquad (9)$$

$$\gamma = 978032.67714\left(\frac{1+0.00193185138639\,sin^2\varphi}{1-0.00669437999013\,sin^2\varphi}\right) \qquad (10)$$

Where: γ = Normal gravity

φ = Geodetic Latitude

Given the initial orthometric height of the 6 points used in this study, normal gravity values was computed at each point using equation (10) and an initial W_0 was selected. The geo-potential value for each of the 6 points (W_A) was thereafter computed using equation (9).

Since geo-potential and normal gravity values are position dependent and do not change with time, the newly computed geo-potential value for each point and their corresponding normal gravity value are then used to recomputed the orthometric height for each point using equation (9).

From Figure 3, we have adopted W_0 values that correspond to about 50cm rise in MSL in this study. The adopted values are as shown:

(Adopted) Initial W_0 Value: 62 636 860.0 m^2s^{-2}

(Adopted Final) W_0 Value: 62 636 854.0 m^2s^{-2}

GAUSS MARCOV MODEL

The classical Gauss Marcov functional model has been used in this study to determine the height implication of a 50cm sea Level variation on the VRF within the study area. Given the stochastic formulation for the Gauss Marcov in equation 11 (Helmert, 1924; Fotopulous, 2003)

$$C_v = \sigma^2{}_0 Q \qquad (11)$$

If the given set of orthometric heights of points are described as H_p and the re-computed set of orthometric height values (signifying the effect of sea level rise) described as H_n; then the resulting framework of condition equations for determining the variance-covariance of adjusted observations between both VRF's (previous heights and new heights) shall be as equation 12

$$[(H_2 - H_1) + (H_3 - H_2) + (H_1 - H_3)]_P = [(H_2 - H_1) + (H_3 - H_2) + (H_1 - H_3)]_n = 0 \quad (12)$$

Equation 12 shall be satisfied in loops through-out the entire leveling Network or Vertical Reference Frame. The Leveling Network is as shown in Figure 4

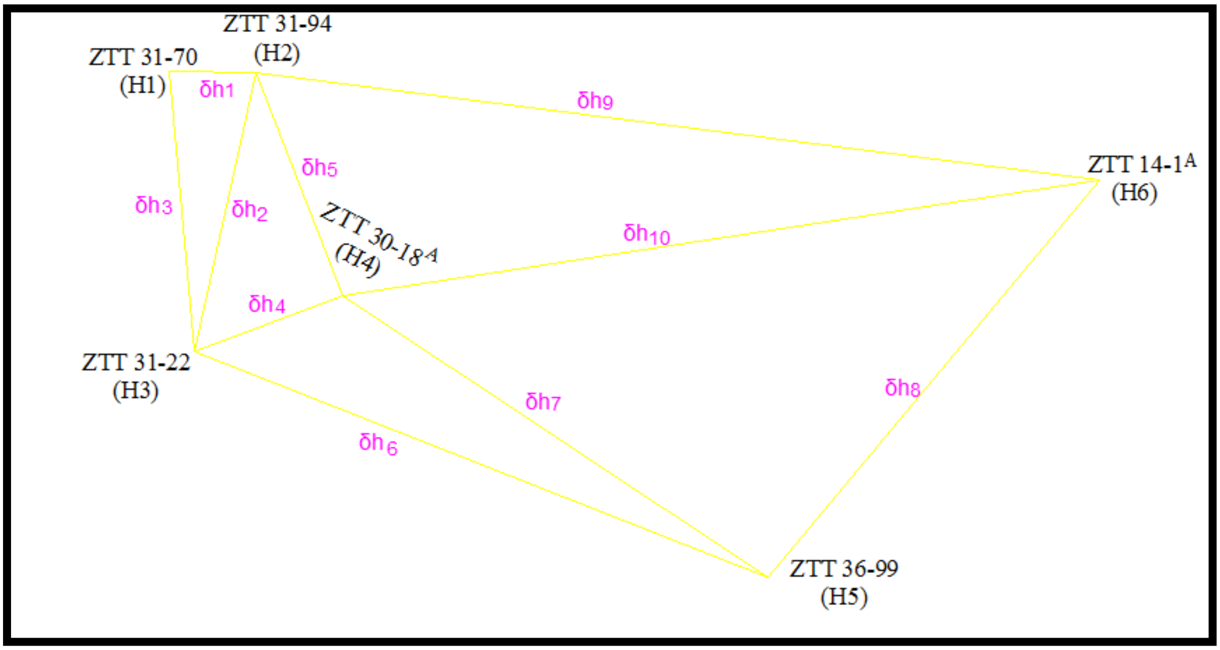


Figure 4: Leveling Network / VRF

Let

$$[H_2 - H_1]_p = \Delta h_{1_p} \quad (13a)$$

$$[H_2 - H_1]_n = \Delta h_{1_n} \quad (13b)$$

$$\therefore \Delta h_{1_p} - \Delta h_{1_n} = \delta h_1 \quad (14)$$

Equation (12) then becomes (15)

$$\delta h_1 + \delta h_2 + \delta h_3 = 0 \quad (15)$$

Eleven (11) condition equations were formed from the leveling Network following Equation (15) leading to the formulation of an 11 by 10 design matrix (B) and a uniform scaled weight matrix (P) was adopted.

Equation (11) then transforms into equations 16 - 18 (Ayeni, 1985)

$$C_v = \sigma^2{}_0 \, Q_{L^a} \tag{16}$$

$$\sigma^2{}_0 = {V^T PV}/{r} \tag{17}$$

Where:

V = Observational Residuals

r = Number of conditions

$$Q_{L^a} = P^{-1} - P^{-1}B^T M^{-1} B P^{-1} \tag{18}$$

STUDY AREA

The control points selected being part of the ZTT 1 – 39 Series covering the Central and Eastern parts of Lagos State. The information was collected from the office of the Surveyor General of Lagos State. Being a coastal state, it is mainly low lying and highly vulnerable to inundation due to MSL variations.

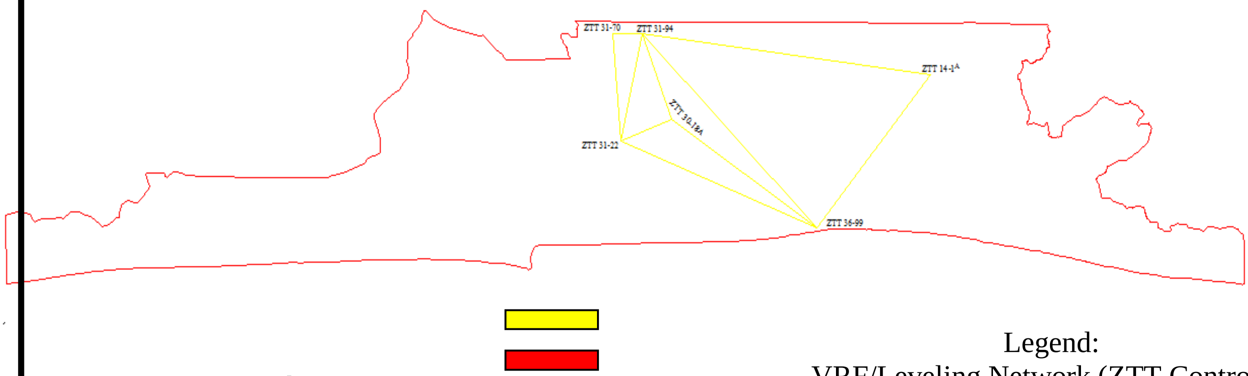


Figure 5: Study Area.

DATA USED

Presented in table 1 below is a summary of the data used

S/N	DATA	SOURCE	ACCURACY
1.	Initial Orthometric Heights (H_p)	Office of the Surveyor General of Lagos State – Interspatial Surveys. (6 points within the 2nd Order State-wide Controls Network)	2nd – Order Accuracy
2.	Normal Gravity	Computed using Equation (10)	N/A
3.	Station Geo-potential	Computed using Equation (9)	N/A
4.	Final Orthometric Heights (H_n)	Computed using Equation (9)	N/A

RESULTS

Presented in Table 2 are the initial and newly computed orthometric heights of the selected controls within the VRF.

Table 2: Heights of selected Control points within the VRF both before and after MSL rise.

STATn_ID	EASTINGS (m)	NORTHINGS (m)	Initial Wo (m2/s2)	Final Wo (m2/s2)	Station Potential	Initial Ht (m)	Final Ht (m)	Residual
ZTT31-70	556698.923	737215.7	62 636 860.0	62 636 854.0	17640164.58	46.002	46.001970	-0.000030
ZTT31-94	561055.077	737189.968	66 636 860.0	66 636 854.0	31558211.47	31.773	31.772977	-0.000023
ZTT31-22	557938.52	723141.589	63 636 860.0	63 636 854.0	58366291.08	4.366	4.365995	-0.000005
ZTT30-18A	565399.781	725965.523	64 636 860.0	64 636 854.0	45288512.01	17.736	17.735998	-0.000002
ZTT36-99	586740.558	711778.59	65 636 860.0	65 636 854.0	58010263.45	4.730	4.729993	-0.000007
ZTT14-1A	603337.562	731753.378	67 636 860.0	67 636 854.0	56825701.69	5.941	5.940993	-0.000007

A graphical plot of the residuals obtained is presented in Figure 6 – 7 to provide a brief impression of the spatial relationship between MSL variation and heights within the study area.

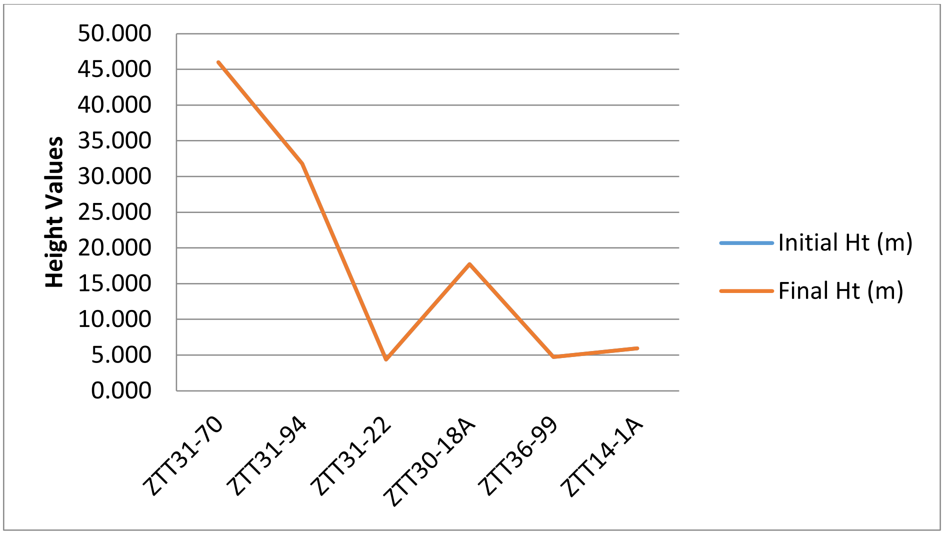


Figure 6: An Overlay Plot of heights of Selected Controls Points before and after MSL rise

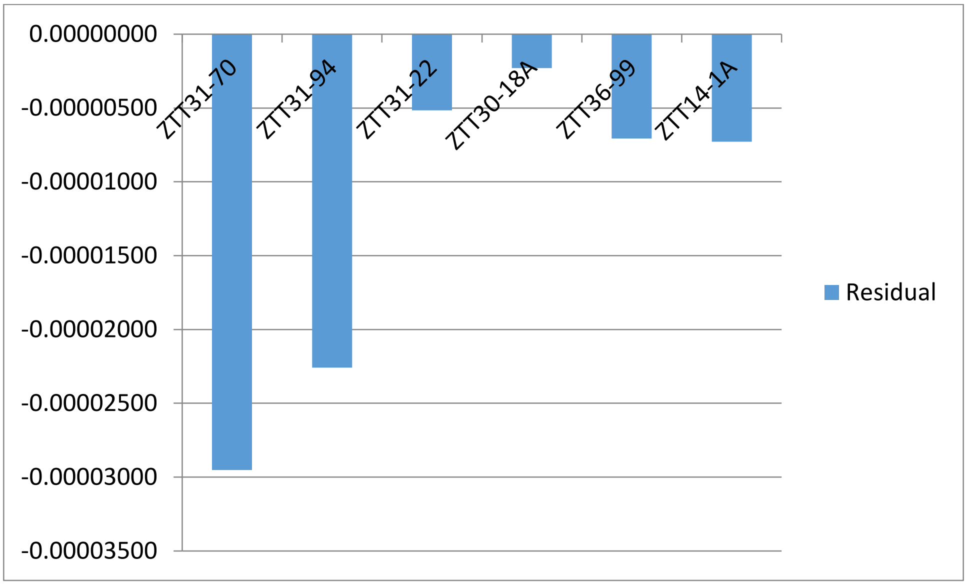


Figure 7: Plot of spatial pattern of the magnitude of residual between Heights of selected control points before and after MSL rise.

The matrix of residuals of the condition equation (V) and the design Matrix (B) are also presented below.

$$V = \begin{pmatrix} -0.00000064 \\ +0.00000247 \\ +0.00000312 \\ -0.00000328 \\ -0.00000016 \\ -0.00000080 \\ -0.00000293 \\ +0.00000528 \\ +0.00000822 \\ +0.00000494 \\ +0.00000281 \end{pmatrix}$$

$$B = \begin{pmatrix} 1 & 1 & -1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & -1 & 1 & 0 & 0 & 0 & 0 & 0 \\ -1 & 0 & 1 & -1 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 1 & -1 & 0 & 0 & 0 \\ -1 & 0 & 1 & 0 & 1 & 1 & -1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 1 & 1 & -1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 & -1 & -1 & 1 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 1 & 1 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 & 1 & 0 & 1 \\ 0 & 0 & 0 & 1 & 0 & 1 & 0 & 1 & 0 & 1 \\ 0 & -1 & 0 & 1 & 0 & 0 & 0 & 0 & 1 & 1 \end{pmatrix}$$

The Variance-Covariance matrix of adjusted observations after application of the gauss markov functional model therefore becomes:

C_v =

-2.83E-10	-5.96E-11	2.39E-10	2.98E-11	2.68E-10	-2.98E-11	5.96E-11	5.96E-11	0.00E+00	2.98E-11	1.19E-10
-5.96E-11	-3.88E-10	-3.43E-10	7.45E-11	-2.68E-10	-3.28E-10	-2.24E-10	-1.19E-10	1.04E-10	1.79E-10	2.83E-10
2.39E-10	-3.43E-10	-5.67E-10	4.47E-11	-5.37E-10	-2.98E-10	-2.83E-10	-1.79E-10	1.04E-10	1.49E-10	1.64E-10
2.98E-11	7.45E-11	4.47E-11	-3.73E-10	-3.43E-10	-3.13E-10	-2.09E-10	-1.04E-10	1.04E-10	-2.83E-10	-1.79E-10
2.68E-10	-2.68E-10	-5.37E-10	-3.43E-10	-8.65E-10	-6.11E-10	-4.92E-10	-2.83E-10	2.09E-10	-1.34E-10	-1.49E-11
-2.98E-11	-3.28E-10	-2.98E-10	-3.13E-10	-6.11E-10	-6.26E-10	-4.32E-10	-2.24E-10	2.09E-10	-1.04E-10	1.04E-10
5.96E-11	-2.24E-10	-2.83E-10	-2.09E-10	-4.92E-10	-4.32E-10	-5.37E-10	-2.83E-10	2.68E-10	5.96E-11	-5.96E-11
5.96E-11	-1.19E-10	-1.79E-10	-1.04E-10	-2.83E-10	-2.24E-10	-2.83E-10	-3.28E-10	-5.96E-11	-1.64E-10	-2.24E-10
0.00E+00	1.04E-10	1.04E-10	1.04E-10	2.09E-10	2.09E-10	2.68E-10	-5.96E-11	-3.13E-10	-2.24E-10	-1.64E-10
2.98E-11	1.79E-10	1.49E-10	-2.83E-10	-1.34E-10	-1.04E-10	5.96E-11	-1.64E-10	-2.24E-10	-4.92E-10	-3.43E-10
1.19E-10	2.83E-10	1.64E-10	-1.79E-10	-1.49E-11	1.04E-10	-5.96E-11	-2.24E-10	-1.64E-10	-3.43E-10	-4.92E-10

A summary of the results is presented in table 3 (a & b):

Table 3(a): Summary of Results

Measured Parameter (Among Baselines)	**Value (m)**
Standard Deviation	∓ 0.000000000015
RMSE	0.00000000000299
Variances along bases $\begin{bmatrix} \delta h_1 \\ \delta h_2 \\ \delta h_3 \\ \delta h_4 \\ \delta h_5 \\ \delta h_6 \\ \delta h_7 \\ \delta h_8 \\ \delta h_9 \\ \delta h_{10} \end{bmatrix}$	$\begin{bmatrix} -0.000000000283 \\ -0.000000000388 \\ -0.000000000567 \\ -0.000000000373 \\ -0.000000000865 \\ -0.000000000626 \\ -0.000000000537 \\ -0.000000000328 \\ -0.000000000313 \\ -0.000000000492 \end{bmatrix}$

Table 3(b): Summary of Results (Contd)

Measured Parameter (Among Baselines)	**Values (m)**
Minimum Deviation along base lines (δh_1)	-0.000000000283
Maximum Deviation along base lines (δh_5)	-0.000000000865

DISCUSSION OF RESULTS

From Table 1 and further supported by Figure 7, all residuals in the heights are negative. This trend is expected as a rise in MSL will lead to inundation of land masses. As seen however in Figure 7, the pattern of the inundation is irregular; further proving the non-parallelism of the equipotential surfaces. The control points ZTT36-99 and ZTT 14-1A which both lie close to the Lagoon (about same equipotential surface) experienced similar amount of inundation as a further evidence to the non-parallelism of the equi-potential surfaces and dependence of heights on geo-potential differences.

ZTT31-70 and ZTT31-94 which are located far from the shoreline/coast area however experienced a greater inundation than some coast-line controls; signifying a possibility of greater effects of MSL variation on interland points than in coastal areas.

The statistical analysis performed as summarized in Table 3 shows a standard deviation of ∓ 0.000000000015 along the base lines; while the variances experienced along each baseline is also as expressed in Table 3. The standard deviation implies an unnoticeable change in the vertical reference frame as a result of sea level rise within the study area. It can however be seen from the gauss marcov functional statistical model that the maximum effect of the MSL variation in the VRF is noticeable along the baseline δh_5 and minimum variation along baseline δh_1.

It should be noted that the variation observed in results could have been different if actual gravity observations were taken on the selected control stations rather than resorting to the normal gravity (as used in this research); although the expected differences in both cases should not be large.

CONCLUSION

It therefore can be concluded that the variation of the MSL has a minimal effect ($\mp$ 0.000000000015 m) on the VRF within the study area (Miyahara, 2015). As such, the changing MSL does not pose any danger to the suitability of the existing vertical controls within the study area.

It can also be verified from the gauss marcov functional model analysis that the effect of MSL variation on VRF is non-linear i.e does not dependent on distances between baselines.

REFERENCES

Agren, J. (2015): Gravity and Height for National Mapping & Geodetic Surveying, Dublin, Ireland, 2-6 February 2015.

Ayeni O.O. (1985) "Comparison of Least Squares of Adjustment Methods for Geodetic Levelling Network." (Proceedings of the of the NAG Conference on Datum Determination in Nigeria, June 1985, Ed (S. I. Agagelu)

Fotopulous, G. (2003): An analysis on the optimal combination of geoid, orthometric and ellipsoidal height data. A PhD thesis submitted to the department of Geomatics Engineering, University of Calgary.

Heitz, S. (1988): *Coordinates in geodesy*. Springer, Berlin-Heidelberg-New York. 1988

Helmert, F. R (1924): Die Ausgleichungsrechnung nach der Methode der Kleinsten Quadratic, 3. AUFL., Leipzig/Berlin.

Jekeli, C. (2007): Potential Theory and Static Gravity Field of the Earth. Elsevier B. V. The Ohio state University, Columbus, OH, USA.

Kotsakis, C. (2012): A conventional approach for comparing vertical reference frames. *Journal of Geodetic Science.* 2(4) • 2012 • 319-324 DOI: 10.2478/v10156-011-0046-3. Pg 319- 324.

Listing, J.B. (1873): *Über unsere jetzige Kenntnis der Gestalt und Größe der Erde*. Nachr.d. Kgl Gesellsch. d. Wiss. und der Georg-August-Univ., Göttingen: 33-98.

Meyer, T.H., Roman, R.D., Zilkoski, D.B., 2005. What does height really mean? Part 1: Introduction. Survey Land Information. Sci. 64 (4), 223–234.

Miyahara, B (2015): Case studies of Japan: Current situation and challenges in Vertical Reference Frame of Japan. FIG/IAG/UN-GGIM-AP/SLA Technical Seminar on Vertical Reference Frames in Practice. Singapore. 27 – 28, July, 2015.

Odumosu, J.O, Ajayi, O. G, Idowu, F. F and Adesina, E. A (2015): Evaluation of the various orthometric height systems and the Nigerian scenario – A case study of Lagos State. *Journal of King Saud University – Engineering Sciences*. http://dx.doi.org/10.1016/j.jksues.2015.09.002

Ojinaka,O. J. (2007): Principles of *Hydrographic Surveying_ From Sextant to Satellite*. First Edition. International Standard book No 978-8143-10-5

Rizos, C. (2015(a)): Vertical Reference frames in Practice – Introduction and definitions. FIG/IAG/UN-GGIM-AP/SLA Technical Seminar on Vertical Reference Frames in Practice. Singapore. 27 – 28, July, 2015.

Rizos, C. (2015(b)): Vertical Reference frames in Practice – Time dependence and Transformations. FIG/IAG/UN-GGIM-AP/SLA Technical Seminar on Vertical Reference Frames in Practice. Singapore. 27 – 28, July, 2015.

Sanchez, L. (2013): Heights and Height Datum. 11th Int. School of the Geoid Service, Loja, Ecuador, 7-11 October 2013.

Seeber, G. (2003). *Satellite Geodesy*. Second Edition. Walter de Gruyter, Berlin, New York.

Torge, W. (2001): *Geodesy*. Third Edition. Walter de Gruyter GmbH & Co. KG, 10785 Berlin, Germany

CLIMATE CHANGE, RELATED EVENTS AND THE CHALLENGE OF SUSTAINABLE ENVIRONMENTAL QUALITY: THE NIGERIAN EXPERIENCE

[1]UYOBONG Sunday Etuk, [1]NYENEIME Victor Raphael & [2]EDIDIONG Elijah Usip

[1] Dept. of Estate Management, Akwa Ibom State Polytechnic, Ikot Osurua
[2] Dept. Of Urban and Regional Planning, Akwa Ibom State Polytechnic, Ikot Osurua

This paper discusses with empirical evidence the state of climate change in Nigeria by studying 12 communities in Itu Local Government Area of Akwa Ibom State documented as being flood prone zone by the state government. The study adopted survey design. Primary and secondary sources were used to obtain data for the study. A total number of 400 copies of structured questionnaire were distributed to elicit data in addition to those gathered from observation. The data so gathered were analyzed using Multiple Linear Regressions (MLR) and Relative Effective Index. The study revealed that the people of the area had devised some coping strategies which included: Use of Contours and Barriers, Building Elevated Surface, Strengthening of Building Materials, Use of Floated Canoes, Use of Local Building Materials, Use of cover crops, Early Planting etc. and that those strategies had helped in mitigating the effect of climate change related events especially flood. The paper recommends that the various agencies of the government should be properly funded to carry out research especially in the area of improving the coping strategies of the people of the study area with a view to incorporating them in National Planning.

Keywords: Climate Change, Sustainable Environmental Quality, Flood.

uyobongetuk@yahoo.com
blackvictor25@yahoo.com
edidiong.usip@yahoo.com

Etuk, et. al. (2016). **CLIMATE CHANGE, RELATED EVENTS AND THE CHALLENGE OF SUSTAINABLE ENVIRONMENTAL QUALITY: THE NIGERIAN EXPERIENCE** Sustainable Built Environment and Climate change; The challenges of Post 2015 Development Agenda. School of Environmental Technology Conference, SETIC, 2016

INTRODUCTION

Change, perceived "as passing from one state or condition to another…", is said to be the only permanent feature in human life and perhaps the environment. The entire human life is enveloped in one change or the other – social, economic, political, cultural, scientific, technological and spiritual. Without change, humanity will remain static (Ikpe, 2013). Change is almost always expected to be positive and have great benefits derivable therefrom. However, change in some instances has been noted to be non-beneficial if not totally disastrous.

Climate from the perspective of Physical Geography may simply be defined as 'a regular pattern of weather conditions of a particular place: mild/temperate /warm/wet. While Climate Change, according to Intergovernmental Panel on Climate Change (2007), "is a statistically significant variation in the mean state of the climate or its variability, persisting for an extended period (typically decades or longer)".

Climate change characterized by global warming has become a new reality, with deleterious effects, such as disruption of ecosystems. A developing country like Nigeria, where about 70 percent of the population make their living from ventures with strong reliance on the biophysical environment is bound to be adversely affected by climate change. Consequently, this research tried to critically assess the impact of climate change with special focus on flood and the threat it poses to sustainable environmental quality in Nigeria and to find out the attempts by individuals and communities to tackle it using selected communities in Itu Local Government Area of Akwa Ibom State as a case study.

Theoretical Background/Review of Related Literature

According to Ekpoh (2013), significant changes in global climate are not strange in earth's history. However, the current climate change which started since the late 1960s as global warming is strange because of the alarming speed at which it is occurring, and the fact that it is largely anthropogenic in origin. As communities try to improve their living standards, with its concomitant modernization of urban and rural environments through the provision of infrastructures, there will always be pressure on earth's resources, especially fossil fuel and forest resources. Carbon dioxide, a major bi-product of fossil fuel consumption and forest clearance has been implicated, alongside other greenhouse gases such as methane, nitrous oxide and chlorofluorocarbon, as being largely responsible for the current global warming. Ogbonna and Otegbulu (2014) on their part maintain that climate change is caused by so many factors both natural and human (anthropogenic), including ozone layer depletion. The human factors take many forms such as bio-geographical materials absorbed or sequestered by ocean/land or decomposed by chemical reactions; astrological causes such as eccentricity of earth's orbit, obliquity; and extra-terrestrial occurrences such as solar radiation (sunspot) and quality (ultra violet radiation change), earth surface heating.

The various views of scholars and scientists as to what climate change is and the causes of it have led to seven theories being propounded. These theories, though separately advanced and at different times, have come to be known as the theories of climate change (Akpan 2014).

The Seven Theories of Climate Change

a. The First Theory (Anthropogenic Global Warming): This theory contends that human emissions of greenhouse gases, principally Carbon (iv) Oxide, methane, water vapour and Nitrous Oxide, cause a catastrophic rise in global temperatures (Green, 2007).
b. The second Theory (Bio-Thermostat): This theory holds that negative feedbacks from biological and chemical processes entirely or almost entirely offset whatever positive feedbacks might be caused by rising CO_2. These processes act as a 'global bio-thermostat' keeping temperatures in equilibrium. They are: Carbon Sequestration, Carbonyl Sulphide, Diffuse Light, Dimethyl Sulphide and Aerosols (Akpan 2014).
c. The Third Theory (Cloud Formation and Albedo): The third theory postulates that changes in formation and albedo of clouds create negative feedbacks that cancel out all or nearly all of the warning effect of higher levels of CO_2. This theory is based largely on observational data reported by a series of researchers, rather than computer models as in the case of AGW theory.
d. The Fourth Theory (Human Forcing besides GreenHouse Gases): The fourth theory of climate change holds that mankind's greatest influence on climate is not his greenhouse emissions but his transformation of Earth's surface by clearing forests, irrigating deserts and building cities (Pielke, 2009).
e. The Fifth Theory (Ocean Currents): The fifth theory of climate change contends that global temperature variations over the past century and a half, and particularly the past 30 years, were due to the slow-down of the ocean's Thermohaline Circulation (THC). Water is constantly transferred from the surface mixed layer to the interior ocean through a process called ventilation (Loehle, 2004).
f. The Sixth Theory (Planetary Motion): This sixth theory contends that most or all of the warming of the latter part of the twentieth century can be explained by

natural gravitational and magnetic oscillations of the solar system induced by the planet's movement through space (Al, 2006).

g. The Seventh Theory (Solar Variability): The seventh theory has it that solar variability accounts for most or all of the warming in the late twentieth century and will dominate climate in the twenty-first century regardless of man-made greenhouse gas emissions. Changes in the brightness of the sun are caused by sunspots (bursts of energetic particles and radiation- that vary in frequency in cycles roughly 11, 87 and 210 years). These cycles cause changes in the amount of electromagnetic radiation- also called 'solar wind' - that reaches Earth and its atmosphere, which in turn affect the earth's climate (Soon, 2005).

Impacts of Climate Change on the world

Climate change, whether in the form of frequent and intensified thunderstorms, incessant droughts, severe floods, destructive hurricanes, or monstrous tornadoes, has had great adverse effects on the entire universe. Recent examples of some of these devastating climatic events include: the 2010 Pakistani floods which directly affected 20 million people through the destruction of property, livelihood and infrastructure, as well as, killed about 2, 000 people, the 2010 Sokoto flood which washed away 20 villages, displaced 130, 000 people, killed 6 persons, destroyed the Goronyo Dam, devastated farmlands, collapsed the major bridge linking Usumanu Danfodio University to Sokoto Town; the March 2010 abnormal dust storm which enveloped Nigeria for about one week and led to multiple cancellation of flights nationwide; the July 10, 2011 extreme rainfall in Lagos which saw non-stop downpour for 14 hours that produced 231mm of rainfall; the 2012 floods in Lagos, Ibadan and Calabar that destroyed property, killed and rendered many people homeless; the 2012 floods in Makurdi, Lokoja, Yenogoa, etc., the historic Mississippi river floods of April/May 2011 (the like of which has not been seen since 1937); the deadly tornado that struck Joplin, Missouri, U.S.A. on May 24, 2011, killing 116 people in 20 minutes, injuring 400 others, and damaging some 2,000 homes, businesses, churches and a hospital.

Between 1950 and 2000, increasing frequency and intensity of storms caused enormous damages estimated at $87 billion in property losses, $19 billion in crop losses and 12, 000 in human lives in the United States of America alone. Hurricane Katrina which struck the United States of America in August 2005 and virtually submerged the city of New Orleans is said to be the costliest tropical cyclone worldwide, causing $81.2 billion in property damage and killed 1, 836 people. The overall damage caused by Katrina exceeded $100 billion (Ekpoh 2013).

Other impacts that have already manifested and continued to occur as a consequence of climate change include: frequent heat rashes, heat strokes, meningitis, seasonal flash floods, coastal flooding, beach erosion, incessant droughts, desertification, frequent and more severe cyclones such as powerful thunderstorms.

Flood Menace in Nigeria

Throughout history, flood (a consequence of climate change) has proven to be the deadliest natural disaster. The flooding which occurred in 2012 has been the worst in the history of Nigeria. Though the unusually large floods were predicted by the Nigerian Meteorological Agency (NIMET), government at all tiers failed to act on time, resulting in the worst humanitarian crisis in Nigeria since civil war of 1967-1970. Communities in about 30 percent of the country's land mass were submerged by floods, affecting estimated 7.7million persons. Over 300 people were killed and more than 2million people were displaced from their homes. Farm lands and homes were inundated in 30 out of 36 states of Nigeria (Patunola-Ajayi 2014). Among the worst affected states in Nigeria was Akwa Ibom, given its geographical location, terrain and experience.

The Study Area

Itu is located in the south east of Nigeria and is a Local Government Area of Akwa Ibom State. The Local Government Area occupies a landmass of approximately 606.1 0 square kilometres. It is located between Latitude 5°10′0″N and 7°59′0″E east of the equator. It is bounded in the North and North-East by Odukpani in Cross River State and Arochukwu in Abia State, in the West by Ibiono Ibom and Ikono Local Government Areas, in the South and SouthEast by Uyo and Uruan Local Government Areas, respectively**.**

The 12 communitites selected for the study were Odu Itu, Okoho, Edem Inyang, Akpaekpeneton, Afia Isong, Ikot Otu, Etehentem, Mkpan Uruk, Mben Inyang, Mbiabo, Ikot Adakpan, and Ayadehe. All the communities are located in the North Eastern Part of Itu by the Cross River. The impacts of flood in the communities have been so severe in the last decade. Business operation is one of the worst affected sectors of the communities as premises are flooded, goods destroyed, movement restricted and transactions put on hold.

Map of Akwa Ibom Showing the Study Area
Source: Ministry of Lands, Surveys and Town

Research Methodology

The data for the study were collected from primary and secondary sources. Observation and Questionnaire were the main instruments of primary data collection. Data from questionnaire were used extensively in the study, and for the testing of the hypothesis formulated. The following data were obtained using questionnaire: the socioeconomic/bio-data of respondents, the frequency of flood occurrence in the area, the time of flood occurrence, the duration of flood occurrence, the severity of flood damage, the level of damage caused by flood in the area, and the coping strategies used in the area.

Having been documented as a flood prone zone by the state government, the 12 communities in Itu Local Government Area were adopted for this study. Thus the population of the study comprised all the adult men and women of the 12 communities and the sample sizes were obtained through the application of a convenience sampling size of 2.57% and given a total population of 15,183 obtained from the amalgamation of the population of the individual component communities as presented below:

Odu Itu – 868, Okoho – 798, Edem Inyang – 1022, Akpaekpeneton – 980, Afia Isong – 1176, Ikot Otu – 1099, Etehentem – 854, Mkpan Uruk – 728, Mben Inyang – 672, Mbiabo – 1358, Ikot Adakpan – 1722, Ayadehe – 3906 = 15183, the sample size was therefore 390 men and women of the 12 communities. The entire population and the sample size are presented in Table.

Multiple Linear Regressions (MLR) and Relative Effective Index were the two statistical tools used for the analyses. Multiple Linear Regressions (MLR) was used in testing the hypothesis formulated in the study.

Analyses and Discussions

Table 1 showing administration of questionnaire

S/N	Community	Population	Sample size	Percentage	Copies returned
1	Odu Itu	868	22	5.5	20
2	Okoho	798	20	5	19
3	Edem inyang	1022	26	7.5	25
4	Akpaekpeneton	980	25	6.3	24
5	Afia Isong	1176	30	7.5	28
6	Ikot Otu	1099	28	7	27
7	Etehentem	854	22	5.5	21
8	Mkpan Uruk	728	19	4.7	18
9	Mben Inyang	672	17	5	15
10	Mbiabo	1358	36	9	35
11	Ikot Adakpan	1722	45	12	44
12	Ayadehe	3906	100	25	98
	Total	**15,183**	**390**	**100**	**374**

Socio – Economic Characteristics of Respondents

The first bio-data considered was the gender of the respondents in the study area. The study showed that in Odu Itu, 14 respondents were male while the remaining 6 were female. In Okoho 11 were male while 8 were female. Edem Inyang had 17 male respondents and 8 female respondents while Akpaekpeneton had 14 male respondents and 10 female respondents. Afia Isong had 12 male and 16 female respondents respectively. Ikot Otu had 19 male respondents and 8 female respondents. Other areas studied included Etehentem which had 13 male respondents and 8 female respondents. Mkpan Uruk, Mben Inyang, Mbiabo, Ikot Adakpan and Ayadehe had 13 male, 11 male, 19 male, 31 male, 63 male respondents and 5 female, 4 female, 16 female, 13 female and 35 female respondents respectively. Thus the total or overall number of male respondents was 237 while that of female respondents was 137.

The study also obtained age classification of the respondents. 90 (24%) respondents were within 20 – 35 years, 133 (36%) were within 36 – 50 years, 94 respondents which represented (25%) were within 52 – 65 years age structure, 54 (14%) were within 66 – 80 years while only 3 (1 %) respondents were 80 years and above. The findings on marital status revealed that 194 respondents which represented (52%) were married, 34 respondents (9%) were widows, 19 respondents (5%) were divorced, 41 respondents (11%) were widowers while the remaining 86 respondents which represented (23%) were still singles.

The importance of education in any given society cannot be overlooked as it influences individuals' exposure and perception of his physical, economic and socio-cultural environment. Based on the above premise, the study was interested in determining the educational status of the respondents. The study revealed that 47 respondents (13%) had no formal education, 114 respondents (30%) had primary education, and 148 respondents (40%) had secondary education while the remaining 65 respondents (17%) had tertiary education.

Frequency of Flood Disaster in the Area

To determine the frequency of flood disaster in the area, four variables were considered: (1) the frequency of flood occurrence, (2) Time of flood occurrence, (3) Duration of flood occurrence and (4) Severity of flood damage in each of the 12 communities investigated.

Table 2 showing the frequency of flood disaster

Community	Once in Four years	Once in Three years	Once in Two years	Annually	No. of respondents	REI
Odu Itu	-	1	2	17	20	3.80
Okoho	-	-	-	19	19	4.00
Edem inyang	-	-	-	25	25	4.00
Akpaekpeneton	-	2	-	22	24	3.83
Afia Isong	-	-	-	28	28	4.00
Ikot Otu	-	1	3	23	27	3.81
Etehentem	-	-	-	21	21	4.00
Mkpan Uruk	-	-	1	17	18	3.94
Mben Inyang	-	-	1	14	15	3.93
Mbiabo	-	-	-	35	35	4.00
Ikot Adakpan	-	-	2	42	44	3.95
Ayadehe	-	-	-	98	98	4.00
Total	-	**4(1.1)**	**9(2.4)**	**361 (96.5)**	**374**	

Table 3 showing summary of impact ranking

S/N	Com'ty	Bus. Optn.	Drinkg Water	Power Supply	Food Supply	Transport	Health	Housg.	Total	Rank
1	Odu Itu	3.96	3.70	3.70	3.65	3.70	3.65	3.70	**3.68**	**5th**
2	Okoho	3.95	3.84	3.63	3.79	3.74	3.74	3.68	**3.77**	**2nd**
3	Edem inyang	3.88	3.80	3.76	3.92	3.72	3.96	3.68	**3.82**	**1st**
4	Akpaekpeneton	3.71	3.75	3.67	3.83	3.50	3.67	3.54	**3.67**	**6th**
5	Afia Isong	3.79	3.89	3.61	3.82	3.71	3.75	3.68	**3.75**	**3rd**
6	Ikot Otu	3.85	3.78	3.59	3.81	3.63	3.74	3.70	**3.73**	**4th**
7	Etehentem	3.67	3.81	3.52	3.71	3.57	3.67	3.62	**3.65**	**9th**
8	Mkpan Uruk	3.72	3.56	3.33	3.67	3.28	3.83	3.50	**3.56**	**12th**
9	Mben Inyang	3.87	3.67	3.36	3.67	3.33	3.80	3.47	**3.63**	**10th**
10	Mbiabo	3.66	3.71	3.57	3.74	3.66	3.69	3.63	**3.67**	**7th ***
11	Ikot Adakpan	3.66	3.74	3.61	3.70	3.59	3.68	3.64	**3.66**	**8th**
12	Ayadehe	3.65	3.62	3.58	3.64	3.59	3.66	3.60	**3.62**	**11th**
	Total	**3.76**	**3.74**	**3.60**	**3.75**	**3.59**	**3.74**	**3.62**		
	Rank	**1st**	**3rd ***	**6th**	**2nd**	**7th**	**4th ***	**5th**		

Moreover, of the 12 communities investigated, all of them had index scores higher than the REI mean value of 2.5. However, the ranking as presented in table above reveals the level of impact each community experienced. From the table above, the most affected community with the highest score was Mben Inyang with 3.82 indexes. The second highest score was 3.77 of Okoho community. The 3rd position went to Afia Isong community with 3.75 indexes.

Diseases in the Study Area as a result of Flood

Malaria/Typhoid were found out to be the prevalent disease in the 12 communities with a percentage rate of 88.5, followed by dysentery/ Cholera with a percentage of 9.6 and lastly chicken pox/small pox with a score of 1.9%.

Coping Strategies

The study revealed that the residents of the Study Area had devised various strategies to cope with flood. The following coping strategies were identified and their effectiveness investigated:

1. Use of Contours and Barriers 2. Building Elevated Surface 3. Strengthening of Building Materials 4. Use of Floated Canoes 5. Use of Local Building Materials 6. Use of cover crops 6. Early Planting etc.
   Of all the coping strategies, the most effective as revealed from the study was Early Planting with index score of 3.91 followed by the use of Local Building Materials with 3.89 index score. The third most effective coping strategy was the use of Contours and Barriers.

Hypothesis

Ho: There is no significant relationship between the indigenous flood coping strategies used in the area, and the level of damage experienced.

Results

This hypothesis was postulated to determine the relationship between the indigenous flood coping strategies used in the area and the level of damage experienced. Multiple Linear Regression and Pearson Correlation were used to test the level of relationship. The coping strategies were the predictors while the damage made up the dependent variable. The data were fed into SPSS 17.0 version.

The result of the study revealed that there was a significant relationship between the indigenous coping strategies used in the area and the level of damage experienced as evident in the model summary where R = .916 at 0.05. Thus the Ho hypothesis was rejected since there was a significant relationship. The significant relationship meant that the application of the coping strategies had helped to reduce the level of damage experienced in the study areas.

Raised slaps constructed round the building using a concrete mix of shells, gravels and cement to safeguard the foundation in Apkaekpehentem Community

Pillars made of Concrete mix of Shells, sand and cement to Support Already Washed and Exposed Foundation of a

Barrier and Contour Constructed in Afia Isong Community to Restrict Flood Water

Conclusion and Recommendations

The study has once again brought to the fore, the disastrous effects of climate change and the challenge it poses to sustainable environmental quality. Tackling the increasing frequency of climate change related disasters in Nigeria should be everyone's business and not left for government alone. The innovation methods of the rural people of the study area in this regard are highly appreciated.

The current efforts of the Government through forestation scheme, setting up of Special Climate Change Unit (SCCU) in the Federal Ministry of Environment, Abuja, and few institutions at the national level, such as the National Environmental Management Agency (NEMA), the Nigerian Meteorological Agency (NIMET), the Climate Change Centre at the Federal University of Technology, Minna, the Energy Centre at Usman Danfodio University, Sokoto and the Cross River State ban on logging in its rainforest are commendable.

However, more is still to be done. Indiscriminate forest clearance and bush burning should be discouraged by everyone. A shift away from the culture of sustained fossil fuel consumption while pursuing renewable sources of energy, such as solar and wind power will end gas flaring in the Niger delta region and also go a long way in the attempt to control climate change. The various agencies of the government should be properly funded to carry out research especially in the area of improving the coping strategies of the people of the study area.

REFERENCES

Akpan, P. E. (2014): Theories of Climate Change: A Review in Professional Journal of Research and sustainability Development. Vol. 5, No. 1

Al Gore (2006): An Inconvenient Truth, the Planetary Emergency of Global Warming and What we can do about it. Rodales Books.

Ekpoh, I. J. (2013): Climate Change in Nigeria: Issues and Challenges. Being a Paper presented at the Mandatory Continuing Professional Development (MCPD) Seminar of NIESV, Akwa Ibom State Branch, Uyo.

Gray, W. M. (2009): global Warming and Hurricanes. Being Paper presented at the 2nd Annual Acute Weather Hurricane Summit, Houston, Texas.

Green, K. C. and Armstrong, J. S. (2007): Global Warming Forecasts by Scientists versus Scientific Forecasts. Energy and Environment **18**: 997-1021

Hulme, M. (2009): why we disagree about climate change. Cambridge Unviersity Press.

Ikpe, F. S. (2013): Climate Change and Real Estate Practice. Being a Keynote Address presented at the Mandatory Continuing Professional Development (MCPD) Seminar of NIESV, Akwa Ibom State Branch, Uyo.

Loehle, C. (2004): Climate Change- Detection and Distribution of Trends from Long-term Geologic Data. Ecological Modelling **171**: 433-450

Ogbonna, I. O. & Otegbulu, A. (2014): Valuers and Security of Investments in Coastal/Riverine Areas in Times of Climate Change. Being Paper Presented at the 44th Conference of Nigerian Institution of Estate Surveyors and Valuers in Uyo, Akwa Ibom State.

Patunola-Ajayi, B. J. (2014): Maritime, Coastal and Inland Waters Investment and Management in National Development. Being Paper Presented at the 44th Conference of Nigerian Institution of Estate Surveyors and Valuers in Uyo, Akwa Ibom State.

Pielke S. R. (2009): Climate Change- The Need to Consider Human Forcings Besides Greenhouse Gases. EOS **90 :** 45

Soon, W. (2005): Variable Solar Irradiance as a Plausible Agent for Multidecadal Variations in the Artic-Wide Surface Air Temperature Record of the past 30 Years. Geophysical Research Letters 32:10

INVESTIGATION OF THE IMPACT OF SUNSPOTS ON EARTH'S CLIMATE

AJAYI, O. G[1]; IBIK, A. L[2]; ODUMOSU, J. O[1]; BABALOLA, K. H[3] & ADESINA, E. A[1]

[1]Department of Surveying and Geoinformatics, Federal University of Technology, Minna
[2]Department of Physics and Astronomy, University of Nigeria, Nsukka.
[3]Department of Surveying and Geoinformatics, The Federal Polytechnic, Ado-Ekiti

World history of the effect of climate change on humanity is enough witness to attest to its lethal effects. Various researches have delved into the investigation of the probable causes of variation in earth's climatic condition, with majority of such researches concentrating more on the impact of the changes in the reflectivity of earth's atmosphere, surface and increase in the emission of greenhouse gases into the atmosphere chiefly propelled by human inducement, while little has been done to investigate the impact of the temporary phenomena on the photosphere of the Sun that appears visibly as dark spots compared to surrounding regions (Sunspots). Using Global sunspots and annual temperature anomalies data of 1900 - 2014, attempt has been made in this research to investigate temporal variation of the trend of sunspots and their impact on earth's climate since temperature is one of the basic indices that define climate while the sun is the fundamental source of energy that drives our climate system. The result shows that the earth is getting warmer over the years as increase in years lead to increase in annual temperature anomaly. A very weak correlation was observed between the global mean sunspot number and the annual temperature anomaly while there is a positive correlation between the global mean sunspot number and the Earth's temperature though very weak and statistically insignificant. It is thus concluded that the direct impact of sunspots on Earth's anomaly is very weak, minimal and at best, indirect.

Keywords: Climate, Temperature anomalies, Sunspot, Photosphere, greenhouse emission, global warming, sun irradiance.

ogbajayi@gmail.com

Ajayi, et. al. (2016). **INVESTIGATION OF THE IMPACT OF SUNSPOTS ON EARTH'S CLIMATE** Sustainable Built Environment and Climate change; The challenges of Post 2015 Development Agenda. School of Environmental Technology Conference, SETIC, 2016

INTRODUCTION

Climate is the average weather in a place over more than thirty years. It is any long-term significant change in the “average weather” that a given region experiences. Average weather may include average temperature, precipitation and wind patterns. It involves changes in the variability or average state of the atmosphere over durations ranging from decades to millions of years. These changes can be caused by dynamic processes on Earth, external forces including variations in sunlight intensity, and more recently by human.

Our planet's climate is influenced by so many factors some of which include volcanic eruptions, wind, solar radiations and ocean currents to man-made emissions of greenhouse gases. Nearly all the energy impacting Earth's climate comes from the sun, even if it is sometimes indirectly (www.wikibooks.org). The sun can be described as a thermonuclear engine which emits energy that is released by the fusion of hydrogen atoms within the sun’s core. It supplies the energy needed for life on Earth. It is a constant star when compared with many others in the galaxy. Some stars pulsate dramatically, varying wildly in size and brightness and even exploding. In comparison, the sun varies in the amount of light it emits by only 0.1 percent over the course of a relatively stable 11-year-long pattern known as the solar cycle (Charles, 2013). The solar activity which consists of Solar wind, coronal mass ejections (CME), solar flares, sunspots, etc is a major influencer of earth’s temperature.

Sunspot, which is one of the major solar activities can be described as the temporal phenomena on the photosphere of the Sun which appears visibly as dark spots compared to surrounding regions. They form on the surface of the Sun due to strong magnetic field lines coming up from within the Sun through the solar surface. They correspond to concentrations of magnetic field flux that inhibit convection and result in reduced surface temperature compared to the surrounding photosphere (en.wikipedia.org). They are cooler than the surrounding photosphere, typically by about 1500K (thus, they are still at a temperature of about 4500K, but this is cool compared to the rest of the photosphere which could be as high as 6,500K). They could be as large as 50,000 miles in diameter, move across the surface of the sun, contracting and expanding as they go. These sunspots can sometimes become many times bigger than the earth are always dark because they are much cooler than the surrounding surface of the Sun itself. Sunspots are predominantly present during solar maximum (Solar max is the period of greatest solar activity in the solar cycle of the sun, where one solar cycle lasts about 11 years) while only very few or even no sunspot appears during solar minimum (www.spaceweatherlive.com). Sunspot consists of two parts namely: The umbra (dark part) and the Penumbra (Lighter part around the dark part).

REVIEW OF RELATED LITERATURES

Global climate change including long-term periods of global cold, rainfall, drought, and other weather shifts are also perceived to be influenced by solar cycle activity, based on historical evidence as documented by quite a number of researchers some of which are herein presented in this subsection:

Some parts of the solar spectrum, especially ultraviolet, increase a great deal during sunspot activity. Even though ultraviolet radiation makes very little contribution to the total energy that comes from the sun, changes in this type of radiation can have a large effect on the earth's atmosphere, especially the energy balance and chemistry of the outer atmosphere (Wilson, 2014). One of the first notably documented researches on the impact of sunspots and climate change was conducted by Eddy (1976). The research looked at the record of the globally averaged sea surface temperature (SST) and noticed an obvious similarity between this and the variation of solar activity represented by the 11 year cycle sunspot number. He observed that a period of unusually low sunspot activity from 1645-1715, called the Maunder Minimum, coincided with a period of long cold winters and severe cold temperatures." Temperatures dropped by 1.8 to 2.7 degrees Fahrenheit in Western Europe and North America, often called the "Little Ice Age." In 1991, this relationship was further examined using the length of the sunspot cycle as a parameter which varies from cycle to cycle. It had been demonstrated that the length of the sunspot cycle is usually shorter during strong activity cycles than during low activity cycles. A comparison with the Northern Hemisphere land temperature during the last 130 years did show a remarkably good correlation with the smoothed curve of the varying solar cycle length indicating that this parameter was possibly a better indicator of solar activity variations that could affect the Earth's climate (Friis-Christensen and Lassen, 1991).

The recent investigations of possible effects of solar variations on the earth's temperature and on the height of constant pressure levels in the stratosphere were reviewed by Labitzke and Van-Loon (1993). The research found that the correlations between solar activity and climate parameters for the stratosphere on a decadal scale have a specific spatial distribution over the globe, and that they have the highest values between 20° N and 45° N in the Pacific-Atlantic area during most of the year but especially high and statistically significant during summer. But during winter the correlations are not statistical significant. This research also submitted that the solar radiation circulation is a major factor controlling the spatial distribution of the atmosphere's response to solar variability and that the average temperature difference between solar maximum and solar minimum years is largest just below the tropopause.

Lassen (1995) re-examined the solar total and UV irradiances since 1610. The result of the research validated the results gotten earlier by Friis- Christensen (1995) which confirmed that the correlation between the total solar irradiance and the Northern Hemisphere surface temperature from year 1610 to 1800 is 0.86, which suggests a predominant solar influence. By inference, there is an indication that solar forcing may have contributed to about half of the 0.5°C surface warming since the year 1860. Douglas and Kenneth (1997), in the book titled “The Role of the Sun in Climate Change” examined different sampling methods and their problems; they studied data of solar variation with climate in the early centuries and found that the correlation is remarkably parallel. They also summarized several ideas on the recent century results, finding it controversial since the surface temperature of the earth is increasing steady with increased sunspot number.

Friis-Christensen and Henrik (1997), discovered that the relationship between sunspots and the earth’s climate is complex as a result of large radioactive effect of clouds, which could be the missing link between solar activity variations and climate changes. Nine (9) cycles of changes in solar brightness were tracked by Kevin and Kevin (2002) and correlated the solar brightness with the climate of the earth. Their findings observed that the period of low sunspots within the period of their investigation corresponds with the Maunder Minimum, a period of extreme cold in Europe. Scientists from NASA Earth Observatory (2005) confirmed after studying the total solar irradiance (TSI) at different points and time that the amount of radiation arriving from the Sun is not constant. It varies from the average value of the TSI-1,368W/m^2 on a daily basis. They concluded that the number of sunspots on the Sun’s surface is roughly proportional to total solar irradiance.

The Intergovernmental Panel on Climate Changes (IPCC) of Cambridge in 2007 made use of calculations of Total Solar Irradiance (TSI) data of various cycles till 2007 and found out that the sunspots number has been increasing steadily at the time when the earth has been getting warmer during the past periods. This implies that the increase in the number of sunspots corresponds to the increase in the warmness of the earth, even though, the past two cycles indicate that the sun and the climate are moving in opposite directions.

Jennifer (2008) presented that changes in sunspot cycles do change the amount of solar radiation given off by the sun, but by a little bit. Using the solar irradiance and daytime high temperatures relationship, Soon and Briggs (2012) argued that the sun warms the earth and more effects are experienced in the regions of cloudless skies. This findings was also supported by Harry Van Loon and Gerald Meehl (2009). Gerald (2009) presented persuasive evidence that solar variability is leaving an imprint on climate, especially in the Pacific. According to the report, when researchers look at sea surface temperature data during sunspot peak years, the tropical Pacific shows a pronounced La Nina-like pattern, with a cooling of almost $1^{o}C$ in the equatorial eastern Pacific. In addition, "there are signs of enhanced precipitation in the Pacific Inter-Tropical Convergence Zone (ITCZ) and South Pacific Convergence Zone (SPCZ) as well as above-normal sea-level pressure in the mid-latitude North and South Pacific," correlated with peaks in the sunspot cycle. Of course, this was expected since the Sun warms the equator more than the poles, climate varies with latitude.

According to NASA's Marshall Space Flight Center in July 22, 2009, sunspots play a role in climate change, but at very minimal value. They suggest that maybe if carbon emissions are reduced, we will be able to detect the impact of sunspots and other natural influences on earth's climate. Recent research (Lane et al, 1994) indicates that the combined effects of sunspot-induced changes in solar irradiance and increases in atmospheric greenhouse gases offer the best explanation yet for the observed rise in average global temperature over the last century (Geerts and Linacre, 1997). Charles (2013b) opined that even small changes in solar activity can impact Earth's climate in significant and surprisingly complex ways, though it may have more of a regional effect than a global one. Scientists from the American Institute of Physics in 2014 proposed that before 20^{th} century, irregular variations in solar surface activity were connected with earth's climate shifts but from 20^{th} century till date, the variations in solar surface activity with earth's climate is minor.

Study Area

The earth is the only astronomical object in the solar system known to harbor life. It is one of the planets of the solar system contained in the milky-way galaxy. It gravitationally interacts with other objects in space, especially the Sun and the Moon. It rotates about its own axis 366.26 times, creating 365.26 solar days or one sidereal year during its one orbit around the Sun. The earth's only permanent natural satellite is the Moon. The earth's gravitational interaction with its only natural satellite gradually slows earth's rotational rate, stabilizes the orientation of earth's rotational axis and causes ocean tides. The shape of the earth approximates an oblate spheroid (a sphere flattened at the axis from pole to pole creating a bulge around the equator).

According to evidences from radiometric dating and other sources, the earth was formed about 4.54 billion years ago.

MATERIALS AND METHODS

Global sunspots and annual temperature anomalies data of 1900 – 2014 were used for this investigation. The sunspot data was extracted from the online data repository of WDC-SILSO (Sunspot Index and Long-term Solar Observations), Royal Observatory of Belgium, Brussels (http://www.sidc.be/silso/datafiles). The global temperature anomaly data set was extracted from the online data repository of National Aeronautics and Space Administration (NASA) Goddard Institute for Space Studies (http://data.giss.nasa.gov/gistemp/). Both land and satellite based measurements were used to source for these data. All data used can be classified as secondary data.

From the monthly temperature anomaly data, annual temperature anomaly was computed for each of the years from 1900 to 2014 to reduce data complexity for effective data management. Also, yearly mean total number of sunspots were computed for each of the obtained sunspot data. These computed or extracted data were thus arranged in fields and tuples within Microsoft excel worksheet environment which was the software environment where the result was processed using the analyse-it add-in statistical software. Both regression and correlation analysis were adopted to establish the existence of statistically significant relationship (association and dependency) between the variables of the dataset.

RESULTS

- Table 1.0a and b shows the result of the Correlation analysis expressing the relationship between the annual mean temperature anomaly and the years and the result of the regression analysis establishing a dependency relationship between annual mean temperature anomaly and the years of study respectively.
- Figure 1.0a is a scattered diagram superimposed on the histogram showing the correlation between annual mean temperature anomaly and the years while Figure 1.0b presents the scattered diagram showing the association between annual mean temperature anomaly and the years from regression analysis. Figure 1.0c presents the residuals of the regression analysis showing: (a) the relationship between standardized residuals and frequency, (b) standardized residual and observation and (c) standardized residual and Normal theoretical quantile of the annual mean temperature anomaly and the years. The residual plots allow visual assessment of the distance of each observation from the fitted line, while the

histogram of the residuals allows visual assessment of the assumption that the measurement errors in the response variable are normally distributed.

- Table 2.0a contains the result of the Correlation analysis showing the relationship between the Yearly Mean Total Sunspot Number and the years while Table 2.0b shows the results of the regression analysis establishing a dependency relationship between Yearly Mean Sunspot Number and the years of study.
- Figure 2.0a presents a scattered diagram superimposed on the histogram showing the correlation between Yearly Mean Total Sunspot Number and the years while Figure 2.0b is the scattered diagram showing the association between Yearly Mean Sunspot number and the years from regression analysis. Figure 2.0c is the scattered diagram showing the association between standardized residuals and the years from regression analysis while Figure 2.0d: Residuals of the regression analysis showing: (a) the relationship between standardized residuals and frequency, (b) standardized residual and observation and (c) standardized residual and Normal theoretical quantile of the yearly mean number of sunspots and the years.
- Table 3.0a shows the result of the Correlation analysis showing the relationship between the annual mean temperature anomaly and the yearly mean sunspot numbers while Table 3.0b shows the results of the regression analysis establishing a dependency relationship between Yearly Mean Sunspot Number and the annual temperature anomaly.
- Figure 3.0a presents a scattered diagram superimposed on a histogram showing the correlation between Yearly Mean Total Sunspot Number and the annual temperature anomaly, Figure 3.0b is the scattered plot showing the association between Yearly Mean Sunspot number and the annual temperature anomaly from regression analysis. Figure 3.0c presents the scattered diagram showing the association between standardized residuals and the annual temperature anomaly from regression analysis while Figure 3.0d Residuals of the regression analysis showing: (a) the relationship between standardized residuals and frequency, (b) standardized residual and observation and (c) the standardized residual and Normal theoretical quantile of the yearly mean number of sunspots and the annual temperature anomaly.

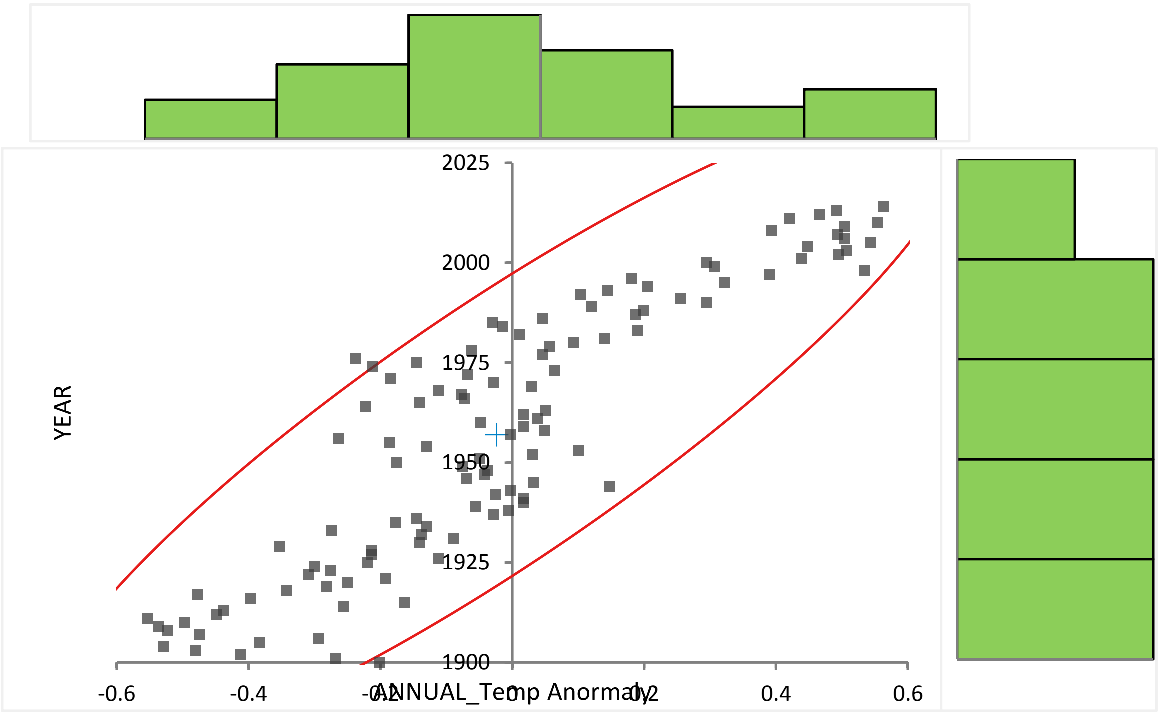


Figure 1.0a: Scattered diagram superimposed on histogram showing the correlation between annual mean temperature anomaly and the years.

Table 1.0: Result of the Correlation analysis showing the relationship between the annual mean temperature anomaly and the years.

N	115	
Pearson's r	0.889	
Fisher 95% CI	0.843	to 0.922
Hypothesized value	0	
t approximation	20.64	
DF	113	
p-value	<0.0001	

H0: $\rho = 0$, The correlation coefficient ρ of the bi-variable population is equal to 0.
H1: $\rho \neq 0$, The correlation coefficient ρ of the bi-variable population is not equal to 0.

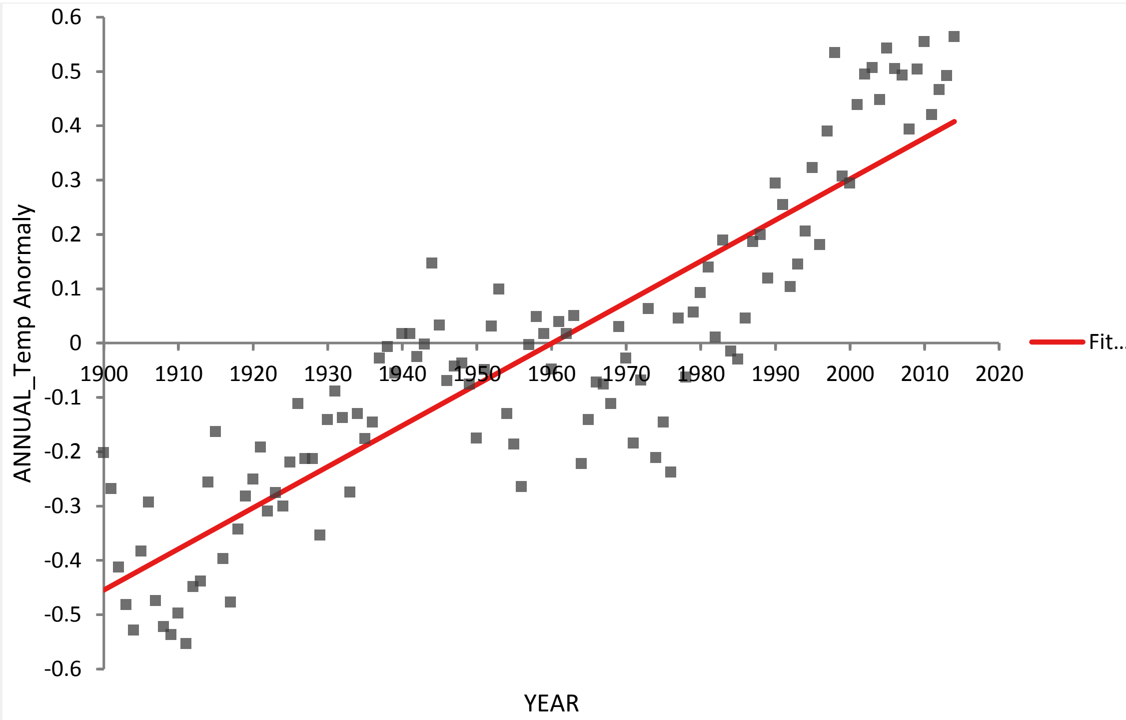


Figure 1.0b: Scattered diagram showing the association between annual mean temperature anomaly and the years from regression analysis.

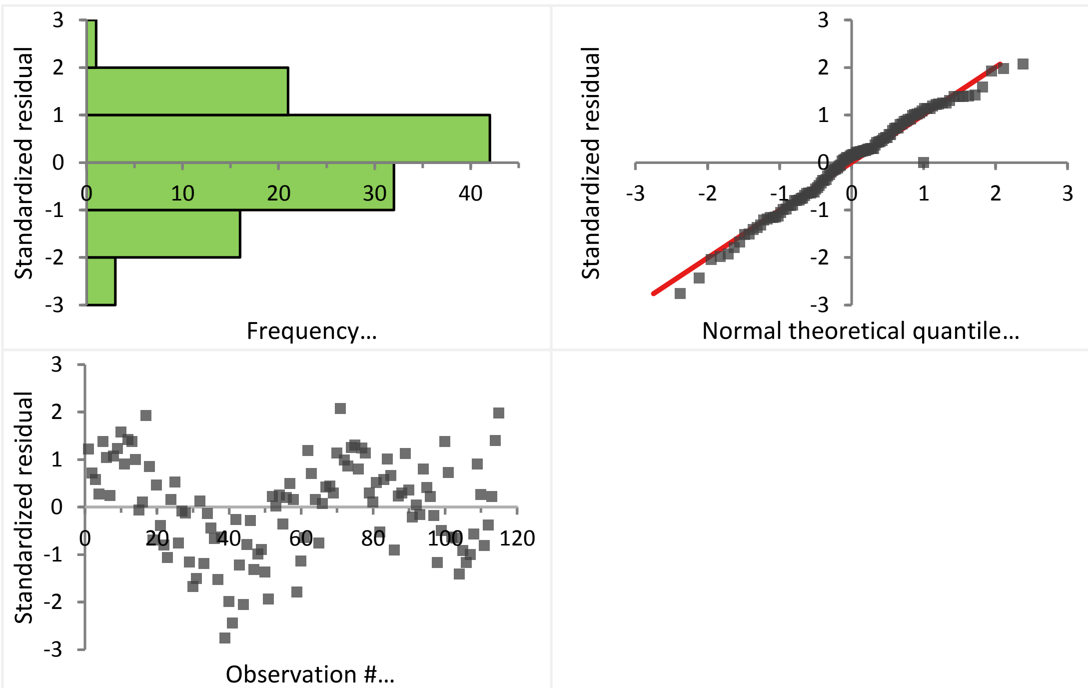


Figure 1.0c: Residuals of the regression analysis showing: (a) the relationship between standardized residuals and frequency, (b) standardized residual and observation and (c) standardized residual and Normal theoretical quantile of the annual mean temperature anomaly and the years.

FIT					
N	115				
Variable	Mean	SD	Minimum	Median	Maximum
YEAR	1957.0	33.3	1900	1957.0	2014
ANNUAL_Temp Anomaly	-0.0236	0.2837	-0.553	-0.0420	0.564
Equation	ANNUAL_Temp Anomaly = -14.83 + 0.007565 YEAR				
R^2	0.790				
R^2 adjusted	0.789				
SE of fit (RMSE)	0.13046				
Parameter	Estimate	95% CI		SE	p-value
Constant	-14.83	-16.25	to -13.41	0.71729	<0.0001
YEAR	0.007565	0.006839	to 0.008291	3.6647 E-04	<0.0001
H0: $\beta = 0$, The parameter is equal to 0. H1: $\beta \neq 0$, The parameter is not equal to 0.					
EFFECT OF MODEL					
Source	SS	DF	MS	F	p-value
Difference	7.2530	1	7.2530	426.14	<0.0001
Error	1.9233	113	0.0170		
Null model	9.1763	114	0.0805		
H0: $E(Y\|X=x) = \mu$, The model is no better than a null model $Y=\mu$. H1: $E(Y\|X=x) = \alpha + \beta x$, The model is better than the null model.					
EFFECT OF TERMS					
Term	SS	DF	MS	F	p-value
YEAR	7.2530	1	7.2530	426.14	<0.0001
H0: $\beta_{Term} = 0$, The term does not contribute to the model. H1: $\beta_{Term} \neq 0$, The term contributes to the model.					

Table 1.0b: Results of the regression analysis establishing a dependency relationship between annual mean temperature anomaly and the years of study.

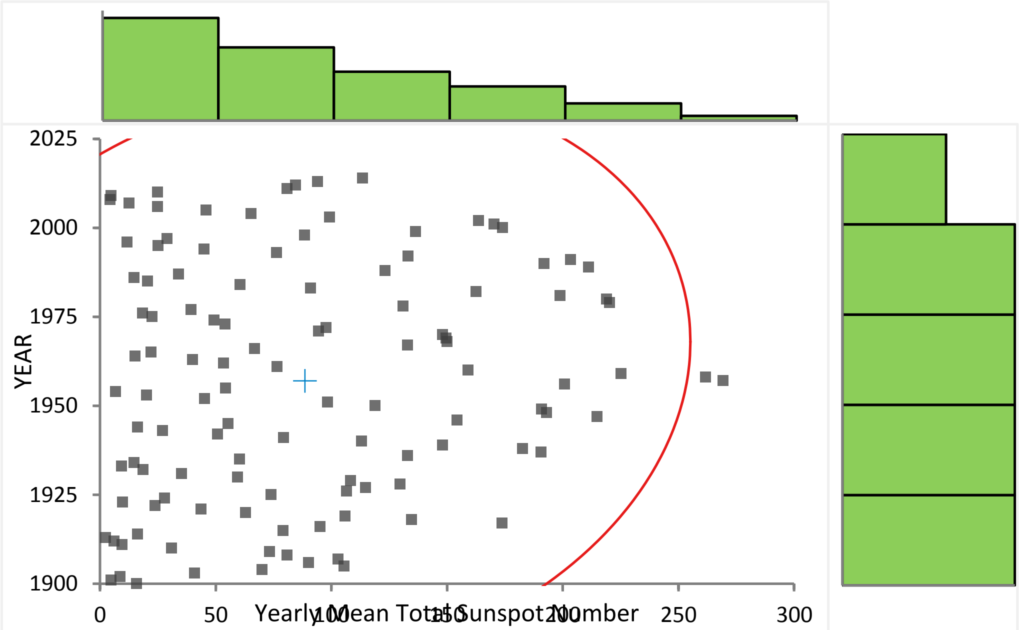


Figure 2.0a: Scattered diagram superimposed on histogram showing the correlation between Yearly Mean Total Sunspot Number and the years.

Table 2.0a: Result of the Correlation analysis showing the relationship between the Yearly Mean Total Sunspot Number and the years.

N	115	
Pearson's r	0.133	
Fisher 95% CI	-0.051	to 0.308
Hypothesized value	0	
t approximation	1.43	
DF	113	
p-value	0.1569	

H0: $\rho = 0$, The correlation coefficient ρ of the bi-variable population is equal to 0. H1: $\rho \neq 0$, The correlation coefficient ρ of the bi-variable population is not equal to 0.

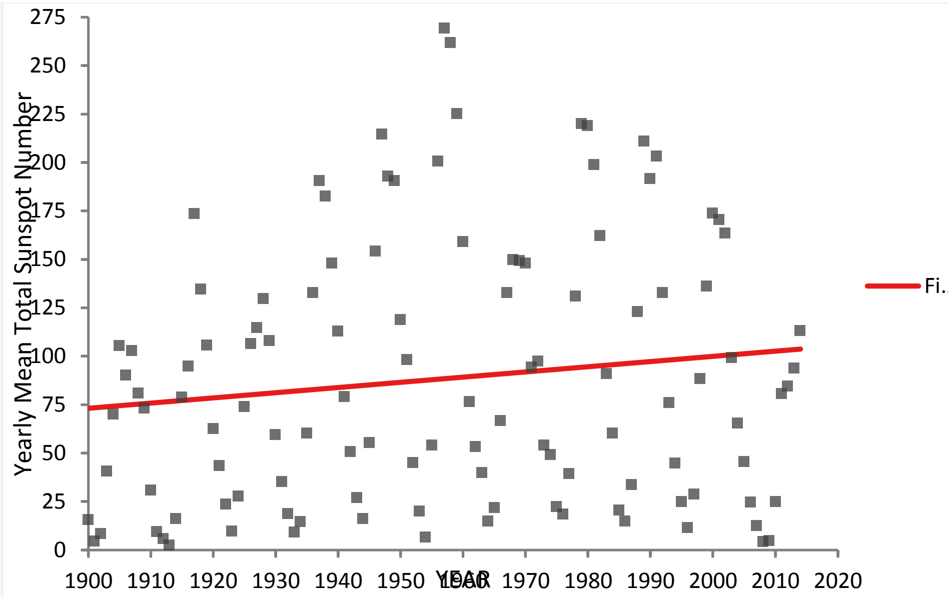


Figure 2.0b: Scattered diagram showing the association between Yearly Mean Sunspot number and the years from regression analysis.

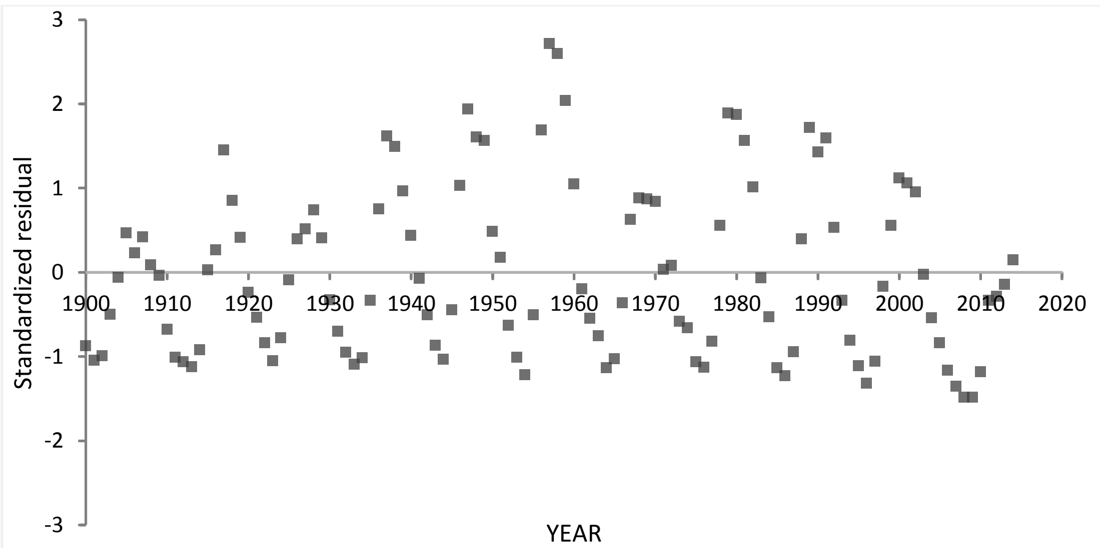
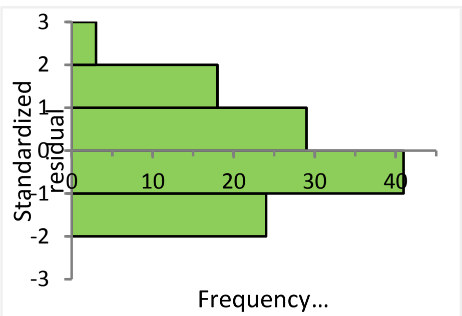
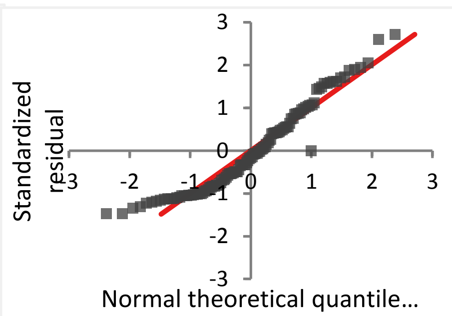


Figure 2.0c: Scattered diagram showing the association between standardized residuals and the years from regression analysis.

Table 2.0b: Results of the regression analysis establishing a dependency relationship between Yearly Mean Sunspot Number and the years of study

FIT					
N	115				
Equation	Yearly Mean Total Sunspot Number = -435.8 + 0.2679 YEAR				
R^2	0.018				
R^2 adjusted	0.009				
SE of fit (RMSE)	66.914				
Parameter	Estimate	95% CI		SE	p-value
Constant	-435.8	-1165	to 293.1	367.90	0.2387
YEAR	0.2679	-0.1045	to 0.6403	0.18796	0.1569
H0: $\beta = 0$, The parameter is equal to 0. H1: $\beta \neq 0$, The parameter is not equal to 0.					
EFFECT OF MODEL					
Source	SS	DF	MS	F	p-value
Difference	9092.75	1	9092.75	2.03	0.1569
Error	505951.46	113	4477.45		
Null model	515044.21	114	4517.93		
H0: $E(Y\|X=x) = \mu$, The model is no better than a null model $Y=\mu$. H1: $E(Y\|X=x) = \alpha + \beta x$, The model is better than the null model.					
EFFECT OF TERMS					
Term	SS	DF	MS	F	p-value
YEAR	9092.75	1	9092.75	2.03	0.1569
H0: $\beta_{Term} = 0$, The term does not contribute to the model. H1: $\beta_{Term} \neq 0$, The term contributes to the model.					





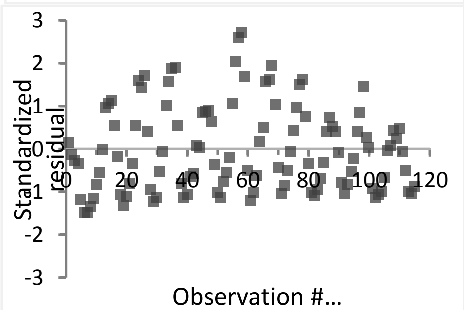


Figure 2.0d: Residuals of the regression analysis showing: (a) the relationship between standardized residuals and frequency, (b) standardized residual and observation and (c) standardized residual and Normal theoretical quantile of the yearly mean number of sunspots and the years.

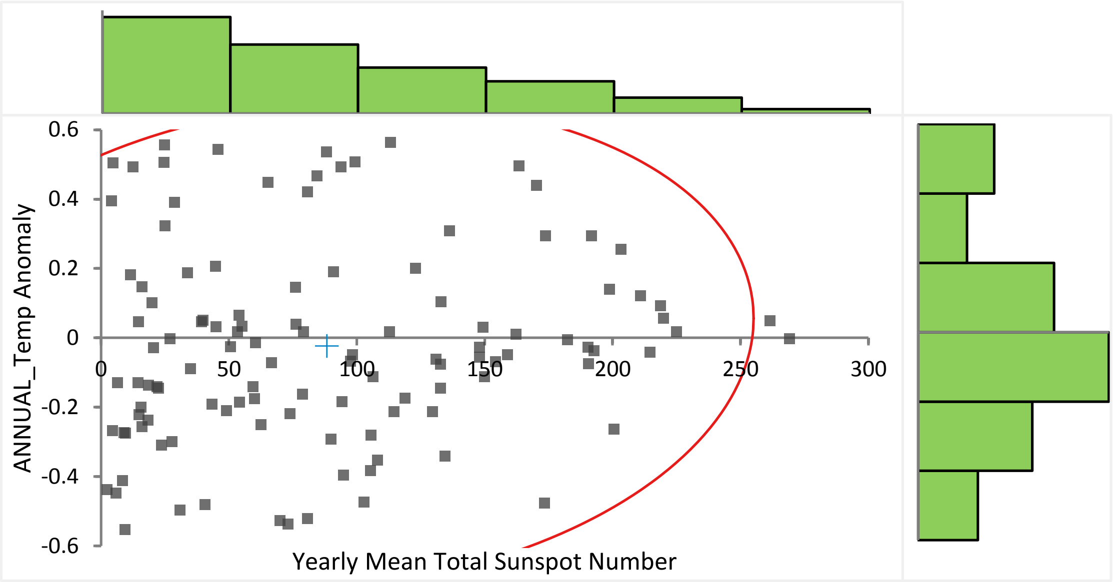


Figure 3.0a: Scattered diagram superimposed on histogram showing the correlation between annual mean temperature anomaly and the yearly mean sunspot numbers.

Figure 3.0a: Scattered diagram superimposed on histogram showing the correlation between Yearly Mean Total Sunspot Number and the annual temperature anomaly

Table 3.0a: Result of the Correlation analysis showing the relationship between the annual mean temperature anomaly and the yearly mean sunspot numbers.

N	115	
Pearson's r	0.114	
Fisher 95% CI	-0.071	to 0.291
Hypothesized value	0	
t approximation	1.22	
DF	113	
p-value	0.2266	

H0: ρ = 0, The correlation coefficient ρ of the bi-variable population is equal to 0.
H1: ρ ≠ 0, The correlation coefficient ρ of the bi-variable population is not equal to 0.

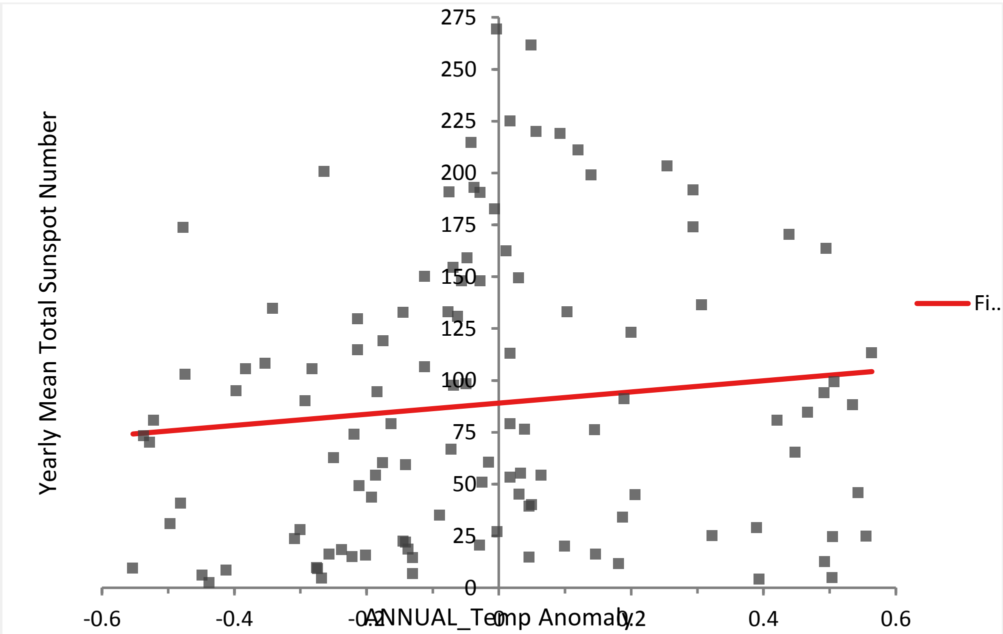


Figure 3.0b: Scattered diagram showing the association between Yearly Mean Sunspot number and the annual temperature anomaly from regression analysis.

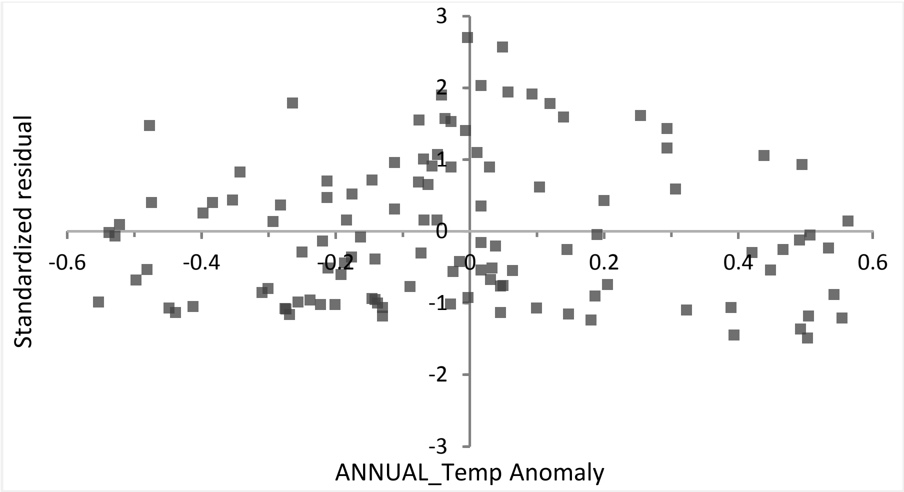


Figure 3.0c: Scattered diagram showing the association between standardized residuals and the annual temperature anomaly from regression analysis.

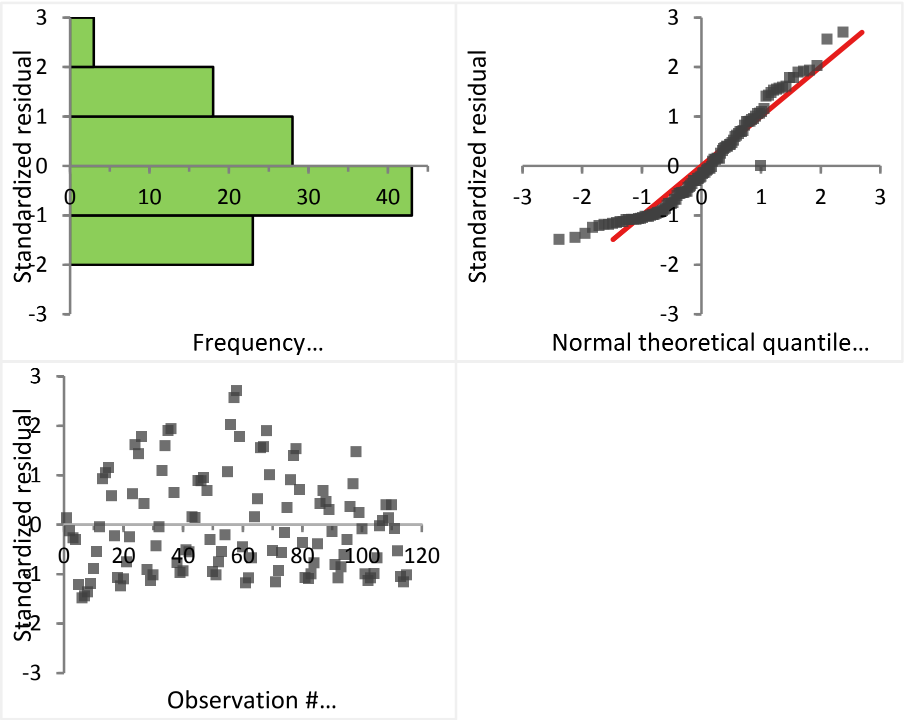


Figure 3.0d: Residuals of the regression analysis showing: (a) the relationship between standardized residuals and frequency, (b) standardized residual and observation and (c) the standardized residual and Normal theoretical quantile of the yearly mean number of sunspots and the annual temperature anomaly.

Table 3.0b: Results of the regression analysis establishing a dependency relationship between Yearly Mean Sunspot Number and the annual temperature anomaly

FIT					
N	115				
Equation	Yearly Mean Total Sunspot Number = 89.04 + 26.92 ANNUAL_Temp Anomaly				
R^2	0.013				
R^2 adjusted	0.004				
SE of fit (RMSE)	67.075				
Parameter	Estimate	95% CI		SE	p-value
Constant	89.04	76.61	to 101.5	6.2766	<0.0001
ANNUAL_Temp Anomaly	26.92	-16.95	to 70.79	22.143	0.2266
H0: $\beta = 0$, The parameter is equal to 0. H1: $\beta \neq 0$, The parameter is not equal to 0.					
EFFECT ON MODEL					
Source	SS	DF	MS	F	p-value
Difference	6651.36	1	6651.36	1.48	0.2266
Error	508392.85	113	4499.05		
Null model	515044.21	114	4517.93		
H0: $E(Y\|X=x) = \mu$, The model is no better than a null model $Y=\mu$. H1: $E(Y\|X=x) = \alpha + \beta x$, The model is better than the null model.					
EFFECT ON TERMS					
Term	SS	DF	MS	F	p-value
ANNUAL_Temp Anomaly	6651.36	1	6651.36	1.48	0.2266
H0: $\beta_{Term} = 0$, The term does not contribute to the model. H1: $\beta_{Term} \neq 0$, The term contributes to the model.					

DISCUSSION OF RESULTS

From Table 1.0a and Figure 1.0a, The Pearson's r value of 0. 889 which is very close to 1 at 95% confidence interval, was obtained in the correlation analysis which seeks to establish the relationship between the annual temperature anomaly and the years of study. The Pearson's r value obtained connotes a very strong and positive correlation between the years and temperature. Also, the p-value (which tests the null hypothesis that the coefficient is equal to zero or of no effect) obtained is less than 0.0001 (which is less than $\alpha = 0.05$) also implies that there is a statistically significant correlation between these two variables thereby rejecting the null hypothesis. The R^2 value (coefficient of determination) of 0.790 and R^2 adjusted value (which adjusts for the number of terms in the model) of 0.789 obtained in the regression analysis

(See Table 1.0b and Figures 1.0b &c) implies a very strong and positive statistically significant relationship between the years and the global annual temperature anomaly and that there is a linear association between the two continuous variables. This defines the degree of dependency of the two variables. This means that increase or decrease in the years do significantly relate to increase or decrease in the annual temperature anomaly. Therefore, increase in year also leads to increase in the annual temperature anomaly on the Earth surface, thereby implying that the temperature of the Earth is on the increasing trend as the year increases. It can thus be statistically safe to infer that the Earth is much hotter today as it used to in past years. This is in synchrony with the current claim that the Earth is indeed getting hotter (Solomon et al, 2007; Lemke et al, 2007) and since temperature is a major driver of climate change, the impact of climate change can be said to be on the increasing trend annually. In fact the hottest year in the Earth's history was recorded with a temperature of 0.68degree Celsius in 2014 followed by 2010 with a temperature of 0.67degree Celsius and 2005 with 0.66degree Celsius (Elena, 2015). More recent investigation by NASA's Goddard Institute for Space Studies (GISS) which is also supported by Scientists from the National Oceanic and Atmospheric Administration also revealed that 2015 is hotter than 2014 and that 2016 will likely be hotter than 2015. This proves that the Earth's temperature warms in an upward trend which has a direct effect on the earth's climatic condition.

The result of the regression analysis conducted with the aim of investigating the statistical relationship between the global mean number of sunspots and the years resulted into a R^2 value of 0.018 and R^2 adjusted value of 0.009 at 95% confidence interval (see Table 2.0b and Figures 2.0 b-d) implies that there is a weak positive association between the global mean number of sunspots and the years of study and that there is no linear association between the two continuous variables (global mean number of sunspots and the year). This suggests a very weak dependency relationship between the two variables which implies that increase in the number of years may not necessarily imply increase or decrease in the number of sunspots. This result is in consonance with the conclusion of Jennifer Bergman (2008) and it is also supported by the outcome of the correlation analysis (See Figure 2.0a and Table 2.0a) which gave a Pearson's r value of 0.133 and p-value of 0.1569 implying that there is a weak relationship between the two variables and that there is no statistically significant correlation between them because we do not have enough statistical evidence to reject the null hypothesis. Based on these results, the Authors do not have enough statistical evidence to affirm that the number of global sunspots increases or decreases as the year increases.

Since the Pearson's r value of 0.114 is less than and not close to 1 in the correlation analysis which seeks to establish the statistical relationship between annual temperature anomaly of the Earth and the global mean sunspot numbers (See Table 3.0a and Figure 3.0a), it can be inferred that there is a very weak correlation between the Yearly Mean Total Sunspot Number and the Yearly mean temperature anomaly. This is also buttressed by the p-value obtained as 0.2266 which is higher than $\alpha = 0.05$. This implies that there is no statistically significant correlation between the two variables since we do not have enough statistical evidence to reject the null hypothesis. This can also be observed in the scattered plot presented as Figures 3.0b - d and the regression analysis result presented in Table 3.0b. The implication of this is that there is no statistically significant relationship between the global Sunspots and the temperature anomaly within the years understudied (1900 - 2014). It is thus the authors' opinion that the increase or decrease in the annual rate of sunspots globally has no direct statistical impact on the temperature of the Earth. This claim is also supported by the outcome of the regression analysis. The R^2 value of 0.013 obtained implies that there only exist a very weak positive association between the global sunspots and the temperature anomaly within the years of study. The 0.004 R^2 value obtained signifies that there is no linear association between the two continuous variables (global mean Sunspots number and annual temperature anomaly). It is thus safe to infer that increase or decrease in the global annual sunspot numbers may not necessarily result into increase or decrease in Earth's temperature thereby having no direct impact on the Earth's climate and even if/when it does affect it, the impact is largely very little or statistically insignificant which at best attest to the indirect impact that has been observed by NASA's Marshall Space Flight Center in July 22, 2009 and the scientists from the American Institute of Physics in 2014, while Charles (2013) opined that this impact may be more of a regional effect than a global one.

CONCLUSION

The following conclusions were made based on the findings of this research:

- There is a strong and positive correlation which is statistically significant between the years and the annual temperature anomaly. Increase or decrease in Years results into increase or decrease in the temperature of the Earth. Since the years have always been on the increasing trend, the Earth's temperature also has been increasing over the years.
- There is a weak, though positive correlation which is not statistically significant between the years understudied and the global mean sunspot numbers. Increase in the years may not necessarily result into increase in the global number of sunspots
- Finally, it was observed that the correlation between the annual temperature anomaly and the global mean sunspot number is positive though weak and statistically insignificant. Increase or decrease in the global mean sunspot numbers has a very weak effect on the Earth's temperature. This implies that the impact of sunspots on Earth's climate is very weak or little.

RECOMMENDATION FOR FURTHER STUDIES

Since this research investigated the direct effect of sunspots on Earth's climate using statistical means, further studies will attempt to investigate the indirect impact of the existence and cycles of sunspots on earth's climate. We shall also consider the study on regional basis to verify the validity of the claim of Charles (2013) which suggest that the impact may be more of regional impact than a global one.

ACKNOWLEDGEMENT

The authors would like to acknowledge the encouragement and motivation of Dr. Wolfgang Kerzendorf of the European Southern Observatory, Germany, Dr. Linda Strubbe of the Department of Physics and Astronomy, University of British Columbia and Dr. Patrice Okouma of the Society for Astronomy and Space Science, Gabon and University of Western Cape, South Africa.

REFERENCES

B. Geerts and E. Linacre (1997). "Sunspots and Climate" Available online at: http://www-das.uwyo.edu/~geerts/cwx/notes/chap02/sunspots.html. Accessed on 22nd February, 2016 by 0840hours.

Charles Q. C, (2013a). "The effects of solar Variability on Earth's climate". A workshop report by Committee on the Effects of Solar Variability on Earth's Climate Space Studies Board Division on Engineering and Physical Sciences, National Research Council. Available online at https://tallbloke.files.wordpress.com/2014/02/nasa-sun-earth.pdf.

Charles Q. C, (2013b). Tiny solar Activity Changes affects earth's climate. Contributions published by Space.com available online at: http://www.space.com/19280-solar-activity-earth-climate.html

David .N, (2009). "The role of sunspots and solar winds in climate change" NASA Marshall Space Flight Centre. Retrieved from http://www.scientificamerican.com/article/sun-spots-and-climate-change/.

Douglas V. H and Kenneth .S, (1997). "The Role of the Sun in Climate Change" Oxford University Press, ISBN: 01950, 94131.

Eddy, J.A, (1976)."The Maunder minimum" Science, 192, 1189-120.

Elena .G. (2015). Global Warming: Earth is Getting Hotter and Hotter; Earth's hottest year revealed. Retrieved from en.yibada.com/articles/46734/20150721/global-warming-earth-getting-warmer-what-keep-planet-safe.htm on 11th January, 2016, 8:54pm.

Friis-Christensen and Henrick S. (1997). Solar-Terrestrial Physics Division, Danish Meteorological Institute, Denmark

Friis-Christensen, E. and K. Lassen, (1991). "Length of the solar cycle: an indicator of solar activity closely associated with climate", Science, 254, 698 - 700.

Gerald. A. Meehl, Julie Arblaster, Katja Matthes, Grant Branstator, Fabrizio Sassi, Harry van Loon, (2009)."Amplifying the Pacific Climate System response to a small 11years Solar Cycle forcing" National Centre for Atmospheric research (NCAR). Retrieved/ accessed online on 22nd February, 2016 by 0904Hours from: http://www.swpc.noaa.gov/sites/default/files/images/u33/Solar.April_.2011%20(1).pdf

https://en.wikibooks.org/wiki/Climate_Change/Science/Sun%27s_Influence_on_Earth accessed on 9th Nov, 2015 by 1035hours.

Intergovernmental Panel on Climate Changes (IPCC), Annex 1, (2007). "The Physical Science Basis working Group 1 contribution to the fourth Assessment report" Cambridge University Press. Pp 941-954.

Jackson C., (2011). "The impact of energetic particles precipitation on the atmosphere" NASA Goddard Space Flight Centre's publication of the 9th September, 2011.

Jennifer B., (2008). "Windows to the Universe" National Earth Science Teachers Association (NESTA)'s publication retrieved online at http://windows2universe.org on 15th August, 2015 by 1420Hours

Kevin D. P. and Kevin K. Y., (2002). "Ancient observations link changes in Sun's brightness and Earth's climate" EOS, Transactions of the American Geophysical Union, Volume 83, No 43.

Labitzke, K. and H. van Loon, (1993)."Some recent studies of probable connections between solar and atmospheric variability", Ann. Geophysicae, 11: 1084-1094.

Lane, L.J., M.H. Nichols, and H.B. Osborn (1994). "Time series analysis of global change data". *Environ. Pollut.*, **83**, 63-68

Lassen, K. and E. Friis-Christensen, (1995). "Variability of the solar cycle length during the past five centuries and the apparent association with terrestrial climate" J. Atmos.

Lemke, P., J. Ren, R.B. Alley, I. Allison, J. Carrasco, G. Flato, Y. Fujii, G. Kaser, P. Mote, R.H. Thomas, and T. Zhang. (2007). Observations: Changes in snow, ice and frozen ground. In: Climate change 2007: The physical science basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Edited by S. Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor, and H.L. Miller. Cambridge University Press.

NASA Earth's observatory "Solar radiation and Climate experiment''. Retrieved online at: http://earthobservatory.nasa.gov/Features/SORCE/

NASA (2016): 2015 Was Earth's Warmest Year on Record But 2016 Might Even Be Hotter. Retrieved online at: http://www.techtimes.com/articles/126343/20160121/nasa-2015-was-earths-warmest-year-on-record-but-2016-might-even-be-hotter.htm on 22nd February, 2016 by 0855Hours

Solomon .S, D. Qin, M. Manning, R.B. Alley, T. Berntsen, N.L. Bindoff, Z. Chen, A. Chidthaisong, J.M. Gregory, G.C. Hegerl, M. Heimann, B. Hewitson, B.J. Hoskins, F. Joos, J. Jouzel, V. Kattsov, U. Lohmann, T. Matsuno, M. Molina, N. Nicholls, J. Overpeck, G. aga, V. Ramaswamy, J. Ren, M. Rusticucci, R. Somerville, T.F. Stocker, P. Whetton, R.A. Wood, and D. Wratt. (2007). Technical summary. In: Climate change 2007: The physical science basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Edited by S. Solomon, D. Qin, M. Manning. Z. Chen, M. Marquis, K.B. Averyt, M. Tignorm, and H.L. Miller. Cambridge University Press.

The Discovery of Global warming, (2014). "Changing Sun, Changing Climate?" Spencer Weart and American Institute of Physics. Retrieved online from https://www.aip.org/history/climate/solar.htm on 22nd February, 2016 by 0906Hours.

WDC-SILSO (Sunspot Index and Long-term Solar Observations), Royal Observatory of Belgium, Brussels (http://www.sidc.be/silso/datafiles) accessed on 11th August, 2015 by 1625Hours.

Willie Soon. and William M. Briggs. (2012), "Global warming fanatics take note" Washington Times. Retrieved online from http://www.washingtontimes.com/news/2012/sep/6/global-warming-fanatics-take-note/ on 22nd February, 2016 by 0908Hours.

Wilson, R. M. (2014). "Comparison of variations of sunspot number, number of sunspot Groups", Huntsville, NASA, Marshall Space Flight Centre. www.spaceweatherlive.com/en/help/what-are-sunspots, accessed on 27th December, 2015 by 0910Hours

ASSESSMENT OF BIOCLIMATIC PRICIPLES IN THE DESIGN OF PUBLIC SPACES IN MINNA

D.O. Alonge[1], S.A. Oyetola[1], G.O. Adebisi[1], O.J. Onuwe[1] & A.U. Attah[2]
[1]Department of Architecture, Federal University of Technology, Minna.
[2]Department of Architecture, Modibbo Adama University of Technology, Yola.

In the design of buildings for the past few decades, Architects have made attempts to develop or create strategies where human requirement and the building as a whole can adapt to the design of such buildings. Apart from building materials which these building enclosure are composed of, other factors like orientation have also been used to achieve a sustainable built environment. Other methods employed include the development of buildings Bioclimatic charts because different regions have different kinds of strategies adopted by them respectively. Bioclimatic architecture deals with the connection of a building to nature, how building takes into account the climate and environmental conditions to favour comfort within the buildings. The aim of this paper is to adopt the building Bioclimatic principles in order to assess the most appropriate building design strategies for office buildings in Minna. These will be achieved by assessing office buildings mainly within Minna city to find out the environmental impact associated with the buildings due to climatic change. The paper proves that, in a long term, Bioclimatic Architecture is profitable, Architects and the society need to be aware that in order to achieve the desired Sustainability, we need to respect the environment and the changes that occur in the climate, so that we can build based on these bioclimatic principles.

Keywords: *Built Environment, Office Buildings, Bioclimatic, Sustainability.*

alonge.olubunmi@yahoo.com

Alonge et. al. (2016). **ASSESSMENT OF BIOCLIMATIC PRICIPLES IN THE DESIGN OF PUBLIC SPACES IN MINNA** Sustainable Built Environment and Climate change; The challenges of Post 2015 Development Agenda. School of Environmental Technology Conference, SETIC, 2016

INTRODUCTION

Buildings constitute major parts in any city, be it public or private building. This is because buildings are major elements in the development of these cities and owing to the fact that people dwell and spend time within the confines of one form of building or the other. Buildings here refer to shelter. Shelter is a basic need and every individual in a city has a right to shelter. Its provision and adequacy should therefore aim at considering good quality in terms of protection, comfort, ventilation, lighting, privacy, amongst others. Various types of buildings have been identified such as, Federal government buildings (secretariats, offices), State Government buildings (State houses, offices), public buildings (private and government owned), airports, seaports, health buildings (hospitals, clinics, pharmacies), institutional buildings (Nursery and primary schools, Universities, colleges), commercial buildings (markets, supermarkets), residential buildings (High rise, detached, duplexes), office buildings (banks) and religious buildings (Mosques and Churches). It is worthy to say that residential buildings is highly dominated by humans and second to the residential buildings are office buildings where time is been spent outside the home to work. Therefore certain factors such as adequate space, flexible space, electrical systems, water system, and conducive environment all contribute to achieving comfort within these office spaces. According to Adedeji & Fadamiro (2012), the internal and external aspects of the workplace environment affects the workers level of comfort (visual comfort, spatial arrangement, security and overall workstation comfort). The general comfort and wellbeing of workers can greatly be influenced by the environment where they work; it is therefore needful to provide buildings and the spaces within these buildings with basic needs to get the best productivities for workers. The aim of this paper is to adopt the building Bioclimatic principles in order to assess the most appropriate building design strategies for office buildings in Minna. These will be achieved by assessing office buildings mainly within Minna city to find out the environmental impact associated with the buildings due to climatic change. Bioclimatic architecture deals exclusively with building design and materials to achieve energy efficiency. For building to be termed as sustainable, a creation of a comfortable environment is the most important factor. According to Jose (2015), it was identified that different from the past age when architecture required an environmental sacrifice, in this century of the environment, an architectural design which lessens the burden on the environment by using natural energy and can also be sustainable to time is required. The design and construction of these buildings are mostly done by professionals; architects, planners, builders as well as engineers. In design of these buildings, a number of factors influence the type of buildings, such as building materials, availability of land, building regulations and codes, concepts, climatic conditions, as well as environmental factors. Adedayo, (2010) stated that seeking users view in creating liveable environment for potential owners assist in meeting up their needs and aspiration, thus their satisfaction is expected to have been captured.Nowadays, what is common practice is that architects are forced to assume the needs of the user of these offices, and design based on that and expects the users to get used to the offices provided for them, which in turn might affect the productivity of the workers.

BIOCLIMATIC DESIGN PRINCIPLE

Bioclimatic architecture is the type of architecture that connects with nature, the building in this type of architecture takes into account, the environment as well as climate, which in turns helps to achieve optimal comfort within the building space. It avoids every mechanical system, often regarded as support. Bioclimatic architecture therefore is not new; most of the traditional buildings work according to the principles of bioclimatic. These principles have worked over the years and still working, modern designs could benefit from careful integration of bioclimatic concepts and principle, making use of natural ventilation, passive solar design, and sustainable materials.

Fig 1 . Passive Climatic Design Principle. Source: www.eastcoastdesigner.com

Passive Solar Architecture

As seen in Fig 1, Passive solar architecture can be referred to as to housing design that makes use of efficient solar energy. As it does not use mechanical systems (thus the term passive), it is closely related to bioclimatic architecture, though the later also deals with other non-solar climatic elements. That is why the term bioclimatic is a little bit more general, and inclusive, although both work in the same direction.

Active Solar Architecture

Active solar architecture refers to taking advantage of solar energy by the means of mechanic and/or electric systems for heating (solar collectors) and electric conversion (photo-voltaic panels). They may complement a bioclimatic house and off-set energy loads of the building's users.(Kane, 2012)

Renewable Energy

Renewable energy is Sources of energy that cannot be exhausted. Bioclimatic architecture incorporates solar radiation (renewable) for heating and cooling. Other kinds of renewable energies include wind or water (hydro), and methane generation from organic waste (biomass).

SUSTAINABLE ARCHITECTURE

Sustainable architecture uses the concept that aims to a minimum environmental impact of all the processes implied in building, from materials, building techniques (for a minimum environmental damage), building location/siting and its environmental impact, energy consumption and its impact, and the recycling of materials when the building has accomplished its function and is demolished. Bioclimatic architecture helps reduce the energy consumption of the building is in use, and can be enhanced when coupled with sustainability architecture techniques. Bioclimatic design measures are centered primarily on the climate of a specific area as thus:

1. **Building envelope and orientation**: The orientation of the building and materials used can reduce the heat gain into a building especially during the hot periods. Therefore the building needs to be protected.

2. **Sun shading devices**: the use of shading devices, either vertical or horizontal as the case may be can reduce heat gain into the building during periods of heat and the use of paints that do not allow solar rays from the sun to penetrate into the building can also be adopted.

3. **Window openings**: the use of large window opening and type of window that will allow for balance and exchange of heat accumulated during the day for the natural and cool breeze at night. Also windows or other devices that collect solar energy should face within 30 degrees of true south and should not be shaded during the heating season by other buildings or trees from 9 a.m. to 3 p.m. each day. (Diana 2014)

4. **Indoor air quality**: The use of air locks installed in doors to reduce effect of heat as well as the introduction of green walls can improve the indoor air quality of the building.

5. **Landscape**: the climate around and within the building can be enhanced when trees and shrubs are planted , as well as the introduction of either natural or artificial water bodies around the building.(Kane, 2012).

BUILDING BIOCLIMATIC CHARTS

Building bioclimatic charts offers a convenient way to predict whether or not a passive cooling technique is likely to improve the level of comfort in a building. (NAl-Azri ,Zurigat,and Nal-Rawahi, 2013). Bioclimatic charts facilitate the analysis of the climate characteristics of a given location from the viewpoint of human comfort, as they present on a psychometric chart, the concurrent combination of temperature and humidity at any given time. They can also specify building design guidelines to maximize indoor comfort conditions when the building's interior is not mechanically conditioned. All such charts are structured around, and refer to, the 'comfort zone'. The comfort zone is defined as the range of climatic conditions within which the majority of persons would feel thermally comfortable.

in the early 50s", different bioclimatic charts were developed among which are the Olgyays bioclimatic chart as well as the Givoni's bioclimatic chart, just to mention a few, (Olyays 1963)

Olgyays Bioclimatic Chart

Olgyays Bioclimatic chart was one of the first attempts at an environmentally conscious building design. It was developed in the 1950s. The chart incorporated the outdoor climate into building design. The chart indicates the zones of human comfort in relation to ambient temperature and humidity, mean radiant temperature (MRT), wind speed, solar radiation and evaporative cooling. In order that comfort can be retained within the indoor spaces, wind speed can be offset to increase the indoor temperature. Another factor worthy of note with this concept was the use of Evaporative cooling, which was a means to retain comfort at high temperature values but at low humidity. This bioclimatic chart is applicable for hot humid climate such as Minna, because there is minimal fluctuation between the indoor and outdoor temperature. The concept of the chart was based on the outdoor climatic conditions. This resulted in some limitations in analyzing the physiological requirements of the indoor environment of the building. Therefore the chart is applicable to a hot humid climate since there are no high range fluctuations between indoor and outdoor conditions, (Olgyays 1963)

Givoni's Bioclimatic Chart

It was aimed at predicting the indoor conditions of the building according to the outdoor prevailing conditions. He based his study on the linear relationship between the temperature amplitude and vapour pressure of the outdoor air in various regions. In his chart and according to the relationship between the average monthly vapour pressure and temperature amplitude of the outdoor air, the proper passive cooling strategies are defined according to the climatic conditions.

Prevailing outside the building envelope. The chart combines different temperature amplitude and vapor pressure of the ambient air plotted on the psychometric chart and correlated with specific boundaries of the passive cooling techniques overlaid on the chart. These techniques include evaporative cooling, thermal mass, natural ventilation cooling, and passive heating. It can be applied mainly to residential scale structures which are free of any internal heat gains. In 1970 he published his analysis of the Index of Thermal Stress, which was followed by Humphreys in 1978 and Auliciemes in 1982 with their Thermal Neutrality equations. All of their thought was brought together and they developed the concept that, depending on the location and the people of that location, there are, in fact, two comfort zones rather than one. The zones are based on thermal neutrality correlated to the outdoor mean temperature,(Givoni ,1963)

SUSTAINABLE OFFICE DESIGN

Sustainable design is an exciting area of architecture and building which is moving into the main stream (Martinez 2012). Productivity is gained in terms of better quality of work where office buildings have been designed to be more sustainable. A modern office building always manifests economic strength and a belief in the future, the office for majority, is the daily work environment for an employed citizen of the society, because an employee spends more than 40 hours per week within his office. The office space should then be designed to influence employees and their organization. Public office buildings here refers to a place open to the general public, they can have access to it and because different kinds of people can come and transact business within the offices. Office space can be grouped to be either an open office system or enclosed office system or a combination of both, what matters most is to provide an enabling environment for workers to be productive. The common practice of most public offices in Nigeria is a combination of both office systems.

STUDY AREA

Minna falls within the temperate humid region of the country. These conditions contribute to discomfort in both homes and offices. Public buildings are found next to residential development within the city. It is necessary when designing to reduce the amount of heat gain into these public spaces during the day as Minna is located within the tropics, in most cases the outdoor condition that is air velocity is low and this contributes to inefficient comfort ventilation. It is imperative to seek out designs strategies that will be efficient in office buildings within Minna as well as to maximize evaporative cooling to achieve thermal comfort for users of the public spaces, A survey was carried out within the Federal secretariat of the city, because of the number of offices found within the buildings. 37 parastatals within the city have their offices within the Federal Secretariat like the Civil Defense Commission, National population Commission, Public Control Commission, National Commission for Museum and Housing, NAFDAC, as well as the Prison Commission. Offices are allocated based on the strength of each parastatals. The least office space allocated to a parastatal is 6 different office types and the parastatal with the high population of staff like the Civil Defense Commission has about 15 office spaces allocated to them. The office types ranges from single office, to partitioned offices, double offices for heads of each parastatals.

RESEARCH METHODOLOGY

Primary and secondary data were used for this research. The primary data was gotten through the use of observation directly. The Federal secretariat was selected based on the population of the staff within this secretariat as well as the number of offices found within the building. The observation carried out was done with the use of an observation schedule. The schedule looked critically at the following parameters;

1. The number of people within the office buildings
2. Types of offices within the building
3. The heat gain into the building through the use of these element glazing, roof , wall, floors and windows.

The secondary data were collected from review of related literature

DISCUSSION OF FINDINGS

Table 1 : showing types of offices and number of staff in the office.

	No of staff			
Office types	1-5	5-10	10-15	15-20
Single office		●		
Partitioned single office	●			
Double office	●			
Large Office			●	
Partitioned large office		●		

Source: Author's fieldwork (2016)

From the table above, it can be deduced that, partitioned offices carried the least number of staff, the number of staff with the office space ranged between one to five. Next to that is the single office, which has staff between the range of five to ten, while the office with the largest population is the Large Offices which ranged between ten to fifteen staff. This implies that the number of staff within an office space contributes to the comfort within these spaces.

Table 2 : Rating of comfort within office spaces by staff of the National Museum and housing parastatal.

Office type	**Very poor**	**Poor**	**Indifferent**	**Good**	**Very good**	**Total**
Single office	0	1	0	5	2	8
Partitioned single office	0	0	1	4	0	5
Double office	0	0	0	3	0	3
Large office	2	3	1	6	0	12
Partitioned large office	0	1	2	5	1	9
Total	2	5	4	23	3	37
Percentage (%)	5.4	13.5	10.8	62.1	8.1	100

Source: Author's fieldwork (2016)

From the table 2 above, it can be observed that the number of staff who share office space can contribute to the indoor air quality of such an office. 62.1 % staff rated comfort within their office space as Good. While 5.4% rated very poor for the office space. The windows used within the complex building contribute to the amount of in air quality of the offices. Window used range from top hung projected window as can be seen in Plate 1, as well as louvers window as seen in plate 4, which contributes to about 90% of good window ventilation. Although over time, these windows have been said to be outdated . No matter the kind of window used, it should be located in such a way that the prevailing wind is been used to the advantage of the building.

Units That Allow Heat Gain

Plate 1: exterior view showing vertical Fins Plate 2: interior view showing horizontal Fins

Source: Author's fieldwork (2016) Source: Author's fieldwork (2016)

From the observation carried out, solar radiation that gets in to the building is minimum because of the vertical fins used on the exterior of building as well as horizontal sun shading devices used within the interior of the complex. The use of courtyard has also been used to enhance the outdoor temperature, this implies that heat gain into the building has greatly not been influenced because of the external element used in the construction of the building.

Plate 3: sliding windows
Source: Author's fieldwork (2016)

Plate 4: louvers window
Source: Author's fieldwork (2016)

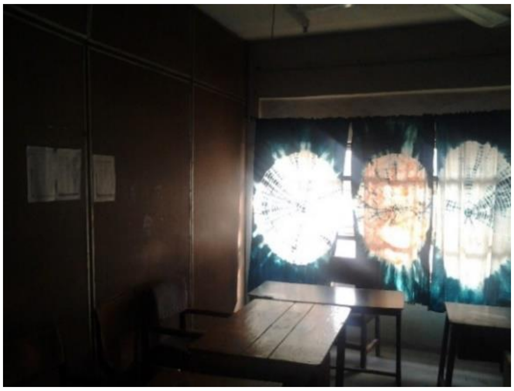


Plate 5: interior view showing wooden partition

Source: Author's fieldwork (2016)

Plate 6: courtyard showing soft landscape

Source: Author's fieldwork (2016)

From plate 3 and 4, it can be observed that heat is accumulated indoor from the glazing of the building, but the type of windows used within the complex is the top hung projecting window, sliding window as well as louvers which gives 90% of air movement within the office space. It was also observed that sun has a direct impact on the roof; therefore the type of material used can help reduce heat gain into a building. The roof used at the federal secretariat is flat with parapets around it, making the roof hidden. Walls are also major source of heat gain for indoor spaces, although wooden partitions have been introduced to partition some large offices . it can be seen in Plate 5,that the rate of block walls used was high, this can retain heat during the day.

CONCLUSION

From the observation carried out in the research, the staff in the single partition offices and double offices have very good rating for the level of thermal comfort within their spaces. The large offices were very poor because of the number of occupants of their office. It was also observed that windows and type of doors used within the building has helped to a large extent the amount of heat gain into the building. This should be recommended for effective design and good thermal achievement in public buildings in Minna. Although the federal secretariat was poorly maintained, the use of courtyards and landscape have helped to improve the surrounding air and it has helped to cool the environment. However, before public buildings are designed or even built, the environmental impact of the building to the occupants as well as the environment should be greatly considered, because a healthy working environment determines the welfare and productivity of the users of the offices. The research has shown the need to consider users of these spaces while designing the magnitude of such a public building.

REFERENCE

Adedayo, Ayuba, and Oyetola (2013). *Bioclimatic Design Principle, a solution to thermal discomfort in Minna Residence*. Environmental and Earth Science Journal3(12), pg 45-51

Ajibola, K. (2000). *Design for Comfort in Nigeria: A Bioclimatic Approach.* Osun, Nigeria: Architecture Department, Obafemi Awolowo University, Ile-Ife.

ASHRAE. A (2010). *Thermal environment conditions for human occupancy*

David, Christian, Adeline,(2011). B*ioclimatic and Design Strategies analysis*. West Africa built Environment Research Conference, Accra Ghana.

Diana M,(2014). *Bioclimatic Principles in Architectural Design ;* A way to better buildings.Vilnius Gediminas Technical University,Vilnius 2014.

Employers Guide (2010). *Managing Work Place Temperature*. Retrieved from www.hse.gov.uk Health and safety executive, 15th Jan 2010.

Federico M.B (1998) .*Principles of thermal comfort*. International conference on renewable and sustainable energy reviews, vol 3, pg 40-66

Kane, C. (2012, September). *Center for Renewable Energy Sources and Savings*. Retrieved December 29, 2015, from http://www.cres.com

Martinez, M. P. (2012). *Bioclimatic Architecture.* Denmark: VIA University College.

Mathoes .S (2005). *Passive cooling in buildings*. Advances of Solar Energy, ISES, James Publishers, London.

Nal-Azri, Zugrigat, Nal-Rawahi, (2013). *Selection and assessment of Passive cooling Techniques for residential buildings in Oman using bioclimatic approaches*, TJER, 10(2), pg 52-68

Passive Solar Architecture :Basics by J.K Nayak. Energy systems engineering, Powai.
Sustainable building design Book (2005). World sustainable building conference Tokyo, 9(17), 22-25.

REVIEW AND DEVELOPMENT OF AN ALGORITHM FOR CARBON DIOXIDE EMISSION MONITOR IN AUTOMOBILE

MUSA Nicholas Akhaze[1*] and AGAJO James[2]

[1*] Department of Mechanical Engineering, Federal University of Technology, Minna, Niger State. Nigeria

[2] Department of Computer Engineering, Federal University of Technology, Minna, Niger State. Nigeria

This work intends to develop an emission monitor in automobile; the work comes up with an advanced and dynamic way of evaluating and capturing the amount of carbon credit deposit in the atmosphere. The impact of global warming, climate change has become a contending issue in most global forum, and it is always at the front burner, ever since most Countries signed up the Kyoto Protocol. Researchers have been trying to see how best carbon can be captured in the atmosphere; this work comes up with a new paradigm which is geared towards developing of a pollutant emission monitor in automobile.

***Keywords**: Carbon Dioxide (CO_2), Emission, Automobile, Analogue to Digital Converter, Sensor, Microcontroller*

madonick1@yahoo.com
agajojul@yahoo.com

MUSA Nicholas Akhaze[1*] and AGAJO James[2] (2016). **REVIEW AND DEVELOPMENT OF AN ALGORITHM FOR CARBON DIOXIDE EMISSION MONITOR IN AUTOMOBILE** Sustainable Built Environment and Climate change; The challenges of Post 2015 Development Agenda. School of Environmental Technology Conference, SETIC, 2016

INTRODUCTION

The most commonly used automotive technologies on a global scale are internal combustion engines by Otto and diesel. Consequently the two most widely used motor fuels are diesel and gasoline whose different qualities exist around the world (Kampet et al, 2003). Jie(2011) opined that today, over 90% of vehicles on the road use gasoline and diesel fuels.

The power to move a car comes from burning fuel in an engine, pollution from cars comes from by-products of combustion process (exhaust) and from evaporation of the fuel itself (USEPA, 2016) as shown in figure 1

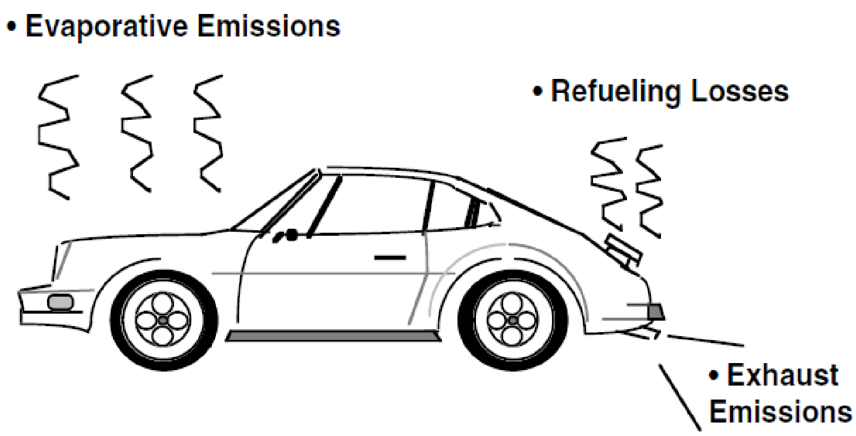


Figure 1: Pollutant emission from Automobile (USEPA, 2016)

The major concerns of gasoline exhaust contaminants are carbon monoxide (CO), hydrocarbon (HC), carbon dioxide (CO_2) and polycyclic aromatic hydrocarbons (PAHs)

Carbon dioxide (CO_2) is desirable by-product that is produced when carbon from the fuel is completely oxidized during the internal combustion process. Higher CO_2 level is indicative of the engine operating efficiency (EPA, 2000) cited by Pilusa et al (2012). Sharaf (2013) remarked that in recent years the US Environmental Protection Agency (EPA) has started to view carbon dioxide a product of perfect combustion as a pollution concern. It is a greenhouse gas that traps the earth heat and contributes to the potential for global warming .Gislason(2016) asserted that CO_2, methane, nitrous oxide and chlorofluoro carbons(CFCs) are greenhouse gases. They let sunlight in but block some of the infrared radiation from the earth's surface that carries heat back into space. These gases act like blanket wherever their concentration increases and this contribute to global warming. Resitoglu et al, (2015) asserted that carbon dioxide (CO_2) has the largest rate among the greenhouse gases, and it is the main reason of global warming. The global emission of carbon dioxide has reached 34 billion tons with an increase of 3 % in 2011(Olivier et al, 2012) cited by Resitoglu et al, (2015). Throughout the world, CO_2emissionsare currently about 35,000 million metric tons per year. Unless the urgent policies are put in action, CO_2 emissions will be projected to rise up 41,000 million metric tons per year in 2020s. In addition to warming in climate systems, the rising of CO_2 concentration in the atmosphere leads ocean acidification as a result of dissolutions (The Potsdam Institute for Climate Impact Research and Climate, 2012) also cited by Resitoglu et al, (2015)

Excess CO_2 in a habitable environment is detrimental to our health. Rice(2003) asserted that human health effects of CO_2 has been examined in the scientific and medical literature as a pre-requisite to health risk assessment for release of CO_2 from CO_2 capture, transport and Sequestration sites, atmosphericCO_2 at 0.037%(370ppm) poses no threat to human health, however, considerably higher concentrations produce adverse effects. According to Vilac and Kouch(2012) when CO_2 is inhaled, it is referred to as " hyper carbia or hypercapina"(carbon dioxide poisoning). Since our blood expels CO_2 inhaling more CO_2 would cause the inability of the body to expel the gas.

In Nigeria and elsewhere in the world like USA, the combustion of fossil fuels such as gasoline and diesel to transport people and goods is the second largest after electricity where fossil fuels are combusted. Large proportion of automobiles uses fossil fuel (petrol and diesel) and the emissions from the combustion of these fossil fuel into the environment are oxides of carbon, oxides of nitrogen, oxides of sulphur , particulate matter etc.(Datta and Mandal, 2012), Emission of carbon dioxide from automobile is a major treat with immeasurable contribution to climate change.

Since the adverse effects of higher concentrations of CO_2 in our environment cannot be compromised, and automobile is one of the sources, it becomes imperative to detect and measure its concentration in the environment so as to know the contribution of automobile to the emission. However this has been achieved by the use of various gas detectors and analysers which measure the concentrations of CO_2 among other gases at moment or interval of time for a particular vehicle.

The aim of this work is to develop an algorithm for a system that will effectively measure the amount of Carbon dioxide discharged into the atmosphere from an automobile, and also come up with a real-time system that will provide a read out of the quantity of carbon dioxide concentration from an automobile as soon as the engine begins its operation. (Estrin et al 2001.)

METHODOLOGY

Carbon dioxide emission monitor in automobile is anchored on CO_2detection and display. An interconnection of various sub-units from sensing to display is involved, and CO_2concentration is detected, conditioned, processed and transmitted (João 2006). The MODEM at the receiver node intercept the signal (CO_2) concentration, the Analogue to Digital Converter condition the signal for the processor and the display is a read out that gives visual information for the signal being mentioned.

The system underlining principles of signal transfer are

i. Signal sensing

ii Signal conditioning

iii. Signal processing

iv. Signal transmission(Zig-Bee MODEM)

Figure 2 shows the block diagram of the interconnection of various stages that make up the entire system. The diagram is a 2 in1 block containing both the sink node and transmission

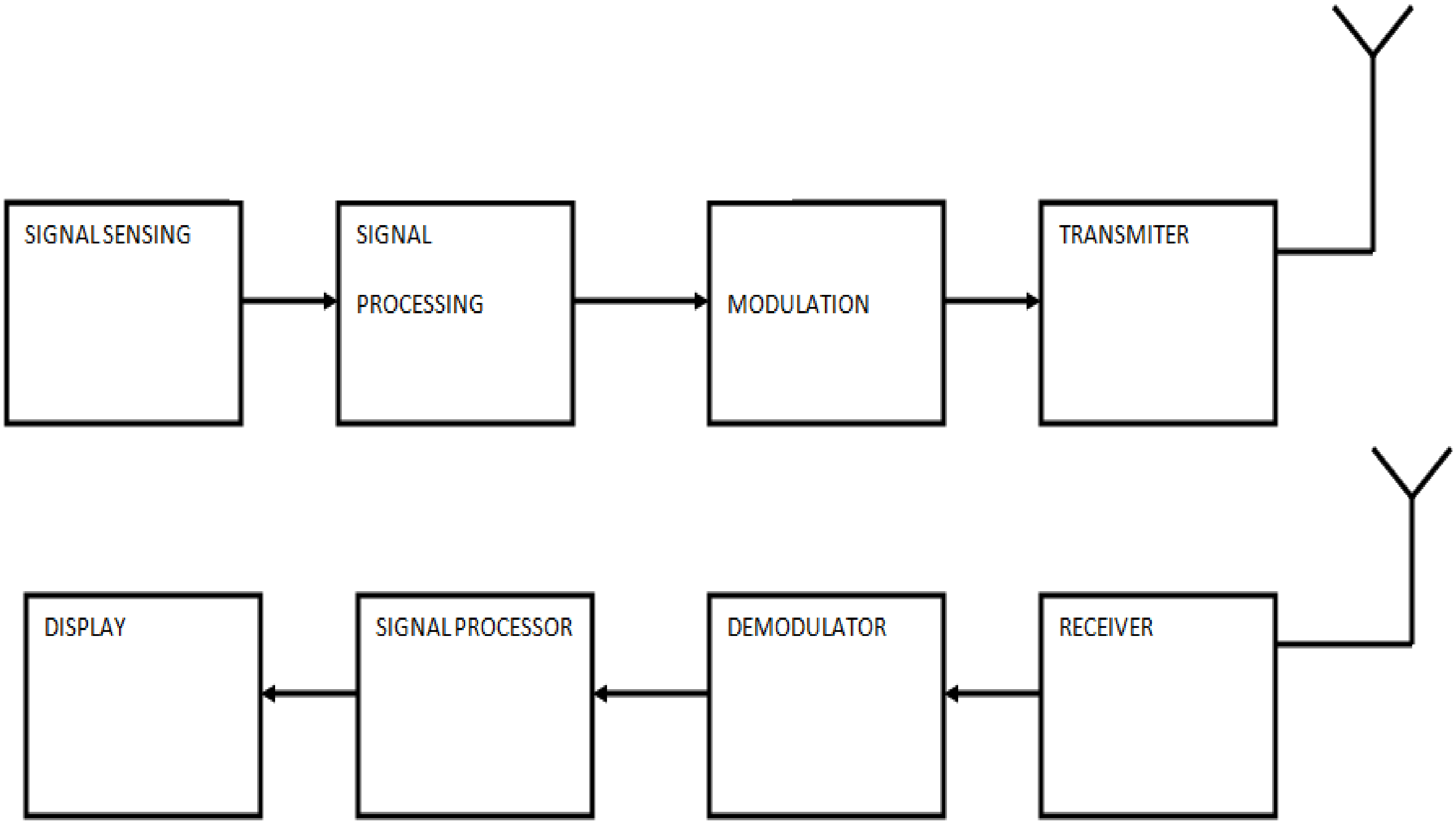


Figure 2: Block diagram representing system interconnection

Signal Sensing

The signal sensing stage contains sensors, a sensor is an object whose purpose is to detect events or changes in its environment, and then provide a corresponding output. A sensor is a type oftransducer that provides various types of output, but typically use electrical or optical signals. A carbon dioxide sensor or CO_2 sensor is an instrument for the measurement of carbon dioxide gas. The most common principles for CO_2 sensors are infrared gas sensors (NDIR) and chemical gas sensors.

NDIR is an industry term for "non-dispersive infrared", and is the most common type of sensor used to measure CO_2 shown in figure 3

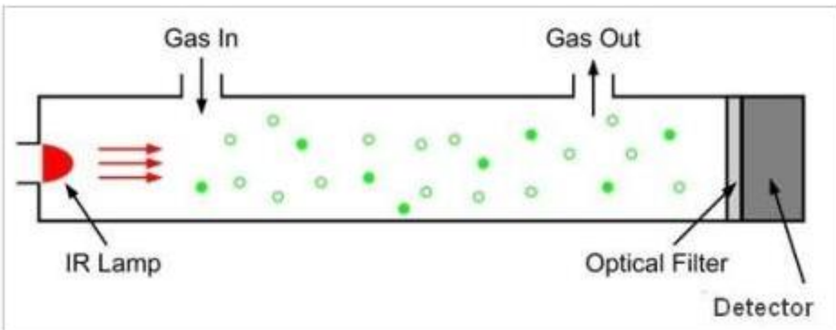


Figure 3: NDIR CO_2 sensor

Source: CO2 Meter (2014)

An infrared (IR) lamp directs waves of light through a tube filled with air toward an IR light detector, which measures the amount of IR light that hits it. As the light passes through the tube, any gas molecules that are the same size as the wavelength of the IR light absorb the IR light light only, while letting other wavelengths of light to pass through.

Next, the remaining light hits an optical filter that absorbs every wavelength of light except the exact wavelength absorbed by CO_2 and finally, an IR detector reads the amount of light that was not absorbed by the CO_2 molecules or the optical filter.

The difference between the amount of light radiated by the IR lamp and the amount of IR light received by the detector is measured. The difference is proportional to the number of CO_2 molecules in the air inside the tub.

Signal Conditioning

A signal conditioner is an application-specific IC (ASIC) that performs compensation, amplification, and calibration of the input signal, normally over a range of values. Depending on the sophistication of the signal conditioner, the ASIC integrates some or all of the following blocks: sensor excitation circuitry, digital-to-analog converter (DAC), programmable gain amplifier (PGA), analog-to-digital converter (ADC), memory, multiplexer (MUX), CPU, temperature sensor, and digital interface.

Signal inputs accepted by signal conditioners include DC voltage and current, AC voltage and current, frequency and electric charge.

Signal Conditioning Processes

Signal conditioning includes amplification, filtering, converting, range matching, isolation and any other processes required to make sensor output suitable for processing after conditioning.

Filtering

Filtering is the most common signal conditioning function, as usually not all the signal frequency spectrum contains valid data. The common example is 50/60 Hz AC power lines, present in most environments, which produce noise when it is amplified.

Amplifying

Signal amplification performs two important functions: increases the resolution of the input signal, and increases its signal-to-noise ratio. For example, the output of an electronic temperature sensor, which is probably in the milli-volts range is probably too low for an analog-to-digital converter (ADC) to process directly. In this case it is necessary to bring the voltage level up to that required by the ADC.

Commonly used amplifiers on signal and conditioning include sample and hold amplifiers, peak detectors, log amplifiers, antilog amplifiers, instrumentation amplifiers and programmable gain amplifiers

Isolation

Signal isolation is used in order to pass the signal from the source to the measuring device without a physical connection: it is often used to isolate possible sources of signal perturbations. Also notable is that it is important to isolate the potentially expensive equipment used to process the signal after conditioning from the sensor.

Magnetic or optic isolation can be used. Magnetic isolation transforms the signal from voltage to a magnetic field, allowing the signal to be transmitted without a physical connection (for example, using a transformer). Optic isolation takes an electronic signal and modulates it to a signal coded by light transmission (optical encoding), which is then used for input for the next stage of processing.

Signal Processing

The Microcontroller is used for signal processing, sometimes called a logic chipor very large scale integrated circuit, is a computer processor on a microchip.

The microprocessor contains all, or most of the central processing unit (CPU) functions and is the "engine" that goes into motion when you turn your computer on. A microprocessor is designed to perform arithmetic and logic operations that make use of small number-holding areas called registers. Typical Microcontroller operations include adding, subtracting, comparing two numbers, and fetching numbers from one area to another. These operations are the result of a set of instructions that is part of the microprocessor design (Agajo, 2013).

In signal transmission using electronic signal processing, transducers convert signals from other physical waveforms to electric current or voltage waveforms, which are then processed, transmitted as electro-magnetic waves, received and converted by another transducer to final form.

Signal Transmission (Zig-Bee MODEM)

The type of MODEM used for wireless data transmission is Zig-Bee MODEM, it can transmit 256 kilo byte per second and also has high level of Energy conservation., Zig-Bee is a specification based on the IEEE 802.15.4 standard for wireless personal area networks (WPANs). Zig-Bee operates in the ISM radio bands, and it defines a general-purpose, inexpensive, self-organizing, mesh network for industrial control, embedded sensing, medical data collection, smoke and intruder warning, building automation and home automation, etc. There are three different types of Zig-Bee devices in a Zig-Bee network. Figure 4 shows a block diagram representing wireless transmission between source node and sink node.

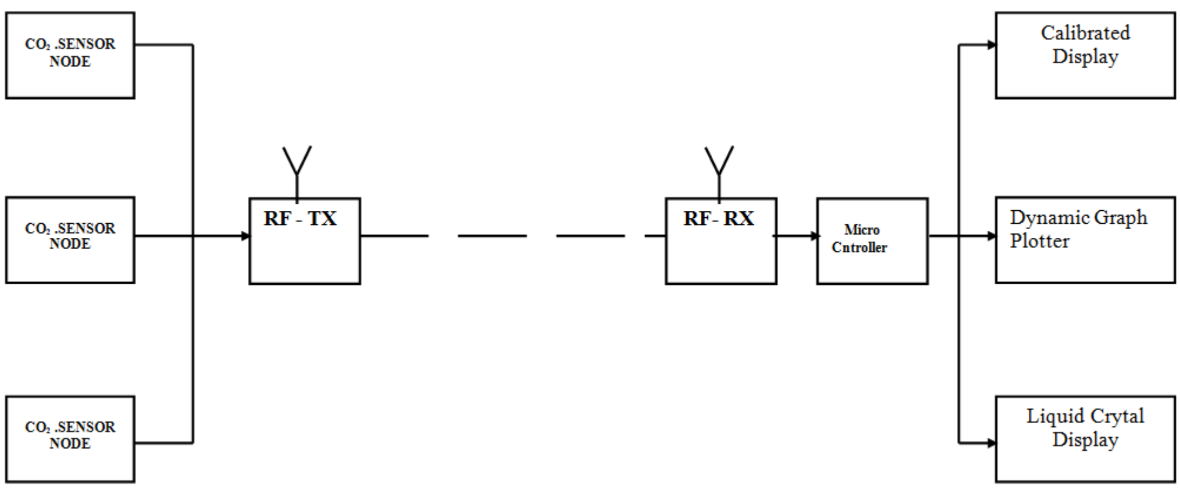


Figure 4. Block diagram of wireless transmission between source and sink node

The Zig-bee MODEM is of MRF24J40 origin and is an IEEE 802.15.4™ Standard compliant 2.4 GHz RF transceiver. It integrates the PHY and MAC functionality in a single chip solution. The MRF24J40 creates a low-cost, low-power, low data rate (250 or 625 kbps) Wireless Personal Area Network (WPAN) device. The MRF24J40 interfaces to many popular Microchip PIC® microcontrollers via a 4-wire serial SPI interface, interrupt, wake and Reset.

The algorithm was developed taken into consideration the following:

1. Sleep Mode

2. Active Mode

3 Node Address

4. Logical Decision Making Command

Sleep Mode

The sleep mode ensures that the system goes to sleep when there is no CO_2 data to be read, this is achieved when the system senses that there is no signal to be read, one outstanding advantage of incorporating the sleep mode is energy conservation, the system is made to come on only when there is data to be read, the affected units are the ADC , Processor and MODEM , the system will go off, when there is no data to be read.

The sleep mode can be logically switched to other modes like the active with the aid of logical techniques.

Active Mode

The active mode wakes up the entire system, this is made possible when signal is available to be read, when the system checks for the presence of signal , it automatically switcesh on the system by engaging all sub-units in the circuit.

The process of switching between modes is carried out by a decision making routine that logically checks and switch between modes. The decision for the mode to switch to is determined by YES or NO.

Node Address

The node address ensures that the data from a precise node is read,CO_2 concentration from other vehicle within the signal range of the car where the device is installed can be differentiated and ignored , the node address ensures that only node installed in the vehicle is monitored and measured.

Logical Decision Making

The algorithm is such that the system can switch mode based on logical decision , the option for Active mode or Sleep mode is carried out by the logical Decision command YES or NO

In evolving the algorithm some basic steps were taken which follows a step by step sequence of executing the work. , this procedure was used to realise the algorithm,

Procedure for Development of the Algorithm

The following were the procedure taken to realise the development of the algorithm.

i. Sensor is made to sense signal (CO_2) concentration.

ii The Sensor node checks for the address of the node to be sensed

iii. The system checks if the node address is the actual node to be sensed.

iv. The system checks if CO2 concentration is available to be read

v. A decision is made to logically check for availability of CO2

vi. if there is no CO_2 available maintain the sleep mode of ELSE

vii. If CO_2 is available (YES) the system will be made to wake up by calling the ACTIVE MODE

Viii Analogue to Digital Converter is made start conversion from analogue to Digital converter

ix Data is being processed by the processor and send to the MODEM

x MODEM Wirelessly transmit the DATA from the transmitting end

xi. At the transmitting end Data is send out by the MODEM

xii. AT the receiving end the MODEM receive signal(CO_2)

xiii The Sensor node checks for the address of the receiving node is actually the node to be sensed

xiv. The system checks if the node address is the actual node to be sensed.

xv. The received Signal CO_2 is then sent to the Processor

xvi The processed signal is sent to the Digital to Analogue Converter for Conversion from Digital to analogue.

xvii The Calibrated Output display the CO_2 concentration from the automobile

RESULTS AND DISCUSSION

The developed algorithm and the flow chart for Source node and sink node(receiver) are shown in figures 5, 6 and 7 respectively.

Start

for node address Ai=Address 1

Get data(CO_2) from Sensor

If data CO_2 not available maintain sleep mode

Else

If data is available

Call wake up mode

System active

Poll ADC to start Conversion

Send data to Microcontroller

Send processed data and modulate in MODEM

Transmit Packets

check Source node address

if source node address =Ai

is data(CO_2) available

if yes

call active mode

Else call sleep mode

Confirm address of data from Transmitting source node

Receive data

Demodulate in modem

send data to processor

store data

Display data(CO_2)

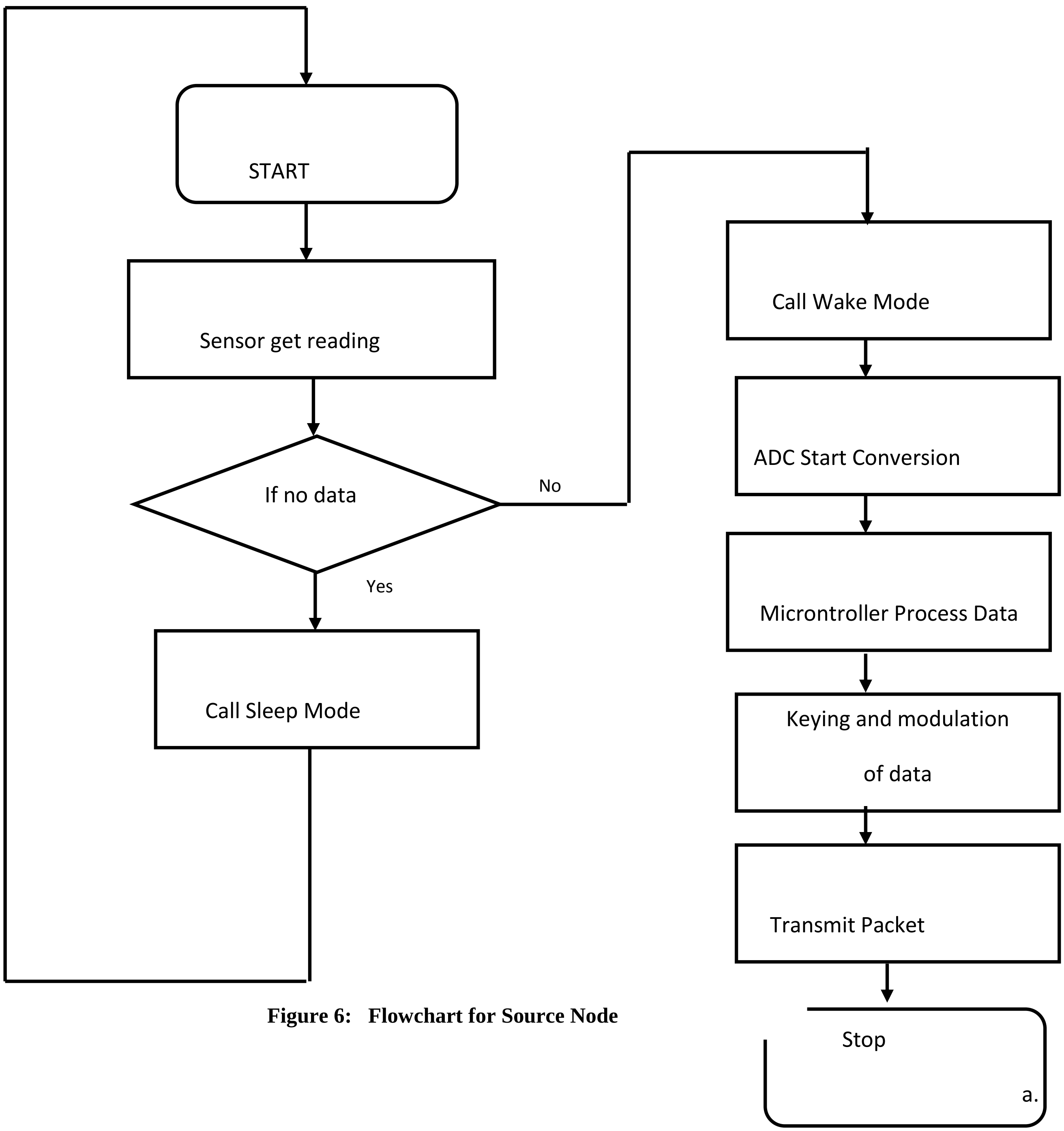


Figure 6: Flowchart for Source Node

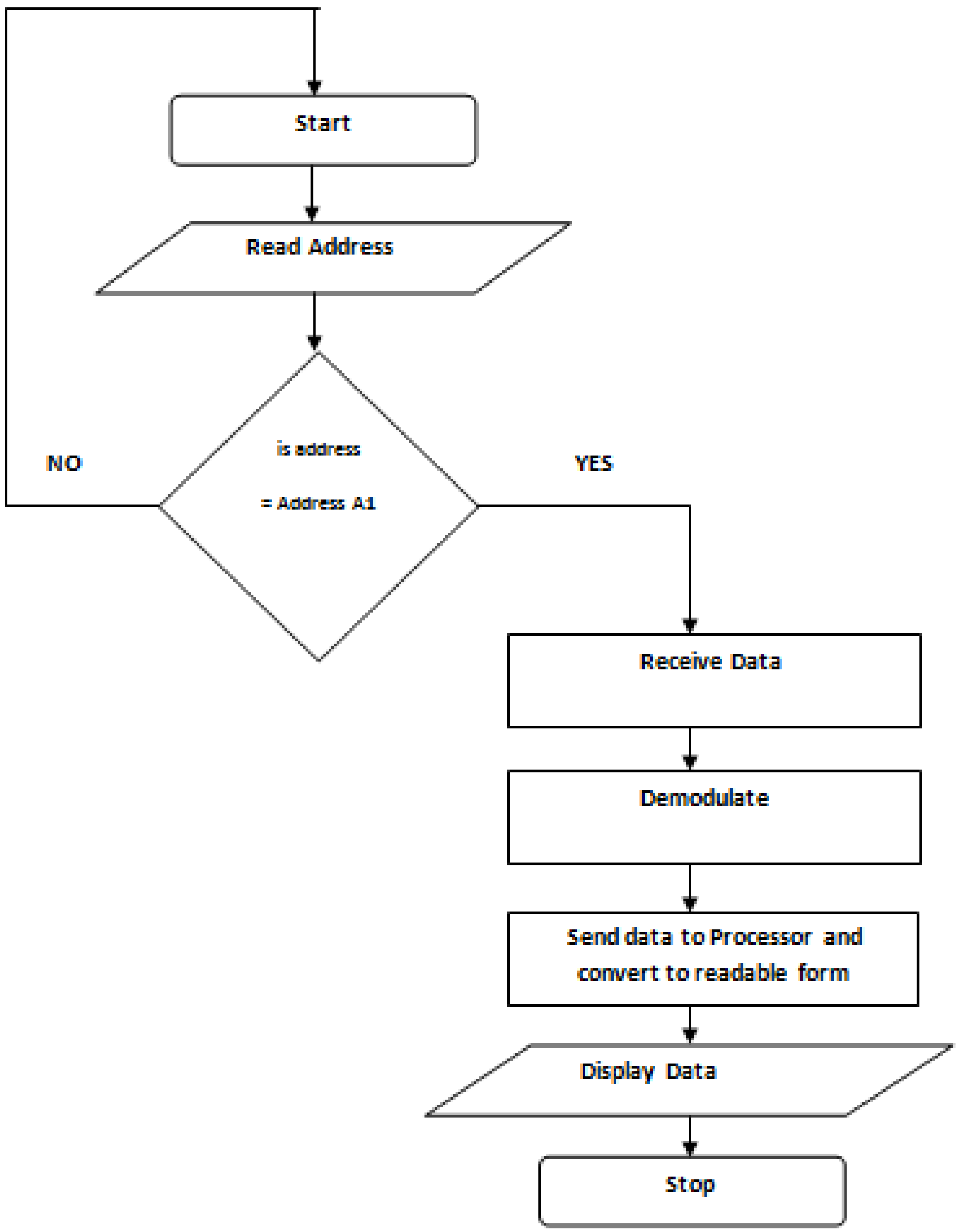


Figure 7: Flowchart For Sink Node(Receiver)

The flowchart in figure 6 and 7 is the pictorial representation of the algorithm , though cascaded in 2 parts for transmission from the source node and reception in the sink node was shown, it shows the process of Signal conversion from start to the end.

Physical parameter like CO_2 is sensed and converted to equivalent electrical signal though analogue , converted to digital via the ADC. Processed and transmitted through the

MODEM, The second flowchart is the receiver sink node system, which demodulates and converts to readable form .

CONCLUSION

This work develop an algorithm for carbon emission monitor in automobile, it suggest ways and processes taken to develop the routine for CO_2 detection and display. Logical switching techniques can be used to switch between option of modes like sleep and active mode which is dependent on availability of CO_2 concentration at the exhaust of the automobile.

Based on the algorithm developed the following inferences can be drawn

i. A networkable CO_2 emission monitor for multiple Cars can be developed for monitoring CO_2 from automobile in a community
ii. A data centre for monitoring and storing data of CO_2 discharge within a community can be achieved.

REFERENCES

Agajo, J. (2013). "Remote Monitoring and Localization pf Fault Node in a Wireless Sensor Network." Ph.D Thesis submitted to the Department of Electronic and Computer Engineering, Nmandi Azikwe University Awka, Nigeria.

.Akyildiz I.F, W. Su, Y. Sankarasubramaniam E. C.(2002). "*Wireless Sensor Networks: a Survey", Computer Networks, Vol 38, N. 4*

CO2 Meter (2014) How Does an NDIR CO2 Sensor Work retrieved from http://www.co2meter.com/blogs/news/6010192-how-does-an-ndir-co2-sensor-work On the 10th of January, 2016.

Datta A. and Mandal B. K (2012) Biodiesel Production and its Emission and Performance: Reviews International Journal of Scientific and Engineering Research (3)6: 6.

Estrin D., L. Girod, G. Pottie, M. Srivastava,(2001). "Instrumenting the world with wireless sensor networks", Proc. Acoustics, Speech, and Signal Processing, 4: 2033–2036.

Gislason, S. J(2016). Car Exhaust- Air pollutants, Retrieved from http://www.nutramed.com/environment/carsepa.htm on the 23rd of January, 2016.

Jie, L(2011) Environmental Effects of Vehicle Exhausts, Global and Local Effects A Comparison between Gasoline and Diesel. Master thesis of Applied Environmental Science, submitted to the School of Business and Engineering, Halmstad University Halmstad

João Carlos Giacomin , Flávio Henrique Vasconcelos, 2006, Wireless Sensor Network As A Measurement Tool In Precision Agriculture, XVIII Imeko World Congress, Metrology for a Sustainable Development.

Kampet, T, Jahn, A and Niemeyer, H (2003). Alternative Automotive fuels- supply, Technological and Environmental Scenarios to 2030.Scientific and Technological Options Assessment Series pp1-79.

Pilusa, T. J, Mollagee, M, M and Muzenda, E(2012). Reduction of Vehicle Exhaust Emissions from Diesel engines using the whale concept filter. *Aerosol and Air Quality Research*, 12:994-1006

Resitoglu, I. A, Altinisik, K and Keskin, A (2015).The pollutant Emissions from Diesel Engine Vehicles and Exhaust after treatment Systems. *Clean Technology Environmental Policy*, 17:15-27

Rice, S. A(2013) Health Effects of Acute and Prolonged CO_2 Exposure in Normal and Selective Populations. Presented at Second Annual Conference on Carbon Sequestration, May 5-8, 2003, Alexandria, Virgina, USA

Sharaf, J (2013). Exhaust Emissions and its Control for an Internal Combustion Engine. *International Journal of Engineering Research and Applications* 3(4):947-960

USEPA(2016) Automobile Emissions: An Overview, retrieved from *www3.epa.gov/otaq/consumer/05-autos.pdf on the 25th of january, 2016.*

Vilac, A and Kouch, T (2012) Carbon Monoxide (CO) versus Carbon dioxide(CO_2) . Retrieved from http://www.critical-environment.com/.../carbon-monoxide-co-versus-carbon-di on the 26th of January, 2016.

SUSTAINABLE BUILT ENVIRONMENT AND CLIMATE CHANGE; THE PLACE OF NEIGHBOURHOOD SECURITY AND EFFECTIVE PROPERTY MANAGEMENT IN NEIGHBOURHOODS OF BIDA, NIGER STATE.

UMAR A. SAIDU, MAMMAN MATHEW & MAXWELL CHIDI DURU
Department of Estate Management and Valuation, Federal University of Technology, Minna

In Man's quest and pursuit for agricultural, socio-economic welfare and general physical development on land space, he has so much altered nature and natural resources. This is why the concept of sustainable development was established with its attendant strategies to ensure human and physical development which will be in conformity to the demands for the protection of our fragile environment. In essence, sustainable development is a process by which the exploitation of natural resources and the present means of achieving development do not reduce or limit the potentials for meeting the needs of future generations. Sustainable development placed emphasis on some target areas of the environment including infrastructural development, security, housing, agricultural development, tackling climatic change among others. The agenda with all these trusts is considered laudable and promising enough to produce a change that Nigerians need. However, the effectiveness of sustainable development may be hindered if adequate attention is not giving to urban neighbourhood security. It is on this backdrop that this study attempts to examine the place of neighbourhood security with emphasis on effective property management in achieving sustainable development and liveable environment. Four neighbourhoods in Bida were selected as case study with the view of making a general deduction of the state of security in the community. The four neighbourhoods were selected using a stratified sampling method; were Bida urban area was divided into wards out of which two wards were picked at random and two neighbourhoods were also selected from each ward at random without any form of bias. The four neighbourhoods selected include Masalaci Bologi and Efu Mayaki (Mayaki Ndajiya ward) while, Banin Bida and Laruta neighbourhoods were selected from Umaru Majigi I. 50% of the compounds in each neighbourhoods were sampled using random sampling method were every 3rd compound was picked for sampling. The variables examined in the study are; building condition, sanitary condition, record of health cases, access to portable water, accessibility and security. It was discovered through the study that poor neighbourhood property management could lead to emergence of neighbourhood slum, poor economic productivity, pollution, outbreak of epidemic diseases, insurgence of social disturbance among others. At the close of the study the following recommendations were advanced; rehabilitation of urban neighbourhoods, provision of community infrastructures, orientation of the public on the dangers of climate change and importance of property management among urban neighbourhood dwellers.

saidumadakikamala@gmail.com

UMAR A. SAIDU, MAMMAN MATHEW & MAXWELL CHIDI DURU (2016). **SUSTAINABLE BUILT ENVIRONMENT AND CLIMATE CHANGE; THE PLACE OF NEIGHBOURHOOD SECURITY AND EFFECTIVE PROPERTY MANAGEMENT IN NEIGHBOURHOODS OF BIDA, NIGER STATE** Sustainable Built Environment and Climate change; The challenges of Post 2015 Development Agenda. School of Environmental Technology Conference, SETIC, 2016

INTRODUCTION

In Man's quest and pursuit for agricultural, socio-economic welfare and general physical development on land space, he has so much altered nature and natural resources. This problem has progressively worsened so much that there is now the fear that if we continue at the present rate of unregulated and unguided development where developers build without regard to the building standards and the conversion of open spaces and residential buildings into other land uses will lead to urban sprawl or other forms of environmental degradation. That is why the concept of sustainable development was established with its attendant strategies to ensure human and physical development which will be in conformity to the demands for the protection of our fragile ecology. In essence, sustainable development is a process by which the exploitation of natural resources and the present means of achieving development do not reduce or limit the potentials for meeting the needs of future generations (Odiette, 1993).Despite the increased campaign and popularity of the use of the term "sustainability", the possibility that human societies will achieve environmental sustainability has been, and continues to be, questioned in light of environmental degradation, climate change, population growth and societies' pursuit of indefinite economic growth in a closed system (Bookchin 2005, Bookchin 2007) The simple definition that sustainability therefore, is something that improves the quality of human life while living within the carrying capacity of supporting eco-systems, though vague, conveys the idea of sustainability having quantifiable limits (Krebs, 2001).Sustainability simply means the capacity to endure, it is a term commonly use to describe the endurance of systems. Adams et al (2008) stated that the organizing principle for sustainability is sustainable development, which includes the four interconnected domains which are all component of the environment: ecology, economics, politics and culture. All geared towards the actualising sustainable environment.

This indeed is a laudable approach that is capable of transforming any Nation particularly the under develop or developing Nations into an enviable position among the Nations of the world. However, sustainable development will remain a mirage if the issue of neighbourhood security through effective property management is disregarded among the trust of the approach.

More often than not, the nature of neighbourhoods in a city would determine the nature of the city and the nation at large. An environmentally and socio-economically balanced neighbourhood will promote a healthy city and a healthy nation. In other words, a developed nation is a product of developed people and neighbourhoods that are environmentally, socially and economically sound.

Masalaci Bologi, Efu Mayaki, Banin Bida and Laruta neighbourhoods in Bida city are handy examples of the appalling conditions of most neighbourhoods in Nigerian cities, where municipal services such as water supply, waste disposal, drainage, streets lights and paved roads are absent. Similarly, the conditions of properties in these neighbourhoods are detrimental to human health, sustainable growth and social life. This scenario does not only pose an environmental threat, but its rippled social, economic and psychological consequences cannot be overemphasised. Apparently such circumstances make these neighbourhoods a staid threat to community sustainable growth, liveable environment and could hinder the actualisation of sustainable development agenda.

It is on this premise that the paper seeks to examine the place of neighbourhood security through effective property management in achieving sustainable development.

AIM

The aim of this study is to examine the place of neighbourhood security in achieving sustainable development.

OBJECTIVES: The paper specifically explored the following objectives by;

i examining the need for sustainable development in the built environment.

ii identifying the place of neighbourhood security in sustainable development agenda.

iii examining the state of security and property management in Masalaci Bologi, Efu Mayaki, Banin Bidaand Laruta areas of Bida.

iv proffering measures for neighbourhood security and property management as tools for sustainable development.

METHODOLOGY OF THE STUDY

In the course of this study two basic sources of information were employed; these include the use of questionnaire and personal observation. Four neighbourhoods were selected using stratified sampling method, where the list of neighbourhoods in Umaru Majigi I and Mayaki Ndajiya wards was prepared and two neighbourhoods were drawn from each ward to represent the neighbourhoods in Bida urban area. A random sampling method was adopted to select 50% of the properties in the neighbourhoods for sampling. Relevant data on health implication and security cases were sourced from Umaru Majigi ward clinic and Niger State Vigilante Corps. Inferences from the data were presented graphically using charts as well as plates.

REVIEW OF LITERATURE

Thorncroft (1976) property management is the direction and supervision of an interest in landed property with the aim of securing the optimum return. This return need not always be financial but may be in terms of social benefits, status, prestige, political power or some other goal or group of goals. It is the proper upkeep of land and building, the provision and maintenance of capital works, full and proper use of estate resources to preserve, conserve, exploit and restore them for the good of the estate and all those who may derive profit, pleasure and enjoyment from them (Miles,1987). Edgson (1972) It is the art of selecting and operating a landed estate with particular regard to maintaining the quality of land and fabric of the buildings, and to preserve and improving the capital value of, and the income from the estate in line with the requirements of the owner. Property management has also been described as the supervision and control of all investment, development. Maintenance, management and agency works relating to a particular collection of property interests combined under one ownership. Such interests may be large or small, concentrated or scattered, public or private, land or buildings, freehold or leasehold, may be used for commercial, residential or industrial purposes. The major objective of property management is to secure the maximum economic return from available resources having regard to present and future social exigencies (Emoh 2004).

Udechukwu and Olusola (2011) Property assets such as land and buildings are key resource for all types of organisations, including public sectors. For the last two decades positive effects of good property management have received increased attention as the stock of new buildings being put into operation. In private sector, this attention is due largely to the recognition of the significant contribution property makes to ultimate success or failure of a business and recognition of strategic importance of property to a company's financial structure. While within public sector organisations property can be considered as having financial contribution and effect upon annual financial statements, asset base and as well as on resale values in case of privatisations of any public entities. Therefore, property resource, in the same way as human, financial and information resources, contributes to the success of these organisations and need to be effectively and efficiently managed. These property assets have to be professionally managed to ensure that the asset value is maintained. It is acknowledge that not only is a large amount of capital devoted to these property assets, they can also add value to an organisation through effective and often creative management (Udechukwu and Olusola 2011).The reason for ownership of property will determine the aims and goal of management. Thus for a property occupied by the owner, the objective of property management would most likely be the need to ensure proper maintenance of the property so that it can continue to provide comfortable accommodation. However, where property is held as an investment, the goal of management is to ensure that the property and its resources are maintained in a way and manner that will enable it continue to generate maximum return (income or capital). This maximum return could be through the additional tax/ shelter they could derive, or as hedge against inflation or as a steady cash flow (Udechukwu 2006).

The condition of properties in most urban neighbourhoods is so poor that the objectives and benefits attributed to property maintenance as explained in this discussion can not be achieved. This is as a result of the poor qualities of properties due to lack of maintenance by the property owners or the family members. The poor quality of properties emanated from intense environmental problems, lack of basic sanitary facilities and poverty. Sanusi (2007) outlined the general condition of housing in urban neighbourhoods as reflected in the poor environmental quality. This include poor access to houses, inadequate open space within housing units, lack of housing facilities, indoor pollution, poor sanitary condition and over crowding. Dimina and Omatsone (2010) premised that the continuous neglect of neighbourhood properties is accountable to physical decay of urban community which consequently stretch the built environment and lead to degeneration of cities. This shows that poor property management in terms of neglect of urban house keeping and irresponsible civic management is a major contributor to urban decay. Adenekan (2012) explained the nature of urban neighbourhoods as they exhibit signs of decay through low quality or sub standard housing, derelict buildings and abandoned structures resulting from poor management of housing. From the forgoing it is apparent that the security of urban neighbourhoods is strongly tied to effective property management.

THE PLACE OF NEIGHBOURHOOD SECURITY

According to Harper (2013) a neighbourhood is a geographically localised community within a larger city, town, suburb or rural area. Neighbourhoods are often social communities with considerable face-to-face interaction among members. Neighbourhood can be defined spatially as a specific geographic area and functionally as a set of social networks. Neighbourhoods, then, are the spatial units or cells where National development begins. This is because neighbourhood makes a town or city and towns or cities make a nation.

Among the attributes of a neighbourhood is enhancing the safety of lives and properties. It is designed to provide space for houses for human habitation and other activities that promote the welfare of the residents. It is also meant to provide safe surroundings, efficient facilities and insulation for anti social challenges. Critically, most profitable ways of achieving a secured neighbourhood is through effective property management, which could be in terms of the maintenance of properties, infrastructures and open spaces within the neighbourhood. This makes the issue of property management critical to neighbourhood security and sustainable development.

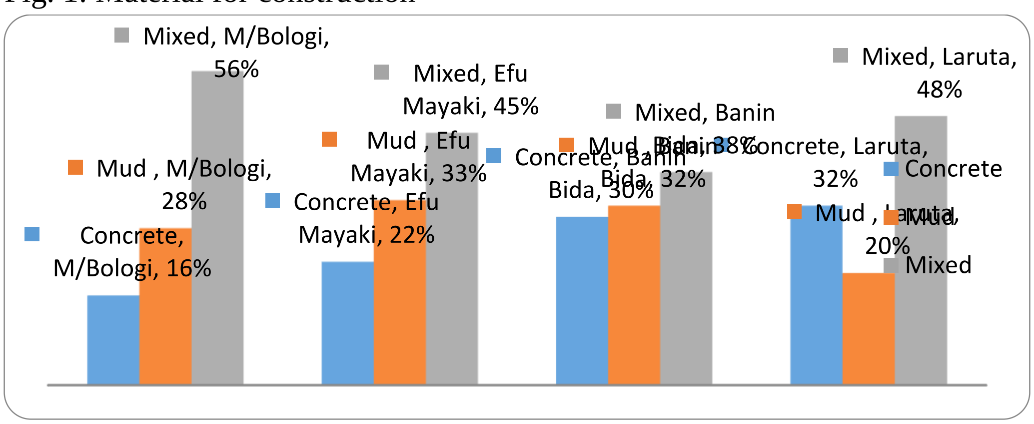
THE STATE OF SECURITY AND PROPERTY MANAGEMENT IN MASALACI BOLOGI, EFU MAYAKI, BANIN BIDA AND LARUTA NEIGHBOURHOODS, BIDA.

This aspect of the study focused primarily on the effect of poor property management on the security of lives and properties in the study area. The indicators examined in this study include housing condition, sanitary facilities and accessibility within the neighbourhoods. Other indicators are access to portable water, security and environmental health cases prevalent in the study areas.

DATA PRESENTATION AND ANALYSIS

1. Building Condition

Fig. 1: Material for construction

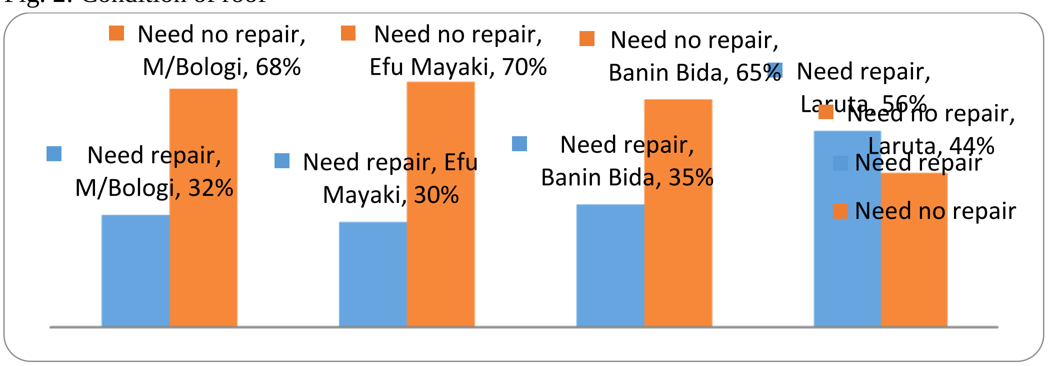


Source: Field Survey 2016.

From figure 1. It is evident that majority of the buildings are constructed of mixed materials i.e the combination of mud and concrete materials. 56% of properties in M/Bologi, 45% in Efu Mayaki, 38% in Banin Bida and 48% in Laruta are found to be constructed of mixed materials. In construction industries this is considered unacceptable development and a contravention to building safety. Similarly, 28% of the properties in M/Bologi, 33% in Efu Mayaki, 32% in Bnin Bida and 20% in Laruta are constructed of mud material, this is also considered as unsafe. The implication of the condition of houses in the study area shows that the safety of life and properties is at high risk which is deteremental to the security of the neighbourhoods and the nation at large. This could also pose a hinderance to the actualisation of sustainable development (See plate 1).

Plate 1. A building in Laruta showing mixed building materials.

Fig. 2: Condition of roof

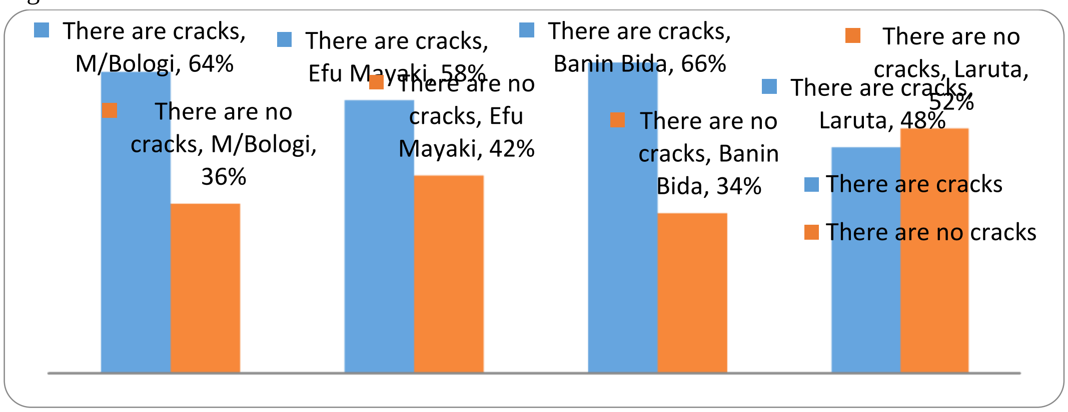


Source: Field Survey 2016.

The survey also examined the condition of roofs in the study area. In Masalaci Bologi 32%, Efu Mayaki 30% and Banin Bida 35% of the properties show poor roofing condition. Similarly, in Laruta 56% of the properties exhibit the need for roof repair which signifies an evidence of poor property management in the neighbourhood. The analysis shows that such condition affect the life span of the structures as well as the security of life of the occupants and generally the liveability of the neighbourhoods.

Plate 2. A building in Masalaci Bologi with a roof that need repairs

Fig. 3: Condition of wall

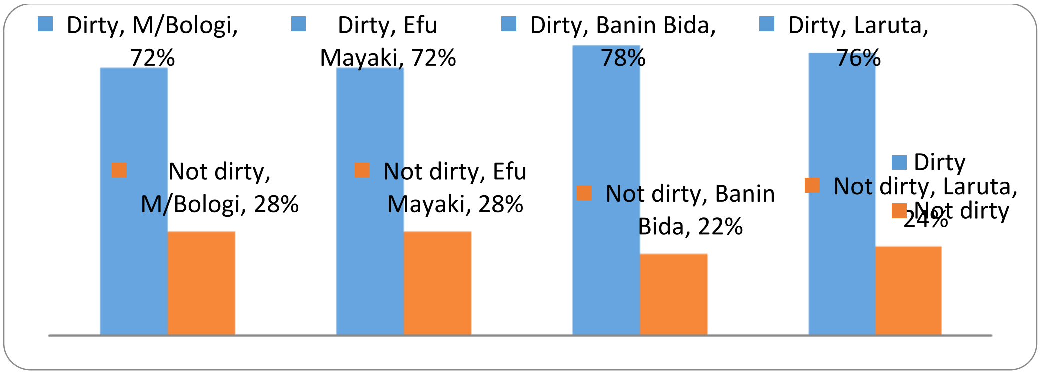


Source: Field Survey 2016.

The study of the condition of walls in the study area indicated that 64% and 58% of properties inMasalai Bologi and Efu Mayaki have varying degrees of cracks, while 66% and 48% of the properties in Banin Bida and Laruta had cracks. Obviously, this condition is detrimental to human safety and the security of lives in these neighbourhoods and by extension that of the nation.

Plate 3. Condition of walls in Masalaci Bologi and Banin Bida.

Fig. 4: Condition of the environment



Source: Field Survey 2016.

The condition of the environment surrounding the houses in the study area was also examined with the view of determining the sanitary condition which account for the health and safety of the inhabitants. From figure 4. 72% of the houses sampled in M/Bologi and Efu Mayaki, 78%in Banin Bida and 76% in Laruta shows that the surrounding (environment) are dirty which signifies poor property and environmental mangement. Aparently, this poor environmental condition tells much about the health and the social life of the people living in the neighbourhoods.

In the course of the study, the researchers visited a primary health care centre loacted at Laruta neighbourhood. It was gathered that the predominant sicknesses in the study area are Malaria and Diarrhea which were attributed to poor environmental conditions. Obviously, the health cases reported in the neighbourhoods is an indication that the efforts of the Federal and the state governments in rolling back malaria have not achieved the expected results. The reason can be attributed to the poor environmental condition observed in the study area. This could be a grave draw back in the actualisation of sustainable development and an indication of climate change.

Table 1. Record of health cases in the study area

Cases in 2016	August	September	October	November
Malaria	23	122	8	64
Diarrhea	3	2	2	6

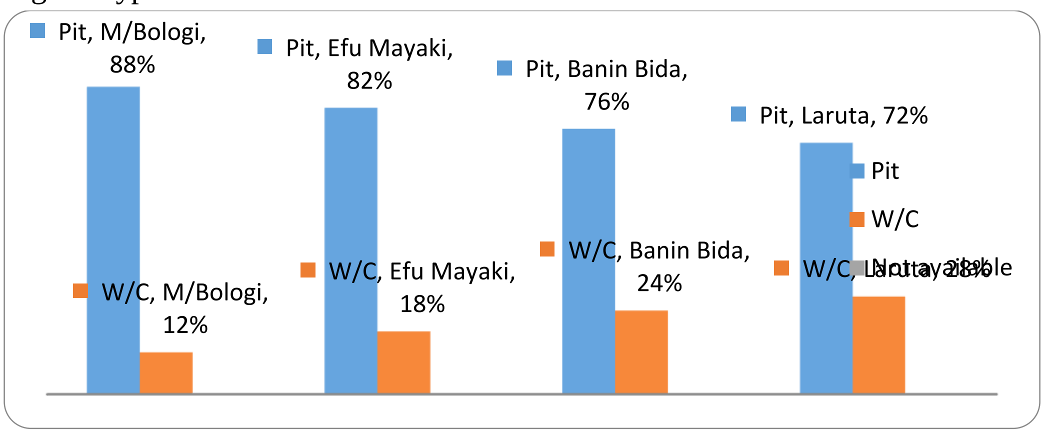
Source: Umaru Majigi `A` Ward Clinic, 2016.

However, the records shows that in september 2016, 122 cases of malaria were recorded, while in October and November 2016, 8 and 64 cases were recorded. This does not mean there was improvement in the health condition but the fact as explained by the officer in charge of the health centre was as a result of some health programmes they were involved in within these months. Hence, no record of health cases was made.

Plate 4. Poor environmental condition in the neighbourhoods

2. Availability of Sanitary Facilities

Fig. 5: Type of toilet



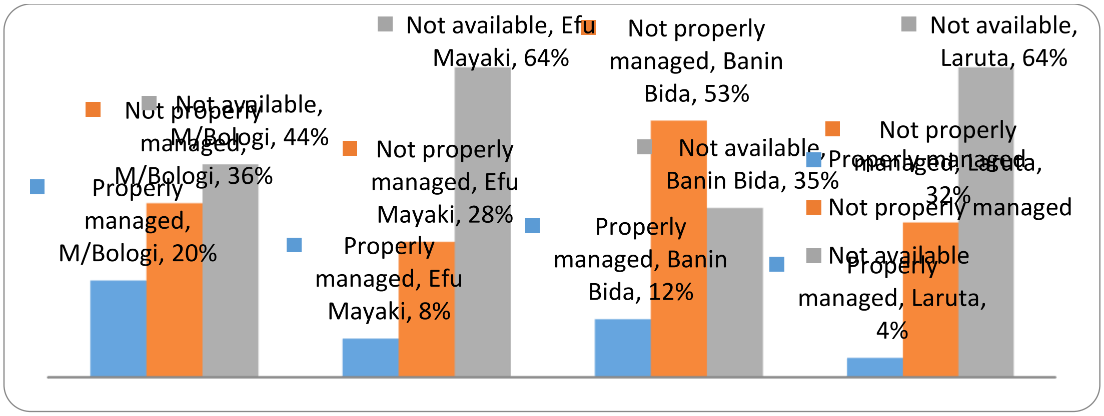
Source: Field Survey 2016.

The survey shows that 88% of residential properties in Masalaci Bologi, 82% in Efu Mayaki, 76% in Banin Bida and 72% in Laruta are equiped with pit latrine, while 12% in M/Bologi, 18% in Efu Mayaki, 24% in Banin Bida and 28% in Laruta are equiped with W/C. This shows that this neighbourhoods are susceptible to enteric diseases which is a threat to the residents life.

Plate 5. Major toilet facilities in the study area

Pit latrine in Laruta neighbourhood. Pit latrine in Masalaci Bologi neighbourhood.

Fig. 7: Condition of drainages around the house



Source: Field Survey 2016.

The survey reveals that there is a dearth of drainage facilities in the study area. Among the properties sampled, 44% in M/Bologi, 64% in Efu Mayaki, 35% in Banin Bida and 64% in Laruta are not supported with drainage facilities. It is obvious from figure 7 that among the properties that have drainage facilities are not properly managed. For instance,36% of the properties that have drainage facilities in M/Bologi, 28% in Efu Mayaki, 53% in Banin Bida and 32% in Larua are found in this condition. This scenario is an indication of poor sanitary neighbourhood which can result into general healthproblems, thereby reducing life expectancy in the neighbourhood, community and the nation at large.

Plate 6. Poor sanitary condition of drainage facilities in the study areas

3. Accessibility

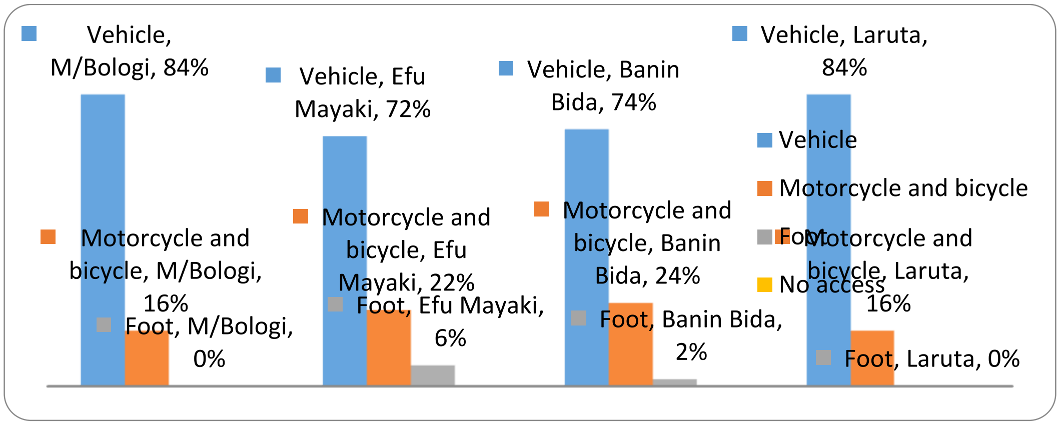


Fig. 8: Condition of roads in the study area Source: Field Survey 2016.

The study also considered accessibility in the study area with the view of determining the access of the residents to social infrastructure in the neighbourhoods. Figure 8 revealed that 84% of the roads in M/Bologi, 72% in Efu Mayaki, 74% in Banin Bida and 84% in Laruta are tarred and wide, while 16% in M/Bologi, 22% in Efu Mayaki, 24% in Banin Bida and 16% in Laruta are untarred and narrow. The situation in Masalaci Bologi shows that all the roads are untarred and narrow. This is evident in figure 8 which shows that 100% of the roads are untarred and narrow. This shows an evidence of socio – economic marginalisation, neighbourhood insecurity and poor property management (Facility) which could pose a threat to socio – economic development of the nation. Plate 7 shows the condition of roads in the study area.

Plate 7. The condition of roads in the study area.

Condition of road in Laruta Condition of road in M/bologi

4. Access to Portable Water Supply

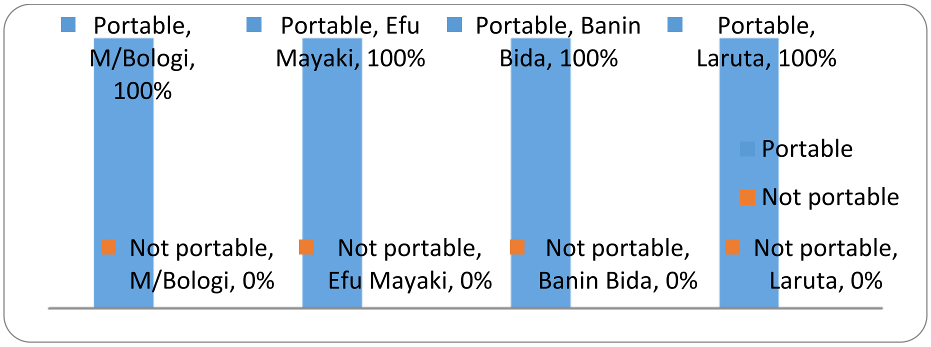


Fig. 9: Type of water supply Source: Field Survey 2016.

The survey on residents access to potable water as illustrated in figure 9 revealed that the residents have direct access to portable water supply in the neighbourhoods. From the figure, there is 100% access to potable water in Masalaci Bologi, Efu Mayaki, Banin Bida and Laruta. A personal observation by the researchers shows that there are 8 public bore holes in M/Bologi neighbourhood, 12 in Efu Mayaki, 9 in Banin Bida and 15 bore holes in Laruta which depict an adequate access to potable water supply. However, this development can be attributed to the recent government interventionthrough ward development project by the administration of Dr Muazu Babangida Aliyu; An effort towards actualisation of the transformation agenda and a step towards sustainable development.

Plate 8. Public bore holes in the study areas.

A public bore hole in Masalaci Bologi A public bore hole in Laruta

5. Proximity to Water Supply

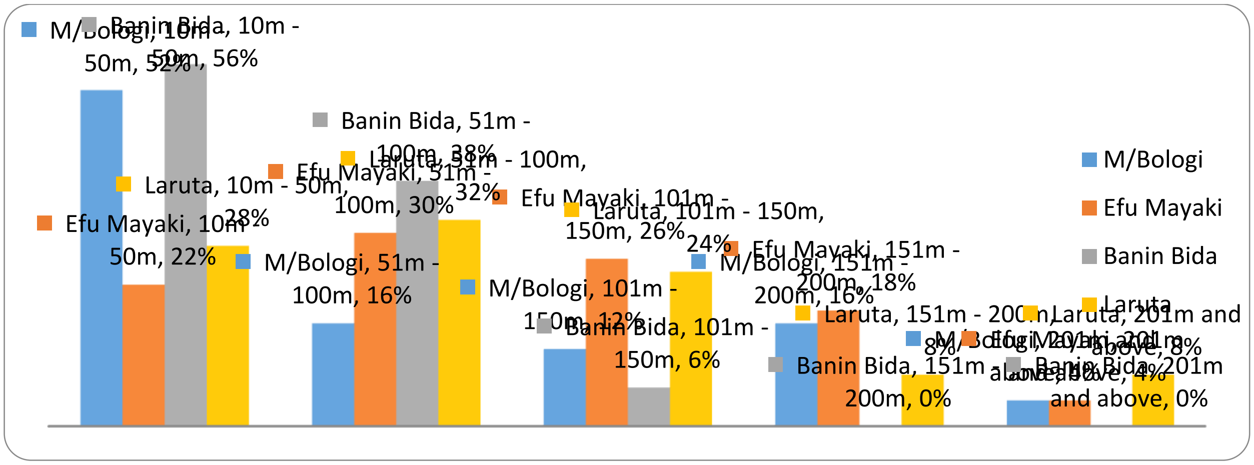


Fig. 10: Distance usually cover to access portable water Source: Field Survey 2016

Another factor employed to determine the access of the residents to potable waster supply in the study area is the distance households within the neighbourhoods have to cover so as to access water. Figure 10 illustrates the maximum distance residents in the neighbourhoods usually cover to access water supply. It is evident from the figure that 68% of the residents in Masalaci Bologi, 52% in Efu Mayaki, 94% in Banin Bida and 60% in Laruta cover between 10m to 100m to access water daily. On the other hand, 32% of the residents in Masalaci Bologi, 48% in Efu Mayaki, 6% in Banin Bida and 40% in Laruta cover the distance between 101m to 200m and more to access water daily. This implies that despitethe availability of bore holes there are cases of water stress in the study area, this is a steady threat to the actualisation of sustainable built rnvironment. See plate 9 for more detail on proximity to water supply.

Plate 9. Residents waiting to access water.

SECURITY CASESRECORDED AT LARUTA, BANIN BIDA, EFU MAYAKI AND MASALACI BOLOGI NEIGHBOURHOODS OF BIDA BETWEEN 2014– 2015.

Table 2. Record of prominent security cases in the study area.

S/N	Types of Crime	No. of Cases in Laruta	No. of Cases in M/Bologi	No of Cases in Efu Mayaki	No of Cases in Banin Bida
1.	Theft	4	6	5	4
2.	Assault	2	4	8	2
3.	House breaking	3	2	2	1
4.	Causing hurt (Fighting)	2	3	5	2
5.	Tress passing	2	NIL	2	NIL
6.	Rape	1	2	3	NIL
7.	Kidnapping	NIL	1	NIL	NIL
8.	Unlawful possession	1	2	3	2
9.	Cheating	3	1	3	1
10.	Drunkeness	2	3	2	NIL
11.	Breach of public peace	1	4	7	2

Source: Niger State Viggilantee Corps, 2016.

Basically, this factor may not be attributed directly to poor property management in the study area. However, its implication in neighbourhood security and sustainable built environment can not be ignored. It is evident from the table that there are 21 security cases reported to the Niger State Viggilantee Corps in Laruta and 28 security cases in Masalaci Bologi between 2014 to 2015 (See details of security cases in table 2). Apparently, the record shows that the study area is highly susceptible to security risk which is a threat to neighbourhood security, national peace and could be a challenge to the actualisation of transformation agenda.

THE IMPLICATIONSOF NEIGHBOURHOOD SECURITY AND POOR PROPERTY MANAGEMENT ONSUSTAINABLE BUILT ENVIRONMENT.

1. Emergence of Neighbourhood Slum

   The situation of the study area as revealed through the study in terms of the condition of properties, shows that the study area can become a slum neighbourhood if no effort is made to improve the condition of properties in the study area. This on the other hand will deter Sustainable Built Environment and could accelerate the Climate Change.

2. Outbreak of Epidemic Diseases

The survey on sanitary condition and facilities in the study area indicate the poor sanitary and a decaying environment. This is an indication that if there is no urgent intervention via adequate property management in the neighbourhoods there could be an outbreak of epidemics diseases such as diarrhea, cholera, polio among others. This could pose a threat to neighbourhood peace and sustainable development.

3. Political protestresulting from Social Marginalisation

The declaration by the Federal and the state Government on fixing several kilometers of road in Nigeria could be true, but the question is how many of such interventions are carried out in core neighbourhoods. This anomaly as observed in the study area could instigate serious political revotes and the actualization of Sustainable Built Environment will be a mirage.

4. Poor Economic Productivity

The case of water stress observed in the study area could be a very stern problem, particularly when substantial man hours in the day is wasted in accessing water for household use. This situation can result into individual poor economic productivity and will definitely impair the effort of the government in creating enabling environment for economicadvancement.

5. Insurgence of Social Disturbance

The rate of security cases reported in the study areas flash a signal of insurgence of social disturbance in the nearest future. A situation where a neighbourhood is susceptible to high security cases as reported in the study areas can engender a social disturbance like protest, youth unrest among others.

CONCLUSION

The study shows that neighbourhood security is critical in ensuring Sustainable Built Environment and mitigating the Climate Change. However, this can not be achieveed except the issue of neighbourhood property management is tackled with all serious effort. Consequent to this, the paper is making case for empowerement of local government, orientation on property management and neighbourhood rehabilitation as a link to achieving sustainable development.

RECOMMENDATIONS

In view of the implications highlighted above, the following recommendations are advanced for enhancing neighbourhood security and sustainable development.

1. Rehabilitation of urban neighbourhoods

Sustainable development agenda should include among its trust issue of neighbourhood rehabilitation, this will create enabling environment for social and economic advancement.

2. Orientation on importance of property management

The Ministry of Environment and Urban Development in collaboration with National Orientation Agency at the state and local level and Ministry of Health should embark on vigorous campaign for property management in urban neighbourhoods and beyond.

3. Provision of community infrastructures

The Ward Development Project initiated by the state government is a right step towards a right direction. However, the project should be sustained and extend beyond provision of potable water within the neighbourhoods, other community infrastructures should be included like fixing of neighbourhood roads, drainages, maintenace of open spaces within neighbourhood among other things.

4. Empowering the local authorities

One of the factors relating to poor state of development in Nigerian cities is the ineffectiveness of the local governments. It is the expectation of this paper that the local government should be empoweered and be made autonomous so as to improve the lifes of the people at the grass root, This will go a long way to ensure Sustainable built environment and mitigate the accelerateed climate change.

REFFERENCES

Adams, W. M. and Jeanrenaud, S. J. (2008). Transition to Sustainability: Towards a Humane and Diverse World. Gland, Switzerland: IUCN. 108 pp. ISBN 978-2-8317-1072-3.

Adenekan, S. B (2012) Challenges of upgrading and integration of slum settlement.
A paper presented in a common wealth of African Planners and Nigerian Institute of Town Planners conference, Abuja.

Bookchin, M. (2005). The Ecology of Freedom: the emergence and dissolution of hierarchy." Oakland: AK Press. ISBN 1-904859-26-7.

Bookchin, M. (2007). Social Ecology and Communalism. Oakland: AK Press, p. 19. ISBN 978-1-904859-49-9.

Dimina K. D and Omotsone M.E.D (2010) Regeneration in the Nigerian built environment.
Kamla – Raj 2010, HUM Vol 29 (20) 141 – 19.

Edgson, P.S (1972) "Objective of property management". The Management of Urban Property, study No. 8 Reading: College of Estate Management.

Emoh, F.I (2004) Real Property Investment and Management.Christon International Company Ltd.

Harper, D. (2013). "neighborhood (n.)". Online Etymology Dictionary. Retrieved July 28, 2013.

Krebs, C.J. (2001). Ecology: the Experimental Analysis of Distribution and Abundance. Sydney: Benjamin Cummings. ISBN 0-321-04289-1.

Miles, C.W.N. (1987) Estate Finance and Business Management. London: The Estate Gazette Ltd.

Odiette, W. O (1993) "Environmental Impact Assessment for Sustainable Development" *Environmental News October – December, 1993.*

Sanusi, Y.A (2007) Perception of income poverty and Environmental quality by households: The case of Minna. Environ, Journal of Environmental studies 2(6) Faculty of Environmental design Ahmadu Bello University, Zaria, Nigeria.

Thorncroft, M. (1976) Principles of Estate Management. London;The Estates Gazette Ltd.

Udechukwu C. E (2006) Introduction to Estate Management. Treem Nigeria Limited, Palm groove, Lagos.

Udechukwu C. E and Olusola O. J (2011) Real Property Management TREEM Nigeria Limited, Bariga, Lagos.

STRATOSPHERIC OZONE VARIABILITY: AN IMPLICATION FOR CLIMATE CHANGE OVER SOME SELECTECTED STATIONS IN NORTHERN NIGERIA

OJOYE, S[1]. and SULYMAN, A.O[2]
1 Department of Geography, Federal University of Technology, Minna
2 Department of Urban and Regional Planning, Federal University of Technology, Minna

The sun is the major source of energy that drives the entire atmospheric processes. The insolation from the sun is responsible for the wind pattern experienced on earth. The harmful part of the radiation from the sun is shielded from the earth by two layers namely; the stratospheric ozone and the tropospheric ozone. In this paper, a study of the statistical analysis of total ozone concentration as released by Earth Probe Total Ozone Mapping Spectrometer (EPTOMS Satellite) was used to get the total ozone variability in some selected stations in northern Nigeria. The annual coefficient of relative variability (ACRV) of ozone at these stations over a period of 72 months from January 2009 to December 2014 was carried out. The climate variables of average annual temperature and rainfall for this stations were obtained from the Nigerian Meteorological Agency (NIMET) office in Oshodi, Lagos. The climatological station used for the study include; Yelwa, Sokoto,Zamfara, Katsina,Kano,Dutse,Damaturu and Maiduguri. The results of the findings showed that there was a variation in the average value of stratospheric ozone between 4.2% and 6.8%.A strong positive correlation of 0.92 was observed between the ACRV of ozone and average annual temperature, which increased from 12°C at Kebbi to 25% at the hot arid north of Maiduguri. Also a negative correlation of -0.32 was observed between the ACRV of ozone and the average annual precipitation over the region which varied from an average of 718.4mm to 1053.7mm. Maximum ozone inter-annual variability of between 6% and 10% occurred between December and March, coinciding with the dry Harmattan season, while the minimum of between 2% and 4% occurred between June and September coinciding with the raining season.The findings of this study reveals that the higher temperature characterize of the study area could be accounted for by the ACRV. This variability of ozone if properly monitored will assist in the prediction of rainfall and temperature variability as the thermal processes observed in the atmosphere is responsible for the convective activities.It will also serve as a good tool for the monitoring of climate variability in the zone.

dejyojo@futminna.edu.ng

OJOYE, S. and SULYMAN, A.O. (2016). **STRATOSPHERIC OZONE VARIABILITY: AN IMPLICATION F OR CLIMATE CHANGE OVER SOME SELECTECTED STATIONS IN NORTHERN NIGERIA**
Sustainable Built Environment and Climate change; The challenges of Post 2015 Development Agenda. School of Environmental Technology Conference, SETIC, 2016

1.0 Introduction.

Air in the troposphere has relatively low ozone concentrations, except in highly polluted urban environments. Even polluted regions are relatively low when compared to stratospheric levels. As this "ozone clean" air moves slowly upward in the tropical stratosphere, ozone is being created by the slow photochemical production caused by the interaction of solar UV radiation and molecular oxygen.

Ozone is created in this region because it is here that the Sun, positioned high overhead during the day all year long, is most intense. There is enough of the necessary sufficiently energetic UV light to split apart molecular oxygen, O_2, and form ozone. It typically takes more than 6 months for air at 16 km (near the tropical tropopause) to rise up to about 27 km.

Even though ozone production is small and slow in the lower tropical stratosphere, the slow lifting circulation allows enough time for ozone to build-up. this ozone has a higher density up to about 27 km. It is this that is commonly referred to as the "ozone layer".(Bojkov and Fioeltov, 1995; Orsolini *et al*., 1998).

Ozone advection shows the effect of weather systems. Transport and wind motion in the stratosphere are interconnected with that of the troposphere. This is important in order to balance both the chemical processes and radiative flux in both regions. This overall way of moving ozone around in the atmosphere is referred to as transport process. It is different from photochemical processes that actually create and destroy ozone. Transport merely redistributes ozone from place to place (Holton, 1992; Cordero and Forster 2006). There is a linkage between ozone depletion and climate change but ozone depletion is not known to be the major cause of climate change. Ozone in its formation performs two basic functions by absorbing the ultraviolet radiation which heats the earth surface from above and also absorbs the longwave infrared radiation that is emitted by the earth surface. Therefore, the changes in the earth ozone concentration will depend on the altitude. The major loses observed in ozone concentration is largely due to human activities which have a cooling effect on the earth’s surface. (Sivasakthivel and Siva,2011)

In the semi-arid mid-north, annual rainfall averages about 480 mm. The far northern portion of Nigeria is hot and arid and stretches into the Chad area with rainfall averaging about 400 mm and less than 250 mm in the Maiduguri and Damaturu areas. All this changes to the rainfall regime in this zone is attributable to the convective activities that takes place in the zone. This is a major reason why the study of the insolation at this zone is important.The duration of the dry season get prolonged as one moves farther north. The average temperature South of Latitude 10^0 is 38°C, and in the north of latitude 12^0 is 44°C, which as been attributed to the depletion of the ozone layer (Ojoye, 2012). The climate system encompasses complex interactions between the different subsystems such as the oceans, the land surface, the ice coverage of land and oceans, thus incorporates many feedbacks. It has also been proven by Forster *et al*., (1997) and Hansen *et al*., (1997) that the stratosphere is a sensitive component of the climate system, which can affect the troposphere through coupling mechanisms and thereby triggers the climate of a place. According to the study of Sivasakthivel and Siva (2011), they observed that the redistribution of ozone in the atmosphere has some link with the weather pattern variation.It is pertinent to note that areas of high ozone depletion are characterized by high temperature This study thereby assesses the total concentration of ozone in the stratosphere as a cause of the observed climate change in some selected parts of Northern Nigeria and in order to achieve this aim, the study examines the linear trend in temperature and rainfall over the study area and examined the relationship between ozone variability and climatic variability over the time under study.

The study area:

The Northern Nigerian lies between 7^{o}N and 12^{o}N, which is known to be vulnerable to climatic and ecological anomalies such as flood, cyclones, drought and desertification. The anomaly had enormous socio-economic impacts in the region where pressure on available resources is on the increase amidst fluctuations of rainfall (Ojoye, 2012). Rainfall in the region is highly seasonal and variable in time and space, with 2 seasons, the wet and dry. The dry season is from October to April/May, while the highly variable seasonal rainfall is concentrated in a short wet season and runs from May to September.(Odjugo, 2010). Annual rainfall in the region is marked by clear seasonal variation and by virtue of the geographical location; rainfall is the most critical element of climate. The effect of the higher and cumulative rainfall variability over this zone is presently not well understood but Ojoye, (2012) explained the fundamentals in terms of the atmospheric systems controlling the whole region. The temperature of the region is generally sufficient throughout the year to allow plant growth but the insufficient rainfall, its variability and the single short rainy season imposed serious limitations on the growth of viable vegetal cover. The region is rich in agricultural production, but the large inter annual variability of rainfall produces dry spells which lead to severe and widespread drought which imposes serious socio-economic constraints.

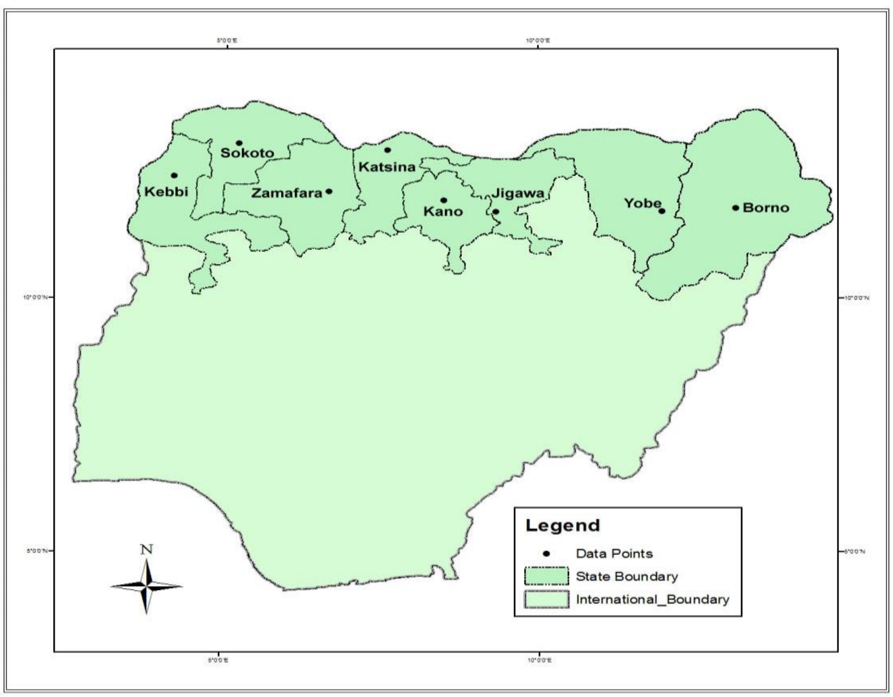


Figure 1: The study area showing the data collection points

The climate of the zone is dominated by the influence of three major meteorological features, namely; the Tropical Maritime (mT) air-mass, the Tropical Continental (cT) air-mass, and the equatorial easterlies. The first two air-masses (mT and cT) meet along a slanting surface called the inter-tropical discontinuity (ITD); the equatorial easterlies are rather erratic and relatively cool air masses from the east in the upper troposphere along the ITD. The movement of the ITD Northwards across the country between January and August, and its retreat from the Southern fringe of the Sahara desert, after August, causes much of Nigeria to experience seasonal rainfall (Ojoye, 2012) Within the mT air mass is enclosed a number of rainfall producing system such as the disturbance lines (especially the easterly waves), squall lines and the two tropospheric jet streams. The magnitude of these systems was reported to be the contributing factor that influences the amount and seasonal distribution of rainfall over the region.

2.0 Materials and Methods.

Total ozone data were collected from the NASA TOMS website for a period of six years (2009 to 2014). The average annual meteorological data of rainfall amount and temperature over eight stations in northern Nigeria were collected from Nigeria Meteorological Agency, Oshodi, Lagos State Nigeria. In order to study the long term trends in the three variables (Ozone, Rainfall and temperature) a linear regression analysis was used on the daily means.

The long term trend is given as

$Y = a + bX + e$ --------------------------------- 1.0

Y = Rainfall variation or Temperature variation

X= ozone variation

a and b are constants of regression.

In order to compute the annual coefficient of relative variation for the ozone values ,the standard deviation (SD) was deduced and the annual coefficient of relative variation (ACRV) was calculated thus:

$$ACRV = \frac{A(t)\ X\ \sigma}{A(mean)}\ X\ 100 - - - - - - - - - - - - - 3.0$$

Where:

ACRV = Annual Coefficient of Relative variation.

A(t) = Annual total

A(mean) = Annual mean

σ = Standard Deviation.

The standardized anomaly index and the coefficient of relative variation were used to compare the relative variability of rainfall and temperature with the ozone value received at the time of study.

The linear multiple regression analysis was used to investigate the relationship between the climate variable and total ozone variability over the study area. The linear multiple regression equation is given as

$$Y = a + b1X1 + b2 - 4.0$$

Where:

Y = ozone variability

X_1 and X_2 are climate variables.

3.0 Results and Discussion

3.1 Spatial Variability of Climatic variables.

The trend analysis carried out on the temperature values reveals that the mean temperature during the dry season is on the decrease over the years under study while the rainfall keep increasing, an indication that for the six years under study, the northern part of Nigeria is getting wetter. This results corroborate the ealier findings of Odekunle, *et.al*., (2008) , Dami, (2008) and Ojoye, (2012) when they found out that the rainfall received in the northern part of Nigeria after the drought episode of 1998 has been on the increase.

In order to investigate the relationship between climate and total ozone variability over Northern Nigeria, a linear multiple regression analysis carried out indicates that the observed variability in the temperature and rainfall over the area could be explained by the annual variability in the stratospheric ozone.The coefficient of multiple determination R^2 reported a 79% variation due to ozone variability in temperature and rainfall combined, a 54% variation on temperature alone and 1% variation on rainfall alone. This inferred that the rainfall received at the station is not connected to the ozone variation at the zone and an indication that the increasing trend in temperature of the area could be attributed to stratospheric ozone variability.

Table 1.0 shows the ACRV at the various stations used for the study. In the six years studied,minimum average ACRV value of 4.2% was observed at Kebbi, 6.0 % in Zamfara, 5.2% in Dutse, 6.7% in Kano, 6.1% in Katsina, 6.5% in Sokoto and 6.8 % at Maiduguri and Damaturu an indication that Maiduguri and Damaturu having the highest variation and Kebbi the lowest. This explains the reason why temperature is higher at this two locations above other locations used for the study. This may not be unconnected with the Sun's inclination and the aridity of the area.

The ACRV of ozone when correlated with average zonal temperature and rainfall revealed significant positive and negative trends respectively in the eight stations. The correlation coefficient of ACRV with temperature was 0.70 in Kebbi, 0.97 in Sokoto, 0.96 in Zamfara, 0.95 in Katsina, 0.92 in Kano, 0.90 in Jigawa and 0.98 in both Damaturu and Maiduguri. This yielded an average positive correlation of 0.92 (Table 2.0). The average zonal temperature increased from 38.4°C at Kebbi to about 45.2°C at Yobe (Table 1). This corroborate the findings of Azeem *et al*., (2001) and Akinyemi, (2010) when they observed that variations observed in total ozone concentration are among other things, directly linked with photochemical coupling between ozone and temperature. The correlation coefficient of ACRV with rainfall as revealed by Table 2.0 was -0.34 for Kebbi, -0.26 for Sokoto, -0.37 for Zamfara, -0.42 for Katsina, -0.23 for Kano,-0.36 for Jigawa, -0.30 for Yobe and -0.33 for Maiduguri. This yielded a notable inverse relation between rainfall and the ozone average ACRV.

Table 1.: The average ACRV, Temperature and Rainfall in the selected stations in some parts of Northern Nigeria

Stations	Average. ACVR	Average AnnualTemp(0C)	Average Annual Rainfall(mm)
Kebbi	4.2	38.4	839.3
Sokoto	6.5	41.3	953.9
Zamfara	6.0	41.8	934.9
Katsina	6.1	41.7	718.4
Kano	6.7	45.6	905.1
Jigawa	5.2	39.3	1053.7
Yobe	6.8	45.2	720.4
Borno	6.8	44.9	739.1

Table 2.: Correlation of ACRV and average annual rainfall and temperature

Stations	ACVR Vs. Average AnnualTemp(0C)	ACVR Vs. Average Annual Rainfall(mm)
Kebbi	0.70	-0.34
Sokoto	0.97	-0.26
Zamfara	0.96	-0.37
Katsina	0.95	-0.42
Kano	0.92	-0.23
Jigawa	0.90	-0.36
Yobe	0.98	-0.30
Borno	0.98	-0.33

3.2 Inter-annual variability of total column ozone

For further investigation of the relationship between total ozone distribution and the climatic variation over Northern Nigeria, seasonal percentage variability of monthly ozone concentration over the period of seventy-two months(January, 2009 to December, 2014) was computed for the eight stations. Figure 2. make the changes in the magnitudes of variability in ozone trend distinct and easy to identify. The figure shows there was an increase in the average ozone variability from December to March coinciding with the peak of harmattan period in the northern hemisphere when the planetary wave causes strong coupling of the stratosphere and the troposphere resulting in large year-to-year or inter-annual ozone variability.

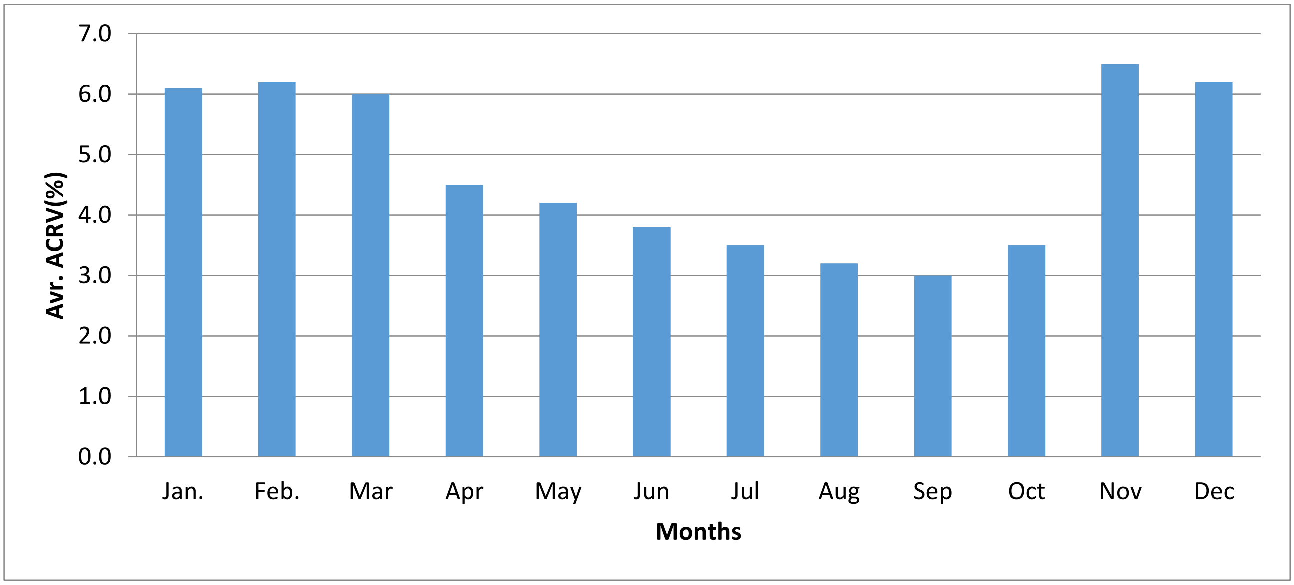


Figure 2: Inter-annual variability of ozone (2009-2014)

This results corroborated the findings of Fusco and Salby, (1999) and Akinyemi (2010) when inter-annual variability was compared for different stations over Africa. The observed maximum inter-annual fluctuations in ozone column from December to March may be associated with the variation in the strength of the local harmattan wind, a prevailing atmospheric dynamics over Northern Nigeria during that period. The year-to-year variability in intensity of the planetary scale atmospheric dynamics is responsible for driving the harmattan wind and could be suggested to be responsible for the high inter-annual fluctuation in total ozone column observed between December and March. The period of maximum ozone concentration coincided with the period of minimum ozone variation which happened to be the peak of tropical over Northern Nigeria between June and September.

This observation could possibly be attributed to reduction in the strength of the extra tropical suction pump (ETSP) action responsible for the transportation of ozone from the tropical stratosphere into the mid and high latitudinal region. The ETSP is a phenomenon, whereby the extra-tropical stratosphere and mesosphere through relevant eddy effects act globally on the tropical stratosphere as a fluid-dynamical suction pump.Thus it may be inferred that there is interconnectivity between reduction in the strength of the ETSP and ozone distribution during the tropical rainfall season.

Conclusion

The average coefficient of relative variability (ACRV) in ozone wasween ACRV computed for eight stations in northen Nigeria between it and climate variability. The mean annual rainfall and temperature was used as an index of climate variability between 2009 and 2014.

The results revealed an average correlation of 0.92 between ACRV and average annual temperature, a result of which manifested in a high temperature received at the stations. The coefficient of determination R2 computed for ACRV and temperature revealed that the ACRV explained 79% variation in temperature and a 1% variation in rainfall, an indication that the rainfall variability observed the station cannot be attributed to the ACRV observed over the years under study in the zone.These observations suggest significant association between the radiative activities and total ozone redistribution over the region and the possibility of total ozone trend over Northern Nigeria being used as an indicator of climate variability over the zone.

References

Akinyemi, M.L. (2010). Total ozone as a stratospheric indicator of climate variability over West Africa. *International Journal of the Physical Sciences.* 5(5), pp. 447-451

Allen J. (2004). Ozone and Climate Change. National Aeronautics and Space Administration (NASA), Earth Observatory Release.

Azeem S.M.I, Palo S.E, Wu D.L., Froidevaux L (2001). Observation of 2-day Wave in UARS MLS Temperature and Ozone Measurements, *Journal of Geophysics*. 28(16): 3147-3315.

Bojkov R.D, Fioeltov V.E. (1995). Estimating the global ozone characteristics during the last 30years, *Journal of Geophysics*. 5 (100):16537-16551.

Cordero E.C, Forster P.M (2006). Stratospheric variability and trends in IPCC model simulations, *Journal of Atmospheric Chemistry* 6: 7657–7695.

Dami, A. (2008). A Predictive Study of Environmental Change in the Nigeria's section of the Chad Basin. *Unpublished PhD Thesis, Obafemi Awolowo University, Ile-Ife.*

Forster P.M, Freckleton R.S, Shine K.P (1997). On aspects of the concept of radiative forcing, *Climate Dynamics* 13: 547-560.

Fusco A.C, Salby M.L (1999). Interannual Variations of Total Ozone and Their Relationship to Variation of Planetary Wave Activity, *Journal of American Meteorological Society* pp. 1619-1629.

Hansen J.M, Sato M,& Ruedy. R. (1997). Radiative forcing and climate response, *Journal of Geophysics*. 102: 6831-6864

Holton J.R. (1992). An Introduction to Dynamic Meteorology. Academic Press, San Diego pp 511-554

Odekunle, O.T., Andrew, O., Aremu, O.S., (2008). Towards a Wetter Sudano-Sahelian Ecological Zone in the Twenty-First Century Nigeria. *Journal of weather and the environment*, March 2008, 63:.3

Ojoye, S. (2012). Climate change and adaptation Strategies to water resources management in Sudano Sahelian Ecological Zone of Nigeria. An unpublished PhD thesis, Department of Geography, University of Ilorin, Ilorin, Nigeria.

Orsolini Y.J, Stephenson D.B, Doblas-Reyes F.J (1998). Storm track signature in total ozone during northern hemisphere winter. *Journal of Geophysics*. 25: 2413–2416.

Sivasakthivel.T and.Siva K.K .(2011). Ozone layer depletion and its effect: A review. *International Journal of Environmental Science and Development* 2(1): 35-36

CLIMATE CHANGE, THE SEGREGATIONAL APPLICATION, THE GWAGWALADA EXPERIENCE

EKWEGHARIRI, L. C., SHAIBU, S. I., OWOYELE, S.G. & IDOWU, O. O.

Department of Urban and Regional Planning, Federal University of Technology, Minna, Niger State

The conflict between the rich and the poor continue to dominate verbal engagements, especially when laws and its application come into play. It will be unreasonable to continue to discuss sustainability and Climate Change seeking the fragmented views of the public and how they can be equitably addressed. Globally, the phenomenon called sustainability often drag climate change to its discussion table. What should be done and what should not be done have gradually shaped the way and manner man exists in the current shape of living. Now the burden created by the phrase, sustainable development and the quest to appreciate this and bring it to reality is still a mirage to many. Man being so conscious of life and how to better life is continually seeking ways to improve life. There is another phenomenon Green Building or Going Green canvassed but the mega structures around Nigeria do not adopt them. This paper will be considering how the law favour the rich and powerful as opposed to the poor and weak. This paper aims at having a general study of climate change and the segregational state of affairs in Gwagwalada area of FCT Nigeria. Primary and secondary data sources shall be applied in data collection. The primary sources shall involve information from the net, text books and library. The research will come up with the findings that proper categorization and sizing of plots can help in sustainability and slow the rate of climate change.

Key words: Density, Landuse, Climate change, Sustainability, Density.

genpapilo@yahoo.com

Ekweghariri, L. C. et al (2016). **CLIMATE CHANGE, THE SEGREGATIONAL APPLICATION: THE GWAGWALADA EXPERIENCE** Sustainable Built Environment and Climate change; The challenges of Post 2015 Development Agenda. School of Environmental Technology Conference, SETIC, 2016

INTRODUCTION

Climate change is a change in the statistical distribution of weather patterns when that change lasts for an extended period of time (i.e., decades to millions of years).Weather is the state of the atmosphere at a particular place and time as regards heat, cloudiness, dryness, sunshine, wind, rain, etc.

Prevailing activities, Farming, hunting, trading, light industrial activities, are common place in this area. The prevailing development is bungalow type of development, usually meant for self inhabitation. It has been observed that developments can largely determine the rate of Climate change either positively or negatively. The traditional compound arrangement that prevail in this environment gives room for improvement in the fight against climate change.

THE HEALTH IMPACTS OF CLIMATE CHANGE

It is expected that a broad range of impacts either directly or indirectly on health this century. There is increase in mortality due to longer and stronger heat waves to health problems created by warming-driven urban smog to risks posed by malnutrition and lack of access to water. Gwagwalada is a largely a hot environment. It is also expected to have higher temperatures as time progresses. Warming will also have some beneficial impacts, most significantly a fair drop in cold related illness and death. But globally over the 21st century, the magnitude and severity of negative impacts are projected to increasingly outweigh positive impacts, as the Intergovernmental Panel on Climate Change concluded in its comprehensive 2014 literature review on “Impacts, adaptation, and vulnerability”.

Most worrisome, if humanity continues close to its current path of greenhouse gas emissions, the IPCC cautions with high assurance that combination of high temperature and humidity in some areas for parts of the year is projected to comprise normal human activities, including growing food or working outdoors. In that case, simply, simply being outdoors in summer months will be unhealthy, and those areas of the world would increasingly be seen as uninhabitable.

It would be common sense to feel that human health impacts of global warming would be among the most well studied areas of climate change, it is only in the last decade that the medical community and other health professionals have focused on this issue in depth. As recently as 2009, a land mark Health Commission created by The Lancet medical journal and the University College London (UCL) Institute for Global Health could warn the full impact of climate change to human health is not being grasped by the healthcare community of policy makers. Lead author , Anthony Costello, a pediatrician and director of UCL

Institute for global Health, said that he himself had not realized the full ramifications of climate change on health until some months ago. Climate change is the biggest global health threat of the 21st century. Be warned Climate change will have devastating consequences for human health from:

. changing patterns of infections and insect-borne diseases, and increased deaths due to heat waves

. reduced water and food security, security leading to malnutrition and diarrheal disease

. increase in the frequency and magnitude of extreme climate events

LANDUSE PLANNING AND CLIMATE CHANGE (RESIDENTIAL)

The subdivision of parcels of land for efficient utilization has been a subject of serious debate amongst developers and professionals. A lot of considerations are being put forward presently especially because of the rapidly changing environment. It has been observed that a major chunk of the subdivision considerations is still colonialistic. They do not reflect the current realities. Consideration will be given to the Residential Landuse. The residential landuse is basically classified into three major groups, low density, medium density and high density. The study area which is Gwagwalada a predominantly low income class environment.

The Development Control standards for development are fairly uniform across the Federal Capital Territory. Below is a table of some of the requirements to be met for development permit to be granted.

Plate 3.0a showing Development Permit Requirements for Residential Approval.

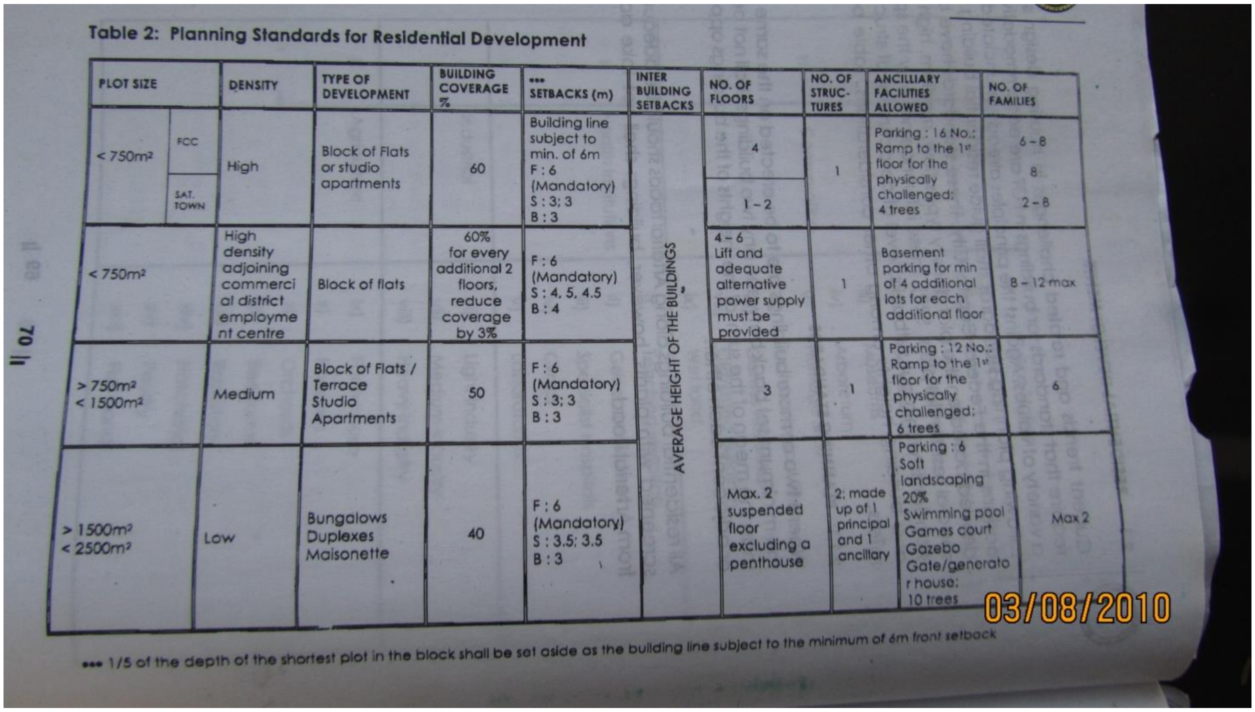


Table 2: Planning Standards for Residential Development

PLOT SIZE		DENSITY	TYPE OF DEVELOPMENT	BUILDING COVERAGE %	*** SETBACKS (m)	INTER BUILDING SETBACKS	NO. OF FLOORS	NO. OF STRUC-TURES	ANCILLIARY FACILITIES ALLOWED	NO. OF FAMILIES
< 750m²	FCC	High	Block of Flats or studio apartments	60	Building line subject to min. of 6m F : 6 (Mandatory) S : 3; 3 B : 3	AVERAGE HEIGHT OF THE BUILDINGS	4	1	Parking : 16 No.; Ramp to the 1st floor for the physically challenged; 4 trees	6 – 8 / 8
	SAT. TOWN						1 – 2			2 – 8
< 750m²		High density adjoining commercial district employment centre	Block of flats	60% for every additional 2 floors, reduce coverage by 3%	F : 6 (Mandatory) S : 4, 5, 4.5 B : 4		4 – 6 Lift and adequate alternative power supply must be provided	1	Basement parking for min of 4 additional lots for each additional floor	8 – 12 max
> 750m² < 1500m²		Medium	Block of Flats / Terrace Studio Apartments	50	F : 6 (Mandatory) S : 3; 3 B : 3		3	1	Parking : 12 No.; Ramp to the 1st floor for the physically challenged; 6 trees	6
> 1500m² < 2500m²		Low	Bungalows Duplexes Maisonette	40	F : 6 (Mandatory) S : 3.5; 3.5 B : 3		Max. 2 suspended floor excluding a penthouse	2; made up of 1 principal and 1 ancillary	Parking : 6 Soft landscaping 20% Swimming pool Games court Gazebo Gate/generator house; 10 trees	Max 2

*** 1/5 of the depth of the shortest plot in the block shall be set aside as the building line subject to the minimum of 6m front setback

Plate 3.0b showing Development Permit Requirements for Residential Approval.

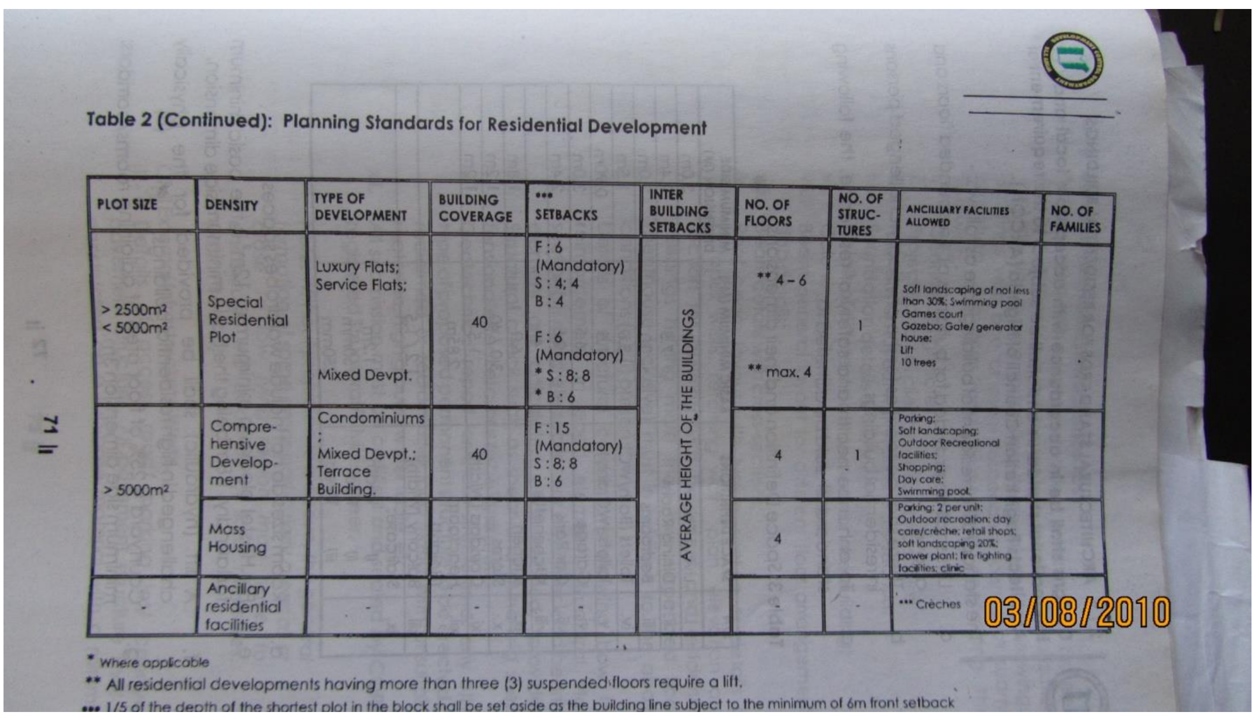


Table 2 (Continued): Planning Standards for Residential Development

PLOT SIZE	DENSITY	TYPE OF DEVELOPMENT	BUILDING COVERAGE	*** SETBACKS	INTER BUILDING SETBACKS	NO. OF FLOORS	NO. OF STRUC-TURES	ANCILLIARY FACILITIES ALLOWED	NO. OF FAMILIES
> 2500m² < 5000m²	Special Residential Plot	Luxury Flats; Service Flats;	40	F : 6 (Mandatory) S : 4; 4 B : 4	AVERAGE HEIGHT OF THE BUILDINGS	** 4 – 6	1	Soft landscaping of not less than 30%; Swimming pool Games court Gazebo; Gate/ generator house; Lift 10 trees	
		Mixed Devpt.		F : 6 (Mandatory) * S : 8; 8 * B : 6		** max. 4			
> 5000m²	Compre-hensive Develop-ment	Condominiums ; Mixed Devpt.; Terrace Building.	40	F : 15 (Mandatory) S : 8; 8 B : 6		4	1	Parking; Soft landscaping; Outdoor Recreational facilities; Shopping; Day care; Swimming pool.	
	Mass Housing					4		Parking: 2 per unit; Outdoor recreation; day care/crèche; retail shops; soft landscaping 20%; power plant; fire fighting facilities; clinic	
-	Ancillary residential facilities	-	-	-		-	-	*** Crèches	

* Where applicable

** All residential developments having more than three (3) suspended floors require a lift.

*** 1/5 of the depth of the shortest plot in the block shall be set aside as the building line subject to the minimum of 6m front setback

Fundamental belief amongst the inhabitants of this area is, there should be significant consideration as regards meeting the set standards of not wasting the environment by the cutting down of trees and burning of bushes and reducing gas emission. It is perceived that the policy pay insignificant consideration to their plight. Taking a look at the current realities, the settlements here believe that their contribution to globally warming is close to nothing.

LANDUSE SUBDIVISSION

Taking a critical look at the Development Control regulations in this area with emphasis on the residential land-use, medium and high densities prevail. The department in-charge of granting building plan approvals as detailed in the Development Control Manual and published in 2007 has classified the plots available into various densities by size in this area. For instance, a plot of about 600sqm (30m x 20m) when put through the rigors of approval standards for a structure to stand on it. See plate below.

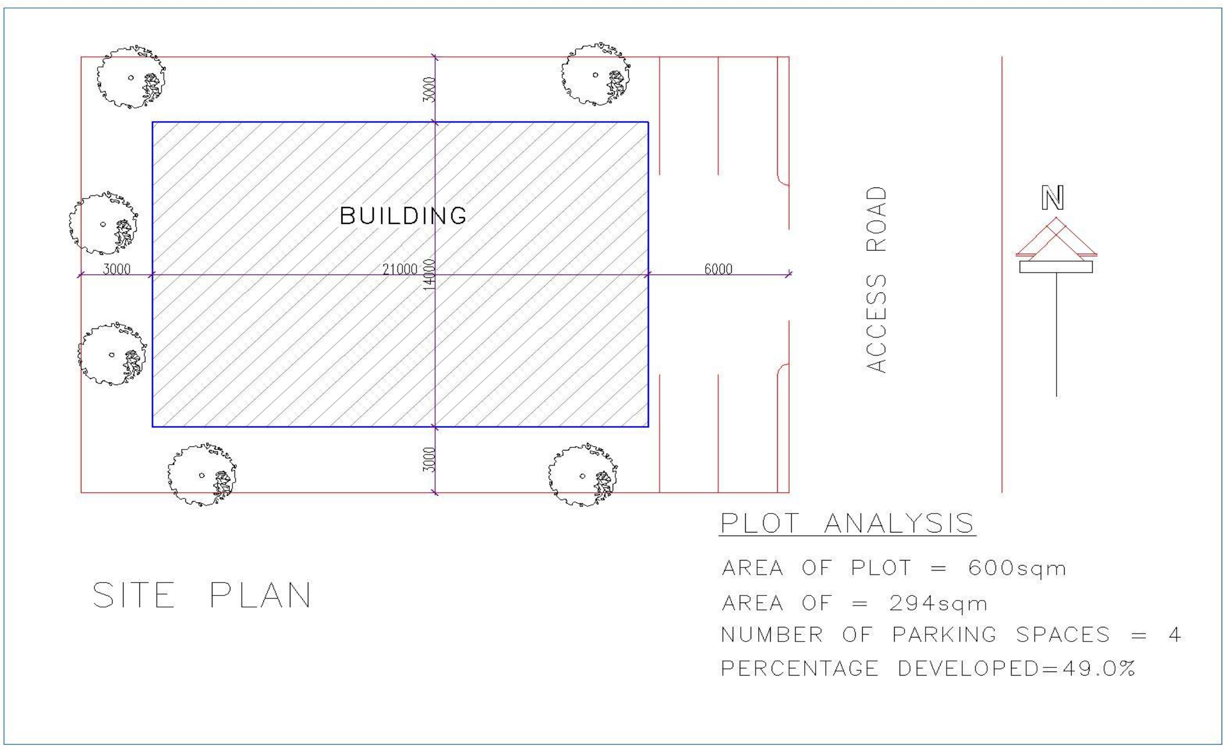


Plate 3.1 Site plan of a 600sqm plot in Gwagwalada.

Considering the sketch above the basic standards of setbacks have been met. It is also expected that this developer will provide packing spaces. The requirement is two (2) parking spaces per two bedroom appartment and one (1) parking space if it is a one (1) bedroom. It is also required that the minimum number of families to be accommodated be four (4). The second dilemma surfaces. This dilemma is that of the possibility of achieving the requirement above and still provide enough parking spaces. It brings to mind the reality of need which will play out as a minimum of two bedrooms per flat so that the developer may occupy one of the flats and lease out the others. The requirement to achieve parking standard becomes a daunting task. The developer is also faced with the issue of plot coverage. The required plot coverage as stipulated in the Development Control manual of the Federal Capital Territory in Nigeria recommends sixty percent but the plate above presents forty-nine percent. This is practically below the requirement as stipulated even after the basic minimum had been met. The tree requirement comes to play and this is a fundamental part of improving the climate of a place but here the available space of three meters is not practically realistic enough to accommodate trees but shrubs and flowers which are not good enough to fight off climate change substantially. The idea of fighting off deforestation is very key to fighting Climate change. Trees and other plants take CO_2 out of the air emit oxygen. This is part of the photosynthesis process whereby trees and plants convert sunlight into energy. Vegetation is therefore a carbon sink result in a net reduction in atmospheric CO_2 as opposed to carbon source such as fossil fuel combustion.

Below is an aerial view of the natural course of development prevailing in Gwagwalada practically ignoring the regulations because they are not realistic. In fact what these photos reveal is a better prospect at addressing the challenges of Climate Change.

Plate 3.2 Aerial View of a layout known as Doma D series showing the prevailing development which is bungalow.

Plate 3.2b Aerial View of a layout known as Doma D series showing the prevailing development which is bungalow.

Plate 3.2c. Arial view of development along the secretariat road around the Doma filling station.

RECOMMENDATION

It is obvious that the degree of damage occasioned by climate change to the wellbeing of the citizens is enormous, but like it is often said in the local parlance, it is better late than the late. Much of the planning regulations which have been observed to be hazardous to the sustainable existence of man, just like the discovery that Carbon IV Oxide (CO_2) and Chlorofluorocarbon have, can be changed.

. Function should be given greater priority than aesthetics.

. The standards applied for development should be reasonably flexible.

. Developers should be encouraged to develop what can be affordable while taking into cognizance climate change implications.

. preparation of layouts should henceforth reflect the current realities.

1. CONCLUSION

It is interesting to note there are some silent development regulations that can make or mar the environment and this should be given due attention. This will help in reducing the climate change incremental rate. From this paper it is obvious that enormous task is upon the planner, planning authority and key players in the quest for sustainable development at various levels to develop and implement rules that are not hostile to the climate.

2. REFERENCES

1. Joseph Romm, Climate change, what everyone needs to know, 2015.
2. Abuja Development Control Manual, 2007.

SUSTAINABLE MATERIALS

EFFECTS OF PALM KERNEL SHELL AS COARSE AGGREGATE REPLACEMENT ON STRENGTH PROPERTIES OF CONCRETE

A. E. Abalaka, O. M. Enejiyon and J. Moses
Department of Building, Federal University of Technology, Minna, Nigeria.

Palm kernel shells (PKS) processed free of fibres were used as coarse aggregate replacement in concrete to determine the effects on compressive and flexural strengths, and modulus of rupture at a free water/cement (w/c) ratio of 0.35. Though the compressive strength of all the specimens containing PKS were less than the control at all the test ages, at 28 and 90 days specimens containing 5% PKS had compressive strength that were comparable to the control. The results show that split tensile strength of specimens with 10% PKS content were higher than the control at 7, 28 and 90 days, however compared to the control the modulus of rupture reduced in beam specimens containing PKS.

Keywords: Palm Kernel Shell, Concrete, Modulus of Rupture

aabalaka@gmail.com

Abalaka et. al.(2016). **EFFECTS OF PALM KERNEL SHELL AS COARSE AGGREGATE REPLACEMENT ON STRENGTH PROPERTIES OF CONCRETE** Sustainable Built Environment and Climate change; The challenges of Post 2015 Development Agenda. School of Environmental Technology Conference, SETIC, 2016

INTRODUCTION

PKS is a waste product of palm oil production process. As an agricultural waste it is usually in abundance in tropical areas with palm processing industries (Payam *et al*., 2011). Nigeria's annual production of palm oil was estimated to be 930,000Tonnes in 2014 (USADA, 2015). This produces a substantial amount of agricultural waste that could be used in construction to reduce environmental pollution footprint, thus the need for research in the potentials of PKS as aggregates for use in concrete. In rural communities where palm oil is produced using traditional processes, PKS is used as biofuel for domestic cooking with little or no consequential environmental pollution. This method of disposal is however unsuitable for PKS waste from oil palm processing factories with large stockpiles.

PKS is a lightweight agricultural waste material with bulk density less than 650kg/m^3. The low bulk density of PKS makes it a potential material for use as aggregates for light weight concrete production. PKS has high water absorption capacity ranging from 14% to 33% when subjected to 24 h of submersion (Alengaram, *et al*., 2011; Mannan & Ganapathy, 2004). Previous studies have used PKS as coarse aggregates in concrete (Basri *et al*., 1999; Mannan & Ganapathy, 2004; Olanipekun *et al*., 2006; Teo *et al*., 2007; Ikponmwosa, *et al*., 2014)). When properly processed to eliminate fibres, it could be used as coarse aggregates to produce light weight concrete (Basri *et al*., 1999; Mannan & Ganapathy, 2001; Mannan & Ganapathy, 2004; Okpala, 1990; Oyejobi *et al*., 2012; Teo *et al*., 2006,) and lightweight masonry blocks (Muntohar & Rahman, 2014). The results of a study by Payam *et al*. (2011) show that when PKS free from fibre was used as coarse aggregates, cube specimens had compressive strength in the range of 43-48 MPa at 28 days with dry concrete density varying from 1868 to 1988 kg/m^3. The work of Alengaram, *et al*. (2011) shows that the shear strength of grade 30 concrete beams containing palm kernel shell with a density of 1850 kg/m^3 was found to be 24% higher than the corresponding normal weight concrete.

The work of Olusola and Babafemi (2015) show the potential of PKS as a floor finish material to reduce dead loads on floors, though its low wear resistance is a concern where durability is paramount. In the work of Olusola & Babafemi (2013), 20 mm maximum size aggregates were reported to give the maximum compressive and tensile strength when compared to 10 and 14 mm maximum sized aggregates at all the test days when PKS was used as coarse aggregate replacement at 20, 40, 60 80 and 100% replacement in concrete at w/c of 0.5; modulus of rupture tests were not reported in their work.

This study investigated the effects of PKS on compressive strength, split tensile strength and modulus of rupture of concrete when used as partial replacement for coarse aggregates at 5, 10, 15% by weight on grade C45 concrete.

Materials and methods.

The PKS was washed and scoured free of fibres. Figure 1 shows the processed PKS used for this study. The presence of fibres in PKS would result in higher water demand and weaker interfacial transition zone between the cement matrix and PKS surface. The PKS was used to replace coarse aggregates by mass at 5, 10 and 15%. The aggregate materials were used in saturated surface dry condition. The materials were weighed and poured into a rotary drum mixer, mixed for three minutes before pouring into steel moulds. The concrete was poured into 100mm steel cube moulds, 150×150mm steel cylinders and 100×100×500mm steel beam moulds and manually compacted. All the specimens were cured in water at ambient temperature and tested at determined ages. The compressive strength of the 100mm cubes and 150×150mm cylinders were determined using a digital compressive test machine. The modulus of rupture of the beams was determined using the third-point loading on 500mm beams with a span of 400mm.

Figure 1. Fibre free PKS

A chloride free high performance super plasticizer based on selected sulphonated naphthalene polymers, *Conplast SP432MS* conforming to BSEN 934-2 (2009) & ASTM C494 (2005) standards was used to improve the slump of the concrete mixes. The doses used were well below the maximum dose of 2.5litres/100kg of cementitious materials recommended by the manufacturers.

The concrete was designed to achieve 40N/mm^2 at 28days. The concrete mix proportions are given in Table 1.

Table 1. Concrete mix

Cement	Fine Aggregates	Coarse aggregates	Free w/c ratio
450kg/m^3	669kg/m^3	1,241kg/m^3	0.35

Table 2. Percentage oxide composition of Type CEM I 42.5R Portland cement

Al_2O_3	CaO	Cr_2O_3	Fe_2O_3	K_2O	MgO	MnO	Na_2O	P_2O_5	SiO_2	TiO_2	LOI at 1000^{o}C	BET surface area (m^2/g)
3.88	61.87	0	2.48	0.44	1.21	0.02	0.13	0.09	15.50	0.20	10.43	1.6016

The *Dangote* commercial brand of Portland cement Type CEM I 42.5R was used for this study. The oxide composition of the cement determined by X-ray florescence (XRF) and the surface area determined by Brunauer–Emmett–Teller (BET) theory analysis using nitrogen (N_2) gas are given in Table 2. BET analysis shows the cement particles to be coarse with a median particle pore width of 12.306Å, adsorption average pore diameter of 149.6614Å and desorption average pore diameter of 148.4267Å. The coarse microstructure of the cement particles determined by back scatter electron (BSE) microscopy is shown in Figure 2. Irregular shaped cement particle morphology of different sizes is clearly visible in the BSE photomicrograph.

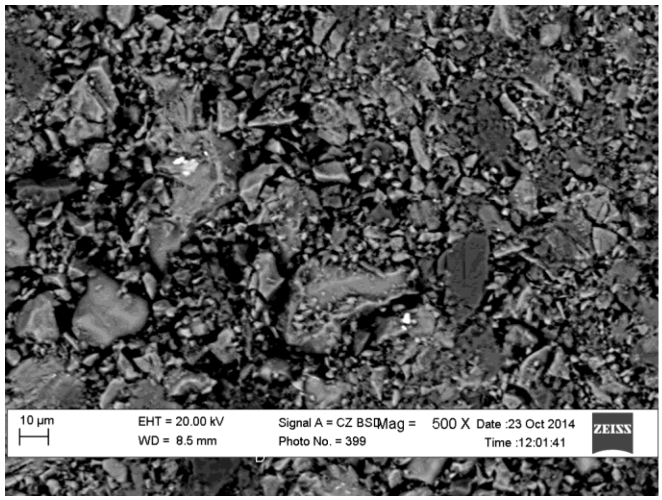


Figure 2. Cement particle morphology

The particle size distributions of fine, PKS and coarse aggregates are given in Tables 3 and 4. The physical properties of the aggregates are given in Table 5. Crushed granite with 20mm maximum size was used as coarse aggregates. Concrete mixes without PKS was used as control.

Table 3. Particle size distribution of fine aggregates

Percentage by weight passing sieves						
4.75mm	2.36mm	1.18mm	600µm	300µm	150µm	75µm
100	96.2	87.6	66.6	27.2	1.8	0.2

Table 4. Particle size distribution of PKS and coarse aggregates

Aggregate	Percentage by weight passing sieves				
	20mm	14mm	10mm	6.3mm	5mm
Coarse aggregate	100	96.2	87.6	66.6	27.2
PKS	100	96.4	86.3	23.5	5.2

Table 5. Physical properties of aggregates

Material	Specific gravity	Compacted bulk density(kg/m^3)
Fine aggregate	2.78	1248.3
Coarse aggregates	2.64	1516.98
PKS	1.30	574.70

Results

The results of the compressive strength tests on 100mm cube specimens at different ages are given in Table 6. The results are averages of five test results.

Table 6. Effect of PKS on slump and compressive strength of concrete

Free w/c	Plasticizer l/kg	PKS (%)	Slump (mm)	Compressive strength (N/mm^2)					
				3days	7days	14days	21days	28days	90days
0.35	0.01	0	28	33	40	44	47	49	53
		5	25	29	38	35	43	49	51
		10	20	29	35	34	43	46	47
		15	15	29	33	35	42	44	46

The results of the split tensile strength tests on 150×150mm cylinder specimens are given in Table 7. The results are averages of three test results.

Table 7. Effect of PKS on split tensile strength of concrete

Free w/c	PKS (%)	Split tensile strength (N/mm^2)		
		7days	28days	90days
0.35	0	3.26	3.48	4.34
	5	3.85	4.01	4.65
	10	3.74	3.96	4.84
	15	1.52	3.41	3.76

Table 8. Effect of PKS on modulus of rupture of concrete

Free w/c	PKS (%)	Modulus of rupture (N/mm^2)		
		7days	28days	90days
0.35	0	4.08	6.80	9.52
	5	3.06	6.19	8.10
	10	2.72	5.44	7.42
	15	2.04	3.40	5.30

The results of the modulus of rupture tests on 500mm beams are given in Table 8. The results in the Table are averages of three test results.

Discussion

The results of compressive strength tests in Table 7 shows that all the specimens containing PKS had strength that are less than the control at all the test days, except the for cubes containing 5% PKS at 28 days where the strength is equal to the control. At 90 days, the strength loss between the control and the cubes containing 5% PKS is 4%. This strength loss is generally less that that reported in literature that used only PKS as coarse aggregates. The strength loss may be considered marginal, thus the compressive strength of the control and that of specimens containing 5% PKS aggregates be comparable at 90 days. Continuous compressive strength losses were recorded as the PKS content in the concrete increased. At the maximum 15% PKS replacement, the strength loss compared to the control at 28 days is 10.2% and at 90 days the strength loss is 13.2%. When aggregates with low bulk densities are used in concrete, the resulting compressive strength is usually lower than that of concrete with standard aggregates. However, the use of light weight aggregates have advantages in concrete production, not least is the reduction in dead weight of concrete.

The effect of PKS replacement on split tensile strength given in Table 7 show that the values are higher for cylinders containing 5 and 10% PKS at all the test days. These improvements in split tensile strength of concrete could be attributed to redirection of crack paths due to the presence of PKS particles in the concrete matrix of the cylinder specimens.

The modulus of rupture test results in Table 8 shows that concrete beam specimens containing PKS had values that are less than the control at all the test ages. This pattern of modulus of rupture reduction within concrete containing PKS was also reported in the work of Muda, *et al*. (2012) and Ikponmwosa, *et al*. (2014). The reduction in the modulus of rupture was due to the relatively low strength of the PKS particles in the concrete.

Conclusion

The results of this study have shown that when 5% of PKS was used to replace coarse aggregate by mass in concrete, the resulting compressive strength is comparable to those containing standard coarse aggregates. The results have further shown that tensile strength of concrete could be improved by replacing standard coarse aggregates with 10% of PKS by weight. Finally, this study has shown that when PKS was used to replace standard aggregates in concrete, reduction in modulus of rupture was recorded.

References

Alengaram U. J., Jumaat M. Z., Mahmud H., Fayyadh, M. M. (2011). Shear behaviour of reinforced palm kernel shell concrete beams. *Construction and Building Materials*, 25, 2918–2927.

American Society for Testing and Materials. (2005). ASTM C494 / C494M-05, Standard Specification for Chemical Admixtures for Concrete, ASTM International, West Conshohocken, PA, 2005, www.astm.org

Basri, H.B, Mannan, M.A, & ,Zain M.F.M. (1999). Concrete using waste oil palm shells as aggregate. *Cement and Concrete Research*, 29, 619–22.

British Standards Institution. (2009). Admixtures for concrete, mortar and grout . Concrete admixtures. Definitions, requirements, conformity, marking and labeling. BS EN 934-2:2009+A1:2012. London.

Ikponmwosa E. E., Salau M. A., Olonode K. A. (2014). Suitability of crushed palm kernel shell as coarse aggregate in structural concrete. *Current Advances in Civil Engineering*, 2 (2), 59-66.

Mannan, M.A., Ganapathy, C. (2001). Long-term strengths of concrete with oil palm shell as coarse aggregate. *Cement and Concrete Research*, 31, 1319–1321.

Mannan, M.A, & Ganapathy, C. (2004). Concrete from an agricultural waste-oil palm shell (OPS). *Built Environment*, 39, 441–8.

Muda, I.Z.C., Sharif, S.F.A, & Honga, N.J. (2012). Flexural behaviour of lightweight oil palm shells concrete slab reinforced with geogrid. *International Journal of Scientific and Engineering Research*, 3(11), 1-18.

Muntohar, A. S., & Rahman, M. E.. (2014). Lightweight masonry block from oil palm kernel shell. *Construction and Building Materials*, 54, 477–484.

Okpala, D.C. (1990). Palm kernel shell as a lightweight aggregate in concrete. *Built Environment*, 25, 291–6.

Olanipekun, E.A., Olusola, K.O., & Ata, O. (2006). A comparative study of concrete properties using coconut shell and palm kernel shell as coarse aggregates. *Built Environment*, 41, 97–301.

Olusola, K.O. and Babafemi, A.J. (2013). Effect of Coarse Aggregates Sizes and Replacement Level on the Strength of Palm Kernel Shell (PKS) Concrete. *Civil Engineering Dimension*, 15(1), 43-50.

Olusola, K. O, & Babafemi A. J. (2015). Assessment of kernelrazzo exposed to aggressive environments. *Construction and Building Materials*, 101, 174–183.

Oyejobi, D. O., Abdulkadir, T. S., Yusuf I. T., and Badiru, M. J. (2012). Effects of Palm Kernel Shells Sizes and Mix Ratios on Lightweight Concrete. *Journal of Research Information in Civil Engineering*, 9(2), 217-226.

Payam, S., Mohd, Z. J., & Hilmi M. (2011). Oil palm shell as a lightweight aggregate for production high strength lightweight concrete. *Construction and Building Materials*, 25, 1848–1853.

Teo, D.C.L., Mannan, M. A., & Kurian V.J. (2006). Structural concrete using oil palm shell (OPS) as lightweight aggregate. *Turkish Journal Engineering and Environmental Science*, l. 30, 251–7.

Teo, D.C.L, Mannan, M.A., Kurian, V.J., & Ganapathy, C. (2007). Lightweight concrete made from oil palm shell (OPS): structural bond and durability properties. *Built Environment*, 42, 2614–21.

United States of America Department of Agriculture (USADA). (2015). Retrieved from http://www.usda.gov/wps/portal/usda/usdahome

EFFECTS OF WASTE BURNT BRICK POWDER ON STRENGTH OF CONCRETE

A. E. Abalaka, M. G. Abubakar, N. Haruna & J. Moses

Department of Building, Federal University of Technology, Minna, Nigeria.

The effects of partial Portland cement replacement with waste burnt brick powder (WBBP) by mass on compressive and split tensile strength of concrete specimens at different ages were carried out at free water/cement (w/c) ratio of 0.35 and 0.40 using two concrete mixes with different cement contents. The effects of WBBP on properties of cement paste at standard consistence were also carried out. WBBP significantly affected initial and final setting times and as well as the water demand in cement. The results of the study shows that strength reductions were recorded for specimens containing WBBP compared to control at all the test days. The lowest strength losses were recorded at lower free w/c ratio mixes for both concrete mixes. The maximum strength recorded for all the test specimens containing WBBP for both mixes was at 10% WBBP content.

Keywords: Waste, Burnt Brick, Control

aabalaka@gmail.com

INTRODUCTION

The increasing costs and scarcity of natural construction materials and the need to conserve non- renewable natural materials, have increased the need to search for use of waste byproducts from manufacturing plants for sustainable construction. Bricks are produced by calcinating alumino-silicate clays. The production of bricks used for building construction usually creates substantial accumulated wastes resulting from rejected and broken bricks. There have been reported research findings about the effect of using waste burnt brick powder in concrete and mortar to determine its suitability as a pozzolan. The varying qualities of the natural deposits of clay used for brick production usually results in different quantities of silica and glass in the resulting brick powder. The heat treatment of clay minerals in brick kilns at temperatures below 900^{o}C causes through the loss of bound water, the collapse of the crystallographic pozzolanicity of bricks and clays and the formation of silica and alumina in an amorphous state or in a state characterized by disorder in the lattice structure that makes WBBP reactive in concrete (Naceri & Hamina 2009; Vanchai *et al*., 2007). The variations of the constituent oxide materials in brick powder accounts for varying findings of research on the effect of WBBP in both concrete and mortar (Kavas & Olgun, 2008; Naceri & Hamina, 2009).

Studies by Schackow *et al*., (2015) using clay brick waste powder in mortar resulted in micro structural changes that improved mechanical strength of specimens but less chemical resistance. The work of Naceri & Hamina (2009) show that when waste brick powder was used to replace Portland cements Types CEM I, CEM II-1-4 in mortar cubes at 5, 10, 15 and 20% content, compressive strength reduction was recorded as the brick powder content increased at 7 and 28days; marginal strength increase over the control was recorded at 5% WBBP at 90 days. In the work reported by Wild et al., (1997), 30% of Portland cement was replaced by ground clay brick collected from four European countries without significantly reducing mechanical properties of concrete. The work of Gonçalves *et al*. (2009) carried out to compare the compressive strength, modulus of elasticity and pore size distribution of mortar mixtures containing waste clay brick powder with mortar mixture containing meta-kaolin found that the use of clay brick powder as a cement replacement reduced the proportion of macro pores and modulus of elasticity of the mortar specimens. However it does appear that certain super plasticizers interfere with pozzolanic reactions of WBBP in concrete; compressive strength test results of concrete were observed to reduce at 29 days for concrete with polycarboxylate self-compacting admixture containing brick powder (Heikal *et al*., 2013). No adequate explanations have been found in literature for these observed strength losses in concrete containing WBBP.

Compressive strength improvement is not the only beneficial use of brick powder in concrete. Results of a study by Afshinnia & Poursaee (2015) on ground clay brick shows that replacing 25% of cement with ground clay brick could significantly decrease the Alkali-silica-reaction (ASR) in mortar expansion by 67% at the age of 14 days.

This is the first attempt at using WBBP from industrial waste bricks produced from local clay deposits in Minna, Nigeria. In this study, the effects of partial Portland cement replacement with WBBP on compressive and split tensile strengths of concrete at two different w/c ratios was investigated in the laboratory; the effects of WBBP on cement paste at standard consistence was also investigated.

Materials

The WBBP used for this study was sourced from waste blocks at a clay block producing factory in Minna. The *Dangote* commercial brand of Portland cement Type CEM I 42.5R was used for this study.

A chloride free high performance super plasticizer based on selected sulphonated naphthalene polymers, *Conplast SP432MS* conforming to BSEN 934-2 (2009) & ASTM C494 (2005) standards was used to improve the slump of the concrete mixes. The doses used were well below the maximum dose of 2.5litres/100kg of cementitious materials recommended by the manufacturers.

The oxide composition of the cement determined by X-ray florescence (XRF) and the surface area determined by Brunauer–Emmett–Teller (BET) theory analysis using nitrogen (N_2) gas are given in Table 1. BET analysis shows the cement particles to be coarse with a median particle pore width of 12.306Å, adsorption average pore diameter of 149.6614Å and desorption average pore diameter of 148.4267Å. The coarse microstructure of the cement particles determined by back scatter electron (BSE) microscopy is shown in Figure 1. The plot of incremental surface area vs. pore width from BET analysis of the Portland cement gives particle mean size as 31.81Å (0.003181µm) with an incremental surface area of 0.042m^2/g.

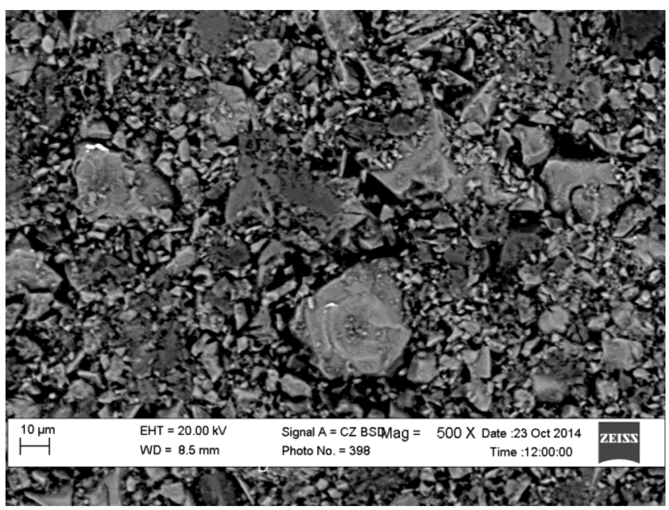


Figure 1. Cement particle morphology

Crushed granite with 20mm maximum size was used as coarse aggregates. The results of the sieve analysis of the coarse aggregates (C_u=1.04; C_c =1.0) are given in Table 2. The results of the sieve analysis of quartzite river sand (C_u=2.95; C_c =0.95) that was used as fine aggregates are in Table 3.

Table 1. Composition of Type CEM I 42.5R Portland cement

Al_2O_3	CaO	Cr_2O_3	Fe_2O_3	K_2O	MgO	MnO	Na_2O	P_2O_5	SiO_2	TiO_2	LOI at 1000ºC	BET surface area (m^2/g)
3.88	61.87	0	2.48	0.44	1.21	0.02	0.13	0.09	15.50	0.20	10.43	1.6016

Table 2. Particle size distribution of coarse aggregates

Percentage by weight passing sieves		
20mm	14mm	10mm
63.75	14.43	0.32

Table 3. Particle size distribution of fine aggregates

Percentage by weight passing sieves						
4.75mm	2.36mm	1.18mm	600µm	300µm	150µm	75µm
98.6	95	92.6	77.6	35.4	7.6	1.4

The physical properties of specific gravity and compacted bulk density of the aggregates and WBBP are given in Table 4.

Table 4. Physical properties of aggregates

Material	Specific gravity	Compacted bulk density(kg/m^3)
Fine aggregate	2.78	2846.04
Coarse aggregates	2.66	2769.81
WBBP	2.83	884.91

Methodology

The WBBP used for this study was milled and sieved and only materials passing 45µm sieve was used. The effects of WBBP on properties of cement mortar at standard consistence were determined using 400g of cement WBBP as control with no content. Determination of the effects of WBBP on standard consistence, initial and final setting time and soundness of cement paste was carried out based on BS EN 196-3:2005+A1:2008 standard procedures.

The WBBP was analyzed for oxide composition by XRF using Mini Pal PW 4030 X-ray spectrometer run on a dedicated Mini pal version 4, analytical software. The sample was weighed and ground in agate mortar and a binder (PVC dissolved in toluene) was added to the sample, mixed and pressed in a hydraulic press into Ø19 mm pellet. The sample was loaded into sample chamber and a spectrum was generated at 30kV and 1mA for 10 minutes. The results of the XRF analysis are given in Table 5.

Table 5. Percentage oxide composition by mass of WBBP

SiO_2	Al_2O_3	Fe_2O_3	CaO	MnO	SO_3	K_2O	ZnO	Mn_2O_3	P_2O_5	TiO_2
56.2	22.5	13.35	3.1	0.22	0.1	2.51	0.01	0.19	3.97	1.03

The coarse and fine aggregates were weighed and used for this study in saturated surface dry condition. The concrete materials were weighed and poured into a rotary drum mixer, mixed for three minutes before discharge. The slumps of the mixes were measured using **BS EN 12350-2:2009 standard procedures.** The plasticizer dose was determined to achieve a minimum slump of 20 mm at a free w/c ratio of 0.35 and 10mm at w/c of 0.40 for mix 1concrete. The plasticizer dose of mix 2 concrete was chosen to achieve a minimum slump of 100 mm at a free w/c ratio of 0.35 and 10mm at w/c of 0.40. The concrete was poured into 100 mm steel cube moulds and 150×150 mm steel cylinders and manually compacted. All the specimens were cured in water at ambient temperature and tested at determined ages.

Two mix proportions at cement contents of 450kg/m^3 designated as mix 1 and cement content 530kg/m^3 designated as mix 2 were used. The concrete mix 1 was designed to achieve 45N/mm^2 at 28 days at free w/c ratio of 0.35 and 40N/mm^2 at a free w/c ratio of 0.40 at 28 days. The concrete mix 2 was designed to achieve 50N/mm^2 at 28 days at free w/c ratio of 0.35 and 45N/mm^2 at a free w/c ratio of 0.40 at 28 days. The mix materials are given in Tables 6 and 7.

Table 6. Mix 1 proportions

Cement content	Sand	Coarse aggregates	Free w/c ratio
450kg/m^3	669kg/m^3	1,241kg/m^3	0.35 and 0.40

Table 7. Mix 2 proportions

Cement content	Sand	Coarse aggregates	Free w/c ratio
530kg/m^3	458kg/m^3	1,302kg/m^3	0.35 and 0.40

Results

The effects of WBBP on properties of cement paste at standard consistence are given in Table 8.

Table 8. Effects of WBBP in cement mortar at standard consistence

	WBBP replacement (%)						
	0	2	5	10	15	20	30
Water content (g)	90	92	94	96	98	100	103
Water content (%)	23	23	24	24	25	25	26
Initial setting time (minutes)	108	93	94	113	115	118	129
Final setting time (minutes)	165	130	144	158	167	169	175
Soundness(mm)	0.95	1.15	1.20	1.25	1.30	1.35	1.45

The effects of WBBP on compressive strength and split tensile strength of mix 1 concrete at 0, 10, 15 and 20% contents are given in Table 9 and 10. The results in Table 9 are averages of results of tests on five 100mm cube specimens, whereas the results in Table 10 are averages of test results of three 150×150mm cylinder specimens. The effects of WBBP on compressive and split tensile strength of mix 2 concrete at 0, 10, 20 and 30% contents are shown in Tables 11 and 12. The results in Table 11 are averages of test results of five 100mm cube specimens and the results in Table 12 are averages of tests on three 150×150mm cylinders.

Table 9. Effects of WBBP on mix 1 concrete slump and compressive strength

w/c	Plasticizer l/m^3	WBBP replacement (%)	Slump (mm)	Compressive strength (N/mm^2)					
				3days	7days	14days	21days	28days	90days
0.35	3.5	0	40	33	40	44	47	49	53
	3.8	10	10	29	38	35	43	49	51
	4.1	15	24	29	35	34	43	46	47
	4.5	20	21	29	33	35	42	44	46
0.40	2.6	0	65	27	35	40	51	43	46
	2.9	10	20	27	34	39	42	43	43
	3.3	15	10	25	29	38	38	42	42
	3.6	20	12	24	26	34	36	39	41

Table 10. Effects of WBBP on split tensile strength of mix 1 concrete

w/c	WBBP replacement (%)	Split tensile strength (N/mm^2)	
		7days	28days
0.35	0	5.15	6.62
	10	5.09	5.64
	15	5.00	5.35
	20	4.65	5.34
0.40	0	3.96	5.33
	10	3.71	4.15
	15	3.54	4.01
	20	3.41	3.57

Table 11. Effects of WBBP on mix 2 concrete slump and compressive strength

w/c	Plasticizer l/m^3	WBBP replacement (%)	Slump (mm)	Compressive strength (N/mm^2)					
				3days	7days	14days	21days	28days	90days
0.35	4.3	0	150	31	39	44	46	48	50
	4.6	10	110	31	39	41	42	45	46
	5.0	20	350	26	36	38	41	43	44
	5.3	30	360	25	35	37	40	41	41
0.40	2.6	0	65	25	30	31	40	44	46
	2.9	10	20	21	28	31	35	37	37
	3.3	20	10	20	26	30	34	35	36
	3.6	30	12	17	23	29	32	33	34

Table 12. Effects of WBBP on split tensile strength of mix 2 concrete

w/c	WBBP replacement (%)	Split tensile strength (N/mm^2)	
		7days	28days
0.35	0	3.83	4.3
	10	3.03	3.4
	15	2.7	2.8
	20	2.5	2.6
0.40	0	3.2	3.5
	10	2.5	2.7
	15	2.4	2.5
	20	2.0	2.2

Discussion

The sum of the mass of SiO_2, Al_2O_3, and Fe_2O_3, from the results of XRF in Table 5 is 92.05%. This is more than the 70% minimum requirement for the sum of these oxides for a material to be classified as a pozzolan by the ASTM standard. Furthermore, the maximum limit of 4.0% sulphuric anhydride (SO_3) content for pozzolans was not recorded in the WBBP used for this study. The WBBP used for this study could therefore be classified as a pozzolan.

The effects of WBBP on cement paste at standard consistence in Table 8 shows that the water content of cement paste required to achieve standard consistence increased with WBBP content. Therefore the use of WBBP in concrete will result in high water demand. Ge, *et al*., (2015) reported significant concrete slump reduction as brick powder replacement increased above 10% in concrete. Table 8 shows that 2 and 5% WBBP content resulted in lower initial and final setting times of cement paste at standard consistence compared to the control. Naceri & Hamina (2009) attributed reduction in initial and final setting times to high water absorption as WBBP content increased. However, at higher WBBP contents both initial and final setting times increased.

Though the soundness increased with increase in WBBP content, it did not exceed the 10 mm maximum recommended in BS EN 196-3:2005+A1:2008 **standard. Similar patterns of increase in initial and final setting times were reported in the work of** Sa'ad & Garba (2008) **carried out on different samples of brick waste powder. The work of** Lin et al., (2010) also reported increase in initial and final setting times of cement mortar containing brick waste powder. Naceri & Hamina, 2009 also recorded increases in water content at standard consistence as the WBBP content increased up to 20%; they also recorded reductions in initial and final setting times as the WBBP content increased up to 20%.
The results of cement Type CEM I 42.5R **replacement with** WBBP for mix 1 recorded in Table 9 shows that the compressive strength of all the cube specimens containing WBBP are less than the control for all the test ages. Similarly, the results of split tensile tests on cylinders in Table 10 for mix 1 show loss of strength for all specimens containing WBBP. At 90 days, the maximum compressive strength attained for cubes containing 10% WBBP was 3.8% less than the control at w/c of 0.35. At a w/c ratio of 0.40, the maximum strength of cube specimens containing WBBP was 6.5% less than the control at 90 days. Also at 90 days, the compressive strength of cube specimens containing 5% WBBP at both w/c ratios was comparable to the control. A similar pattern was reported in the work of O'Farrell *et al*. (2001) on cement mortar containing waste bricks powder at later ages. These patterns indicate that when WBBP is used to replace Type CEM I 42.5R Portland cement in concrete, marginal strength reductions would result. Similar strength reductions were reported in mortar specimens containing WBBP (Sa'ad & Garba, 2008). Mix 1 compressive strength test results show that 10% WBBP content had the lowest strength reduction compared to the control.

The results of split tensile strength test results in Table 10 shows that though specimens containing WBBP recorded strengths that are less than the control, the minimum strength loss was recorded for 10% WBBP content at both 7 and 28 days. At 28 days, the lowest strength loss at 10% WBBP content at w/c ratio of 0.35 was 15%, but at a w/c ratio of 0.40

at 28 days it is 22%. For mix 1 test specimens, the lowest strength reductions were at a free w/c ratio of 0.35 at 10% WBBP content.

The results of compressive strength tests for mix 2 in Tables 11 shows that compressive strength of specimens containing WBBP was lower than control for all the test days at both w/c ratios. The lowest strength loss was recorded for concrete cubes containing 10% WBBP. At 90 days the lowest strength reduction was 8% at w/c of 0.35 at 10% WBBP content, whereas at a w/c ratio of 0.40 the lowest strength reduction at 10% WBBP content was 20% compared to the control.

The split tensile strength results in **Table 12** also show that the lowest strength reduction at 10% WBBP content was 21% at w/c ratio of 0.35 at 28 days. At a w/c ratio of 0.40, the lowest strength reduction at 28 days was 23%. The results in Table 11 and 12 for mix 2 test specimens had the lowest strength reductions recorded at a w/c ratio of 0.35.

The strength losses recorded in this study shows that though by classification, the WBBP was pozzolanic and reactivity was detected in initial and final setting times, the pozzolanic reactions did not result in strength increases in concrete. The strength reductions recorded in this study are due to the pozzolanic reaction of WBBP in concrete.
Similar strength reductions were observed in other studies using waste brick powder as pozzolan in mortar specimens. As observed in mortar studies, the replacement of Portland cement by waste materials is known to result in reduction of clinker content of cement and the amount of cementitious gel formed from pozzolanic reaction (Kavas & Olgun, 2008). The study of O'Farrell *et al*., (2001) showed that the use of brick powder as partial Portland cement replacement increases intruded pore volume and reduces percentage of fine pores and compressive strength of the mortar. Since the strength of mortar or concrete is fundamentally a function of the form and distribution of the internal void space and porosity (Granju & Grandet, 1989; Neville, 2012), strength reductions would result.

The concrete strength losses recorded at the test ages in this study could be attributed to low reactivity of the WBBP caused by low surface area and dilution effect due its high water absorption (Ge *et al*., 2015; O'Farrell *et al*. 2001).

Conclusion

The results in this study has shown that WBBP increased initial and final setting times of cement paste significantly; 2% and 5% WBBP content reduced initial and final setting times whereas 10, 15, 20 and 30% WBBP content increased initial and final setting times.
The results from this study have also shown that the use WBBP in concrete resulted in both compressive and split tensile strength losses compared to the control at all ages tested. The strength reduction can however be mitigated by using lower w/c ratio mixes.

References

Afshinnia K., & Poursaee A. (2015). The potential of ground clay brick to mitigate Alkali–Silica Reaction in mortar prepared with highly reactive aggregate. *Construction and Building Materials*, 95, 164–170.

American Society for Testing and Materials. (2015). ASTM C618-15, Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete, ASTM International, West Conshohocken, PA, 2015, www.astm.org

American Society for Testing and Materials. (2005). ASTM C494 / C494M-05, Standard Specification for Chemical Admixtures for Concrete, ASTM International, West Conshohocken, PA, 2005, www.astm.org

British Standards Institution. (2005). Methods of testing cement. Determination of setting time and soundness. BS EN 196-3:2005+A1:2008. London.

British Standards Institution. (2009). Admixtures for concrete, mortar and grout . Concrete admixtures. Definitions, requirements, conformity, marking and labeling. BS EN 934-2:2009+A1:2012. London.

British Standards Institution. (2009). Testing fresh concrete. Slump-test. BS EN 12350-2:2009**.**London.

Ge, Z., Wang, Y., Sun, R., Wu, X., Guan, Y. (2015). Influence of ground waste clay brick on properties of fresh and hardened concrete. *Construction and Building Materials*, 98, 128–136.

Granju, J.L. & Grandet, J. (1989). Relation between the hydration state and the compressive strength of hardened Portland cement paste. *Cement Concrete Research,* 19, 579-85.

Gonçalves J.P., Tavares L.M., Toledo Filho R.D., & Fairbairn E.M.R. (2009). Performance evaluation of cement mortars modified with metakaolin or ground brick. *Construction and Building Materials*, 23 (5), 1971–1979.

Heikal M., Zohdy K.M., & Abdelkreem, M. (2013). Mechanical, microstructure and rheological characteristics of high performance self-compacting cement pastes and concrete containing ground clay bricks. *Construction and Building Materials*, 38, 101–109.

Kavas, T., Olgun, A., (2008). Properties of cement and mortar incorporating marble dust and crushed brick. *Ceramics-Silikaty,* 52 (1), 24–28.

Lin, K.L, Chen, B.Y., Chiou, C.S., Cheng, A. (2010). Waste brick's potential for use as a pozzolan in blended Portland cement. *Waste Management and Research*, 28(7), 647-52.

Naceri, A., & Hamina, M.C. (2009). Use of waste brick as a partial replacement of cement in mortar. *Waste Management*, 29 (8), 2378–2384.

Neville A. M., (2012). Properties of concrete, Fifth edition, Pearson Educational limited, Edinburgh Gate, Harlow, Essex CM20 2JE. England.

O'Farrell, M., Wild, S., Sabir B.B. (2001). Pore size distribution and compressive strength of waste clay brick mortar. *Cement Concrete Composites*, 23 (1), 81–91.

Sa'ad, M.M., & Garba, M.M. (2008). Percentage replacement of cement by burnt-bricks-pozzolan in mortar production in Nigeria. *Environmental Technology and Science Journal*, 3(2), 1-5.

Schackow, A., Stringari D., Senff L., Correia S.L., & Segadaes, A.M. (2015). Influence of fired clay brick waste additions on the durability of mortars. *Cement and Concrete Composites*, 62, 82–89.

Vanchai, S., Jaturapitakkul, C., Kiattikomol, K. (2007). Influence of pozzolan from various by-product materials on mechanical properties of high-strength concrete. *Construction and Building Materials*, 21, 1589–1598.

Wild, S., Gailius, A., Hansen, H., Pederson, L., & Szwabowski, J. (1997). Pozzolanic properties of a variety of European clay bricks. *Building Research Information*, 25 (3), 170–175.

INFLUENCE OF OIL PALM PLANTATION AGE AND HYDROLOGY ON DISSOLVED ORGANIC CARBON CONCENTRATION OF MALAYSIAN TROPICAL PEATLAND WATER RESOURCES

ADESIJI, R.A[a,f]*, MOHAMMAD, T.A [a], NIK, N.N.D[a], SAYOK, A.K[c], PADFIELD, R[d], EVERS, S[e], JIMOH, I.O [f] and GBADEBO, A.O[f]

a. Department of Civil Engineering, Faculty of Engineering, Universiti Putra, Malaysia, 43400, UPM Serdang, Malaysia
b. Department of Environmental and Chemical Engineering, Faculty of Engineering, Universiti Putra, Malaysia, 43400, UPM Serdang, Malaysia
c. Department of Hydrology and Soil Science, Institute of Biodiversity and Environmental Conservation, Universiti Malaysia, Sarawak
d. Department of Water and Environmental Management, Malaysian-Japan International Institute of Technology, Malaysia
e. School of Bioscience, The University of Nottingham, Malaysia Campus
f. Department of Civil Engineering, Federal University of Technology, Minna, Niger State, Nigeria.

Due to boom recorded globally in oil palm industries, many palm oil producing countries like Malaysia and Indonesia converted the sizeable parts of their carbon-rich previously stable peat swamp forests to oil palm plantation. This conversion resulted in huge loss of the soil carbon in dissolved and gaseous forms to atmospheric body and nearby streams. This paper thus focuses on assessing the influence of oil palm plantation age and hydrological factors on dissolved organic carbon concentration in the tropical peatlands. Four different plantations were considered with different years of peat swamp forest conversion ranging from 2000, 2002, 2006 and 2010. The plantation tagged 2010 was first cleared in 1978 and hereby referred to as 2010/1978 in this study. Two tube wells were installed in each of the plantations for monitoring DOC concentration of groundwater between September 2013 and December, 2014. The results showed positive influence of heavy storm events on DOC concentrations and that the lowest DOC concentration ranging from 18.10 mg/L to 28.60mg/L was observed at 2010/1978 plantation as against the highest DOC concentration of range 169.2 mg/L to 250.50 mg/L at 2000 plantation. The results therefore justify the influence of age of plantation as 1978/2010 plantation recorded the lowest DOC concentration as against the 2000 plantation recording the highest DOC concentration. It is thus recommended that oil palm cultivation on peatlands should be avoided as this practice, if not well-managed, leads to flux and emission of stored soil carbon in both dissolved and gaseous forms to the surrounding water resources and atmospheric body.

Keywords: *oil palm plantation, peat swamp forest, dissolved organic carbon, tropical peatland*

ade.richard@futminna.edu.ng
adrichard01@yahoo.co.uk

ADESIJI et. al. (2016). **INFLUENCE OF OIL PALM PLANTATION AGE AND HYDROLOGY ON Dissolved Organic Carbon CONCENTRATION OF MALAYSIAN Tropical peatland WATER RESOURCES** Sustainable Built Environment and Climate change; The challenges of Post 2015 Development Agenda. School of Environmental Technology Conference, SETIC, 2016

INTRODUCTION

Malaysia is ranked as the second largest producers of palm oil globally after Indonesia. As a result of the boom recorded globally in the oil palm industries, Malaysia and Indonesia converted the sizeable parts of their carbon-rich previously stable peat swamp forests (PSFs) to oil palm plantation. This conversion resulted in a huge loss of soil carbon in dissolved and gaseous forms to atmospheric body and nearby streams. Major parts of the loss were in form of dissolved organic carbon (DOC) to the nearby streams and groundwater body (Kura et al. 2013; Adesiji et al. 2014; Prasanna et al. 2014). Starting from 1978, many of the PSFs have been converted to oil palm plantations in stages (Adesiji et al. 2014) and this has subsequently influenced the rate at which DOC is being exported and polluting to the peatland water resources (Woston et al. 2008).

Dissolved organic carbon (DOC) has been described by Moore *et al.* (1998) as a complex collection of organic carbon molecules produced as a result of plant decay. According to van Hees *et al.* (2005), DOC has been reported to be biogeochemically important pool of total carbon which is stocked in peatlands in large quantity. With this link between plant decay and DOC production, there is therefore strong link between soil organic carbon, SOC and DOC. Thus, the amount of SOC is known to be influenced by the rate of microbial activity in the soil which enhances the plant decay and hence DOC production (Hope *et al.* 1997). Therefore, it is reasonable enough to assume that DOC is sensitive to changes in climate, most importantly temperature and rainfall patterns. DOC has also been described as an important component of soil and aquatic environment. The flux of DOC into streams lowers its DO levels which affect the quality of aquatic life (Mc mahon and Chappelle 2008) and damage the structure and functions of aquatic ecosystems by influencing water (Liu *et al.* 2014). The loss of DOC from peatland to the nearby streams is characterized by brown colour exhibited by the streams which, according to Wallage and Holden (2010), is sometimes used as surrogate measure of DOC concentration in streams. DOC is said to leach from upper organic soil layers to mineral soil layers from where it is absorbed into the receiving streams, lakes, or rivers (Schwesig *et al.* 2003).

Various studies have reported the DOC loss from peatlands and have attributed this loss to various factors. According to Adesiji et al. (2014), many of the PSFs have lost their soil carbon to intensive peatland agriculture which resulted in huge loss of major nutrients stocked within the peatlands. Also peat subsidence which also as a result of peatland oxidation and irreversible drying has also been as a result of soil carbon loss due to PSFs conversion (Couwenberg, 2010). DOC loss in tropical peatland has also been attributed to some hydrological factors like rainfall and temperature. According to Hope *et al.* (1994), DOC loss from the peats is due to microbial synthesis of carbon, root exudation, leaching during rainfall events and as a result of erosion of soil organic matter. Buffam *et al.* (2001) and Inamdar *et al.* (2006) reported the occurrence of large annual DOC export during short-duration but high-intensity storm events. Michalzik, *et al.* (2001) and Neff and Asner, (2001) also reported that soil temperature, soil moisture, nitrogen (N) availability, iron, Fe, soil pH, C:N ratio and the amount of organic matter have been discovered to control the dynamics of DOC in forest soils. Peichl, *et al.* (2007); Dalva and Moore, (1991) and Kalbitz, *et al.* (2000)

have also suggested soil temperature to have huge influence on the productions and concentration of DOC. According to Peichl, *et al.* (2007), the dependence of DOC concentration on soil temperature is pronounced on forest floor. Guggenberger, *et al.* (1998) and Michalzik and Matzer, (1999) also corroborated that there is a strong correlation between soil temperature and DOC production in forest floor. Soil moisture content and DOC concentration have also been found to correlate.

Thus in this study, it is hypothesized that PSFs conversion for agricultural activities and land use change and by extension plantation age greatly influence the concentration of the DOC in peatland streams and groundwater body. In addition, it is hypothesized that hydrological factors have considerable effects on DOC concentration in peatland streams. To test these hypotheses, a periodic check on water chemistry of peatlands covering some selected sampling areas was undertaken. The check which involved some physical properties of the peatland groundwater with DOC was undertaken for the period of twenty-one 21 months covering precisely March, 2013 and December, 2014.

MATERIALS AND METHODS

Study area and site description

The study area is located in Sepang, in the state of Selangor, Malaysia within the Kuala Langat South Forest Reserve area, bounded to the West by Straits of Malacca (Figure 1), sharing the same boundary with the Malaysian Kuala Lumpur International Airport to the east between latitude 02^{o} 43'N and longitude 101^{o} 39'E (Figure 1). According to Cheng, (2011), Kuala Langat South peat swamp forest was first gazetted as a forest reserve in the year 1927. The study area experience tropical climate and high humidity with an annual rainfall between 2500 – 3000 mm. The average monthly air temperature ranges between 26.1^{o}C and 27.2^{o}C, with the highest value recorded in May each year.

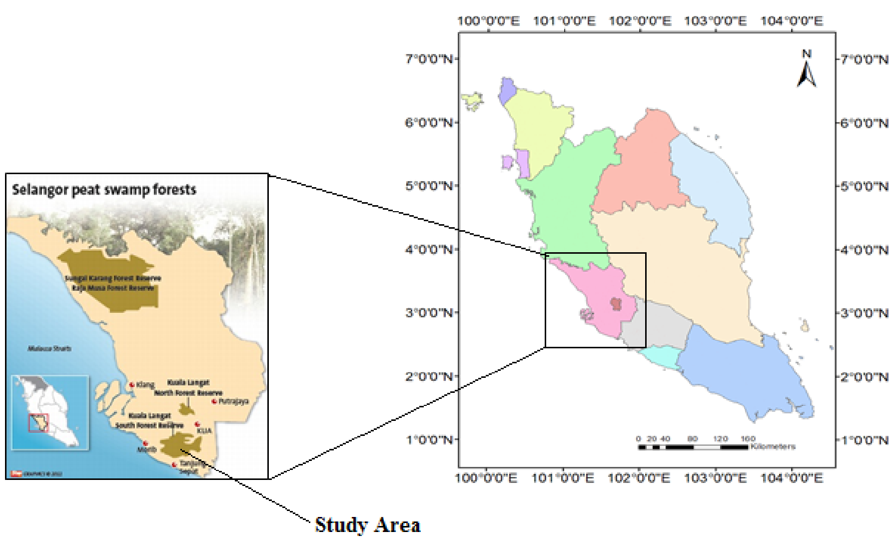


Figure 1: Location of study area

Data collection

The study ran for a period of 14 months from September, 2013 to December, 2014 with both months inclusive. The sampling was characterized by 2-monthly data collection from all the sampling points.

Site selection

The study area was divided into four plots according to the years the PSFs were converted to oil palm plantations. The years of conversion are; 2000, 2002, 2006 and 2010/1978. 2010/1978 represents the first ever conversion of PSFs in 1978 which was later re-cultivated in 2010. The plots were further divided into 10 different sampling points; 2000-A1, 2000-A2, 2000-B1, 2000-B2, 2002-1, 2002-2, 2006-1, 2006-2, 2010-A1, and 2010-A2 which were chosen to fully cover the entire study area.

Water samples collection

Groundwater and surface water samples were both collected for analysis. Two observation wells were installed in each of all the study areas for groundwater sampling (Red circles in Figure 2). For groundwater sampling, water samples were collected from the observation wells in all the sampling points for analysis. Groundwater samples were collected with the aid of improvised bailers before being stored in well-labeled containers and kept in the ice packs and transported to laboratory for analysis. The groundwater *in-situ* data such as dissolved oxygen, DO, temperature, turbidity, groundwater pH, and hydraulic conductivity were analyzed directly in the tube wells by gently raising and lowering an *YSI* multi-probe (556 MPS, YSI Incorporated, Yellow Springs, Ohio) into the tube wells.

For surface water sampling, samples were collected from the site drains that were located adjacent to the study plots that majorly drain the peatlands for the purpose of controlling the peatland water table (Yellow circles in Figure 2). Similar to the groundwater sample collection, surface water samples were collected with the aid of bailers. The *in-situ* data as analyzed in the groundwater were also analyzed and the remaining samples stored in well-labeled containers, kept in the ice packs before transporting them to laboratory for further analysis.

Both the groundwater and surface water collected samples were filtered in the laboratory using 0.45 µm Whatman filter paper and stored at 4^{o}C until the analysis which was shortly after. Both samples were analyzed for DOC using S::CAN spectrolyser (Avagyan et al. 2014). A S::CAN Spectrolyser measures optical spectra from 200 to 750 nm directly in liquid media. A S::CAN Spectrolyser was rinsed with distilled water before and after each measurement was taken. The readings were displayed on the PC that was connected with spectrolyser.

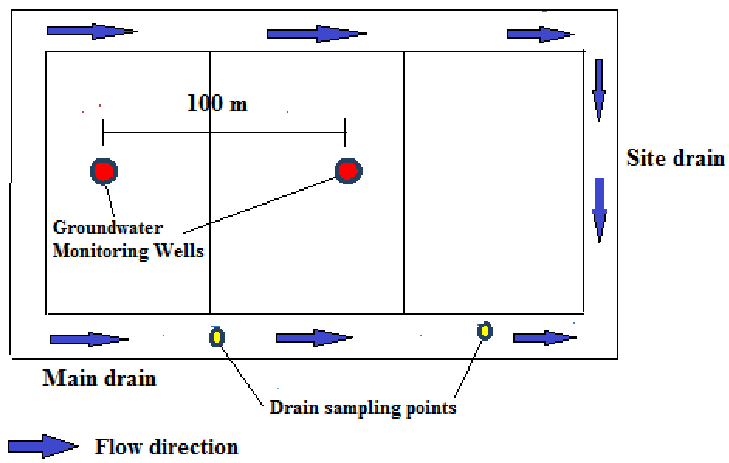


Figure 2. A typical study plot in a peatland. 2 Tube Wells in each Block and 2 Samplings at Ditch as Represented.

RESULTS

Statistical analysis

The statistical analysis gave a negative and weak correlation between DOC concentration and age of plantation. This means the oldest plantation recorded the lowest DOC concentration, though with weak correlation. DOC showed positive and strong correlation with rainfall in 80 % of the sampling points with negative but strong correlations with soil temperature (Kalbitz, *et al.* 2000). DOC also exhibited positive and significant correlation with groundwater depth.

DOC concentration in groundwater

In all the ten sampling points, study plots 2010 (2010-A1 and 2010-A2) recorded the lowest DOC concentration ranging from 18.10 mg/L to 28.60mg/L compared to other plots, especially 2000-A1 and 2000-A2, followed by 2006-A1 and 2006-A2. Figure 3 shows the seasonal pattern of DOC concentration in all the sampling points covering the study period September, 2013 to December, 2014. Sampling point 2000-B1 recorded the highest DOC value of 250.50 mg/L in June, 2014 as against the lowest, 157.70 mg/L at the same sampling point. From the figure, the lowest DOC concentration recorded was in May 2014 at 2010-A1 sampling point (2010/1978 plantation) which coincidentally recorded the lowest groundwater table depth of 90.8 cm though with considerable rainfall depth of 119 mm. The DOC concentration could be described as seasonal as observed in the figure. The highest DOC concentrations in 2013 were observed in September at 2000-B1 sampling point which marked the end of Southwest Monsoon as 230.93 mg/L. Though the DOC concentration further decreased from 230.93 mg/L in September, 2013 at point 2000-B1 to 186.10 mg/L in December, 2013, the DOC concentration continued to increase in almost all other sampling points except at points 2006-A2, and 2010-A2. The lowest DOC concentration was recorded in May, 2014 as 1.60 mg/L in 2010 plot as against the highest, 28.60 mg/L recorded in the same plot during the same period. There was a continuous rise in DOC concentration in all the sampling points until October 2014 when the average monthly rainfall reached its peak. The highest DOC concentration recorded was 250.50 mg/L at 2000-B1 sampling point followed by the lowest, 14.9 mg/L at 2010-A2.

DOC concentration in surface water

The highest DOC concentrations in surface water was recorded in 2000 study plots and ranged from 128.8 mg/L in June 2014 to 155.7 mg/L in December 2014. The lowest was observed in the oldest plantation (1978/2010 plantation) and ranged from 2.9 mg/L in May 2014 to 10.0 mg/L in August same year Influence of hydrology (rainfall, temperature and evaporation) on the DOC concentration from the peatland into the streams was also observed as periods of lower storm events recorded low DOC concentrations.

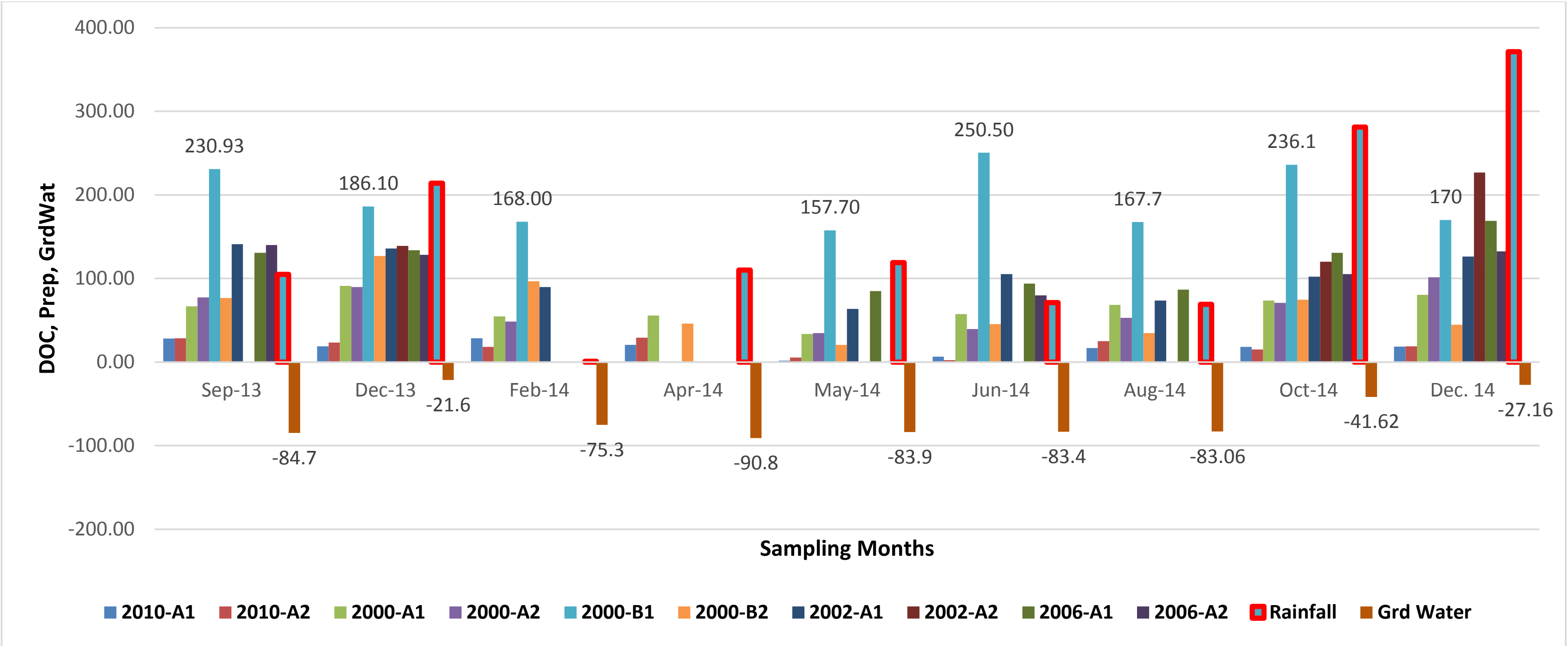


Figure 3. Periodic Groundwater DOC Concentration With Rainfall, Temperature, Evaporation and Groundwater Table Depths for the Study Area Covering the Study Period

Figure 4 reveals the influence of one of the variables over the other, as the peatland experienced rise in groundwater levels with increased rainfall depth as seen in December, 2013. Reverse was the case in April-May due to a prolonged period of no remarkable rainfall between January to April, 2014. The groundwater level reached its lowest level in April (90.8 cm) and as a result, this greatly affected the DOC concentration.

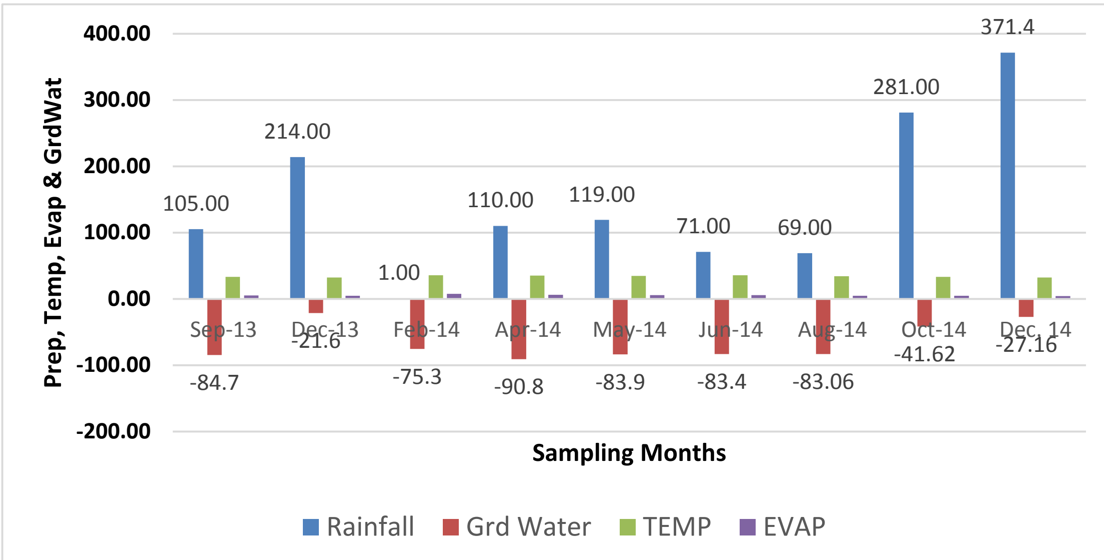


Figure 4. Relationship Between Rainfall, Temperature, Evaporation and Groundwater Levels in the Study Area

DISCUSSION

It has been observed that age of plantation played major role in DOC concentrations. Plot 2010 is the oldest oil palm plantation in the study area having been converted from peatland forests to oil palm plantation for the first time in 1978 before the re-cultivation in the year 2013. It recorded the lowest DOC concentrations in groundwater body. This justifies the effects of peatland farming on tropical peatlands which contributes to soil carbon loss as reported by Hirano et al. 2012, Gandois et al. 2013 and Dowrick et al. 2015)

DOC concentrations in the peatland streams and groundwater in the study area also followed seasonal pattern and are attributed to the hydrological factors like storm events, surface temperature, evaporation pattern, and most importantly, the groundwater table depth which is a function of precipitation. From the statistical analysis, out of 10 sampling points considered, DOC and rainfall were only positively correlated at 2 sampling points namely; 2006-A1 and 2000-A2. Thus the seasonal variation of DOC concentration is consistent with rainfall distribution pattern during the two prominent seasons (Southwest Monsoon and Northeast Monsoon) in Malaysia. DOC showed positive correlation with groundwater depth in four sampling points, namely 2006-A1, 2010-A1, 2000-A2 and 2000-A1 (Worrall *et al.* 2007; Armstrong *et al.* 2010). Though there is correlation between the DOC and groundwater in the remaining plots but the correlation between them was weak in such plots.

DOC was also negatively and strongly correlated with surface temperature in most of the sampling plots like 2006-A1, 2000-A2, 2000-A2 and 2010-A1 (Raymond and Saiers 2010; Clark *et al.* 2009) and though very weak, but still correlated in the remaining plots of 2010-A2, 2000-B2, 2002-A1, and 2000-B1. In all the sampling plots, there was no correlation between the DOC concentration and evaporation.

From these statements, there are two different factors that control the DOC concentration: age of plantation and hydrology. In peat soils, the results of the DOC concentration supported the claims according to Moore *et al.* (2008) and Caverly *et al.* (2013) which suggested that the DOC concentration depend on factors such as hydrological elements which include temperature and storm events coupled with properties of peat soil and types of available vegetation in the region. The results also satisfied the claim by Dillon *et al.* (2005) which reported that the dynamics of DOC within the soil and its hydrologic transportation is greatly influenced by the storm events. However, the observation in February, 2014 in most of the sampling points suggested that surface temperature also influenced the production of DOC. February, 2014 witnessed remarkable low rainfall depth (1.0 mm), highest temperature, (36 ^{o}C), and the highest evaporation (7.4 mm/day) and as a result of extreme drought, peat fires were reported in the sampling areas.

The influence of groundwater levels was also of great significance as observed in May-June, 2014. There was a decline in DOC concentration between January to May 2014, which was attributed to the lowering of groundwater levels from 21cm (from peat surface) in January to 90.8 cm in April, 2014 as a result of decrease in rainfall depth. In other words, the DOC concentrations were highest when the groundwater levels were far below the peat surface. This could be further explained by relating the DOC concentration with soil moisture content which is controlled by the groundwater levels (Beldring *et al.* 1999; Swenson *et al.* 2008; Rosenbaum *et al.* 2012). Therefore the increase in DOC concentrations during the Northeast Monsoon period could be due to increased microbial activity within the biomass which was further enhanced by the increase in moisture content of the soil (Manzoni *et al* 2012; Myer *et al.* 2012; Kwon *et al.* 2013)

Regarding the DOC concentrations in surface water, DOC concentrations increased during the storm events as a result of increased runoff which aided the influx of DOC from forest floors to peatland streams (Raymond and Saiers, 2010; Matsunaga *et al.* 2014). December 2013 recorded the highest DOC concentration which was consistent with rainfall depth recorded during the period. The low DOC concentration observed in February, 2014 in all the streams sampled could be attributed to drought experienced as a result of low rainfall, high surface temperature and high evaporation which could result to a decrease in microbial activity within the soil channels.

CONCLUSIONS

Land use changes have been observed to influence the rate of DOC concentrations in peatland water resources. This was concluded as older plantations recorded the lowest DOC concentrations compared to the recently converted PSFs. Hydrological factors like precipitation, evaporation and temperature coupled with soil properties like moisture content which determines the depth to groundwater table have also been observed to increase the rate of DOC concentration in the peatlands. The seasonal variation in the concentration of DOC was observed and the concentration were higher during Northeast Monsoon periods (November to March) which was characterized by heavy rainfall and subsequent increased microbial activities within the peat soils than that observed during the period of Southwest Monsoon (May to September). The observed results thus tend to support the hypothesis that the PSFs conversion and land use change greatly influence the concentration of the DOC in peatland streams and groundwater body. It was also concluded that DOC concentration follow a seasonal pattern and is dependent of storm events, surface temperature and groundwater depth. It is thus recommended that best management practices (BMPs) should be extended to oil palm cultivation on peatlands in order to avoid emission and influx of stored soil carbon in both dissolved and gaseous forms to the surrounding water resources and atmospheric body.

REFERENCES

Adesiji, R. A., Mohammed, T. A., Daud, N., and Mustapha, S. (2014). Impacts of oil palm cultivation on soil chemistry in a Malaysian tropical peatland.*Advances in Environmental Biology*, 369-374.

Armstrong, A., Holden, J., Kay, P., Francis, B., Foulger, M., Gledhill, S., McDonald, A., and Walker, A. (2010). The impact of peatland drain-blocking on dissolved organic carbon loss and discolouration of water; results from a national survey. *Journal of Hydrology, 381*, 112-120

Avagyan, A., Runkle, B. R., and Kutzbach, L.: Application of high-resolution spectral absorbance measurements to determine dissolved organic carbon concentration in remote areas, J. Hydrol., 517, 435–446, doi:10.1016/j.jhydrol.2014.05.060, 2014b. 10198

Beldring, S., Gottschalk, L., Seibert, J., and Tallaksen, L. (1999). Distribution of soil moisture and groundwater levels at patch and catchment scales. *Agricultural and Forest Meteorology, 98*, 305-324

Caverly, E., Kaste, J. M., Hancock, G. S., and Chambers, R. M. (2013). Dissolved and particulate organic carbon concentration from an agricultural watershed during consecutive tropical storms. *Geophysical Research Letters, 40*(19), 5147-5152.

Clark, J.M., Ashley, D., Wagner, M., Chapman, P., Lane, S., Evans, C., and Heathwaite, A.L. (2009). Increased temperature sensitivity of net DOC production from ombrotrophic peat due to water table draw-down. *Global Change Biology, 15*, 794-807

Couwenberg, J., Dommain, R., and Joosten, H. (2010). Greenhouse gas fluxes from tropical peatlands in south-east Asia. *Global Change Biology, 16*(6), 1715-1732.

Dalva, M, and Moore, T. R. (1991) Sources and sinks of dissolved organic-carbon in a forested swamp catchment. *Biogeochemistry*, *15*:1–19.

Dillon, P. J., Molot, L. A. (2005). Long-term trends in catchment export and lake retention of dissolved organic carbon, dissolved organic nitrogen, total iron and total phosphorus: the Dorset, Ontario study, 1978–1998. J Geoph Res 110: doi:1029/2004JG000003.

Dowrick, D. J., Freeman, C., Lock, M. A., & Yusoff, F. M. (2015). Using Thermal Sensitivity Analysis to Determine the Impact of Drainage on the Hydrochemistry of a Tropical Peat Soil from Malaysia. *Communications in Soil Science and Plant Analysis*, *46*(17), 2168-2176.

Gandois, L., Cobb, A. R., Hei, I. C., Lim, L. B. L., Salim, K. A., & Harvey, C. F. (2013). Impact of deforestation on solid and dissolved organic matter characteristics of tropical peat forests: implications for carbon release.*Biogeochemistry*, *114*(1-3), 183-199.

Guggenberger, G., Kaiser, K., and Zech, W. (1998). Mobilization and immobilization of dissolved organic matter in forest soils. Z Pflanzenernahrung Und Bodenkunde 161:401–408.

Hirano, T., Segah, H., Kusin, K., Limin, S., Takahashi, H., & Osaki, M. (2012). Effects of disturbances on the carbon balance of tropical peat swamp forests. *Global Change Biology*, *18*(11), 3410-3422.

Hope, D., Billett, M.F., and Cresser, M.S., (1994). A review of the export of carbon in river waters: concentration and processes. *Environ. Pollut*. 84, 301 – 324

Hope, D., Billett, M. F., Milne R., and Brown, T. A. W. (1997) Exports of organic carbon in British rivers. *Hydrol Process* 11: 325–344

Inamdar, S., O'Leary, N., Mitchell, M., and Riley, J. (2006). The impact of storm events on solute exports from a glaciated forested watershed in western New York, USA. *Hydrological Processes*, *20*, 3423-3439

Kalbitz, K, Solinger, S, Park, J. H, Michalzik, B, and Matzner, E (2000) Controls on the dynamics of dissolved organic matter in soils: a review. Soil Sci 165:277–304

Kura, N. U., Ramli, M. F., Sulaiman, W. N. A., Ibrahim, S., Aris, A. Z., and Mustapha, A. (2013). Evaluation of factors influencing the groundwater chemistry in a small tropical island of Malaysia. *International journal of environmental research and public health*, *10*(5), 1861-1881.

Kwon, M. J., Haraguchi, A., and Kang, H. (2013). Long-term water regime differentiates changes in decomposition and microbial properties in tropical peat soils exposed to the short-term drought. *Soil Biology and Biochemistry*, ***60,*** 33-44

Liu, W., Xu, X., McGoff, N. M., Eaton, J. M., Leahy, P., Foley, N., and Kiely, G. (2014). Spatial and seasonal variation of dissolved organic carbon (DOC) concentrations in Irish streams: Importance of soil and topography characteristics. *Environmental management*, *53*(5), 959-967.

Manzoni, S., Schimel, J.P., and Porporato, A. (2012). Responses of soil microbial communities to water stress: results from a meta-analysis. *Ecology*, *93*, 930-938

Matsunaga, T., Tsuduki, K., Yanase, N., Kritsananuwat, R., Hanzawa, Y., and Naganawa, H. (2014). Increase in rare earth element concentrations controlled by dissolved organic matter in river water during rainfall events in a temperate, small forested catchment. *Journal of Nuclear Science and Technology*, 1-16

McMahon, P., and Chapelle, F. (2008). Redox processes and water quality of selected principal aquifer systems. *Groundwater*, *46*, 259-271

Michalzik, B., Kalbitz, K., Park, J. H, Solinger, S., and Matzner, E (2001). Concentration and concentrations of dissolved organic carbon and nitrogen—a synthesis for temperate forests. Biogeo chemistry 52:173–205.

Michalzik, B. and Matzner, E (1999) Dynamics of dissolved organic nitrogen and carbon in a Central European Norway spruce ecosystem. *Eur J Soil Sci 50*:579–590

Moore, T. R., Paré, D., Boutin, R. (2008) Production of dissolved organic carbon in Canadian forest soils. Ecosystems 11: 740–751. doi: 10.1007/s10021-008-9156-x

Myers, B., Webster, K. L., Mclaughlin, J. W., and Basiliko, N. (2012). Microbial activity across a boreal peatland nutrient gradient: the role of fungi and bacteria. *Wetlands Ecology and Management*, *20*(2), 77-88.

Neff, J. C., and Asner, G. P. (2001). Dissolved organic carbon in terrestrial ecosystems: synthesis and a model. *Ecosystems* **4**:29–48

Peichl, M., Moore, T. R., Arain, M. A., Dalva, M., Brodkey, D., and Joshua McLaren, J. (2007). Concentrations and fluxes of dissolved organic carbon in an age-sequence of white pine forests in Southern Ontario, Canada. *Biogeochemistry* **86**:1–17.

Prasanna, M. V., Nagarajan, R., Chidambaram, S., Manikandan, S., and Elayaraja, A. (2014). Drip water Geochemistry of Niah Great Cave, NW Borneo, Malaysia: a base line study. *Carbonates and evaporites*, *29*(1), 41-54.

Raymond, P.A., and Saiers, J.E. (2010). Event controlled DOC export from forested watersheds. *Biogeochemistry*, *100*, 197-209

Rosenbaum, U., Bogena, H., Herbst, M., Huisman, J., Peterson, T., Weuthen, A., Western, A., and Vereecken, H. (2012). Seasonal and event dynamics of spatial soil moisture patterns at the small catchment scale. *Water resources research, 48*

Schwesig, D., Kalbitz, K., and Matzner, E. (2003). Mineralization of dissolved organic carbon in mineral soil solution of two forest soils. Journal of Plant Nutrition and Soil Science, 166, 585-593

Swenson, S., Famiglietti, J., Basara, J., and Wahr, J. (2008). Estimating profile soil moisture and groundwater variations using GRACE and Oklahoma Mesonet soil moisture data. *Water resources research*, *44*

van Hees, P. A., Jones, D. L., Finlay, R., Godbold, D. L., and Lundström, U. S. (2005). The carbon we do not see—the impact of low molecular weight compounds on carbon dynamics and respiration in forest soils: a review. Soil Biology and Biochemistry, 37(1), 1-13.

Wallage, Z., and Holden, J. (2010). Spatial and temporal variability in the relationship between water colour and dissolved organic carbon in blanket peat pore waters. *Science of the total environment*, *408*, 6235-6242

Worrall, F., Armstrong, A., and Holden, J. (2007c). Short-term impact of peat drain-blocking on water colour, dissolved organic carbon concentration, and water table depth. *Journal of Hydrology*, *337*, 315-325

Wösten, J. H. M., Clymans, E., Page, S. E., Rieley, J. O., and Limin, S. H. (2008). Peat–water interrelationships in a tropical peatland ecosystem in Southeast Asia. *Catena*, *73*(2), 212-224.

PARTICLE SIZE DISTRIBUTION METHODS AS ADOPTED FOR DIFFERENT MATERIALS

BABATUNDE J. Olawuyi[1, 2] & SAMUEL Asante[1]

[1]Department of Civil Engineering, University of Stellenbosch, Private Mail Bag X1, Matieland 7600, Stellenbosch, Western Cape, South Africa
[2]Department of Building, School of Environmental Technology, Federal University of Technology, Minna, P.M.B 65, Minna, Niger State, Nigeria

Information on particle size, shape, porosity and pore distribution of constituent materials are very important for choice and their appropriate use in construction. The known methods available for particle size distribution (PSD) are appropriate for materials of specific size range, shape, nature and distribution, while improved techniques are emerging with the advent of computer application in construction. Analysis of materials of varied grain sizes, shape, nature done by three methods of PSD (mechanical sieving, laser diffraction and CT-scanning) were reported in this paper for an assessment of their appropriateness and effectiveness for specific material. The study revealed mechanical sieving has effective for granular materials of 45 µm to 125 mm size range, but the laser diffraction is noted to be suitable for materials of fine particles but gives inadequate results when adopted for very fine materials susceptible to particle agglomeration. The CT- scanning on the other hand is noted to be adequate for PSD analysis of materials having medium to coarse size classification giving more definitive data on actual shape, distribution and volume of the material's particle. CT-scanning also gave results that are comparable to the laser PSD analysis when adopted for finer materials. The study concludes that required details and specific characteristics of the materials of concern should govern the choice PSD methods and a call is made for good knowledge of available techniques by operators and investments on digital and recent equipment by our Institutions for improved outputs in materials research.

Keywords: particle size distribution, mechanical sieving, image analysis, CT-scanning and concrete constituent materials.

babatunde@futminna.edu.ng
babatundeolawuyi@yahoo.com

B.J. Olawuyi[1, 2] and S. Asante[1] (2016). **PARTICLE SIZE DISTRIBUTION METHODS AS ADOPTED FOR DIFFERENT MATERIALS** Sustainable Built Environment and Climate change; The challenges of Post 2015 Development Agenda. School of Environmental Technology Conference, SETIC, 2016

Introduction

Particle size distribution (PSD) has been known to be of importance in the way the material performs and this is critical in mix proportioning of concrete, while the new development of high-performance concrete (HPC) and ultra – high performance concrete (UHPC) has brought about the need for having many constituent materials of varied sizes (some as supplementary cementitious materials and others as fillers) to be combined for an appropriate particle parking. The level of information required on these particles and their fineness level calls for adoption of more efficient approach to particle size analysis than what can be achieved from the conventional sieve analysis. Laser diffraction, scanning electron microscopy (SEM) and X-ray computed tomography scanning (CT-scanning) in the recent times are some of the approaches been adopted for materials characterisation. The characterisation of these materials includes different particle sizes ranging from several millimetres to hundreds of nanometres has been determined successfully, (Nenadović et al. 2010). In these approaches, data for different particle sizes within a sample are captured at the same time by light, electron or x-ray emission and the data are processed to produce a PSD. This paper presents the report of three PSD analysis approaches (mechanical sieving, laser diffraction and CT-scanning) conducted on some constituent materials of concrete with a view to outlining the appropriateness of particular method for specific material as influenced by their nature, properties and fineness.

Sieve Analysis

Sieve analysis (also known as gradation test) is a simple technique and possibly the most common procedure in use for assessing the PSD of granular materials. It is used for determination of the relative proportions of different grain sizes that make up a given soil/material mass. The analysis can be wet or dry while the sieving methods can be further classified as throw-action, horizontal, tapping, super-sonic, wet and air circular jet given the nomenclature as the specific activities required for effectiveness of the sieve operations. The test may be performed on many types of materials of non-organic or organic nature including sand, crushed rock, clays, granite, feldspars, coal, soil, a wide range of manufactured powders, grain and seeds, down to a minimum size depending on the exact method.

It entails allowing particles to pass through stack of sieves with known opening sizes and shaken for 10 minutes as recommended by Bowles (1992), using a mechanical test sieve shaker (Figure 1).

Figure 13: Set of Sieve on a horizontal sieve shaker AS 400 control (copyright Retsch Ltd.)

The sieves then removed from the shaker and weight of each sieve with the sample retained taken to the nearest 0.1 g. The mass of sample retained on each sieve obtained by subtracting the respective mass of each sieve (BS EN 933 Pt. 1: 1997) and the percentage passing calculated by subtracting the cumulative percent retained from one hundred percent (100%). From the calculated results, a semi-logarithmic curve is plotted with the ordinary axis (arithmetic) being the percent fines and the aperture size as abscissa (logarithmic scale).

Further quantitative analysis of the slope and shape of the PSD curve is done by means of the geometric values termed as the coefficient of uniformity (C_u) and the coefficient of curvature (C_c). The coefficient of uniformity (C_u) and the coefficient of curvature (C_c) can be expressed mathematically as:

$$C_u = \frac{D_{60}}{D_{10}} \text{ and } C_c = \frac{(D_{30})^2}{(D_{60} * D_{10})} \quad (1)$$

Where, D_{10} is the grain diameter (mm) corresponding to 10 percent passing on the PSD curve. D_{30} is the grain diameter (mm) corresponding to 30 percent passing on the curve. D_{60} is the grain diameter (mm) corresponding to 60 percent passing on the PSD curve (ASTM D421/422 2012; Vandevelde, 2008).

Atkinson (1993), Neville and Brooks (2002) and Shetty (2004) present “Fineness Modulus (FM)” as a ready index of coarseness or fineness of a material. It is the empirical factor obtained by adding the cumulative percentages of materials retained on each standard Sieve ranging from 80 mm to 150 µm and dividing this sum by an arbitrary number 100.

The main limitation of mechanical sieving is the range of particle sizes that can be analysed (often 45 µm to 125 mm), which makes it ineffective for materials of very fine grains such as cement and other supplementary cementitious materials (SCM). Another limitation is the integrity of the mass-based results in mechanical sieving. This is because needle or rod like particles will either pass through the sieve or remain behind on the sieve, depending on its orientation.

Laser Diffraction

In laser diffraction, particle size is calculated from the collection of light intensity data by a detector. The passage of the laser beam is through the sample particle at many different angles from the axis of the laser beam, as depicted in Figure 2. Fraunhofer diffraction and Mie theory of light scattering are the common diffraction theories used in particle size analysis by laser diffraction. Both theories claim that "the particle dimension is the optical spherical diameter" (Di Stefano et al. 2010).

Although laser diffraction is widely used, due to its simplicity and the capability of measuring a wide range of particle sizes (with the smallest particle limit as 1 µm and the largest particle limit as 600 µm). Kowalenko & Babuin (2013) and Di Stefano et al. (2010) argued that the technique has some inherent factors limiting its performance. Kowalenko & Babuin (2013) concluded from their research conducted on five different types of soils with a wide range of textures, that for a given weight of sample, the sample's distribution becomes too large to employ the use of the modern laser diffraction instrumentation for particle size analysis as the change in particle geometry decreases. To support this argument, Burma et al. (1997) proposed that another limitation in the laser soil particle sizing is the accuracy of the optical parameters available for soil particles. This limitation leads to the under-estimation of clay particles sizes, although studies conducted using laser particle sizing produce repeatable results.

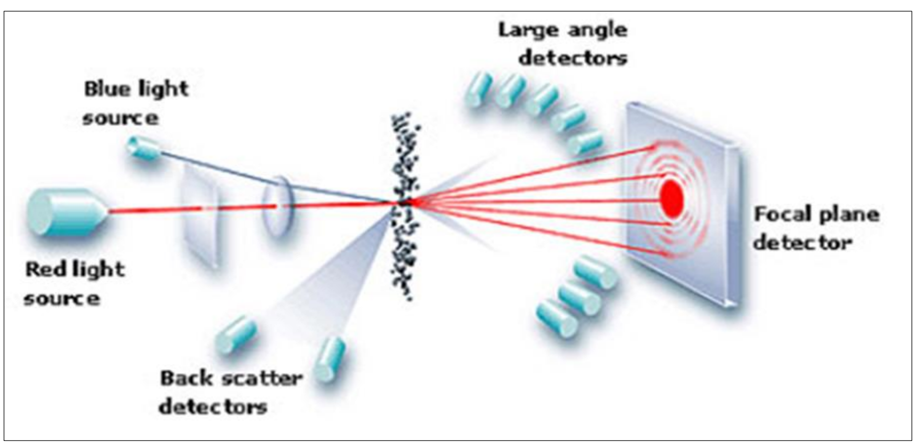


Figure 14: Principle of a laser diffraction (copyright Malvern Instruments Ltd.)

The identified issues with the conventional sieve analysis and laser diffraction for PSD has brought to fore the porosity and pore size distribution approach. Porosity is the measurement of voids between the particles or grains of a material. The porosity and pore size distribution are a function of the pore geometry which is directly affected by the packing density, particle size, particle shape, and cementation. Several studies have been conducted to quantify porosity and pore size distribution of different materials such as soil, cement, wood and metals using techniques including water retention curves, mercury intrusion porosimetry (MIP), tomography, nitrogen adsorption, and microscopy, but all these techniques have their limitations (Abell et al. 1999; Nimmo 2004; Romero & Simms 2009). However, to determine the geometric properties of pores, Abell et al. (1999); Nimmo (2004), and Romero & Simms (2009), suggested the application of image analysis using microscopes and tomography.

Abell et al. (1999); Nimmo (2004) and Romero & Simms (2009) categorically states that MIP should be coupled with an image analysis to establish a better understanding of porosity and pore distribution.

X-ray CT-scanning

X-ray CT-scanning involves the visualization of the internal structure of objects without sacrificing it. CT-scanning has been used in the medical field for several decades with technological advancement leading to its continuously growing usage as an analytical tool in the civil engineering industry (Asante, 2015). Although there is a difference in the conventional medical CT and industrial CT (e.g. microCT); the technical principles are the same for the two. Data acquisition and image reconstruction are the two major processes. Image reconstruction refers to the conversion of the measured X-ray CT signals to a two-dimensional (2D) or three-dimensional (3D) image. Various mathematical procedures are employed (e.g., “Filtered back projection”, the “Feldkamp algorithm,” or Fourier-transform methods) depending on the technique and instrument used.

Specimen scanning by CT involves taking photographs of the sample from multiple angles by exposure to X-ray beams. An X-ray involves the penetration of various materials using the ability of electromagnetic radiation (high-energy photons). When an X-ray beam is directed to a material, part of their energy is either scattered, absorbed, or will travel through the material without any interaction with the material particles (Russ, 2002).

The thickness, density, and atomic number of the material, coupled with the energy of the photons, greatly affect the amount of X-ray transmitted, as shown in the Figure 2 below. For example, a dense object (e.g. metal and rock) absorbs more rays than less dense materials such as plastics.

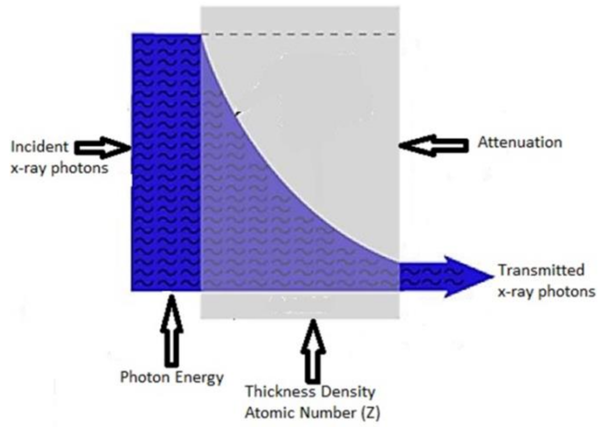


Figure 15: Factors affecting the transmission of X-ray through a material (Sprawls, 1995)

The purpose of radiography is to obtain a detailed image of the internal structure of an object. Radiography requires careful control of a number of different variables. A single image is not sufficient to give a description of an object's internal structure.

Data collection generally occurs after the visualization of an object image file, which is visualized and analysed using a wide variety of 2D and 3D-based image rendering software.

The CT data collection depends on many variables, which includes; the number of views and the signal acquisition time per view. To capture a view, scanning can be done either by half rotation (180°) or full rotation (360°) at a closely or widely spaced view. A more closely spaced view yields finer image resolution and vice versa (Russ, 2002).

Materials and Methods:

Undisturbed soil samples were collected from burrow pits in Stellenbosch environment and made to undergo sieving and sedimentation (mechanical sieving) in accordance with ASTM D421/422 (2012) for PSD analysis. The clay fraction within the soil samples was determined by hydrometer analysis using 50g of the material passing through the number two hundred sieve (0.075 mm) and was dispersed for twenty-four hours in a one hundred and twenty-five millilitres (125 ml) solution of sodium hexametaphosphate and deionized water. The resulting solution was then thoroughly mixed and poured into a jar up to the one thousand millilitres (1000 ml) mark. The percentage passing was then calculated by subtracting the cumulative percent retained from one hundred percent (100%). The calculated results was plotted on a semi-logarithmic curve with the ordinary axis (arithmetic) being the percent fines and the aperture size as abscissa (logarithmic scale) as shown in Figure 4 (mechanical sieving). Some portion of the soil sample was also analysed with the CT-scanning and the result plotted on the same semi-logarithmic curve (Figure 4 – CT-scanning) for comparative study of the output from the two methods.

Laser diffraction analysis was carried out on six different fine particles comprising binders - CEM I 52.5 N supplied by Pretoria Portland Cement (PPC), Western Cape, South Africa conforming to BS EN 197-1-2000 and SANS 50197-1; silica fume (SF) by SiliconSmelters of the FerroAltantica group; fly ash (FA) from AshResources; corex slag (CS) supplied by PPC and two size classifications of superabsorbent polymers (SAP) – a concrete internal curing agent (i.e. FLOSET CS 27 (< 300 µm) and FLOSET CC 27 (< 600 µm) supplied by SNF Floerger, France. The two size classifications of SAP was also analysed for PSD with the CT-scanning for a comparative study of the Laser diffraction and the CT-scanning methods.

Analysis of the binders and SAP particles through the Laser diffraction for PSD adopted the use of a Saturn DigiSizer 5200 V1.10 (5200 LSHU V2.01 S/N 216) high definition digital particle size analyser with a Mie model, while specific surface area in nitrogen (N_2) adsorptive medium was also determined using 3Flex (Version 1.02 and S/N 103) surface characterisation (both equipment made by Micrometrics Instruments Corporation). The Laser diffraction particle size analysis was by a wet technique using Isopropanol (an ethanol non-absorbent liquid medium) at a Refractive Index (RI) of 1.376 with a Laser 658 nm light source giving analysed particle range specification of 0.1 to 1000 µm up to a lower limit of 0.07 µm on the instrument. The instrument has a 600 ml reservoir at a 1.2 litre/min pump speed.

Analysing the grain sizes and distribution of the soil and SAP particles by CT-scanning involve scanning to obtain 3D X-ray images using a General Electric Phoenix VTomeX L240 X-ray microCT scanner. The 3D X-ray images were then examined and analysed using Avizo Fire, version 8.0 by FEI Visualisation Science Group and VG Studio Max 2.2 by Volume Graphics to filter and classify the individual grains for determination of the sizes and their distribution.

Results and Discussion:

The plot of the PSD of the soil samples by the mechanical sieving and CT-scanning method is shown in Figure 4 while Table 1 gives a summary of the characteristics. The PSD result from the CT-scanning differs slightly from that obtained from mechanical sieving.

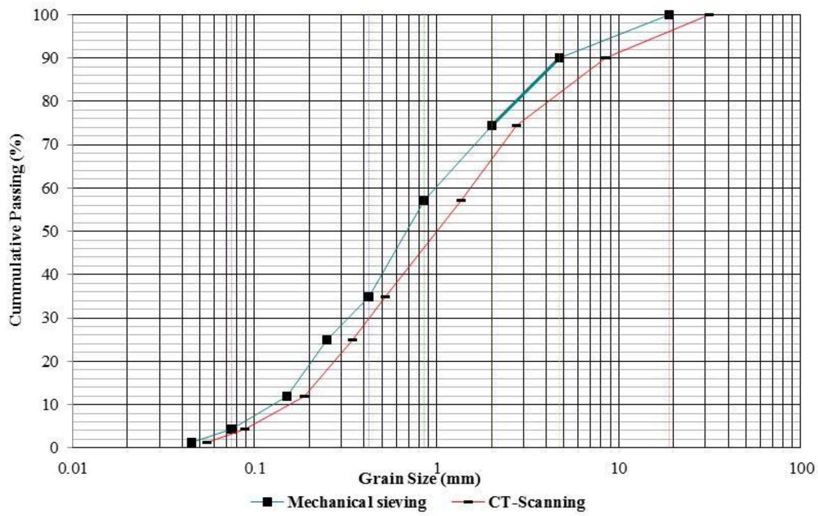


Figure 16: Comparative plot of PSD by Mechanical Sieving and CT-Scanning (Asante, 2015)

Table 5: Summary of PSD for Soil Sample by Mechanical Sieving and CT-Scanning (Asante, 2016)

	diameter (mm) PSD of soil sample	
Characteristics	MS*	CT*
D_{90}	4.75	8.50
D_{60}	0.85	1.70
D_{50}	0.78	1.00
D_{30}	0.33	0.40
D_{10}	0.14	0.18
C_u	6.07	9.44
C_c	0.92	0.52

*MS = Mechanical Sieving; *CT = CT-scanning

The CT-scan measured particle size in Figure 4 seems larger than the measured mechanical sieve particle size. This occurs when very fine particles (silt) clump together and are then sent in a digital image as a single homogenous particle. This makes individual particles blurry. The parameters retrieved from CT-scan images using Avizo Fire version 8.0 includes the volume and area of the individual particles within the region of interest (ROI). The actual diameter of each particle/grain can be calculated from either the volume or area as obtained from Avizo Fire version 8.0. Therefore, CT-scan measured coarse particles are more accurate than particles measured in mechanical sieving, which operates on a mass-based result instead of particle diameter. On the other end, the measured particle size for finer particles is more accurate in mechanical sieving (i.e. hydrometer analysis) than in CT-scanning. PSD of finer material (<150 μm) when done by dry sieving will yield significantly less accurate results due to the fact that, in sieve analysis, particles are assumed spherical and this is not true for all particles. Needle or rod like particles will either pass through the sieve or remain behind on the sieve, depending on its orientation.

PSD for medium to coarse particles is observed as more accurate in CT-scan than in mechanical sieving while, the measured PSD for finer particles on the other hand can be more accurate in mechanical sieving (i.e. the hydrometer analysis) than CT-scanning depending of the minimum pixel size of scanning in the CT.

Figure 5 (PSD plot) and Table 2 gives a summary of the PSD and specific surface area of cementitious materials (CEM I 52.5 N, SF, FA and CS) and dry SAP particles (SP_1 and SP_2) carried out by laser diffraction PSD method and Brunauer–Emmett–Teller (BET) nitrogen absorption technique analysis.

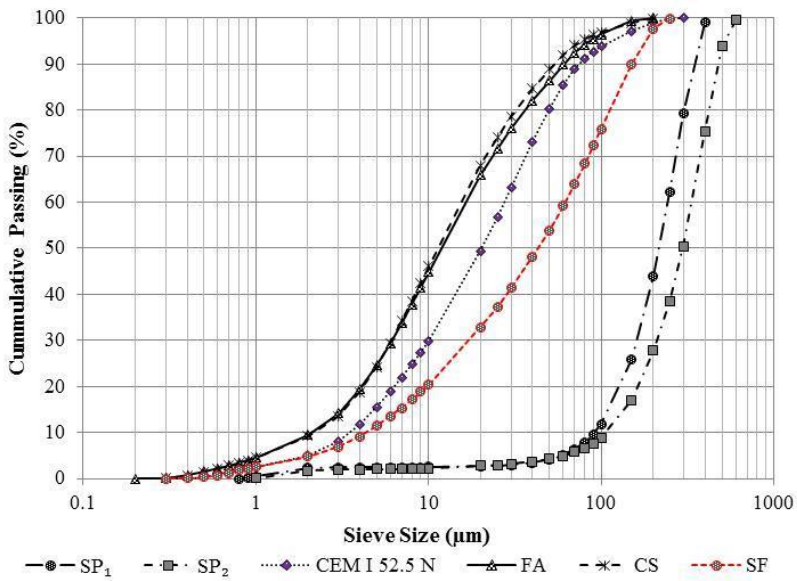


Figure 17: PSD analysis of various fine materials by Laser Diffraction (Olawuyi, 2015)

Table 6: Summary of Laser Diffraction PSD of Binders and SAP (Olawuyi, 2015)

	diameter (um)					
Characteristics	SP_1	SP_2	CEM I 52.5N	SF	FA	CS
D_{90}	337.8	472.4	73.7	150.3	60.3	53.2
D_{50}	216.1	298.4	20.4	43.2	11.7	11.2
D_{10}	91.8	108.1	3.5	4.4	2.1	2.2
Mean	214.9	293.8	32.9	61.5	23.0	21.6
Median	216.1	298.4	20.4	43.2	11.7	11.2
Model	300.4	400.5	30.0	112.9	11.3	11.3
BET surface area (m^2/g)	3.82	4.45	5.56	19.16	5.13	3.22
Model	(1.43, 0.001), 1.376	(1.43, 0.001), 1.376	(1.72, 0.100), 1.376	(1.52, 0.100), 1.359	(1.45, 1.000), 1.376	(1.45, 1.000), 1.376

The laser diffraction PSD was repeated and similar result obtained with the grain size of SF presented (red colour on Figure 5 and Table 2) to be larger than other cementitious materials (CM).

The results show that the binders are fine in nature with the CEM I 52.5 N, FA and CS having over 90% (D_{90}) of the particles below 75 µm size and 50% (D_{50}) of the particles being lower than 25 µm (CEM I 52.5 N) and 12 µm in size (FA and CS) respectively.

SF is reported from the laser diffraction PSD as the coarsest of all the cementitious materials (CM). It has D_{50} of 43 µm and D_{90} of 150 µm but BET specific surface area is 19.16 m^2/g. This is about four/five times the BET specific surface area of other cementitious materials (CEMI – 5.56 m^2/g, FA – 5.13 m^2/g and CS – 3.22 m^2/g). This affirms that SF is actually much finer than the other the three CM. The BET method is recommended in literature (Silica Fume Association, 2005) as the best approach for determining the specific surface area of SF while laser or other PSD methods may be adopted for other CM; specific surface area for SF particles is often determined by the BET method. Neville (2012) is of the view that absolute measurement of specific surface area can be obtained by BET – nitrogen adsorption method as the internal area of the particles is also accessible to the nitrogen molecules.

The Laser diffraction PSD result for grain sizes of SF reported in Table 2 and Figure 5 (red colour) can be adjudged as incorrect. The grains sizes in SF are expected to be much lower in value (about 100 to 150 times finer than CEM I 52.5 N), typically < 1 µm which happens to be the lowest grain size assessable in a Laser PSD. Reports from literature (Siddique & Khan, 2011) gave an average particle size of 150 nm. It should be of note that the SF came out of the bag in the condensed form and effort made at grinding with mortar and pestle in the laboratory before the laser diffraction PSD test, possibly did not result in complete separation of the grains. This could explain the error in the result of the laser diffraction PSD test on SF. The Laser diffraction method is reported by (DiStefano, et al. 2010; Kowalenko & Babuin, 2013) as having some inherent errors in determining particle sizes of very fine materials susceptible to particle aggregation.

The SAP particles were observed to be coarser than the various CM with SAP type II (SP_2) having grains ranging between 0 and 600 µm in size, D_{90} and D_{50} of 472.4 µm and 298.4 µm respectively, being the coarsest. SAP type I (SP_1) has particle sizes between 0 and 400 µm sizes, D_{90} and D_{50} of 338 µm and 216 µm. BET specific surface area values - 3.82 m^2/g (SP_1) and 4.52 m^2/g (SP_2) respectively are similar but a bit lower than that of CEM I 52.5 N and FA.

The CT-scanning analysis of the SAP particles sizes and distribution (Figure 6 and Table 3) gave similar result as the Laser diffraction. SP_1 has particle sizes within 3 and 300 µm (i.e. < 300 µm), while SP_2 has particles ranging between 3 and 600 µm (i.e. < 600 µm) as presented in Figure 6.

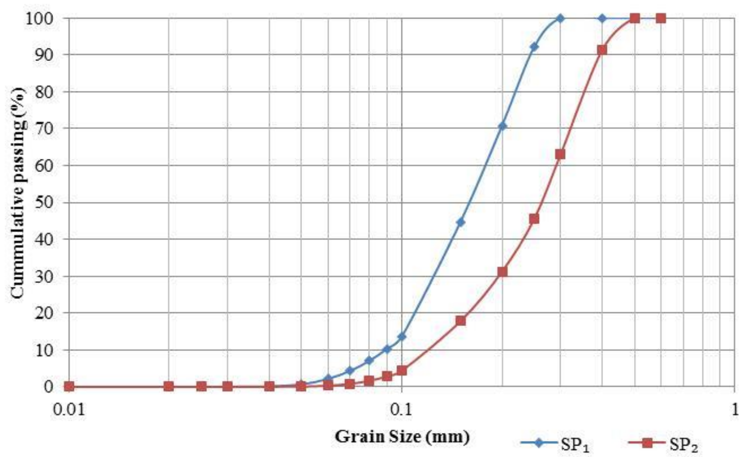


Figure 18: PSD analysis of SP_1 and SP_2 by CT-scanning (Olawuyi, 2015)

The D_{90} and D_{50} for SP_2 as shown in Table 3 are 400 µm and 270 µm against the earlier Laser diffraction values of 472.4 µm and 298.4 µm. SP_1 has D_{90} (= 250 µm) and D_{50} (= 170 µm) as against the 338 µm and 216 µm gotten from Laser diffraction. The little differences can be accounted for by the image reconstruction and data processing approach employed. The issue for further study is the level of accuracy to which CT-scanning can be for analysing materials of very fine nature like the SF.

Table 7: Summary of PSD of SAP determined by CT-scanning (Olawuyi, 2015)

	diameter (µm) PSD of SAP particles by CT	
Characteristics	SP_1	SP_2
D_{90}	250	400
D_{60}	180	300
D_{50}	170	270
D_{30}	140	195
D_{10}	90	130
C_u	2.00	2.31
C_c	1.21	0.98

Conclusion and Recommendations

This study revealed that the choice of particular methods of PSD should be governed by the details required and specific characteristics of the material to be analysed. Mechanical sieving though simple and easy, is only suitable for granular materials while little error may arise in size classification and distribution caused by shape and nature of the material sample. The use of laser diffraction and image analysis may serve as better alternatives and improved method of PSD with resultant more detailed characteristic data such as pore size, porosity and pore distribution possible. Particle agglomeration and disintegration of some materials under light or image data acquisition and processes calls for some caution. Good knowledge of the available techniques and investing in digital and recent equipment will enhance more reliable output in materials research and usage in Building and Construction works. The following inferences and recommendations are thereby offered:

(i) PSD by the mechanical sieving method except the hydrometer analysis should be restricted to granular materials and soil samples of grain sizes above 150 µm.

(ii) Laser diffraction when adopted for fine materials such as cement and other cementitious materials should give consideration to compatibility of the material to the dispersing medium and appropriate refractive index for the particular material known. Analysing very fine materials requires determination of the specific surface area of the materials possibly through the BET approach.

(iii) PSD analysis by CT-scanning (at both Micro and Nano-image analysis levels) should be given more attention in future studies with a view at establishing possible alternative method suitable for wider particle size range.

(iv) Universities and Research Institute in Nigeria should invest more in the specialist training and development of the technical staff and acquisition of new improved facilities and equipment for better quality of research targeted at addressing specific needs of our environment.

Acknowledgements

We acknowledge the followings persons: Mr. Guillaume Jeanson (Construction Product Manager) SNF Floerger - ZAC de Milieux, 42163 ANDREZIEUX Cedex – FRANCE; Davy Penhard, FEI Visualisation Science Group; Dr. Anton du Plessis and Stephan le Roux, CT Scanning Unit, Central Analytical Facilities (CAF), Mrs Hanlie Botha, Process Engineering Department, Stellenbosch University, South Africa for the assistance received in materials procurement, use of facilities, softwares and time input in the analysis.

Reference

Abell, A., Willis, K., & Lange, D. (1999), Mercury intrusion porosimetry and image analysis of cement-based materials, *Journal of Colloid and Interface Science*, 211(1), pp. 39–44. doi:10.1006/jcis.1998.5986

American Society for Testing and Materials (2012), Annual Book of ASTM Standards – ASTM D421/422 – *Dry Preparation of Soil Samples for Particle-Size Analysis and Determination of Soil Constants/Particle-Size Analysis of Soil,* ASTM International, West Conshohocken, PA

Asante, S. Y. (2015), Alternate methods to determine the microstructure of potentially collapsible soils, M.Sc. Thesis submitted to Department of Civil Engineering, University of Stellenbosch, South Africa, available online at www.suncholar.sun.ac.za

Atkinson, J. H. (1993), The Mechanics of Soils and Foundations, Mc-GrawHill International (UK), Ltd., p. 45.

British Standard Institution (1997), Test for geometrical properties of aggregates, BS EN 933 - 1 - determination of particle size distribution (sieving method), London, BSI.

DiStefano, C., Ferro, V., & Mirabile, S. (2010), Comparison between grain-size analyses using laser diffraction and sedimentation methods, *Biosystems Engineering, 106*, 205-215.

Kowalenko, C. G., & Babuin, D. (2013), Inherent factors limiting the use of laser diffraction for determining particle size distribution of soil and related samples. *Geoderma*, *193 -194*, 22-28.
Nenadović, S., Nenadović, M., Klajajević, L., Pavlović, V., Đorđević, A. & Matović, B. (2010), "Structure and composition of soils", Process and Application of ceramics, 4, 259–263.
Neville, A.M and Brooks J.J (2002), Concrete Technology, 2nd Edition (Second Indian Reprint) copyright © 1987, Pearson Education (Singapore) Pte. Ltd, Indian Branch, Delhi, Pp.438
Neville, A. M. (2012), *Properties of concrete* (Fifth ed.), England: Pearson Educational Limited.
Nimmo, J. R. (2004). "Porosity and pore size distribution". *Encyclopedia of Soils in the Environment*, pp. 295–303. doi:10.1016/B978-0-12-409548-9.05265-9
Olawuyi, B. J. (2015), The mechanical behaviour of high-performance concrete with superabsorbent polymers (SAP), PhD Thesis, Department of Civil Engineering, University of Stellenbosch, South Africa, available online at www.sunscholar.sun.ac.za
Romero, E., & Simms, P. H. (2009), Microstructure investigation in unsaturated soils: A review with special attention to contribution of mercury intrusion porosimetry and environmental scanning electron microscopy, *Laboratory and Field Testing of Unsaturated Soils*, pp. 93–115. doi:10.1007/978-1-4020-8819-3_8
Russ, J. C. (2002), The Image Processing Handbook, 4th ed. Boca Raton, FL: CRC Press.
Shetty, M. S. (2004), *Concrete technology - theory and practice*, New Delhi, India: S. Chand and Company Limited.
Siddique, R., & Khan, M. I. (2011), Chapter 2: Silica fume, *Supplementary cementitious materials* (XVI ed., pp. 67-119), Verlag Berlin Heidelberg: Springer.
Silica Fume Association (2005), Silica Fume Ushers' Manual.
South African Bureau of Standards (2001), SANS 50197 - 1 - Cement - Part 1: Composition, specifications and conformity criteria for common cements, Pretoria, (SABS).
Vandevelde, P. E. (2008), Structural Mechanics (Version Fall, 2008), GEM Engineering Inc. (pdf. accessed online on 10/9/2010 by 4.49pm)

RECYCLING OF DECONSTRUCTED BUILDING MATERIALS FROM SELECTED URBAN RENEWAL AND RENOVATION PROJECTS IN MINNA, NIGER STATE

Ayuba, P. and Albert, B. S.
Department of Architecture, Federal University of Technology, Minna

Deconstruction involves the process employed to disassemble the existing building structures such that it can be reused or recycled. As cities develop and grow, urban renewal is often carried out which requires that existing structures be made to reflect changes in modern architecture and to meet new standards. This process is often done hurriedly and without necessary precautionary measures required to salvage building components that may still be valuable and reusable. The resultant effect is great economic loss, damage and more worryingly generation of significant waste and lots of debris to the built environment. Selected urban renewal and renovation sites were examined to find out the techniques employed in removing whole or parts of such existing structures allow for effective reuse or recycling. The study employed the case study survey and descriptive research methods. Data were collected by means of structured observation schedules and interviews. The findings further demonstrated that 75% of sites lacked technical know-how while 87% deployed unsuitable equipment during the construction process. The study recommended that there is need for the engagement of deconstruction experts and specialists in order to ensure proper deployment of appropriate tools in carrying out the work. The research further recommended that Greater partnership between construction industries and recycling factories should also be encouraged. The study concluded that more emphasis was given to the economic benefits of Deconstruction over its sustainable benefit.

Keywords: Building components, deconstruction, recycle, reuse, salvage, waste

bundialbert@yahoo.com
arcayubaxx2@yahoo.com

Ayuba, P. and Albert, B. S (2016). **RECYCLING OF DECONSTRUCTED BUILDING MATERIALS FROM SELECTED URBAN RENEWAL AND RENOVATION PROJECTS IN MINNA, NIGER STATE** Sustainable Built Environment and Climate change; The challenges of Post 2015 Development Agenda. School of Environmental Technology Conference, SETIC, 2016

INTRODUCTION

Buildings are known to require overhauling, refurbishment or renovation to sustain its life cycle. It may also be completely demolished when it has approached its end of life. Over the years, demolition has been mostly employed to achieve this partial or complete removal of buildings. This process generates tremendous amount of waste and debris.

Santos and Brito (2005) confirm that Construction and Demolition wastes are responsible for up to a third of all wastes dumped into landfills. The result of this includes ecological impacts, severe negative landscape, and occurrence of illegal dumps, emissions and leaks.

The Boulder County (2008) adds that about 136 million tons of debris is generated annually in the United States arising directly from building related Construction and Demolition waste. The bulk of which comes from renovation and urban renewals. The Century Bay Builders (2016) further reiterates that the decomposition of construction and Demolition waste is directly responsible for the production of methane – one of the most portent greenhouse gases. It is the largest producer of this poisonous greenhouse gas.

However, as more attention is continuously drawn towards sustainability, more attention is also paid to the techniques and methods that are used to take buildings apart. The process where old buildings are dismantled carefully in such a manner as to preserve the building components for reuse or recycling is referred to as Deconstruction (Sherman, 1998). He further explains that deconstruction can be seen to be the opposite of building construction as the building is dismantled in the reverse order in which it was built. Century Bay Builders (2016) and Greer (2004) also concur with the above definition that deconstruction is simply construction in reverse.

Diven and Taylor (2006) put deconstruction to mean the process by which a building is dismantled from the roof down, a piece at a time. Deconstruction can be similarly seen as a green approach to the dismantling of buildings. It ensures that the waste arising as a result of the debris are minimized and the building components are recycled (Addis, 2006). The Century Bay Builders (2016) similarly defines deconstruction to be the selective dismantlement of building components for recycling, reuse and efficient management of waste. Santos and Brito (2005) also describes it to be a process that ensures the maximization of whole building materials and components to complete the duration of their technical life cycle for social, sustainable, economical purposes by means of careful disassembly methods and techniques. This is as opposed to demolition where the 'wrecking ball' or 'bulldozer' approach is employed to teardown a building with all of the building components crushed into debris that would typically end up in landfills or dumps (Thomsen, Schultmann, Kohler, 2011). It can hence be deduced that deconstruction is a sustainable practice that can be harnessed to significantly reduce waste and debris arising from renovation or renewal projects. The potentials that deconstruction possesses especially when sustainability is factored is quite enormous and could potentially lead to massive energy savings and enhance the environment.

This paper seeks to assess the extent to which building deconstruction is employed in building renovation and renewal projects in Minna to reuse or recycle building components and materials.

DECONSTRUCTION AS A SUSTAINABLE PRACTICE

The modern concept of Deconstruction goes well beyond the economic benefits to being strongly tied to environmental sustainability (The Century Bay Builders, 2016). It continues that beyond giving a building material a new life cycle, it helps reduce the craving for new resources and materials for building new projects. This leads to lower energy consumption and emissions that could have otherwise been emitted from the production of new building components. The Century Bay Builders (2016) continues that since deconstruction is usually carried out on a local level, it saves energy that would have been expended on transporting debris and wastes to dumps or landfills. It also grossly reduces the production of solid waste by ensuring that construction waste is either significantly minimized or not produced entirely. It further opines that since construction and demolition waste accounts for up to 20% of solid waste, this should be a big saving for better sustainability.

The New South Wales Department of Environment, Climate Change and Water (2010) also alludes to the fact that Deconstruction contributes immensely to sustainability and helps avoid negative environmental impacts associated with Construction and Demolition wastes. This can be achieved through the lowering of the amount of materials extracted and reducing the amount needed to be produced. Other benefits of Deconstruction to sustainability include protection of air quality, reduction of water pollution, reduction in energy use, reduction of habitat loss as well as reduction in the production of greenhouse gases.

The National Association of Home Builders [NABH] (2000) – who are responsible for the construction of over 80% of US homes- further support the earlier assertions by The Century Bay Builders (2016) and New South Wales Department of Environment, Climate Change and Water (2010) that Deconstruction has important benefits to sustaining the environment by diverting valuable resources from dumps into recycled components for profitable uses.

STAGES IN DECONSTRUCTION

The main goal in deconstruction is to ensure that disassembled building components are either reused or recycled. However, that may not often be the case as certain building materials may not be salvageable entirely.

The figure below further explains the process involved in the Deconstruction cycle.

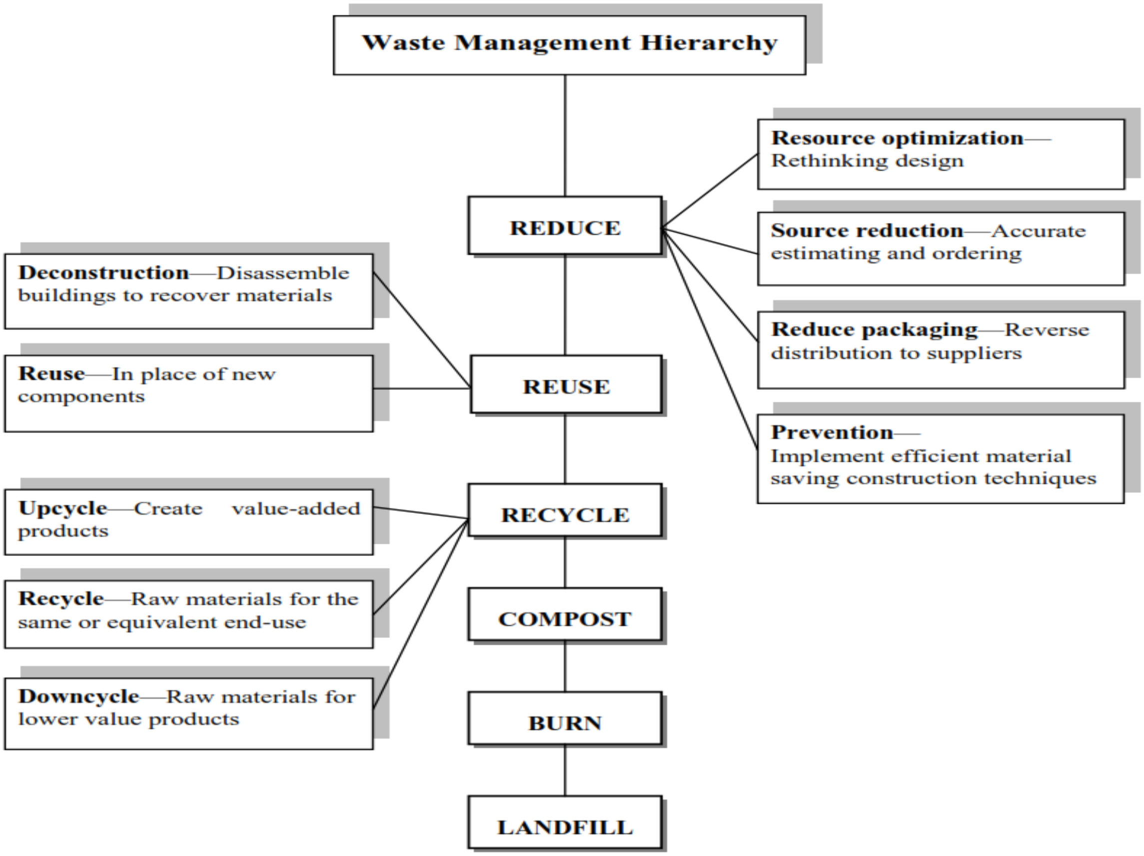


Figure 1: Stages in Deconstruction.
Source: Kibert, Chini (2000).

BENEFITS OF DECONSTRUCTION

What incentive is there for a contractor or client to take the deconstruction option as against the generally accepted norm of the 'bulldozer' or 'wrecking ball' demolition approach? Is deconstruction really a better alternative to demolition? A case needs to be made for deconstruction to be advanced to construction industry stakeholders and professionals as a viable alternative to demolition.

The New South Wales Department of Environment, Climate Change and Water (2010) posits that the choice between Demolition and Deconstruction lies with the factors of time, cost, site security, availability of storage space, health and safety issues, construction company/client reputation and environmental sustainability.

Sherman (1998) comments that Deconstruction is increasingly becoming practical for its savings on disposal costs, reducing Demolition costs, decreasing distance to dump sites, the generation of financial revenue from the sale of recycled materials, minimizing dangerous air pollutants such as asbestos, lead, dust and burning of building components on construction sites. He further states other benefits to include the enhancement of contractor/client image as being more environmentally responsible, preserving landfill spaces, while conserving energy at various stages of deconstruction and preserving raw materials.

Daven and Taylor (2008) similarly support the postulation put forward by Sherman (1998) that apart from financial benefits that would likely accrue to the client/contractor, the environmental trade-off as well as life cycle assessment of building materials with the accompanying savings on the acquisition, transportation, manufacture, installation and energy expended makes Deconstruction an interesting prospect. It continues that the use of Deconstruction can lead to less dust, less noise and reduced vibrations around sites.

The New South Wales Department of Environment, Climate Change and Water (2010) further reiterate some of the benefits of Deconstruction to include;

- Financial gains from the sale of salvaged components.
- Lowering of disposal costs as well as transportation of debris to dumps sites.
- Reduction in the consumption new resources that would have been manufactured.
- Increasing the business prospects and opportunities of contractors to environmentally savvy costumers.

The Indiana Brown Fields Program (2010) further comments that as much as 30-50% can be saved from using Deconstruction when compared to traditional labour cost. It can be deduced that there exist quite some advantages when using Deconstruction over the traditional Demolition in addition to sustaining the environment.

CURRENT ISSUES ON DECONSTRUCTION

Although a lot of advantages and benefits exist for Deconstruction vis-a-vis Demolition, quite a number of issues remain unresolved and serve as potential stumbling blocks to the use of Deconstruction. Some of these issues observed include;

- Longer time taken to deconstruct
- The labour required is more skilled and intensive.
- Specialised tools and equipment

(New South Wales Department of Environment, Climate Change and Water, 2010). Jacque (2008) also opines that Deconstruction takes more time, requires more pre-planning and involvement in the process by everyone and requires more on-site storage space.

Bruening and Chini (2004) provide further insight into some of the current challenges to Deconstruction viz;

- Existing buildings structures were neither designed nor constructed in such a manner as to allow for Deconstruction
- Deconstruction often requires special equipment and tools and is sometimes unavailable or even non-existent.
- Building codes and building standards very rarely adopt standards or regulations to aid Deconstruction.
- Lack of expertise.
- Financial and environmental benefits have not been sufficiently established.

As specialised tools and equipment for Deconstruction become more available and accessible, the intensive nature of the labour would likely reduce. This could in turn lead to lesser time required to successfully Deconstruct a building. As more attention is continuously drawn to field of Deconstruction, experts and skilled technicians and artisans may likely emerge to further enhance the disassembly of building parts. This could also further provide job employment opportunities as well as make Deconstruction even more efficient in reducing waste until eventually a situation is reached where everything can be salvaged.

Greer (2004) however argues that unless there are more economic and financial benefits to Deconstruction, its potentials based on sustainability alone may be limited. This is especially because the construction industry is largely money driven and heavily influenced by financial benefits.

TYPES OF DECONSTRUCTION

Deconstruction is basically divided into two:

A. Non-structural Deconstruction: connotes the disassembly of building components that are not part of the structural framework of the building and do not affect the structural integrity of the building.
B. Structural Deconstruction: this is the opposite of non-structural Deconstruction. It refers to Deconstruction where the assembly of the building component directly affect the structural integrity of the structure.

Table 1 summarises the types of deconstruction, its characteristics and likely Deconstructed materials.

Table 1: Types of Deconstruction

TYPE OF DECONSTRUCTION	DEFINITION	CHARACTERISTICS	TYPES OF MATERIALS SALVAGED
Non-structural	Non-structural deconstruction involves removal of building parts and elements whose disassembly does not affect the structural integrity of the building.	Normally light and can be salvaged with minimum safety issues. It seldom requires bracing or support to disassemble.	Floor finishes, doors and windows, wall finishes, sanitary wares, electrical fittings and installations, fire fighting fittings.
Structural	Structural deconstruction involves the removal of building parts and elements that constitutes an integral part of the building and/or contributes to the integrity of the building structure.	Typically large, rough and often more likely to be reused as building materials or recycled into other products.	Roofing sheets, roof trusses, ceilings, suspended floor systems, blocks/bricks, steel/wooden beams and columns

Source: National Association of Home Builders [NAHB] (2000).

RESEARCH METHODOLOGY

The study employed the Case Study and Descriptive Research methods to study the problem. Both primary and secondary data were used. Primary data were obtained from direct observation and interviews. A total of 8 renovation/ urban renewal sites within Minna metropolis were studied using 8 observation schedules. Sites were selected using purposive non-probability sampling based on the magnitude of renovation work to be carried out. Public works were accorded more priority while simple residential buildings were given lesser priority. Secondary data were obtained from journals, textbooks, online sources and other publications to further corroborate findings from the field. The data were analysed and computed using the SPSS 17 and tabulated with Microsoft Word 2010.

STUDY SAMPLE.

Table 2: Sampled Project Sites

S/NO	NAME OF PROJECT
1	CBN MINNA, Paiko Road
2	MINI MARKET, FUT MINNA (GIDAN KWANO CAMPUS)
3	Late Idris Kuta's Villa, IBB Drive, Hill Top Minna
4	City centre Shopping Mall, Mobil Roundabout
5	No 15. Commissioners Quarters.
6	DSS Office Minna
7	Residential Estate, Behind Bomas Supermarket.
8	Kuta Road

Source: Authors field survey (2015).

DISCUSSION OF RESULTS

The table 3 shows the demography of the samples studied. 37% of the sampled studied were urban renewal projects while 63% were renovation works. This implies that a lesser amount disassembling of building components is required since renovation works requires lesser amount of stripping and removal of components and materials.

Table 3: Demography of the samples studied

NAME OF PROJECT	Nature of Project		Nature of Client	
	Renewal	Renovation	Public	Private
CBN MINNA, Paiko Road		1	1	
MINI MARKET, FUT MINNA (GIDAN KWANO CAMPUS)	1		1	
Late Idris Kuta's Villa, IBB Drive, Hill Top Minna		1		1
City centre Shopping Mall, Mobil Roundabout	1		1	
No 15. Commissioners Quarters.		1		1
DSS Office Minna		1	1	
Residential Estate, Behind Bomas Supermarket.		1		1
Kuta Road	1		1	
TOTAL	**3**	**5**	**5**	**3**
Percentage (%)	**37**	**63**	**63**	**37**

Source: Authors field survey (2015).

Renovations are mostly carried out on non-structural components of buildings; hence the materials salvaged are mostly non-structural components. Table 3 also shows 63% of the Clients public/ government institutions and 37% of were private clients. This signifies that majority of the projects studied were sufficient in scope and size as most public buildings or offices have large acreage.

Table 4: Method of disassembly

NAME OF PROJECT	Labour used			Equipment Used	
	Skilled	Unskilled	volunteers	Simple tools	powered tools
CBNMinna, paiko road	1				1
Mini market, fut minna (gidan kwano campus)		1		1	
Late Idris Kuta's Villa, IBB Drive, Hill Top		1		1	
City centre Shopping Mall, Mobil Roundabout			1	1	
No 15. Commissioners Quarters.	1			1	
DSS Office Minna		1		1	
Residential Estate, Behind Bomas Supermarket.		1		1	
Kuta Road			1	1	
TOTAL	**2**	**4**	**2**	**7**	**1**
Percentage (%)	**25**	**50**	**25**	**87**	**13**

Source: Authors field survey (2015).

Table 4 above shows the distribution of the various methods and skill sets employed in carrying out the task. The table indicates the 50% of the projects employed unskilled labour, 25% skilled labour and a further 25% utilised volunteers. Proper Deconstruction of building components or building structures require sufficient knowledge of the building process as deconstruction is merely construction in reverse. It then means that unskilled labour and volunteers which constitute 75% of the labour used- though cheaper and more economical – are generally unsuitable for deconstruction works. This results in more wastage and poor management of the Deconstruction activity. Buildings materials and components salvaged are hardly reusable immediately and end up being recycled (raw materials for the same or equivalent product) or down cycled (raw materials for lower value goods). The wasted components or materials remaining sadly end up in dumps or landfills due the use of inappropriate labour force which endanger the environment.

Table 4 further shows the equipment utilised during the Deconstruction process. 87% of projects studied utilised simple handheld tools and 13% employed the use of powered tools. This reveals that more time and effort will be required in 87% of Deconstruction works. Since powered machines require careful handling, skilled labour will be required to execute the job as is the case on the CBN Minna site shown in plate 1. Less time will also be spent in carrying out the work.

Plate 1: Removal of Floor Finish using powered tools
Source: Author field Survey (2015)

Table 5 shows deconstructed building materials salvaged on the respective sites. All sanitary fittings, roofing (Plate 3), egresses and wooden trusses were salvaged in all of the samples studied. Floor finishes were sampled in 87% of sites. The remaining 13% were salvaged due to the nature of floor finish involved (cement sand screed). 63% of sample studied also made efforts to salvage power fixtures and steel bars.

Ceiling, Blocks/bricks, lighting fitting and wall finishes were only deconstructed in 13% of sites sampled, while no site salvaged sanitary piping and concrete as also shown from Table 5. Wall finishes were salvaged in only 13% of sites because they were finished in tiles as shown in Plate 2. Concrete and sanitary wares were not salvaged on any of the sites sampled. Very few site disassembled Ceiling and Lighting fitting and may not be unconnected with the low resale value of these components.

Table 5: Deconstructed Building Components and Materials

NAME OF PROJECT	Non-structural Components							Structural components					
	Plumbing wares	Plumbing	Power	Light	Floor	Wall	Egresses	Roofing sheets	Ceiling	Wooden trusses	Blocks/Bri	Steel Bars	Concrete
CBNMinna, paiko road	1		1		1		1	1		1		1	
Mini market, fut minna (gidan kwano campus)	Na	Na	1				1	1		1		1	
Late Idris Kuta's Villa, IBB Drive, Hill Top	1		1		1	1	1	1		1			
City centre Shopping Mall, Mobil Roundabout	1				1		1	1		1			
No 15. Commissioners Quarters.	1				1		1	1	1	1	1	1	
DSS Office Minna	1		1		1		1	1		1		1	
Residential Estate, Behind Bomas Supermarket.	1		1	1	1		1	1		1			
Kuta Road	na	na			1		1	1		1		1	
TOTAL	**6**	**0**	**5**	**2**	**7**	**1**	**8**	**8**	**1**	**8**	**1**	**5**	**0**
Percentage (%)	**100**	**0**	**63**	**13**	**87**	**13**	**100**	**100**	**13**	**100**	**13**	**63**	**0**

Source: Author field Survey (2015)

Although sanitary piping (PVC or Galvanised) and lighting fittings (tungsten) have harmful impacts on the environment, they were not salvaged. This further confirms that economic benefits are the primary motivation for deconstruction with sustainability of the environment probably being a secondary reason. Blocks were also predominantly neglected due to difficulty and expertise required in carefully disassembling. This further reiterates the assertion made from Table 4 that the use of unskilled workers will result in wastage and turning of blocks and concrete into debris. The lack of technical know-how in recycling blocks and concrete even when broken or turn to debris further contributes the neglect in deconstructing blocks and concrete.

Plate 2: Wall tiles carefully salvaged.
Source: Authors Field Survey (2015)

Plate 3: Roofing sheets carefully salvaged.
Source: Authors Field Survey (2015)

Plate 4: 'Bulldozer approach' used in demolishing structural waste.
Source: Authors Field Survey (2016)

CONCLUSION

A lot of waste is generated from Construction and Demolition sites. Deconstruction is one of the sustainable practices that can be employed to mitigate and reduce substantially the amount of waste and debris generated, conserve energy and protect the environment. Deconstruction was shown to be more beneficial and helpful than 'wrecking ball' or 'bulldozer' style demolitions. Deconstructed materials salvaged from buildings can be reused, up cycled, recycled, down cycled, compost, and burn or landfilled in the order of preference. The study further showed lack of expertise, equipment and incorporation of deconstruction principles at the design stage are some challenges facing deconstruction. The study also shows that more preference is given to the economic benefits of deconstruction to its sustainability.

RECOMMENDATIONS

- Tax breaks or relief or other reward systems can be offered to companies and contractors who choose Deconstruction over Demolition as practiced in Australia, US and the EU.
- Efficient Deconstruction requires specialisation and expertise. Companies that specialise in Deconstruction should be subsidized and encouraged.
- The Leadership in Energy and Environmental Design (LEED) rating system should be incorporated into the National Building Code to encourage industry professionals to adopt sustainable practices like Deconstruction.
- Architects should design buildings in to allow for Deconstruction. More modular, demountable and prefabricated construction should be encouraged as it allows for easy disassembly.
- Recycle plants and Processing facilities for concrete, blocks and cement related waste is highly required to eliminate cement waste as it constitutes the bulk of the debris that end up in landfills and dumps.
- Surveys need to be carried out prior to Deconstruction to determine the required tools, equipment and technicality to be used.

REFERENCES

Addis, B. (2006). Building with Reclaimed Components and Materials. Earth scan Publications Ltd. Retrieved from http://www.amazon.com/Building-Reclaimed-Components-Materials-Recycling/dp/1844072746 last accessed at 10:36pm on the 7th January, 2016.

Boulder County (2008). Deconstruction and Recycling. Boulder County Land Use Publication. Retrieved from www.bouldercounty.org/doc/landuse/bs02bldsmrtdeconstruct.pdf last accessed at 9:36pm 7th January, 2016.

Bruening, S., Chini, A. (2004). Deconstruction and Materials Reuse, An International Overview. *Final Report of Task Group 39 on Deconstruction*. A CIB Publication, University of Florida, USA.

Diven, R., Taylor, M. (2006). Demolition Planning. Supplementary Architectural Services. Excerpt from The Architect's Handbook of Professional Practice, Update 2006. John Wiley and sons Incorporated, USA.

Greer, D. (2004). Building the Deconstruction Industry. *Biocycle*, November 2004, 36-42.

Indiana Brown Fields Program (2010). Demolition, Deconstruction, Environmentally-Responsible Waste Management. Responsible Brownfields Redevelopment. Indiana Brown Fields Program.

Jacque, R. (2008). Waste diversion during Deconstruction. *Build June/July 2008 72-75.*

Kibert, C., Chini, A. (2000). Deconstruction as an essential component of sustainable construction. In Proceedings of *CIB Conference on Overview of Deconstruction in Selected Countries*, University of Florida, Gainesville, FL, USA, 18–19 May 2000;6-14.

National Association of Home Builders [NABH], (2000). A guide to Deconstruction. *The Path, a publication of the US Department of Housing Development.* Retrieved from http://www.huduser.org/publications/pdf/decon.pdf last accessed at 11:12pm on 7th January, 2015.

New South Wales Department of Environment, Climate Change and Water (2010). House Deconstruction. *Information booklet.* ISBN 978 1 74232 434 0, Australia.

Santos, A., Brito J. (2005). Building Deconstruction: A contribution to Sustainable building. *The Second Scottish Conference for Postgraduate Researchers in the Built and Natural Environment (ProBE),593-600. Doi:10.13140/RG.2.1.1744.2009.*

Sherman, R. (1998). Deconstruction: Giving Old Buildings new lives. *Water Quality and Waste Management journal.* A publication of the North Carolina Cooperative Extension Service, USA.

The Century bay Builders (2016). Deconstruction. Retrieved from www.centurybaybuildes.com/index.php/green-info/deconstruction last accessed on at 10:11pm on the 7th January, 2016.

Thomsen, A., Schultmann, F., Kohler, N. (2011). Decostruction, Demolition and Destruction. *Building and Research Information journal 39(4), 327-332.* Retrieved from http://dx.doi.org/10.1080/09613218.2011.585785 last accessed at 10:44pm on 7th January, 2016.

POTENTIAL OF COMPRESSED EARTH BLOCKS FOR LARGE SCALE AFFORDABLE HOUSING DEVELOPMENT IN NIGERIA.

Obaje Juliet A.[1], P. Bajere[2] & P. Ayuba[1]
[1]Department of Architecture, Federal University of Technology, Minna
[2]Department of Building, Federal University of Technology, Minna

.

The use of Compressed Earth Blocks for housing construction is at its infancy in Nigeria. This is as compared to many developing and developed countries where it is utilised in several other components of the building such as foundation, cladding and roofing. The paper discusses the housing challenges of Nigeria, earth application types and techniques, the prospects and innovations in Compressed Earth Block as an affordable building material as applied in various components of the housing units and lastly the its advantages and limitations. Local and international Case studies of buildings were reviewed. These confirmed that Compressed Earth Blocks has great advantage over most contemporary building materials; it is cost effective and can be well applied in the production of components such as roofing, walling and flooring. The paper concludes that Compressed Earth Blocks (CEB) if appropriately applied will significantly reduce the cost of construction, facilitate the development of environmentally friendly and sustainable housing that would help to ameliorate housing challenges and the negative effects of climate change.

***Keywords**: Compressed Stabilised Earth; Housing Development, Sustainable Built Environment.*

obajeazuka@gmail.com;

INTRODUCTION

Housing or shelter challenge is global especially in developing countries in which Nigeria can be categorised. Nigeria housing deficit is put at above 16 million translating to about N80 trillion costing at least 3.5 million conservatively to construct a housing unit (Gemade, 2014; Star Connect Media [SCM], 2014) and this can be traced to the exponential population growth in the urban areas. Adequate shelter is basic human need for survival (Ayedun & Oluwatobi, 2011; Federal Government of Nigeria [FGN], 2012) therefore for the housing deficits gap to be bridged there must be well thought out plans and implementation.

Several issues have been identified as challenges to housing deficits, for instance the National Housing Policy adopted in 2012 recognises land as a basic requirement for sustainable housing delivery (FGN 2012) noting that its acquisition (accessibility, availability, political will by government) plays a major role to housing provision; secondly inadequacy in implementation of the existing National Housing Policy to meet current challenges and economic trends and to guide development in the sector (Ademiluyi, 2010; FGN 2012); then Jinadu (2007), Fagbamila (2009) Olotuah and Ajenifujah (2009) opined that finance is the oxygen to housing provision and the first requirement for successful and effective housing delivery which is essential to lease of land, prepare documents, provide materials, and engage professionals and labourers; several studies also asserted that building materials constitutes the single largest input in housing construction, sometimes accounting for as much as 60% to 75% of low-cost house (Adedeji & Ogunsote, 2012; Ademiluyi 2010; Eromobor & Das, 2013; Hammond, 1990; Kerali, 2001); Social infrastructure and amenities are crucial to creating sustainable communities and poor state of the infrastructures is a major aspect of urban problem with respect to housing (Ajayi & Omole, 2012).

Building materials which have been identified as one of the major components of housing provision is associated with major challenges such as availability, quality, cost (affordability), effective application, aesthetics and material properties. The choice of building materials used in housing development can greatly influence the cost of housing production. According to Kerali (2001) about 60% of housing production cost is from building materials, therefore the urgent need to develop low-cost, readily available and quality building materials such as earth. Earth is a basic and universal building material, found on most of the surface of the world, it is extensively used, cheap and having at least 50% of world's population living in houses constructed of it (Morris & Booysen, 2000; Adam & Agib, 2001; Rael, 2009). Earth has the potential to make a significant contribution towards reduction of carbon emissions, pollution and waste production impact on the environmental when used for construction (Little & Morton, 2001; Zami & Lee, 2011; United Nations Environment Programme- Sustainable Buildings and Climate Initiative [UNEP-SBCI], 2012).

This paper aims to identify the potentials and prospects of Compressed Earth Blocks as an economically viable building material to solving the challenge of housing and establish its application for the various building components. Literatures were reviewed and case studies carried out to establish and analyse housing issues, Compressed Earth Block building material potentials and its application.

Housing Challenges in Nigeria

UN-HABITAT (2012) averred that one major challenge of housing development for the low income groups is the bias by stakeholders to address the issue in an essentially structured, sustainable and large scale approach. Survey carried out by Ibem, Anosike and Azuh (2011) from fifteen public housing agencies in southern Nigeria, found that the challenges militating against public housing provision are scarcity of housing finance, lack of consistency and continuity in housing policy formulation and poor implementation of strategies, unfavourable political environment and declining population of tradesmen in the construction industry.

International Housing Collation [IHC], (2007) described major constraints to providing housing and related infrastructure in africa as lack of priority for housing urban infrastructure investments in national planning strategies; recognition of the public sector roles in the provision of housing; lack of human and institutional capacity; legal and regulatory framework; need for effective macroeconomic policies; shortage of land for housing; inability to provide infrastructure a second major constraint to providing decent, affordable; high construction costs and housing finance constraints.

Federal Government of Nigeria [FGN] (2012) recognised that land is a basic requirement for sustainable housing delivery and has some problems associated with the acquisition of land for housing as availability, lack of political will on the part of government, accessibility, ownership rights including security of tenure and absence of land use plans. Basorun and Fadairo (2013) examined the activities of Ekiti state government in housing the poor in Ado-Ekiti within the framework of the policies on housing reform in Nigeria and averred that the major challenges of public housing includes administrative, institutional and management; financial and economic; physical and local participatory (adequate knowledge and application of the local building resources to minimize construction cost) challenge.

Akeju (2007) identified the problems faced with affordable housing provision as legislation (land use act); registering property; finance; acquisition of permits/licences; Tax burden, High Cost of Building Materials and lastly infrastructure provision. Finance is a part of housing problems but land and building materials are placed higher (Agbola, 1987; Onibokun , 1985 as cited by Akinluyi & Adeleye, 2013).

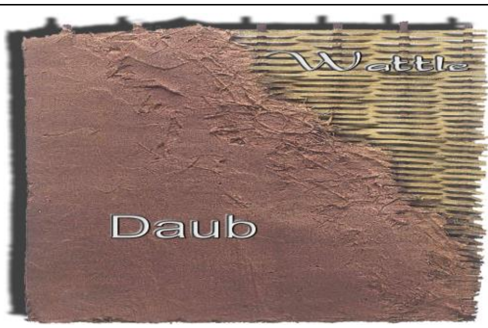
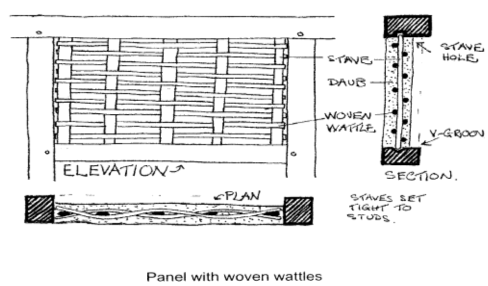
The impediments to rapid housing growth are Macro-economic environment and absence of financing systems; Land Use Act restricting access to land that have no titles on them and limits development of housing units; High cost of building materials which are not necessarily of the appropriate type; High construction costs/dearth of good quality construction companies/poor quality of construction; High cost of land in urban areas and lack of physical infrastructure and social amenities (Adeleye, 2008).

Housing challenges can be summarised to include political will, finance, consistency and continuity in housing policy formulation and poor implementation, declining population of tradesmen in the construction industry, the onus is now on the housing provider stakeholders to sought solutions to the various problems of housing. One of these as provided by the Federal Government of Nigeria in the National Housing Policy (2012), the use of local building materials such as Compressed Earth Blocks.

Earth Application Types and Techniques over the Years

There are various earth types and techniques which builders can select from, they include cob, wattle and daub, rammed earth, adobe, burnt bricks compressed (or machine-made) blocks.

Table 1.0: Types of Earth Construction Methods and their Evolution.

Earth type	Application and Techniques
Cob	Is a natural building material made from subsoil, water, fibrous organic material (typically straw), and sometimes lime. The method of construction is by moulding stiff mud into balls then piled up in thick layers to form the wall directly without the use of any kind of forms. The clay acts as the glue, while the sand gives strength to the mixture and the straw gives the walls tensile strength once hardened into place. Workers usually stand or sit astride the walls so that scaffolding is not needed. Cob houses hardly look similar since it involves a flexible method of construction making the builder to create just about any shape
 Plate I: Sota Construction Corporate Headquarters in Pittsburgh, featuring cob walls. Source: Brian (2015).	 Plate II: Cob construction process.
Wattle and Daub	involves daubing a woven lattice of wooden strips called wattle with a sticky material usually made of combination of wet soil, clay, sand, animal dung and straw.
 Plate III: Wattle and Daub construction. Source: Higgins (2008).	 Fig. 1.0: Details of wattle and daub Source: Carson (2012).
Rammed Earth	known as *taipa* (Portuguese), *tapial* (Spanish), and *pisé (de terre*) (French), is a technique for building walls using natural raw materials such as earth, chalk, lime or gravel. It is an ancient building method where continuous strip of walls are built by ramming moist soil into position between heavy wooden forms horizontally. When a short section of wall is completed the forms are moved upwards or sideways and the process is repeated until the walls are completed. The ramming may be done with either hand or pneumatic tampers, but either way the soil has to be rammed until it becomes dense and extremely firm.

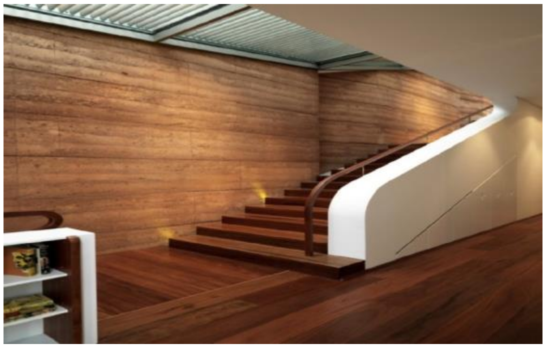


Plate IV: The Tidal Resonance Chamber, Tacoma, WA.
Source: Horner (2010).

Plate V: Extension to a home in North Vietnam
Source: Neyer (1995).

Adobe Blocks /Mudbrick

Mud brick or adobe is a building material which consists of clay-loam soil puddled with water, sometimes containing straw. The ideal soil requires clay content and the straw can be added to reduce drying and cracking. However, almost any soil can be adapted to make mud bricks; making it one of the most flexible and convenient building methods. Adobe blocks are one of the most oldest and popular forms of earth housing due to its simplicity made by placing a wet mud in boxes/formworks which are removed after a while and allowed to dry (or cure) for about a month before application in construction of walls. Mortar made of mud or other materials can be used in the construction. If the design and construction of adobe are good, the building will last indefinitely.

Plate VI: Mixing mud and straw in brick frames
Source: Wikipedia (2015).

Plate VII: Adobe brick house under construction

Compressed Earth Brick/Block (CEB) or Pressed Earth Block

Is an earthen bricks produced by applying force to compact either with hand-operated or motorised hydraulic machines. It is a building material made primarily from damp soil compressed at high pressure to form blocks; is a mixture of non-plant soil consisting of gravel, sand, and fine particles (silt and clay) and an aggregate binder (cement or lime in many cases). If the blocks are stabilized with a chemical binder it's called **compressed stabilized earth block** (**CSEB**) or **stabilized earth block** (**SEB**).

Compressed earth block uses a mechanical press to form block out of an appropriate mix of fairly dry inorganic subsoil, non-expansive clay, aggregate, and sometimes a small amount of cement. Typically, around 3000 psi is applied in compression, and the original soil volume is reduced by about half. The compression strength of properly made CEB can meet or exceed that of typical cement or adobe brick. Building standards have been developed for CEB.

CEB blocks are assembled onto walls using standard bricklaying and masonry techniques. The mortar may be simple slurry made of the same soil/clay mix without aggregate, spread or brushed very thinly between the blocks for bonding, or cement mortar may also be used for high strength, or when construction during freeze-thaw cycles causes stability issues. Hydraform blocks are shaped to be interlocking.

Plates VIII & IX: Compressed Earth Buildings Exterior and Interior
Source: Dwell Earth, (2015).

Prospects of Compressed Earth Blocks Building Material

Adedeji (2012) asserted that buildings are the largest energy consumers and greenhouse gases emitters therefore the choice of building materials should be such that has the capability of reducing energy used in buildings towards achieving materials efficiency and cost reduction. Adogbo and Kolo (2009) submitted that building materials constitute the single largest input in construction, have a great influence on the total cost of any construction product and the potential benefits to be derived from using IBMs include provision of affordable housing and reduced cost of constructions.

A study carried out by Alagbe (2005) evaluated Compressed Stabilized Laterite Bricks CSLBs as a building material for sustainable housing construction and focused primarily on its physical properties; it potentials as a building material; and a measure of its level of acceptability for housing construction among the populace. The study established that CSLBs is a sustainable and cheaper alternative to sandcrete blocks.

Taiwo and Adeboye (2013) carried out a study on how to use indigenous and composite building materials to solve the challenge of housing needs so as to cater for the ever increasing urban population in Nigeria. The paper established that the combination of stabilized earth blocks and composite building materials for construction will drastically reduce housing scarcity in Nigeria; the cost and technology required for manufacturing of some existing locally produced building materials are high and sophisticated; materials used for the manufacture of stabilized earth blocks abound locally; production is with little environmental impact and construction requires very little skill and is ideally suited to owner–building projects. It recommended policy formulation and promote partnership among Governments, Housing Authorities and allied professional bodies in the building construction industry, in the use of stabilized blocks and composite building materials.

Arumala and Gondal (2007) in a study on Compressed Earth Building Blocks for Affordable Housing explored the possibility of using local soils for making compressed earth blocks for the construction of affordable residential buildings and also examining compressed earth blocks. Findings of the study are that the compressive strength of soil depends on density; compressive strength can be increased by chemical stabilisation, suitability of the soil depends on its constituents and ratio of sand, silt and clay and laterite is abundant in continents of Africa, Asia, South America and Australia. The study concluded that CEB are alternatives to masonry blocks.

According to Waitkare City Council [WCC], (2008) using earth as a building material is sustainable management of the Earth's resources. It is said to check deforestation and pollution, and can achieve low energy costs throughout their lifetime. Earth construction is also valued for its aesthetic qualities.

Didel, Matawal and Ojo (2014) carried out cost comparative analysis between compressed stabilised blocks and sandcrete blocks for affordable housing delivery in Nigeria on three bungalow designs (1, 2 and 3- bedroom bungalow); found out that cost of construction can be reduced by 20 percent using compressed earth blocks and concluded that compressed earth blocks is a more sustainable and cost-effective alternative building material to achieve affordable housing delivery.

Maton, Danjuma,Didel, and Edom (2014) averred that Nigerian Building Road Reasearch Institute (NBRRI) interlocking block technology was necessitated for the development of locally sourced, viable, affordable environmental/user friendly, better end-user thermal performance among others alternatives to conventional walling materials; interlocking blocks have about 20% construction cost advantage and 12.27% Mortgage repayment advantage over sandcrete blocks.

The challenge of high building cost can drastically be checked and reduced by the use of earth construction especially the most recent technology of compressed earth bricks and interlocking blocks.

Innovations in Compressed Earth Brick

Recently CED have developed new innovations other than the regular original shape of a solid rectangle

a. Bricks with incorporated holes or grooves in the blocks to allow for the use of steel or bamboo to resist earthquakes.
b. Interlocking shapes (don't need to be laid in a bed of mortar)
c. U-shapes or tapered bricks for use in reinforced lintels or arches
d. Floor tiles and roof tiles

Advantages and Limitations of Compressed Earth Blocks Building Material

Table 2.0: Advantages, Disadvantages and Remedies for Compressed Earth Blocks

Advantages	
Availability- in large quantities in most regions; practically unlimited supply.	Strength: The blocks are strong, stable and long-lasting; greater strength than adobe; CEB block can have a compressive strength as high as 2,000 pounds per square inch (psi) with the average compressive strength being around 1,200 psi.
On-site materials can be used, which reduces cost, minimizes shipping costs for materials, and increases efficiency and sustainability.	Low energy input in processing and handling unstabilised soil, requiring only 1 % of the energy needed to manufacture and process the same quantity of cement concrete.
Energy saving- without the need for heat, CEBs save large amounts of energy.	Unlimited reusability of unstabilised soil (i.e. recycling of demolished buildings).
Favourable climatic performance in most regions, due to high thermal capacity, low thermal conductivity and porosity, thus subduing extreme outdoor temperatures and maintaining a satisfactory moisture balance.	Easy to build- buildings can be rapidly built using unskilled labour/lower skill level; simple thin mud slurry; stabilisation with several materials (lime, cement, fly ash etc); encourages self-sufficiency, community involvement and speed.
Eco-friendly- The earth used in the production of the CEB is actually subsoil which leaves the	High block production speed- The production rate is limited more by the ability to get material into the machine, than the machine itself.

nutrient rich topsoil. This healthy topsoil can then still be used for agriculture.	
The resulting hole can also be put to use. It can become a basement, cellars, cister, pond or smoothed out to blend in with the landscape.	Environmental appropriateness (use of an unlimited resource in its natural state, no pollution, negligible energy consumption, no wastage).
Recyclable/reusable- there is no wastage leftover bricks can be turned back into soil.	CEB can be pressed from damp earth. Because it is not wet, the drying time is much shorter.
Labour intensive and employability- employing people locally.	Some soil conditions permit the blocks to go straight from the press onto the wall.
Applicability and suitability as building material on all building components	Flexibility: can be manufactured to a predictable sizes, shapes and angles.
Time saving during production – easy to produce and cure	Non-toxic: materials are completely natural, non-toxic, synthetic chemical-free, and do not out-gas
Low cost- of materialsenergy and transportation; thermal mass for natural heating by the sun; low fire risk and non-combustible.	Presses allow blocks to be consistently made of uniform size, while also obtaining strengths that exceed the ASTM standard for concrete blocks (1900 psi).
Thermal comfort- gains/losses heat at a slower rate than the surrounding air; allowing buildings to store warmth in the cold weather and remain cool in hot weather.	Sound resistant: an important feature in high-density neighbourhoods, residential areas adjacent to industrial zones
The uniformity of the blocks simplifies construction, and minimizes or eliminates the need for mortar, thus reducing both the labour and materials costs.	Insect resistant: Insects are discouraged because the walls are solid and very dense, and have no food value
Aesthetic- natural warm texture and colours; allows expression of personal creativity using traditional crafts and skills; can be shaped into attractively rounded forms and niches; variable light quality reflected from moulded and textured surfaces.	Mold resistant: there is no cellulose material - such as in wood, Oriented Strand Board or drywall - that can host mold or rot.
	Fire resistant: earthen walls do not burn
Disadvantages	
Excessive water absorption of unstabilized soil, causing cracks and deterioration by frequent wetting and drying (swelling and shrinkage) as well as weakening and disintegration by rain and floods.	Low resistance to abrasion and impact, if not sufficiently stabilized or reinforced, thus rapid deterioration through constant use and possibility of penetration by rodents and insects.
Low tensile strength, making earth structures especially susceptible to destruction during earthquakes.	Time and expense required for soil testing, calculations, and reports.
Low acceptability amongst most social groups, due to numerous examples of poorly constructed and maintained earth structures, usually houses of the underprivileged population, thus qualifying earth as being the "poor man's material".	Lack of awareness/knowledge/misinterpretation. The use of CEBs is very uncommon, because of this many people misinterpret what CEBs are about and they don't understand that CEBs are a high quality and eco-friendly alternative to common building construction methods.
On account of these disadvantages, lack of institutional acceptability in most countries, which is why building and performance standards often do not exist.	Access to the CEB press machine – the machine requires some raw materials such as steel to be constructed and this raw material must be imported from abroad.

The technicality of producing and applying CEB on other building components other than walling is lack in most developing countries.	Requires more customised design effort design limitations, e.g. wall heights, the size of openings for windows and doors, or necessary roof overhangs to provide weather protection.
Construction is weather-dependent	Bad quality or un-adapted production equipment.
Proper soil identification is required or unavailability of soil.	Low social acceptance due to counter examples (By unskilled people, or bad soil & equipment).
Unawareness of the need to manage resources.	Low technical performances compared to concrete.
Lack of knowledge of the basics for production & use.	Untrained teams producing bad quality products.
Difficulty in construction of wide spans, high & long building.	Under/ Over-stabilization resulting in low quality products.
Remedies	
• Stabilisation of soil with suitable stabilizer and/or waterproofing agent. • Avoidance of excessive water absorption by selection of the most appropriate type of soil and/or correcting the particle size distribution • Good compaction • More importantly by good design and protective measures.	• Resistance to abrasion and impact is generally improved by the same measures as above • Also special additives may be needed and special surface treatment.
• Soil constructions in earthquake zones require careful designing to minimize the effect of destructive forces, but also the use of additional materials, which possess high tensile strength (especially for reinforcements).	Building important public buildings and high standard housing with earth can be convincing demonstrations of the advantages of the technology and thus improve its acceptability.
By eliminating the major disadvantages, the lack of institutional acceptability can be overcome. Because of the importance of the material, methods of testing and improving soils for building construction are dealt with in more detail.	

Adapted from Hadjri, Osmani, Baiche and Chifunda (2007); Waitkare City Council [WCC], (2008); Minke, (2006) and Openator, (2014).

From the Table above it will be observed that the disadvantages/limitations of CEB are things that can be either corrected, avoided, reduced or eliminated and /or basically negligible.

RESEARCH METHODOLOGY

The historical and case study designs were employed for this research, using both primary and secondary sources of data collection. Literature reviews, pictures, sketches, observations and interviews were data instruments used for the study. Literatures were reviewed to understand the challenges of housing and how compressed earth block can be a potential building material to proffer some solutions to the challenges faced. Buildings constructed with various earth types and techniques that have lasted reasonable number of years were sampled and data analysed using content analysis.

FINDINGS AND DISCUSSION

Earth Building Examples around the World

Compressed Stabilised Earth has built a bridge between traditional and contemporary architecture of various building elements as has been established by several authors such as Minke (2006); Guillaud, Joffroy and Odul (1995); Houben and Guillaud (1994) and Rigassi (1985) and these components include roof, renders, embellishment and decoration.

Plates X and XI show barrel-vaulted structure of this primary school in the village of Tanouan Ibi with compressed earth blocks from local clay mines by Dutch firm Levs Architecten. The architects enlisted students from a nearby University and members of the local community to help construct the building, using the compressed clay bricks to build walls, floors and roofing.

Plates X & XI: Tanouan Ibi Primary school Exterior and Interior of a classroom
Source: Rael (2014)

Below are pictures of Granary in Hacienda De San Diego, Chihuahua, Mexico; Five-story Rammed-earth Building in Morocco; Swan House, Presidio, Texas and Rammed- earth Housing, isle DÁbeau, France: 1,000 Years of Earth Building in the Desert Southwest.

Plate XII: Granary in Hacienda De San Diego Chihahua, Mexico
Source: Sun Stick and Mud (2014).

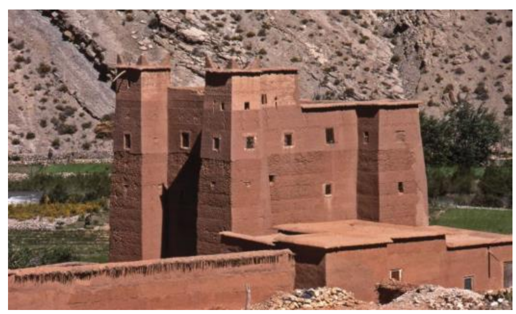


Plate XIII: Five-story Rammed-earth Building in Morocco; walling and roofing.

Plate XIV: Swan House, Presidio, Texas

Plate XV: Rammed- earth Housing, isle DÁbeau, France. Applied on the floor, wall and roof.

Source: Sun Stick and Mud (2014).

See Plates below showing Compressed Earth Blocks utilised at different forms.

Plate XVI: Optimized Pointed Vaults construction.
Source: Rabie (nd). Auroville Earth Institute

Plate XVII: Segmental Vault
Source: Rabie (nd). Auroville Earth Institute

Plate XVIII: Semi Circular Vault

Plate XVIX: Free Standing Vault

Plate XX: Catenary Vault

Source: Rabie (nd). Auroville Earth Institute

Plate XXI: Segmental Groined Vault

Plate XXII: Egyptian Vault

Source: Rabie (nd). Auroville Earth Institute

Plate XXIII: Vault (with compressed earth blocks) connecting between a segmental arch and a semicircular arch.

Source: Rabie (nd). Auroville Earth Institute

Plates XXIV & XXV : Exterior and Interior views of the Earth Brick Residence in Chiba, Japan. Compressed Earth Bricks applied on walling
Source: Rael (2009). Earth Architecture

CONCLUSION

In proffering solution to the looming challenge of housing shortage, Compressed Earth Blocks (CEB) has been identified as a viable material for large scale housing development because of it is available in abundance, flexible and easy to use, can be enhanced/upgraded/strengthen through stabilisation to be durable for vast application. Limitations arising from the production and use of CEB can be either corrected, avoided, reduced or eliminated and /or are basically negligible. Compressed Earth Blocks (CEB) can be applied to any component/element of the building; it's environmentally friendly, socially acceptable by few who knows the properties; reflection of some existing cultures and most of all affordable. Compressed Earth Blocks (CEB) if appropriately applied will significantly reduce the cost of construction; facilitate the development of environmentally friendly and sustainable housing that would help to ameliorate housing challenges and the negative effects of climate change.

RECOMMENDATIONS

- The Nigeria Government should encourage the acceptance and use of Compressed Earth Blocks (CEB) by utilising same for their various projects.
- The government should ensure implementation of the policy on the use of local building materials in the Nigeria Housing Policy of (2012).

- The government should also invest and promote the conduct of research in Compressed Earth Blocks (CEB) to enhance its quality and vast use on various components.
- The government in partnership with private firms/individuals should provide infrastructures that will attract investments and production of housing using Compressed Earth Blocks (CEB).
- Designers should research on how developed countries apply Compressed Earth Blocks (CEB) on other building components apart from walling.
- They should ensure application of Compressed Earth Blocks (CEB) is carried out neatly and not haphazardly to produce affordable and attractive structures.
- They should enlighten and encourage their clients to utilise Compressed Earth Blocks (CEB). This they can only do when they are aware and knowledgeable of the material itself.
- Developers and/or Marketers should produce large scale Compressed Earth Blocks (CEB) for easy access or sale in the market.
- Purchase/manufacture machines for easy access to intended clients/builders.

REFERENCES

Adam, E. A. and Agib, A. R. A., (2001). *Compressed Stabilised Earth Block Manufacture in Sudan*. France, Paris: United Nations Educational, Scientific and Cultural Organization (UNESCO). Retrieved on 21/06/2014 from http://unesdoc.unesco.org/images/0012/001282/128236e.pdf

Adedeji, Y. M. D., (2012). Sustainable Housing Provision: Preference for the Use of Interlocking Masonry in Housing Delivery in Nigeria. *Journal of Architecture Research*. 2 (5), 81-86 DOI: 10.5923/j.arch.20120205.03

Adedeji, Y. M. D. and Ogunsote, O. O., (2012). Anticipated Contributions of Modern Building Materials to Sustainability: Climate Change Scenario in Hot and Humid Regions of Nigeria. *Scientific and Academic Publishing Journal. Architecture Research,* 2(4), 55-59 doi: 10.5923/j.arch.20120204.04 http://article.sapub.org/10.5923.j.arch.20120204.04.html

Adeleye, A., (2008). ERSO Expert Meeting Stockholm 21-22 April, 2008. Retrieved on 19/01/2013 from http://www.unhabitat.org/downloads/docs/ERSO/Mr.%20Adeniyi%20Adeleye.pdf

Ademiluyi, I. A., (2010). Public Housing Delivery Strategies in Nigeria: A Historical Perspective of Policies and Programmes. *Journal of Sustainable Development in Africa*, 12(6), 153-161.

Adogbo, K. J. and Kolo, B. A., (2009). *The Perceptions on the Use of Indigenous Building Materials by Professionals in the Nigerian Building Industry*. Retrieved on 15/02/2014 from www.abu.edu.ng/publications/2009-06-28-132407_3039.doc.

Ajayi, M.A. and Omole, F.K., (2012). Sustainable Housing Development And Communal Provision Of Infrastructures In Asuwamo Residential Estate Akure, Nigeria *In:* Laryea, S., Agyepong, S.A., Leiringer, R. and Hughes, W. (Eds) *Procs 4th West Africa Built Environment Research (WABER) Conference*, Abuja, Nigeria, 191-201.

Akeju, A. A., (2007). *Challenges to Providing Affordable Housing in Nigeria*. Being a Paper presented at the 2nd Emerging Urban Africa International Conference on Housing Finance in Nigeria. Retrieved on 31/10/2014 from http://nigeria.usembassy.gov/uploads/images/EpaZi8mzSJHiFpSWvhOT2A/Challenges_affordable_housing_update_Akeju.pdf

Akinluyi, M. L. and Adeleye, O. O., (2013). The Building Industry in the Housing Programme: Technology, Materials and Labour towards Addressing Housing Shortage in Nigeria. *Global Journal of Arts Humanities and Social Science*, 1(3), 58-70. Retrieved on 31/10/2014 from http://www.eajournals.org/wp-content/uploads/THE-BUILDING-INDUSTRY-IN-THE-HOUSING-PROGRAMME-TECHNOLOGY-MATERIALS-AND-LABOUR-TOWARDS-ADRESSING1.pdf

Alagbe, O. A., (2005). *Prospects and Challenges of Compressed Stabilized Laterite Bricks in Enhancing Sustainable Housing Development in Nigeria.* Retrieved on 03/03/2014 from http://eprints.covenantuniversity.edu.ng/389/1/Prospects_and_Challenges_of_Compressed_Stabilized-Alagbe_OA.pdf

Arumala, J. O. and Gondal, T., (2007). *Compressed earth Building Blocks for Affordable Housing*. Royal Institution of Chartered Surveyors (RICS). London: COBRA. ISBN: 9781842193570

Atolagbe, A. M. O., (2010). An Evaluation of the Adaptability of Nigerian Indigenous Building Tools in Modern House Construction. *Journal of Hum Ecol*, 32(1), 63-68. Retrieved on 25/11/2015 from http://www.krepublishers.com/02-Journals/JHE/JHE-32-0-000-10-Web/JHE-32-1-000-10-Abst-PDF/JHE-32-1-063-10-1686-Atolagbe-A-M-O/JHE-32-1-063-10-1686-Atolagbe-A-M-O-Tt.pdf

Ayedun, C. A. and Oluwatobi, A. O., (2011). Issues and Challenges Militating against the Sustainability of Affordable Housing Provision in Nigeria. *Journal of Business Management Dynamics.* 1(4), 1-8. Retrieved on 03/03/2014 from http://bmdynamics.com/issue_pdf/bmd110141_01_08.pdf.

Basorun, J. O. and Fadairo, G., (2013). *Government challenges in housing urban poor*. Nigeria: 2014 Vanguard Media Limited.

Didel M. J., Matawal D. S. and Ojo E. B., (2014). Comparative Cost Analysis of Compressed Stabilised Blocks and Sandcrete Blocks in Affordable Housing Delivery in Nigeria. Proceedings of International Conference Housing Summit 2014: Achieving Affordable Housing in Nigeria

Eromobor, S. O. and Das, D.K., (2013). *Dynamic Modelling Approach for Designing Sustainable Green Buildings.* SB 13 South Africa: Creating a Resilient and Regenerative Built Environment, Cape Town, South Africa. Retrieved on 15/02/2014 from http://sbconferences.org/sb13safrica/

Fagbamila J., (2009). *Economic Recession: Stakeholders urge Promotion of Investment Opportunities in Housing Sector*. Published in Compass Real Estate In Nigeria Compass Newspaper, 30 June, 2009 22-23.

Federal Government of Nigeria [FGN], (2012). *National Housing Policy.* Abuja Nigeria: FGN Press.

Gemade, T., (2014). *The Role of Federal Housing Authority Nigeria*. Retrieved on 28/11/14 from http://www.globalhomesmagazine.com/ghm-articles/the-role-of-federal-housing-authority-nigeria

Guillaud, H., Joffroy, T. and Odul, P., (1995). Compressed Earth Blocks: Manual of Design and Construction. *Manual of design and construction,* II. Eschborn, Germany: Deutsches Zentrum für Entwicklungstechnologien – GATE.

Hadjri, K., Osmani, M., Baiche, B. and Chifunda, C., (2007). Attitudes towards Earth Building for Zambian Housing Provision. *Engineering Sustainability* 160(ES3), 141–149. Retrieved on 19/12/2014 from https://www.academia.edu/3828194/Attitudes_towards_earth_building_for_Zambian_housing_provision

Hammond, A. A., (1990). Housing in Africa, Problems, Prospects and Strategies. *Journal of the Network of African Countries on Local Building Materials and Technologies,* 1(4). Retrieved from http://www.greenstone.org/greenstone3/nzdl?a=d&c=cdl&d=HASH016918725b64c5faad271500.4&sib=1&p.a=b&p.sa=&p.s=ClassifierBrowse&p.c=cdl

Houben, H. and Guillaud, H., (1994). *Earth Construction, A comprehensive guide*, CRATerre-EAG, Intermediate Tecnology Publications Ltd.

Ibem, E. O., Anosike, M. N and Azuh, D. E., (2011). Challenges in Public Housing Provision in the Postindependence Era in Nigeria. *International Journal of Human Sciences,* 8(2), 421-443. Retrieved on 19/12/2014 from http://www.insanbilimleri.com/en

International Housing Collation [IHC], (2007). Housing Challenges and Opportunities in Sub-Saharan Africa. Developing Countries.

Jinadu, A. M., (2007). *Understand the Basics of Housing.* Nigeria*:* Jos Universal Press.

Kerali, A. G., (2001). *Durability of Compressed and Cement-Stabilised Building Blocks*. PhD Thesis, University of Warwick, School of Engineering, UK. Retrieve on 27/10/2014 from http://www2.warwick.ac.uk/fac/sci/eng/research/civil/crg/dtu-old/pubs/reviewed/building/agk_thesis/agk_thesis.pdf

Little, B. and Morton, T., (2001). *Building with Earth in Scotland: Innovative Design and Sustainability.* Edinburgh: Scottish Executive Central Research Unit.

Maton, D. J., Danjuma, G. A., Didel, M. J. and Edom, A., (2014). Quality, Application and Cost Benefits of NBRRI Interlocking Blocks as Solution to Nigerian Affordable Housing Aspirations. Proceedings of International Conference Housing Summit 2014: Achieving Affordable Housing in Nigeria.

Minke, G. (2006). *Building with Earth, Design and Technology of a Sustainable Architecture*. Basel, Berlin, Boston: Birkhauser publishers for architecture.

Morris , J . and Booysen , Q ., (2000) *Earth Construction in Africa* . Proceedings: Strategies for a Sustainable Built Environment; 23 – 25 August, Pretoria, South Africa.

Olotuah, A. O. and Ajenifujah, A. O., (2009). Architectural Education and Housing Provision in Nigeria. *Journal of Centre for Education in the Built Environment*, 6(1), 86-102. ISSN: 1745-0322 (Online). Retrieved on 29/05/14 from http://cebe.cf.ac.uk/transactions/pdf/OlotuahAjenifujah6(1).pdf

Openator, (2014). *The Advantages of Compressed Earth Blocks (CEBs).* Retrieved on 21/03/15 from http://www.openator.com/advantages-of-compressed-earth-blocks/

Rabie, O., (nd). Revealing the Potential of Compressed Earth Blocks. *A Study in the Materiality of Compressed Earth Blocks (CEB): Lightness, Tactility, and Formability*. orabie@alum.mit.edu.

Rael, R., (2009). *Earth Architecture*. California, Berkeley: APA Press publication. ISBN 9781568987675. Retrieve on 20/10/14 from http://www.eartharchitecture.org/

Rigassi, V. and CRATerre-EAG, (1985). Compressed Earth Blocks: Manual Of Production. CRATerre-EAG Manual of Production, I. Deutsches Zentrum für Entwicklungstechnologien - GATE in: Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ).

Star Connect Media [SCM], (2014). *Housing Deficit, Challenges of Mass Housing in Nigeria.* Retrieved on 28/11/14 from http://starconnectmedia.com/2014/03/23/housing-deficit-challenges-of-mass-housing-in-nigeria/

Taiwo, A. and Adeboye, A., (2013). Sustainable Housing Supply in Nigeria Through the Use of Indigenous and Composite Building Materials. *Journal of Civil and Environmental Research,* 3(1). www.iiste.org ISSN 2222-2863 (Online).

United Nations Environment Programme- Sustainable Buildings and Climate Initiative [UNEP-SBCI], (2012). *Building Design and Construction: Forging Resource Efficiency and Sustainable Development*.

United Nations Human Settlements Programme (UN-Habitat), (2012). Urban Housing Challenges and Opportunities in Developing Countries.

Waitkare City Council [WCC], (2008). *Earth Building.* Waitakere City Council's Sustainable Home Guidelines. New Zealand:Waitakere City Council.

Zami, M. S. and Lee A., (2011). Inhibitors of Adopting Stabilised Earth Construction to Address Urban Low Cost Housing Crisis: An Understanding by Construction Professionals. *Journal of Building Appraisal* 6, 227–240. Retrieved on 27/06/2013 from http://www.palgrave-journals.com/jba/journal/v6/n3/full/jba201025a.html.

COMPRESSED EARTH BRICKS FOR SUSTAINABLE BUILT ENVIRONMENT IN NIGERIA.

Obaje Juliet A.[1], M. Zubairu[2] & Ryal-Net Marcus Balah[3]
[1]Department of Architecture, Federal University of Technology Minna.
[2]CHSUD, Federal University of Technology Minna.
[3]Department of Architecture, Kaduna Polytechnic, Kaduna.

Until very recently, the Compressed Earth Bricks building material has registered low patronage and acceptability in Nigeria. The paper analysed sustainability concepts and features to the built environment; sustainability and housing provision; features of sustainable building materials and the properties of Compressed Stabilised Earth Bricks as a sustainable building material. It also assessed the degree of awareness and application of Compressed Earth Bricks by some selected professionals in the Building Industry and its sustainability as a building material. Descriptive survey designs were used, through the application of review of related literatures, questionnaires, interview and personal observation methods of data collection. The instruments were applied to designers/professionals in the building industry in Kaduna state, Nigeria. The findings of the research are that there is high level of awareness but low level of use of Compressed Stabilised Earth for building construction. Secondly 41% of 27 respondents strongly agreed that Compressed Earth Brick is a sustainable building material while the rest of them simply agrees that it is economical, environmental and socio-cultural sustainable. If the professionals in the building industry will utilise CEB in their projects; masses are well educated and enlightened on the viability and sustainability of Compressed Earth Brick building material, more people will embrace and apply it for their construction and thereby eliminating the negative impact of other building materials on the built environment and climate.

***Keywords**: Awareness, Knowledge, Compressed Stabilised Earth; Sustainable Built Environment and Sustainability.*

obajeazuka@gmail.com

Obaje Juliet A.[1], M. Zubairu[2] & Ryal-Net Marcus Balah[3] (2016). **COMPRESSED EARTH BRICKS FOR SUSTAINABLE BUILT ENVIRONMENT IN NIGERIA** Sustainable Built Environment and Climate change; The challenges of Post 2015 Development Agenda. School of Environmental Technology Conference, SETIC, 2016

INTRODUCTION

Theories have evolved and postulated that natural resources are limited and so the world's population can outweigh the resources considering the current rate of its exploitation and development (Russell, 1995 and Beckett, 2011). Obonyo, Exelbirt and Baskaran (2010) averred that worldwide 'green'/'sustainability' movement has greatly prejudiced the design and construction of buildings, infrastructure and the built environment entirely through ensuring delivering of high performance building systems. Sustainability of the built environment is cautiously carrying out or following suitable practices in the selection and source of materials, design, construction, operation and maintenance of new buildings, retrofitting of existing ones from individual buildings and homes, to entire neighbourhoods and communities by efficiently using more natural, financial and social resources to achieve improve performance, healthy environment and people, decrease environmental burden and waste (Abolore, 2012; National Planning Policy Framework (NPPF) & Cross Sector Group on Sustainable Design and Construction (CSGSDC), 2012; United Nations Environment Programme- Sustainable Buildings and Climate Initiative [UNEP-SBCI], 2012 & Feltes, 2007).

Sustainability is to be able to have, keep, carry forward, support or sustain for a long-lasting time without end (Abolore, 2012). Lehrer and Teicholz (2001), defined sustainability as a goal that allows for the continuing improvement of standard of living without reversible damage to resources that we need to survive as species. The establishment of the World Commission on Environment and Development (WCED), (1987) report, 'Our Common Future', defined sustainable development as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs." Feltes (2007) averred that sustainability involves design, construction and operation of buildings that are resource efficient by utilisation of minimal energy, control of waste, and provision of healthier and productive environments.

Bartuska (2007) defines the built environment by means of its interrelated characteristics (manmade elements, human activities/purpose and overall environment) as shown in Figure 1.0. This reinforces the fact that people are at the centre of the creation of the built environment, whatever the results for the external natural environment.

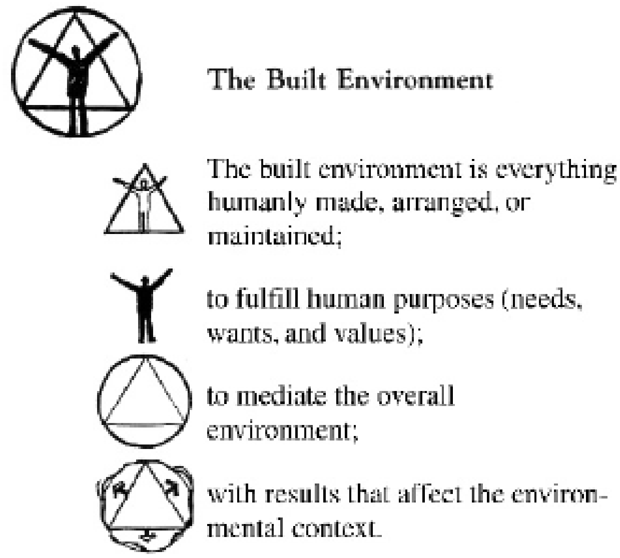


Figure 1.0: Four related characteristics of the built environment
Source: Bartuska (2007).

The relevance of sustainability to the built environment cannot be overemphasised because it provides the opportunity to utilise materials that are sustainable; applying them in such a way that will not be potential danger to future use either by running out or harming the environment (with minimal environmental impact) at any time (UN-Habitat, 2011 and Taiwo & Adeboye, 2013). Sustainability ensures that buildings are designed, constructed, operated, maintained and disposed having minimal impact on human and the built environment (environmentally responsible) via waste reduction/recycling and resource conservation/efficiency (energy, water, material, human efficiency and land) to ensure cost effectiveness (NPPF & CSGSDC, 2012). It also subsequent lessens frequent visit to resource base for extraction and exploitation, thereby elongating our resource lifespan.

Little and Morton (2001) averred that earth have outstanding sustainability characteristics such as low carbon emissions, recyclable, energy efficient, use of finite resources, minimised pollution, minimised waste, use of benign materials, local sourcing and biodegradability which makes it the principal reason for application. According to Roy and Chowdhury (2013) and Rael (2009), an estimate of about 1.7 billion people of the world's population live in earthen houses, 50 % of the population in the developing countries, and at least 20% of the urban and suburban populations. Studies also indicate that earth is one of the oldest building materials known for over 9000 years that has been used in construction in every single continent and nearly every country possesses a rich heritage of earthen buildings (Minke, 2006; Vador, 2012).

The assumption that earth is a fragile, ephemeral, aspre-modern or backward building material and only used for housing in poor rural areas does not stand. Earth is rather the oldest building material in existence showcasing one of the most beautiful and simple humankinds most evolved and sophisticated building technologies and have been used to construct bungalows, offices, apartments, institutions and landscapes (Vador, 2012). This timeless building material can be an important and strategic instrument for improved and sustainable built environment particularly in Nigeria where it abounds.

According to Vador (2012); Roy & Chowdhury (2013) earth may have its own limitations such as water penetration, erosion of walls at level by splashing of water from ground surfaces, attack by termites and pests and high maintenance requirements but with continuous studies and experiments on its application solutions to the various challenges could be generated and will be advantageous to the built environment. Earth application will invariably eliminate depletion of the natural resources; reduce global energy consumption and the harm these have on the people.

The paper aims at reviewing related literatures on sustainable built environment, compress earth bricks and its features; identifying the level of awareness/knowledge and application of compressed earth bricks for building and also ascertaining its sustainability features including qualities as it relates to its various limitations.

Concepts of Sustainability and Sustainable Built Environment

To achieve sustainable built environment, major sustainability concepts environmental, social, cultural and economic must have to be drawn together which are expressed as impacts on the environment and climate change (Gilkinson & Sexton, 2007; NPPF & CSGSDC, 2012 & UN-Habitat, 2012).

Economic: shelter policies, design, and construction should be tied to micro and macro-economic development, employment and revenue creation, produce goods and services on a continuing basis, avoid extreme sectoral imbalances which damage agricultural or industrial production. The support from Government in giving the initial up-front costs needed for building sustainable built environment is required (Harris, 2000 & UN-Habitat, 2012).

Environmental: According to UN-Habitat (2012), environmental sustainability means saving energy in construction, manufacturing and transportation of materials; designing and planning for energy efficiency; prioritizing natural and recycled materials; connecting housing with sustainable energy provision; and avoiding poisons and pollutants, over-exploitation of renewable resource systems, material availability and environmental resources (biodiversity, atmospheric stability).

Socio-cultural sustainability: has large scope and different strategies, for example the empowerment of poor communities; inclusion of all groups in planning, design and governance decisions; building the skills of people; and creating training and employment opportunities through construction processes, promote social integration, gender and distributional equity, political accountability and participation, cultural heritage (people's uniqueness and characteristics) and appropriateness (UN-Habitat, 2012 & Harris, 2000).

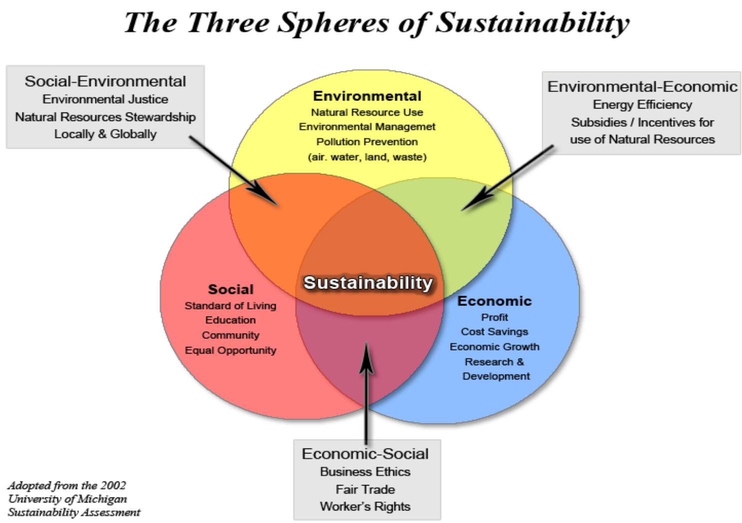


Figure 2.0: The Three Concepts/Spheres of Sustainability
Source: Adopted from University of Michigan Sustainability Assessment, (2002).

The Features of Sustainable Built Environment

- **Site**: The site should take advantage of the transport system, existing landscapes and natural features; planting with low water, maintenance and pesticide needs; use recyclable materials and furnishings to cut cost and waste.
- **Energy efficiency**: The National standard requirements for energy efficiency levels can be reached through passive design; choice of colours for building materials; alternative energy sources such as photovoltaic (PV) and fuel cells, renewable energy sources (RES) and computer modelling.
- **Materials efficiency**: Sustainable construction materials and products promote resource conservation and use efficiency analyse through reused and recycled-content; zero or low off-gassing of harmful air emissions; zero or low toxicity; durability; longevity; and local production.
- **Water efficiency**: design for dual plumbing; minimise wastewater; install point-of-use hot water heating systems and use water budget approach.
- **Occupant health and safety:** use non-toxic materials; provide adequate ventilation and in-duct filtration systems and effective drainage system.
- **Building operation and maintenance:** systems must meet design criteria; instructions on the operation and maintenance of equipments.

Adapted from United Nations Industrial Development Organization (UNIDO) and the International Centre for Science and High Technology (ICSHT), (2008).

Sustainability and Housing Provision in the Built Environment

It is no longer news that provision of adequate and decent housing is a major challenge to developing countries including Nigeria. The challenge does not lie only on housing deficit but also on quality of houses being developed. The provision of adequate (quantity) and well maintained (quality) housing in any country is a stimulant to the economy (Fadairo & Olotuah, 2013; Burgess, Monk & Whitehead, 2010; Oladapo & Olotuah, 2010; Omole, 2010). Kronenburg (2001); Oppong and Badu (2012) and Gilbert (2004) observed that provision of adequate housing in decent environments will build up the physical, biological and social needs of the users improving their quality of life.

According to the National Housing Policy (FGN) (2012) and United Nations Human Settlements Programme (UN-Habitat), (2012), housing is one of those basic societal setting that determines the quality of life and welfare of people, reflecting their socio-economic, cultural aspirations and preferences. Housing is the procedure of supplying/providing safe, comfortable, attractive, functional, affordable and private shelter in appropriate location within a neighbourhood, sustained by continuous maintenance of the built environment for the daily living activities of people within the society. Housing is vital to sustainable built environment as it influences the daily lives of people, their health, security and wellbeing as is knitted into the environmental, social, cultural and economic framework of the communities.

Housing shortage in many parts of the world could be alleviated by developing new building concepts, durable and sustainable materials, which will need minimum maintenance during the life of the structure (Bredeveldt, 2002). Several researchers such as Yuefeng (2011); World Business Council for Sustainable Development [WBCSD] (2009) and Roodman and Lenssen, (1995) have revealed that buildings universally are responsible for at least 40% of global energy consumption and uses up fossil fuel to run and this invariably contributes to anthropogenic climate change and global warming. Statistics has also shown that the building sector produces about 50% of greenhouse gas (GHG) emissions; chlorofluorocarbons (CFCs) and also comprise 40% of acid-rain producing sulphur dioxide and nitrogen oxides causing major environmental crisis more than other sectors put together (Yuefeng, 2011; Green Play Book (GPB), 2010; Roodman & Lenssen, 1995).

In the United States, 48% of total energy is consumed in buildings (Architecture 2030, 2009). In Figure 3.0, 41% represents operating energy and 7% embodied energy, resulting in 48% of all GHG emissions.

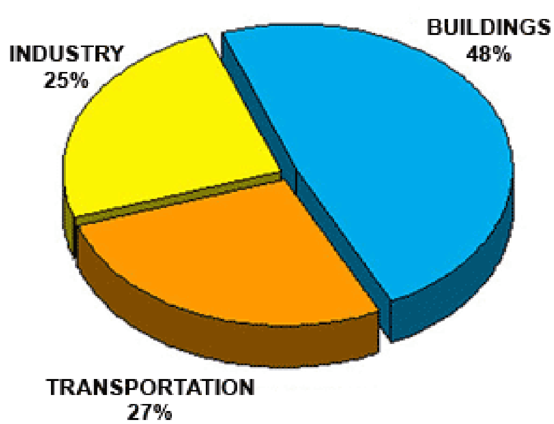


Figure 3.0: US energy consumption (http://www.campusclimatenetwork.org/wiki/Buildings)

Adedeji (2012), observed that sustainable housing provision is the gradual, continual and replicable process of meeting the housing needs of the populace, the vast majority of who are poor and are incapable of adequate housing provision. Sustainable housing provision requires proper definition of housing needs, and the participation of the end users to ensure their satisfaction following the general goal of sustainable development, which is to meet the essential needs of the world's poor while ensuring that future generations have adequate resources base.

Features and Efficiency of Sustainable Building Materials

Kim and Rigdon (1998) noted that the "off-the-shelf" price of a building component represents only the manufacturing and transportation costs, not social or environmental costs but analysis of building products, from the gathering of raw materials to their ultimate disposal, provides a better understanding of the long-term costs of materials. The final costs are paid by the client, the owner, the occupants, and the environment. They identified three groups of criteria, based on the material life cycle that can be used in evaluating the environmental sustainability of building materials which are Pre Building Phase (Manufacture), Building Phase (Use) and Post Building (Disposal).

Buildings and its construction guzzles a total of 40 percent universally used raw materials accounting for about 3 billion tons every year (Roodman and Lenssen, 1995). Sustainable built environments can be assured via application of green building materials and products thereby reducing the environmental impacts associated with the extraction, transportation, processing, fabrication, installation, reusing, recycling and disposal of these materials (Mauro 2012).

The presence of one or more of these features in building materials makes it environmentally sustainable (Kim & Rigdon, 1998; Riza, Abdulrahman and Zaidi, 2011 & UNEP-SBCI, 2011).

- **Resource Efficiency: (recycled content; natural, plentiful or renewable**; r**esource efficient manufacturing process; locally available; salvaged, refurbished, or remanufactured**; r**eusable or recyclable**; use of natural, non-toxic or less-toxic materials; r**ecycled or recyclable product packaging;** reduction of construction waste; biodegradability; waste reduction measures in manufacturing; longer life **and durable).**
- **Indoor Air Quality (IAQ): (Low or non-toxic; minimal chemical emissions; low-VOC assembly; moisture resistant; healthfully maintained and** pollution prevention measures in manufacturing; **systems or equipment).**
- **Energy Efficiency**: (materials, components, and systems that help reduce energy consumption in buildings and facilities); embodied energy reduction; renewable energy systems
- **Water/treatment Conservation:** (products and systems that help reduce water consumption in buildings and conserve water in landscaped areas).
- **Affordability:** (building product life-cycle costs).

Sustainable Features of Compressed Earth Bricks (CEB) as a Building Material

Material efficiency has been identified as one of the major features of a sustainable built environment and several description of what makes a building material efficient has been elucidated in this paper. Compressed Earth Bricks (CEB) can therefore comfortably be said to fit in to the required criteria's of sustainable building materials.

Table 1.0 Sustainability of Compressed Earth Bricks

Sustainability Variables	**Features**	**Source (authors)**	**Remarks**
Economical	Cheap and affordable; Saves material and transportation costs	Brown (2014); Openator (2014); Deboucha, S. Hashim, R. (2011); Riza, Abdulrahman and Zaidi (2011); Arumala and Gondal (2007); Minke (2006) and Adam and Agib (2001).	Little or no cost for retrieval of raw material which usually is from construction vicinity; requires only stabiliser, water and pressure (minimal energy).
	Management of resources; Uniform building components eliminating waste	Openator (2014); Auroville Earth Institute (AEI), (2012); Rigassi and CRATerre-EAG (1985).	Bricks are used as moulded without need to cut; bricks are neatly and regularly laid.
	Transferable technology resources; Easy to build with unskilled labour	Openator (2014); Auroville Earth Institute (AEI), (2012); Deboucha, S. Hashim, R. (2011); Adam and Agib (2001) and Guillaud, Joffroy, Odul and CRATerre (1995).	Requires very little training and input to acquire the required skills
	Available and abundance; practically unlimited supply	Brown (2014); Openator (2014); Deboucha and Hashim (2011) and Adam and Agib (2001).	The raw material (earth) is abundant; available almost everywhere and easily can be replenished with time.
	Market opportunity; reducing imports.	Auroville Earth Institute (AEI), (2012) and Rigassi and CRATerre-EAG (1985).	Locally sourced and abounds around.
	Job creation opportunity	Auroville Earth Institute (AEI), (2012); Rigassi and CRATerre-EAG (1985).	Provision of employment for the production, construction to marketing.
	Flexible production scale	Auroville Earth Institute (AEI), (2012) and Guillaud, Joffroy, Odul and CRATerre (1995).	Production can be at large scale within short periods.
Environmental	Eco-friendly; balances air humidity	Riza, Abdulrahman and Zaidi (2011) and Minke (2006).	There are no emission of gases or chemical reactions involved
	Favourable climatic performance with high thermal capacity, low thermal conductivity and porosity; moderates and balances temperature.	Deboucha and Hashim (2011); Riza, Abdulrahman and Zaidi (2011); Minke (2006) and Adam and Agib (2001).	Presents the most suitable and conducive atmosphere.
	Energy efficient; saves energy and reduces environmental pollution	Deboucha and Hashim (2011); Riza, Abdulrahman and Zaidi (2011); Minke (2006) and Adam and Agib (2001).	Does not require energy for heating or cooling of spaces
	Stabilised for strength; stronger than conventional concrete bricks	Openator (2014) and Guillaud, Joffroy, Odul and CRATerre (1995).	Adequately and appropriately stabilised is stronger than most other building materials.

	Resistance to fire; sound; bullets and earthquake	Deboucha and Hashim (2011); Openator (2014); Adam and Agib (2001); Arumala and Gondal (2007).	Wholly compacted so can hardly be penetrated.
	Resistance to mole and insects	Openator (2014); Arumala and Gondal (2007).	Does not contain cellulose to breed moles and very dense to allow for the penetration of insects
	Non-toxic	Openator (2014); Arumala and Gondal (2007).	No chemical reactions and emissions
	Aesthetically pleasing	Guillaud, Joffroy, Odul and CRATerre (1995); Openator (2014);	Naturally beautiful and can also be rendered
	Bio-degradable material	Auroville Earth Institute (AEI), (2012); Rigassi and CRATerre-EAG (1985).	When disintegrate can blend back into the environment
	An adapted material	Auroville Earth Institute (AEI), (2012); Rigassi and CRATerre-EAG (1985).	Can be moulded into different sizes depending on need.
	Material efficient; suitable as a construction material for most parts of the building and reusable.	Deboucha and Hashim (2011); Adam and Agib (2001); Minke (2006); Riza, Abdulrahman and Zaidi (2011).	Can be applied in every component of the building.
	Building products standards	Guillaud, Joffroy, Odul and CRATerre (1995); Rigassi and CRATerre-EAG (1985).	Production process ensures quality control from identification, selection and extraction of the earth to assessment of the brick.
	Limiting deforestation; Preserves timber and other organic materials	Minke (2006); Auroville Earth Institute (AEI), (2012);	Preserving natural resources
Socio-cultural	Ideal self and community participation construction	Minke (2006) and Rigassi and CRATerre-EAG (1985).	Encourages community participation.
	Renewal of social acceptance building with earth.	Auroville Earth Institute (AEI), (2012) and Guillaud, Joffroy, Odul and CRATerre (1995)	Promote the use of sustainable building materials

Source: Adapted from various authors.

The Table 1.0, show findings of studies on the sustainability of compressed earth bricks which can be used for housing production and building a sustainable environment.

RESEARCH METHODOLOGY

The research design adopted in carrying out the study was descriptive survey, where multiple (primary and secondary) data types were retrieved and applied. The area of study is Kaduna state in Nigeria. The choice of study area is on the centrality of Kaduna state in Northern Nigeria and headquarters of the North Central states; the availability of the material and its diverse application.

Related literatures were reviewed to analysis the relevance, concepts and features of sustainability; features of sustainable built environment and building materials lastly sustainable features of compressed earth bricks as a building material. Interviews and structured questionnaire were administered to selected professionals in the building industry (Architects, Builders and Engineers) to ascertain the degree/extent of awareness and application of compressed earth bricks and its sustainability as a building material. The specific content validity of the questionnaire was by experience experts in the building industry including a competent and experienced statistician. The four (4) point Likert rating scale was used to design the questionnaire administrated to the respondents. For the extent of awareness and use of compressed earth brick the rating scale regarded point ‘4’ as the Very High; ‘3’ as High; ‘2’ as Low while ‘1’ is Very Low point and for ascertaining the sustainability of compressed earth building material, point ‘4’ is Strongly Disagree ‘3’ is Disagree while ‘2’ and ‘1’ are Agree and Strongly Agree respectively.

The population (registered members of each of the profession) size was retrieved from their various Chapter offices Nigerian Institute of Architects (NIA); Nigerian Institute of Builders (NIOB) and Nigerian Society of Engineers (NSE) respectively. Thirty building industry professionals were sampled representing 10% each of the profession based on Glenn (2013) ‘Determining Sample Size’, retrieved from the Table 2; Sample Size for +/-5%, +/-7% and =/-10% Precision Level where Confidence Level is 95% and P=0.5 but only 27 questionnaires were retrieved. The data collected from the structured questionnaire was analysed using Descriptive statistics to establish frequency, mean and standard deviation.

RESULTS, DISCUSSION AND FINDINGS

Table 2.0: Distribution of Respondents by Sex base on Compressed Earth Bricks Awareness and Usage.

Gender	Awareness		Usage	
	Freq	Percent	Freq	Percent
Male	20	74.1	7	35.0
Female	7	25.9	2	28.6

Source: Researcher Field Work (2015).

DISTRIBUTION OF RESPONDENTS BY SEX BASE ON AWARENESS AND USAGE.

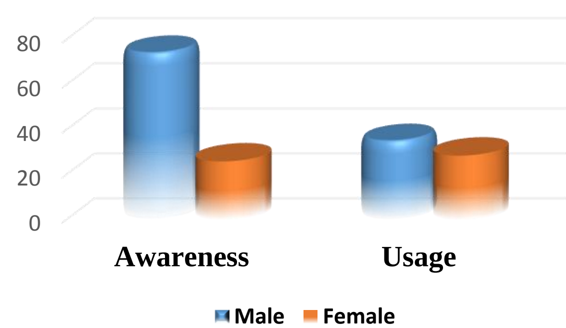


Fig 4.0: Bar Chart Showing Distribution of respondents by Sex base on Awareness and Usage.
Source: Researcher Field Work (2015).

The result in Table 2.0 and Figure 4.0 displays the distribution of the respondents by sex base on compressed earth bricks awareness and usage also indicating that the male which are 20 in number and 74.1% of the respondents are more aware of CEB, and out of 20 male, 7 comprising 35% have applied CEB in their projects. The female respondents were 7 making 25.9% of the population are all aware but only 2 females (28.6%) applied CEB in their projects. It implies that male show more interest in new technology and experiments the use of new/modified materials in their construction with 35%.

Table 3.0: Distribution of Respondents by Age Base on Awareness and Usage.

Age	Awareness		Usage	
	Freq	Percent	Freq	Percent
26 – 30	3	11.1	0	0.0
31 – 40	7	25.9	2	28.6
40 and above	17	63.0	7	35.0

Source: Researcher Field Work (2015).

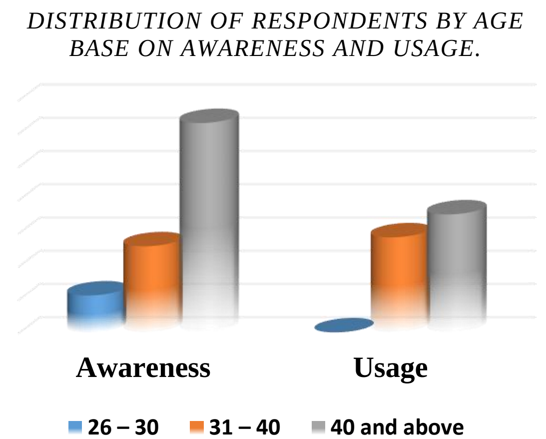


Fig 5.0: Bar chart showing Distribution of respondents by Age base on Awareness and Usage.
Source: Researcher Field Work (2015).

From Table 3.0 and Figure 5.0 the respondents 40 years and above has the high awareness of CEB and its utilisation as 63% and 35% respectively. While the other age groups below 40 years, 26-30 years and 31-40 has low awareness of CEB at 11.1%; 25.9% and its application at 0.0%; 28.6% respectively. This indicates that the older respondents who possibly have lived in earth structures are more aware, interested and utilised compressed earth bricks in their projects.

Table 4.0: Distribution of Respondents by Profession Base on Awareness and Application.

Profession	Awareness		Usage	
	Freq	Percent	Freq	Percent
Architects	13	48.1	5	38.4
Structural Engineers	10	37.0	3	30.0
Builders	4	14.8	1	25.0

Source: Researcher Field Work (2015).

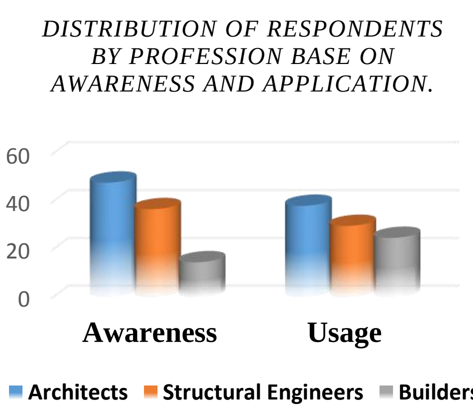


Fig 6.0 Bar chart showing Distribution of respondents by Profession base on Awareness and usage.
Source: Researcher Field Work (2015).

From Table 4.0 and Figure 6.0 the distribution of respondents by profession based on awareness and application indicates that Architects were the modal respondents with

13(48.1%) aware of CEB, which out of the 13, 5(38.4%) applied it; Structural engineers 10(37%) were aware of CEB, while only 3(30%) had applied it and for the Builders 4(15%) are aware of CEB but only 1(25%) applied it. This means that all three professionals are aware of CEB and averagely have applied the building material to their projects as shown by the slant on the chart.

Table 5.0: Distribution of respondents by Years of Practice base on Awareness and Usage.

Years of Experience	Awareness		Usage	
	Freq	**Percent**	**Freq**	**Percent**
5 – 10yrs	7	25.9	2	28.6
10 – 15yrs	1	3.7	1	100.0
15yrs and above	19	70.4	6	31.6

Source: Researcher Field Work (2015).

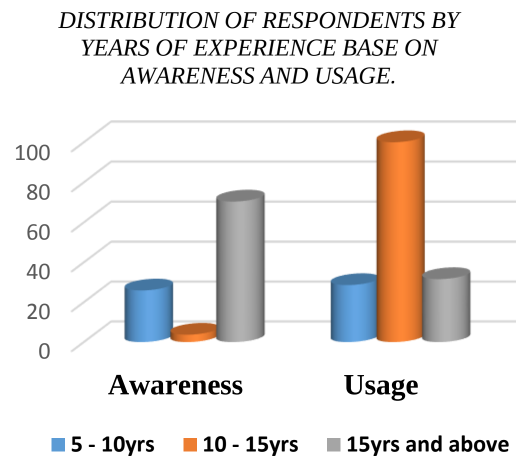


Fig 7.0 Bar chart showing Distribution of respondents by Years of Experience base on Awareness and Usage.
Source: Researcher Field Work (2015).

Table 5.0 and Figure 7.0 shows that the respondent with higher years of experience (15 years and above) indicated more awareness of CEB with 19 at 70.4%, while 31.6% of the 19 respondent has utilised it in their projects. The younger respondents with lower years of experience (10 – 15years and 5 – 10years) showed lower awareness with 1 and 7 (3.7%; 25.9%) while out of the 1 and 7 the utilisation was (100%; 28.6%) respectively. The result then implies that the respondents with the higher years of experience have seen, understood and then applied the technology of CEB as a result of their long years of practice and exposure to the built environment.

Table 6.0: Level of Knowledge/Awareness and Application of Compressed Earth Building Material.

	N	MEAN	STD. DEVIATION
Level of Awareness	27	2.61	.354
Application	27	1.81	.834

Source: Researcher Field Work (2015).

Generally from the above Table 6.0, the respondent have High level of awareness of compressed earth bricks with mean of 2.61 and a standard deviation of 0.354 while level of application has been identified to be low with mean of 1.81 and a standard deviation of

0.834. It was observed that awareness of the good qualities of CEB greatly influences its use/application for construction.

Table 7.0: Sustainability of Compressed Earth Blocks

	N	Sum	Mean	Std. Deviation	Remarks
Economic Sustainability					
Compressed Earth Brick is Affordable	27	96	3.56	.506	Strongly Agree
Compressed Earth Brick is Marketable	27	89	3.30	.775	Agree
Production of Compressed Earth Brick is Time saving	27	92	3.41	.694	Agree
Compressed Earth Brick is Easy to Use	27	96	3.56	.577	Strongly Agree
Compressed Earth Brick has Easy Technique/Skill production	27	88	3.26	.656	Agree
Compressed Earth Brick can provide Employment Opportunity	27	70	2.59	.888	Agree
Compressed Earth Brick is a Modern material	27	71	2.63	.884	Agree
Compressed Earth Brick has Production Continuity quality	27	82	3.04	.759	Agree
Environmental Sustainability					
The constituent material is Available	27	98	3.63	.688	Strongly Agree
Compressed Earth Brick is Durable	27	94	3.48	.849	Strongly Agree
Compressed Earth Brick is Strong	27	95	3.52	.849	Strongly Agree
Compressed Earth Brick is Energy efficient	27	100	3.70	.542	Strongly Agree
Compressed Earth Brick is Non-toxic	27	96	3.56	.751	Strongly Agree
Compressed Earth Brick is Recyclable/Reusable	27	96	3.56	.577	Strongly Agree
Compressed Earth Brick has Thermal comfort qualities	27	103	3.81	.396	Strongly Agree
Compressed Earth Brick is Biodegradable	27	86	3.19	.879	Agree
Compressed Earth Brick is Flexible in use	27	83	3.07	.730	Agree
Compressed Earth Brick is Aesthetical	27	74	2.74	.526	Agree
Socio-cultural Sustainability					
Compressed Earth Brick has good Users perception	27	86	3.19	.786	Agree
Compressed Earth Brick construction encourages Community participation	27	87	3.22	.698	Agree
Compressed Earth Brick is Acceptable	27	88	3.26	.656	Agree
Compressed Earth Brick showcases Cultural heritage	27	84	3.11	.801	Agree
Valid N (listwise)	27				

Source: Researcher Field Work (2015).

From Table 7.0 the respondents strongly agree that CEB is Affordable and Easy to use with a mean of 3.56 and standard deviation of 0.506 and 0.577 respectively while they agreed that CEB exhibits other Economical sustainability characteristics with a minimum mean of 2.59 and standard deviation of 0.888 respectively. The Environmental sustainability has a minimal mean of 2.74 with it standard deviation at 0.526 agreeing that CEB is Aesthetical and the highest mean at 3.81and standard deviation at 0.396 indicating that the respondents strongly agree that CEB has Thermal Comfort qualities. Also for the Socio-cultural sustainability 3.11; 0.801 and 3.26; 0.656 are the minimum and maximum means; standard deviations respectively, which means that the respondents agree that CEB showcases Cultural heritage and is Acceptable.

From the literatures reviewed, sustainability; sustainable built environment and sustainable building material revolve within several concepts and features. It has also been established that compressed earth bricks is a sustainable building material (as shown on Table 1.0) which has the criteria's of developing sustainable built environment and checking climate change through its availability, affordability flexibility, energy efficient, recyclable and community involvement to mention a few.

The field work carried out has indicated that the respondents comprised more of male 20(74%), the female who were 7(25.9%) of the 27 respondents had 2(28.6%) applied compressed earth bricks in their projects and the application by male is 7(35%), while all respondents indicated awareness of CEB. Respondents 40 years and above has high level of awareness and usage of CEB at 63% and 35% respectively. More architects were sampled and they indicated high level of awareness while 5 out of 13 architects representing 38.4% had applied earth to their projects showing low application. Respondents 15 and above years of experience had utilised CEB in their projects with 31.6%. All the respondents sampled agreed that CEB is a sustainable building material with maximum (Thermal comfort qualities) and minimum (Employment Opportunity) with mean of 3.81; 2.59 and standard deviation of 0.396; 0.888 respectively.

CONCLUSION

Sustainability is paramount to human existence and the built environment but to achieve sustainability, sustainable practices must be incorporated to our day-day activities, especially in carrying out design, construction, operation and maintenance of new buildings and retrofitting of existing ones. Another important means of attaining sustainability is through ensuring the utilisation of sustainable building materials and applying them efficiently. These sustainable building materials are materials that fit into the concepts of sustainability which includes economical, environmental and socio-cultural. Even though there is high level of awareness and low use/application of compressed earth bricks for building most professionals indicated interest in application. It was also ascertained that compressed earth bricks comprised of high sustainability qualities such as energy efficiency, thermal comfort, affordable and showcasing the cultural heritage of the society.

RECOMMENDATIONS

Stakeholders in the building industry (professionals and developers) should encourage their clients through advertisements, exhibits and pilot-projects in the use of CEB.

Application of compressed earth bricks as a major building material should be incorporated into the formulation and implementation of housing policies and programs by all levels of the government so as develop a society and environment that is sustainable.

Governments at all levels should partner with grassroots organisations, private developers and professionals to organise training seminars and education on the use of compressed earth bricks for mass housing.

Machines used for production of CEB should be purchased by government in the construction parastatals; developers and individual professionals for lease to clients and interested users.

REFERENCES

Abolore, A. A. (2012). Comparative Study of Environmental Sustainability in Building Construction in Nigeria and Malaysia. *Journal of Emerging Trends in Economics and Management Sciences (JETEMS)* 3(6): 951-961. © Scholarlink Research Institute Journals, 2012 (ISSN: 2141-7024. Retrieved on 15/02/2014 from jetems.scholarlinkresearch.org

Adam, E. A. and Agib, A. R. A., (2001). *Compressed Stabilised Earth Block Manufacture in Sudan*. France, Paris: United Nations Educational, Scientific and Cultural Organization (UNESCO). Retrieved on 21/06/2014 from http://unesdoc.unesco.org/images/0012/001282/128236e.pdf

Adedeji, Y. M. D. (2012). Sustainable Housing Provision: Preference for the Use of Interlocking Masonry in Housing Delivery in Nigeria. *Journal of Architecture Research*. 2 (5): 81-86 DOI: 10.5923/j.arch.20120205.03

Arumala, J. O. and Gondal, T., (2007). *Compressed earth Building Blocks for Affordable Housing*. Royal Institution of Chartered Surveyors (RICS). London: COBRA. ISBN: 9781842193570

Auroville Earth Institute (AEI), (2012). *Compressed Stabilised Earth Bricks*. Retrieved on 29/05/2014 http://www.earth-auroville.com/maintenance/uploaded_pics/cseb.pdf

Bartuska, T J, (2007). *The Built Environment: a collaborative inquiry into design and planning*. 2nd eds, 3-14. Hoboken: John Wiley & Sons.

Beckett, C. T. S (2011). *The Role of Material Structure in Compacted Earthen Building Materials: Implications for Design and Construction.* Durham theses presented in the School of Engineering & Computing Sciences Durham University, United Kingdom. Retrieved on 20/10/14 from http://etheses.dur.ac.uk/3313/1/CTSB_Thesis_Final.pdf?DDD10+

Bredeveldt, T. K., (2002). *An Investigation into the use of Concrete Block Construction in Low Cost Housing in the Western Cape.* A thesis presented in the Faculty of Engineering and the Built Environment, in partial fulfilment of the requirements for the Degree of Master in Science in Engineering, University of Cape Town.

Brown, M. (2014). *Compressed Earth Block (CEB) Construction: A Viable Building Alternative for Olancho, Honduras.* Being a Master of Science Thesis submitted to the Department of Construction Management, Colorado State University Fort Collins, Colorado Spring.

Burgess, G., Monk S. and Whitehead C., (2010). *How can the planning system deliver more housing?* Cambridge Centre for Housing and Planning Research, University of Cambridge. Retrieved on 15/02/2014 from http://www.jrf.org.uk/sites/files/jrf/planning-and-housing-delivery-summary.pdf

Mauro A. P., (2012). *Sustainable Building Materials List*. Retrieved on 10/10/2014 from http://www.gogreenacademy.com/sustainable-building-materials-list/

Deboucha, S. and Hashim, R., (2011). A review on bricks and stabilized compressed earth blocks. *Scientific Research and Essays,* 6(3), 499-506. Retrieved on 15/10/2015 from http://www.academicjournals.org/SRE. ISSN 1992-2248 .

Fadairo, G. and Olotuah, A. O., (2013). Low Cost Housing for the Urban Poor in Akure, Nigeria-Materials and Techniques of Construction. *Journal of Environmental and Earth Science. 3(9).* Retrieved on 25/11/2015 from http://www.slideshare.net/AlexanderDecker/low-cost-housing-for-the-urban-poor-in-akure-nigeriamaterials-and-techniques-of-construction

Federal Government of Nigeria [FGN], (2012). *National Housing Policy.* Abuja Nigeria: FGN Press.

United Nations Human Settlements Programmes [UN-Habitat], (2012). *Going Green: A Handbook of Sustainable Housing Practice in Developing Countries.* Retrieved on 25/02/14 from http://www.masshousingcompetition.org/sites/default/files/going_green_1.pdf

Feltes, V., (2007). *Toward Sustainable Building - Green Building Design and Integration in the Built Environment.* A thesis submitted in partial fulfilment of the requirements for the degree of Master of Science in Architecture Washington State University School of Architecture & Construction Management. Retrieved on 02/09/2013 from http://www.dissertations.wsu.edu/Thesis/Spring2007/v_feltes_050307.pdf

Gilbert, A. (2004). Housing in Third World Cities: The Critical Issues. *JSTOR*, (85), 145-155. Retrieved on 20/02/2014 from http://www.jstor.org/stable/40573408.

Gilkinson, N. and Sexton, M. (2007). Delivering sustainable Homes; Meeting Requirements: A Research Agenda; Proceedings *of XXXV IAHS World Congress on Housing Science, Melbourne, Australia,* 4-7 September, 2007, CD ROM.

Glenn, D. I., (2013). *PEOD6, Determining Sample size*. Agricultural Education and Communication Department, UF/IFAS Extension. Gainesville: University of Florida.

Green Play Book (GPB), (2010). *Building Sector Emissions*. Retrieved on 25/02/2015 from http://www.greenplaybook.org/building/learn/ghg_reductions/articles123.htm.

Guillaud, H., Joffroy, T., Odul, P. and CRATerre-EAG,(1995). Compressed Earth Blocks: Manual of Design and Construction. *Manual of design and construction,* II. Eschborn, Germany: Deutsches Zentrum für Entwicklungstechnologien – GATE.

Kim, J. J. and Rigdon, B. (1998). *Sustainable Architecture Module: Qualities, Use, and Examples of Sustainable Building Materials.* United States: National Pollution Prevention Centre for Higher Education, 430 E. University Ave., Ann Arbor, MI 48109-1115. Retrieved from http://www.umich.edu/~nppcpub/resources/compendia/ARCHpdfs/ARCHsbmIntro.pdf

Kronenburg, R. (2001). Spirit of the Machine:Technology as an Inspiration in Architectural Design. Great Britain: Wiley-Academy.

Lehrer, D. and Teicholz, E., (2001). Sustainable Design: Facility Design and Management Handbook, McGraw-Hill, New-York.

Little, B. and Morton, T., (2001). *Building with Earth in Scotland: Innovative Design and Sustainability.* Edinburgh: Scottish Executive Central Research Unit.

Minke, G. (2006). *Building with Earth, Design and Technology of a Sustainable Architecture*. Basel, Berlin, Boston: Birkhauser publishers for architecture.

National Planning Policy Framework (NPPF) and Cross Sector Group on Sustainable Design and Construction (CSGSDC), (2012). *Good Practice Guidance: Sustainable Design and Construction.* Retrieved on 11/02/14 from http://www.breeam.org/filelibrary/BREEAM%20and%20Planning/Good_Practice_Guidance_-_Sustainable_Design_and_Construction.pdf

Obonyo, E., Exelbirt, J. and Baskaran, M. (2010). Durability of Compressed Earth Bricks: Assessing Erosion Resistance Using the Modified Spray Testing. *Sustainability Journal*. Retrieved on 20/10/14 from file:///C:/Users/E/Downloads/sustainability-02-03639.pdf

Oladapo, R. A. and Olotuah. A. O., (2010). Appropriate Real Estate Laws and Policies for Sustainable Development in Nigeria. *Structural Survey (Special Issue)*. 25 (3/4) 330 – 338. UK: Emerald Publication.

Omole, K. F., (2010). An Assessment of Housing Condition and Socio-Economic Life Styles of Slum Dwellers in Akure, Nigeria. *Journal of Contemporary Management Research*, 6(4). Retrieved from http://www.cmr-journal.org/article/viewFile/2980/5130

Oppong, R. A. and Badu, E., (2012). Evaluation of Stabilised-Earth (TEK) Block for Housing Provision and Construction in Ghana. *Journal of Science and Technology, 32(2), 104-118. Retrieved on 15/01/2015 from* http://www.ajol.info/index.php/just/article/viewFile/81395/71568

Openator, (2014). *The Advantages of Compressed Earth Blocks (CEBs).* Retrieved on 21/03/15 from http://www.openator.com/advantages-of-compressed-earth-blocks/

Rael, R., (2009). ***Earth Architecture*.** California, Berkeley: APA Press publication. ISBN 9781568987675. Retrieve on 20/10/14 from http://www.eartharchitecture.org/

Rigassi, V. and CRATerre-EAG, (1985). Compressed Earth Blocks: Manual Of Production. CRATerre-EAG Manual of Production, I. Deutsches Zentrum für Entwicklungstechnologien - GATE in: Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ).

Riza, F. V., Abdulrahman, I. and Zaidi, A. M. A., (2011). *A Brief Review of Compressed Stabilized Earth Brick (CSEB).* International Conference on Science and Social Research (CSSR), December 5-7, 2010 Kuala Lumpur, Malaysia. Retrieved on 04/01/16 from http://www.researchgate.net/publication/224238871

Roodman, D. M. and Lenssen, N., (1995). *A Building Revolution: How Ecology and Health Concerns are Transforming Construction.* Worldwatch Paper 124,5. Washington, D.C: Worldwatch Institute.

Roy, S. and Chowdhury, S., (2013). Earth as an Energy Efficient and Sustainable Building Material. *International Journal of Chemical, Environmental & Biological Sciences (IJCEBS)* 1(2), 248-252. Retrieved on 11/01/2016 fromhttp://www.isaet.org/images/extraimages/D313014.pdf

Russell, D., (1995). *Theory and Practice in Sustainability and Sustainable Development.* Research and Reference Services Project.

Taiwo, A. and Adeboye, A. (2013). Sustainable Housing Supply in Nigeria Through the Use of Indigenous and Composite Building Materials. *Journal of Civil and Environmental Research*, 3(1). www.iiste.org ISSN 2222-2863 (Online).

United Nations Environment Programme- Sustainable Buildings and Climate Initiative [UNEP-SBCI], (2012). *Building Design and Construction: Forging Resource Efficiency and Sustainable Development*.

United Nations Industrial Development Organization [UNIDO] and the International Centre for Science and High Technology [ICSHT], (2008). *Available Technologies for Local Building Materials.* Retrieved on 18/02/14 from

http://institute.unido.org/documents/M8_LearningResources/ICS/12.%20Available%20technologies%20for%20local%20building%20materials.pdf
UN-Habitat, (2011). Shelter Initiative for Climate Change Mitigation and Adaption (SICCMA). *Scoping Paper, Sustainable Building Practices for Low Cost Housing: Implications for Climate Change Mitigation and Adaptation in Developing Countries*. Retrieved on 03/02/2014 from http://www.unhabitat.org/downloads/docs/10785_1_594340.pdfVador, B. (2012). *Earth Architecture Innovations in Earth Construction and Potential of Earth Architecture in Contemporary Scenario*. An undergraduate Research Thesis Vyavasayi Vidya Pratisthan's Indubhai Parekh School of Architecture Rajkot, India.
World Business Council for Sustainable Development (WBCSD), (2009). *Transforming the market: energy efficiency in buildings*. Switzerland: WBCSD.
World Business Council for Sustainable Development (WBCSD) and Arup, (2012). *Material Choice for Green Buildings.* Retrieved 29/10/2014 on from http://www.wbcsdcement.org/pdf/WBCSD_Material%20choice%20for%20green%20buildings_201201(Jan).pdf
World Commission on Environment and Development (WCED), (1987). "Our Common Future", Oxford: Oxford University Press.
Yuefeng G. (2011). *Promoting a Paradigm Shift toward Sustainability of the Built Environment: Problems, Opportunities, Strategies and Implementation*. A thesis submitted in fulfilment of the requirements for the degree of Doctor of Philosophy in Architecture, School of Architecture and Planning National Institute of Creative Arts and Industries, The University of Auckland, New Zealand. Retrieved on 21/06/2014 from https://researchspace.auckland.ac.nz/bitstream/handle/2292/17972/whole.pdf?sequence=2

CROSS CUTTING ISSUES

3D MODELING OF STRUCTURES USING TERRESTRIAL LASER SCANNING TECHNIQUE. *Case Study: Faculty of Engineering, University of Lagos*

OSENI, Ayokunle Ebenezer
Department of Surveying & Geoinformatics, Bells University of Technology, Ota, Ogun state, Nigeria.

Corridor and internal mapping is almost impossible with the fastest means of survey, there is a need for a system that can capture object geometry in 3D in a direct, rapid and detailed manner; also with the possibility to survey remotely very complex, inaccessible and hazardous objects and areas, where the traditional techniques are either incompetent or slow. The laser scanning technology provides multipurpose use of the data, both currently and for future use, with the completeness and comprehensiveness of scanning. "Everything" in the scene is captured at once without a need for lighting for data acquisition. Therefore, the user does not need not return to the site if some new data is needed leading a dramatic reduction in costs and much faster project completion. Coverage of the whole object is achieved through scanning, by means of an opto-mechanical scanner, in both horizontal and vertical directions, at the rates of thousands to several hundreds of thousands of points per second, depending on the ranging approach employed. The output of this process is a highly detailed 3D image of the object, typically consisting of millions of densely spaced points, called "point cloud". The aim of the project was to develop a 3D model of some parts of the faculty of Engineering, University of Lagos using the Laser scanning technology. The field work entailed the use of a Leica TS06 total station instrument to coordinate 32 survey control points serving as stations on which the laser scan station 2 instrument was set. The reflector less Total station was used to get the coordinates of some points for georeferencing and checking points for the distance comparison analysis. The Leica scan station 2 was used to acquire fine scans, images and acquire targets from fence at each station. The scans where done at 150mm horizontal point spacing by 150mm vertical point spacing. Leica Cyclone 7.0.software designed for the Scan station 2 was used to carry out the scans, image, registration, meshing and animation. The results showed that 3D models of structures can be modelled and also, the point cloud coordinate are about the same as total station survey. Also, queried distances on object have been found to be the same with the measurements obtained from using the linen tape. The research concludes 3D terrestrial laser scanning has been shown to be a very effective and time efficient technology for data capture. The time spent on the field is much shorter with greater data acquired than regular survey methods. When also likened to close range photogrammetry, the time spent on data processing makes terrestrial laser scanning more efficient.

Keywords: *Modelling, Scan station, Cyclone, Point Cloud, Scan world*

ayo_oseni@yahoo.com
aeoseni@bellsuniversity.edu.ng

OSENI, A.E (2016). 3D Modeling of Structures Using Terrestrial Laser Scanning Technique: Case Study: Faculty Of Engineering, University of Lagos: Sustainable Built Environment and Climate change; The challenges of Post 2015 Development Agenda. School of Environmental Technology Conference, SETIC, 2016

INTRODUCTION

In any field of study, solutions to problems are developed based on the information acquired about the subject matter. The subject matter may involve tangible or intangible entities but, in engineering, the subject matter is usually tangible, and in this case, it is a physical structure. To obtain any relevant information about a structure, data has to be collected.

Remote sensing is the acquisition of information about an object or phenomenon, without making physical contact with the object. This is possible with the aid of sensors which measure and record some properties (radiation) of the object. This project attempt to explore one of the recent data acquisition systems which can be termed a fusion of 'remote sensing' techniques and 'close range photogrammetry' methods. Remote sensing could be **passive** or **active**; **passive** when the sensor records natural emissions and reflection from the object and, **active** when the sensor itself sends a signal to the object and measures the reflected signal over a short space of time. The data acquisition system used in this project operates on the active remote sensing technique. It can also be likened to CRP with respect to the design of the instrument and target positioning, data processing (interior, relative and absolute orientation) and accuracy.

The Leica Scan Station2 High Definition Surveying (HDS) equipment was used along with Cyclone 7.0.3 for data acquisition and processing in this project. **High Definition Surveying (HDS) or simply laser scanning is the collection of high density spatial data sets relating to a structure/objects or land for use in asset and site development planning or dimensional control (http://www.starnetgeomatics.com/laser_scanning.php.**

Terrestrial laser scanners acquire data in form of point clouds in 3 dimensions x, y and z, from every scene or station without the need for overlap. It provides the users with the possibilities of direct and automated 3D data capture. TLS employs an indirect ranging principle. The distance, or range from the sensor (a terrestrial laser scanner) to a point on the object surface is determined with high accuracy by measuring the time elapsed between the emission of a laser signal and detection of its portion backscattered from the surface (time-of-flight, TOF). TOF laser scanners employ the following techniques for measuring the travel time of a signal by utilizing different physical effects (Hebert and Krotkov 1992; Wehr and Lohr 1999; Lange 2000).

3D data acquisition about terrestrial objects has been a source of continual research as new technologies keep coming up year after year. The most celebrated methods of simultaneous 3D data acquisition of multiple points and objects are still terrestrial laser scanning and CRP. The data obtained are processed on the computer. In computer graphics, 3D modelling is the process of developing a mathematical representation of any three-dimensional surface of an object using specialized software. Such an output is called a 3D model. A model so called because it is a representation of some real object and the relationship within sub-parts of that object in real life is maintained on the model. 3D models are formed using a collection of points in 3D space, connected by various geometric entities such as triangles, lines, curved surfaces, etc. They can be created manually, algorithmically (procedural modelling), or scanned. Close range photogrammetry (CRP) methods are more procedural based. Scanning usually returns conformal mapping; in scale, angles and distances in relation to the real world object.

Digital close range photogrammetry is a technique for accurately measuring objects directly from a photograph or digital image captured with a camera at close range, and multiple images are used to create accurate 3D models of objects (Kraus, 2007). Photogrammetry techniques allow you to convert images of an object into a 3D model. Using a digital camera with known characteristic (lens focal length, imager size and number of pixels), you need a minimum of two pictures of an object. If you can indicate the same three object points in the two images and you can indicate a known dimension, then you can determine other 3D points in the images (Atkinson 1996), (Cooper and Robson 1996).

The laser scanner technology is an accurate and efficient way to collect and present field data; it provides rich and reliable information about the base design of buildings, monitor changes, etc. Moreover, one of the main benefits of this technology is the fact that the point cloud is an unambiguous measurement of what exists in the real world.

Today, 3D models are used in a wide variety of fields. The medical industry uses detailed models of organs. The movie industry uses them as characters and objects for animated and real-life motion pictures. The video game industry uses them as assets for computer and video games. The science sector uses them as highly detailed models of chemical compounds. The architecture industry uses them to demonstrate proposed buildings and landscapes through Software Architectural Models.

BACKGROUND TO THE STUDY

The way and manner by which processed data is presented affects perception either positively or otherwise. In surveying and engineering, proper, accurate and explicit presentation of data especially spatial data, enhances accurate judgment and analyses. A creative and explicit way to present and display data is to model these data in three dimensional views or 3-D. Three dimensional (3- D) modeling (also known as meshing) is the process of developing a mathematical representation of any three-dimensional surface of object (either inanimate or living) via specialized software- the product is called a three dimensional model. Three dimensional models represent a three dimensional object using a collection of points in three dimensional space, connected by various geometric entities such as triangles, lines, curved surfaces, etc. Being a collection of data (points and other information), three dimensional models can be created by hand, algorithmically (procedural modeling), or scanned- Wikipedia.

The generation of three dimensional models of objects and features, these days is not an unfamiliar concept. Over the years, several kinds of models have been developed for different uses within different fields in and outside engineering. One of the methods for developing the three dimensional models that seems to be fast gaining grounds is the reality-based approach. The generation of the reality based three dimensional models is usually performed by means of images or active sensors like a laser scanner. According to Waggott, Clegg and Jones (2003), the laser scanner technique has allowed the rapid data collection of complex and complicated structures, both natural or manmade structures.

Generally three dimensional scanners are devices that analyze a real-world object or environment to collect data on its shape and possibly its appearance (i.e. color). The collected data can then be used to construct digital, three dimensional models. Collected three dimensional (3-D) data is useful for a wide variety of applications. These devices are used extensively by the entertainment industry in the production of movies and video games. Other common applications of this technology include industrial design, orthotics and prosthetics, reverse engineering and prototyping, quality control/inspection and documentation of cultural artifacts.

The Laser scanner ,an example of a three dimensional scanners ,is a terrestrial laser-imaging system that quickly creates a highly accurate three-dimensional (3D) image of an object for which can be further processed, analyzed and manipulated in software packages like the Cyclone 7.0.3. The system can produce more accurate as-built data and/or drawings in less time compared to the standard approaches. The generation of the three dimensional view of some parts of Engineering discussed in this project was achieved using an active sensor, the Leica Scan Station 2 laser scanner

PROBLEM STATEMENT

There is a need to be able to model structure in such way that accurate needed information about positions of features and points can be easily extracted without having to pay physical visits to site. A model that represents an accurate as built survey would effectively solve this problem. The risk involved in some engineering works especially with high rise structure sometimes can be so enormous. Development of models like this therefore becomes imperative in order to reduce risk to as low as reasonably practicable.

LITERATURE REVIEW

Terrestrial Laser Scanning

Terrestrial laser scanning provides highly accurate, three-dimensional images to and delivers directly point-clouds in computer-aided design software. The laser scanners can record thousands of 3D points in seconds. That is, high speed data-acquisition in combination with high accuracy.

Laser scanners are optical measuring systems based on the transmission of laser light. The environment is illuminated on a point by point basis and then the light reflected by an object is detected. A laser scanner consists of a one-dimensional measuring system in combination with a mechanical beam-deflection system for spatial survey of the surroundings. The laser system measures range images which generates geometric dimensions of the environmental scenes whereas the reflectance image generates a photographic like impression of the scanned environment which can be used for feature extraction, visual inspection, object identification, surface classification and documentation purposes. The laser scanners thus provide an active illumination, non-contact measurement of the environment. This is advantageous in many situations, where operator access is limited or poor ambient lighting exists. In combination with passive CCD cameras colour information is mapped onto the geometry, leading to virtual reality. At the moment terrestrial laser scanners are used mainly in many engineering applications in order to digitize the 3D model of objects.

A laser-scanner generates 3D-coordinates of an object point by measuring the horizontal and vertical angle and the distance between the scanner's center and the object point. This happens with high performance. Depending on the type of scanner and the method of distance measurement used (time of flight or phase difference), it produces from 50,000 points per second (Leica scan station 2 HDS3000) up to over 900,000 points per second (Faro Photon).

Laser Scanner Overview

Laser scanners are able to conduct rapid and very dense surveys of a structure within an hour (Hirst and Roberts, 2005). The laser scanner can capture and record hundreds and thousands of angles and distances. The distance and angles recorded are transformed in to a dense point cloud of millions of x, y, z points that represent the object being scanned. Laser scanners record up wards of 50,000 points a second and the finished point cloud contain many millions of x,y,z points. The point cloud is displayed in a software package such as Leica's Cyclone or Maptek's Vulcan but for the purpose of the project, the Cyclone 7.0.3 software was used. Many conventional survey software packages have been upgraded to have the ability to view or edit point clouds. The laser scanner works somewhat like an automated total station in that it can be force-centred over a mark and back-sighted to a target. Unlike a total station, where the operator selects all the points for measuring and recording, the laser scanner uses a time of flight measurement or pulsed diode laser for measuring the distance of the transmitted laser and an internal angle recorder to measure the angle that the laser transmitted and the angle the laser receives. The laser scanner has an automated system that programs the scanner to rotate 360° in the horizontal plane and up to 270° in the vertical plane. Different brands of laser scanners have different fields of view (Lichti et al, 1999).

The laser that is transmitted hits the surface of the structure being scanned and reflects back to the laser scanner. The laser scanner measures the intensity of the return beam. This intensity is dependent on the reflectivity of the surface. A high reflectivity surface such as a white smooth wall, will give good results while a dark or wet surface will have the low reflectivity. Most laser scanners are able to take a 360 degree panoramic photo of the area being scanned and this photo can provide real colour to the point cloud. This is done by providing coordinates of the digital photo. This allows easy interpretation of the point cloud (Bornaz et al, 2004). The spot size of the transmitted laser is an important factor to consider when discussing laser scanning. When a laser is transmitted the laser spot size will increase in size the further the laser has to travel to meet its reflective surface. In the instance of Leica's new HDS6000 the spot size is 8mm at 25 metres and 14mm at 50 metres. Edges of structures will also affect the transmitted laser beam. When only part of the laser beam reflects back off a surface, the other part of the laser will continue until it hits a reflective object and reflects back to the scanner.

Application of Terrestrial Laser scanning approach to 3D modelling

Due to its fast and accurate ability to scan objects and surfaces, the laser scanner is being utilized in many industries including mining and archeology. The ability of the laser scanner to pick up points without having to have an assistant place a target on the surface or object means that it is perfectly suited to survey dangerous features like busy highways (Chow, 1999) and landslide surveys (Bitelli et al, 2004). Bitelli et al (2004) used laser scanning to monitor a land slip site in Northern Italy (Fig. 1). Usually this type of work would be done by aerial Photogrammetry methods. The traditional method of airborne surveying was compared to terrestrial laser scanning of the land slip site, which was 40,000 square meters in size. The authors found that the laser scanner provided a fast, accurate and relatively cheap way to monitor mid-size landslide areas compared to airborne survey techniques.

Chow (2004) used a Leica HDS3000 laser scanner to pick up surfaces on high-speed highways in Hong Kong (Fig. 2). Using traditional surveying methods, this would have involved the closure of roads and would have been costly. It would have been unlikely to be approved by the road transport authority of the Hong Kong Police. Laser scanning allowed the safe and accurate, non-contact survey of the highway surfaces and features without the closure of roads and the risk to survey personnel.

Leica Scan station 2

The laser scanner that was used in this project will be the Leica ScanStation2. The ScanStation2 is a pulsed time of flight scanner that has the ability to scan up to 50,000 points a second. The ScanStation2 has a range of up to 300m with a position accuracy of ±6mm and a distance accuracy of ±4mm. The ScanStation2 has the ability to setup over a known survey station and back sight to a known point. The scanner is also able to calculate a resection off 2 or more known points and is even able to traverse (reference). The ScanStation2 is also able to stake out known points.

ScanStation 2 adds blazing speed to the four, fundamental total station features that made ScanStation a new category of laser scanner for as-built and topographic surveys. Now, with a 50,000 points/sec maximum instantaneous scan rate, full field-of-view, survey-grade tilt compensation, survey accuracy for each measurement, and excellent range, ScanStation 2 has set a new standard for versatility, productivity and ease-of-use in High-Definition Surveying™ (HDS™). Pulsed or "time-of-flight" scanners are often considered highly versatile because of 24 Scan Station 2 delivers survey accuracy for each measurement. Its ultra-fine scanning and small laser spot also let users achieve optimal project control and registration.

Its capture range (up to 300m for 90% surface reflectivity) combines with its narrow beam and ultra-fine scanning capabilities to address a wide variety of sites. Stake out and traverse points can be picked by Aiming/Sighting Optical sighting using QuickScan™ button.

General Leica Geosystems HDS Cyclone - software modules provide point cloud users with the widest set of work process options for 3D laser scanning projects in engineering, surveying, construction and related applications.

The Software consists of five packages:

- Cyclone-Scan: Allows the user to control the Scanner
- Cyclone-Register: Allows the user to register multiple Scans together or to Geo-reference the point cloud.
- Cyclone-Survey: It gives the user basic functionality to extract and measure information out of the rich point cloud.
- Cyclone-Model: It gives the user the full functionality of Cyclone. The user is able to extract and measure features and to create a 3D Model out of the Point Cloud.
- Cyclone-Publisher: Allows the user to publish point cloud data to a panoramic viewing format which can be posted to the web. The user can then view this data using the Internet.

Some terms are peculiar to the cyclone environment, some of which will be used in other chapters. Some of these terms are;

- Scan world: It is an object that contains information about a particular laser scanned objects
- Point Cloud: A point cloud is a geometric object in a scan world, defined by x, y and z coordinates. It also has the ability to store intensity and colour.
- Model Space: It is a collection of geometry and information about the organization of the geometry.
- Control Space: The Control Space is used to review, organize, or remove objects; it is also used to add constraints manually.
- Registration: The Control Space is used to review, organize, or remove objects; it is also used to add constraints manually.

RESEARCH METHOD

Terrestrial laser scanning technique used in this project bears some similarities to some photogrammetric principles. The similarities include registration of scan to scan, which can be likened to relative orientation; georeferencing by registration, which is also similar to absolute orientation etc.

The instruments used in this project are classified into hardware and software. The different hardware used are; from control survey was done by GPS, target coordination by total station e.t.c. Leica Promark 3 (dual antenna) GPS and accessories, Leica TS06 total station and accessories, Leica Scan Station 2 HDS and accessories. Various software products were used for data acquisition, data processing, visualization, analyses and interpretation which include Cyclone 7.0.3, Leica Geo-Office, Microsoft Access 2007 and Microsoft Excel 2007. A Reconnaissance survey of the area of study was carried out. The design stage was done in the office, drawing from the experience of the field reconnaissance survey and the data acquired from the office reconnaissance survey. Identified spots from the field were marked on the architectural plan and a network was created of points were created. Every prospective station was designed to accommodate four target points in four different directions, so as to have good alignments for scan world to scan world registration (relative orientation).

The instrument stations were marked on the ground by a 'point edge nail' embedded in a triangular mark on the ground each station was also given specific names or code. The first station occupied was named "station1", and its corresponding targets were coded as 'tgt1', 'tgt2', 'tgt3'and 'tgt4'.

Figure1: Station marking for one of the stations

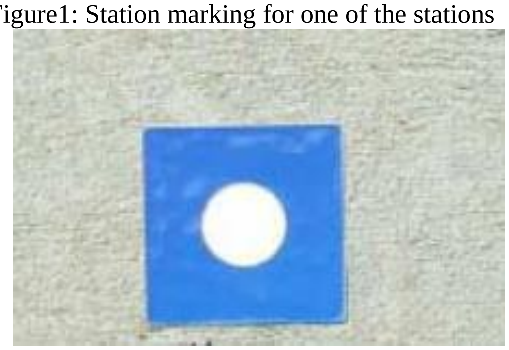


Figure 2: Target and target description

The survey can be classified into three different classes namely; Laser scanning, Control survey, Specific point survey. The laser scanning was done using the Leica Scan Station 2 (HDS 3000). The Leica Scan Station 2 is also used in a step by step approach. Set up, configuration, settings, probing, 3d image acquisition, target acquisition, point cloud acquisition.

Figure 3: Showing the set up of the instrument, after connecting the cable

The scanner was configured by adding a new scanner on the window. It was named Unilag and the IP address (10.1.204.55) on the instrument was entered.

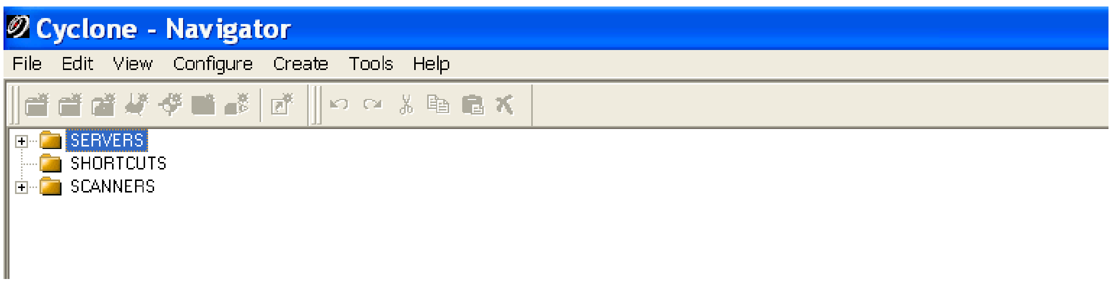


Figure 4: showing the default look of the cyclone 7.0.3 environment

Other configurations that were done were for the 'server' and the 'database' used for the project. The server was added as 'USER (Unshared)' and the database was named '3d modelling'.

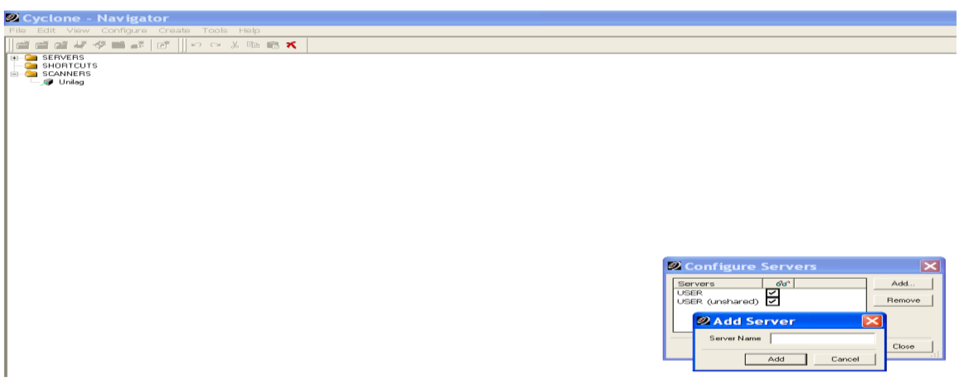


Figure 5: Showing configuration stage for server after configuring the scanner

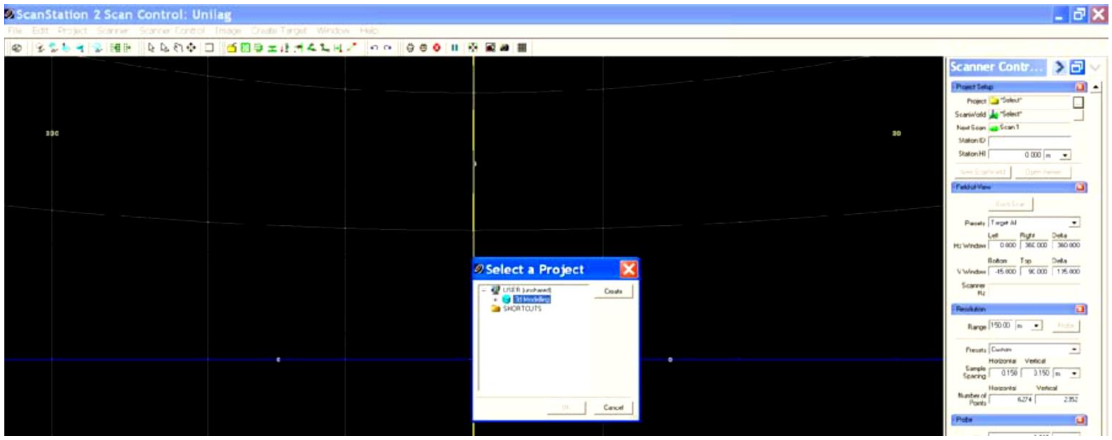


Figure 6. Creation of a project into the configured database via the scan control window

Once created, the workspace automatically opened up with a scanworld name which was edited and saved as ‘station1

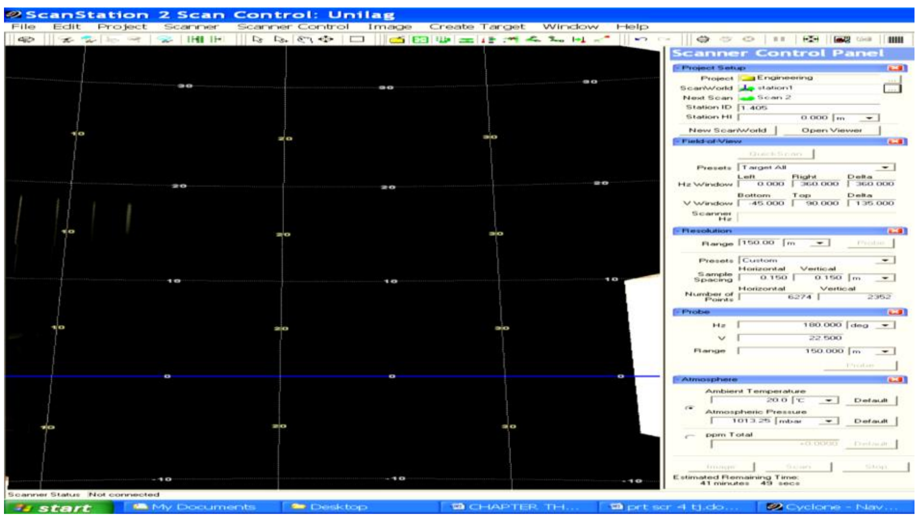


Figure 7: Showing the scan control window

For every station occupied, the 3D image was taken, spanning the field of view, it was done by clicking ‘get image’ on the image menu from the scan control window. This enabled us to see the features around the structure, especially the targets and where they fell in the scan control window. Knowing where the targets are on the scan control window makes it easier for anyone to acquire the scan for the targets.

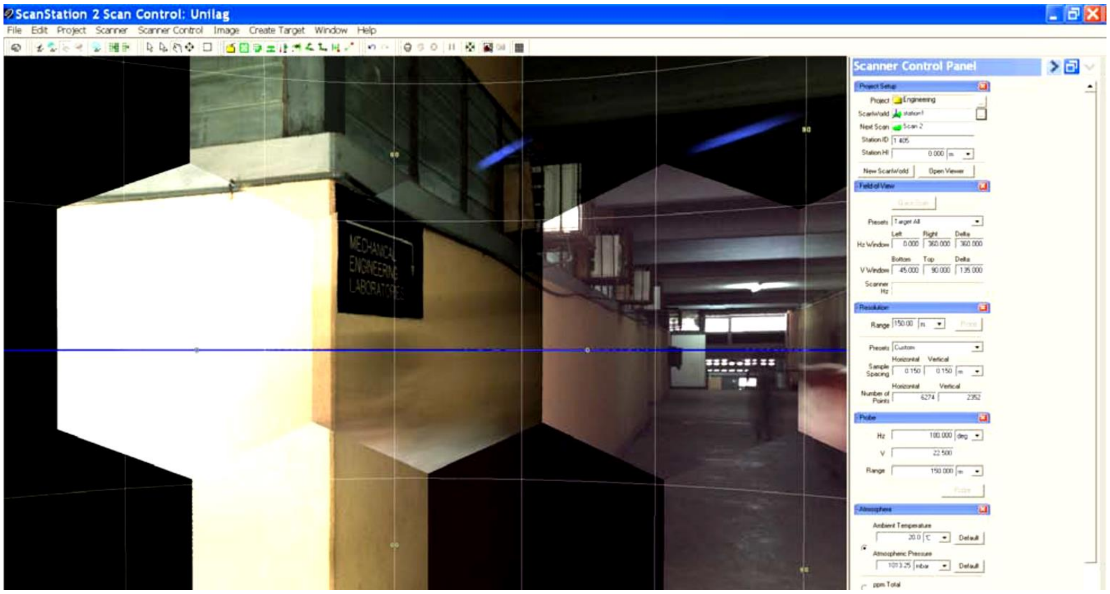


Figure 8: Acquiring the 3D image (from the scan control window).

Targets were acquired by first defining a fence around where they were shown in the image acquired. The fence was to define a smaller field of view for the scanner to search for them, it made target acquisition easier and faster. After defining the fence, the targets were acquired using the scanner control menu and clicking on ‘Acquire targets’. As it was with the instrument itself, the target height was noted and imputed in the target listing, with each target given its own target ID.

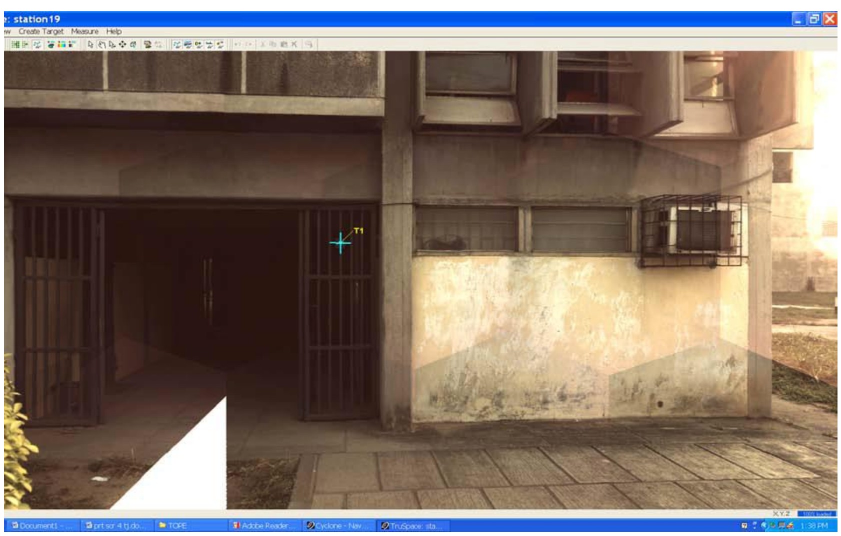


Figure 9: Acquired targets from the 3d picture taken from another station

To acquire the point clouds, the scan button on the scan control window or navigating through the scan control menu on the menu bar. We used either as soothing to the person acquiring the scan at that specific station.

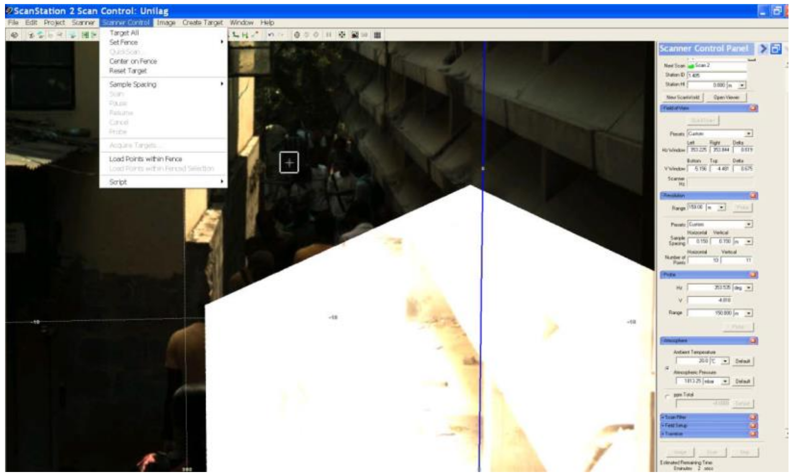


Figure 10. Process of initiating the scan

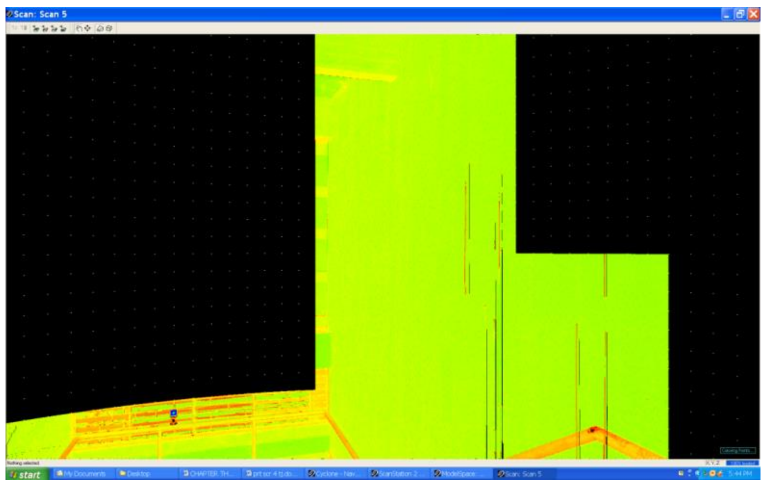


Figure 11. Point clouds loading during scanning

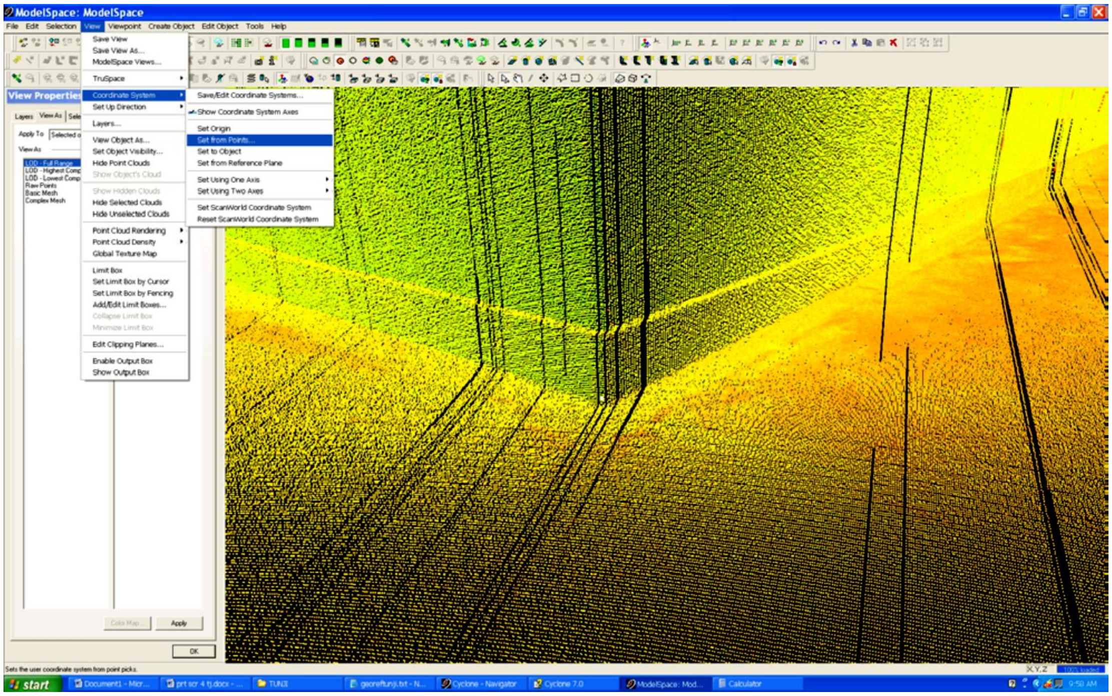


Figure 12. Accessing the coordinate system of the current scanworld for the transformation.

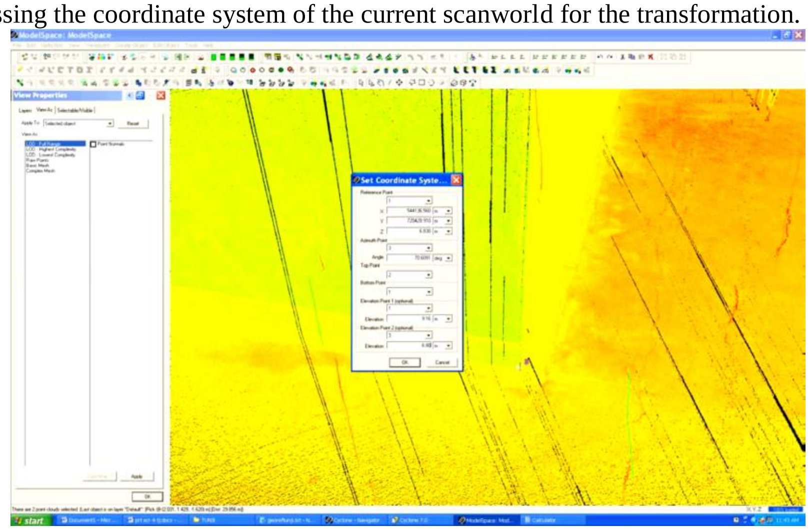


Fig 13. Fixing the required parameters for the three points in chosen.

Modeling in the cyclone environment is also refered to as ‘meshing’. The meshing tool that defines the solid/model that we desire is called complex meshing. However, the complex meshing tool became inactive when all the point clouds were selected. As such all the point clouds in ScanWorld [Surveying and Geo Office] could not be used to make the model. Alternatively, point clouds were selected generally across the scanworld and the space was viewed as a complex mesh

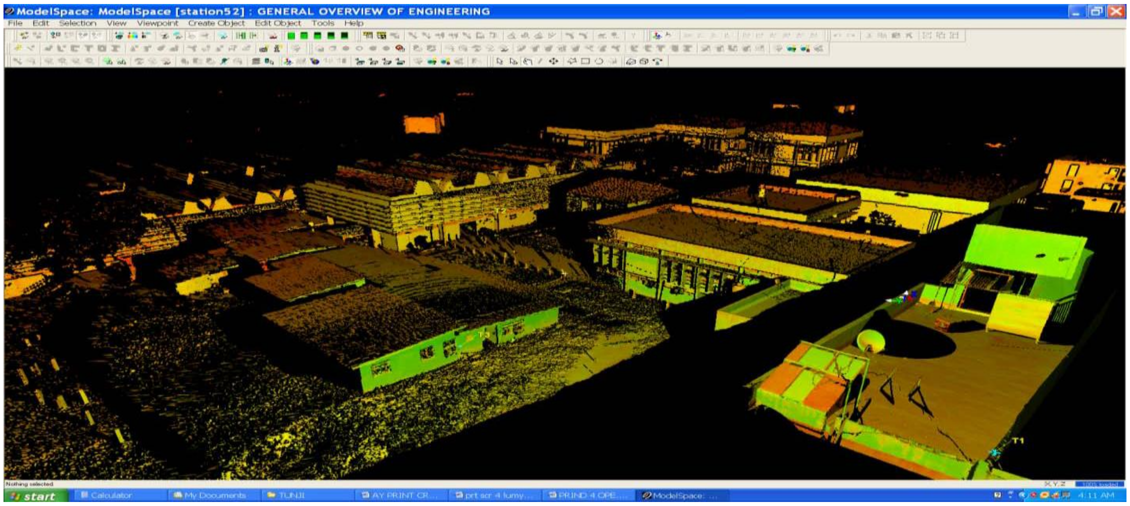


Fig 14: The Mesh Aerial View of the faculty of engineering from energy and conservation centre

A 'fly through' was done on the modelled structure by panning and zooming through in point cloud or model viewing mode. The animation was done by creating a layer for animation, inserting cameras, connecting cameras with paths, editing animation parameters and saving the animated view as a video file.

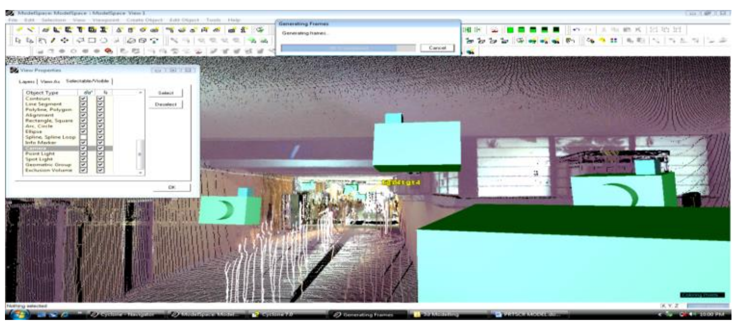


Fig 15: camera position and positioning during animation building

FINDINGS AND DISCUSSION OF RESULTS

From the control and target surveys, coordinates were obtained for about one hundred points in and around the survey area. However only the coordinates relating to station1 and station two are shown

Easting	Northing	Elevation	Point Id	Remark
544197.299	720454.173	6.779	L001	Control
544231.361	720437.129	7	L002	Control

Table 1. Showing the coordinates established from the GPS control survey.

x	y	z	tgtid
544183.13	720446.22	9.17	GEOREF_T1
544182.28	720448.41	9.02	GEOREF_T2
544182.22	720448.38	6.8	GEOREF_T3
544183.17	720446.25	6.81	GEOREF_T4
544135.12	720432.18	7.6	GEOREF_T5
544135.85	720430.4	7.58	GEOREF_T6
544136.56	720428.9	9.16	GEOREF_T7
544136.56	720428.91	6.83	GEOREF_T8
544168.91	720440.5	9.15	GEOREF_T9
544168.9	720440.5	6.83	GEOREF_T10
544164.62	720438.77	9.16	GEOREF_T11
544164.63	720438.79	6.8	GEOREF_T12
544172.01	720430.07	9.27	CHECK_T1
544172.92	720430.4	9.28	CHECK_T2
544172.95	720430.38	7.78	CHECK_T3
544172.01	720430.08	7.76	CHECK_T4
544151.58	720471.22	8.91	CHECK_T5
544154.54	720472.41	8.92	CHECK_T6
544150.89	720470.07	6.76	CHECK_T7
544160.86	720442.37	8.96	CHECK_T8
544160.87	720442.37	6.83	CHECK_T9

Table 2: Showing the coordinates and codes of the points or features on the structure, obtained from the total station survey.

The results of the laser scanning yielded scan worlds at every station. In all, thirty two (32) stations were occupied and the scan world all exists in the database. As it was with the field coordinates, this write up would only show two of the scan worlds (station1 and station2)

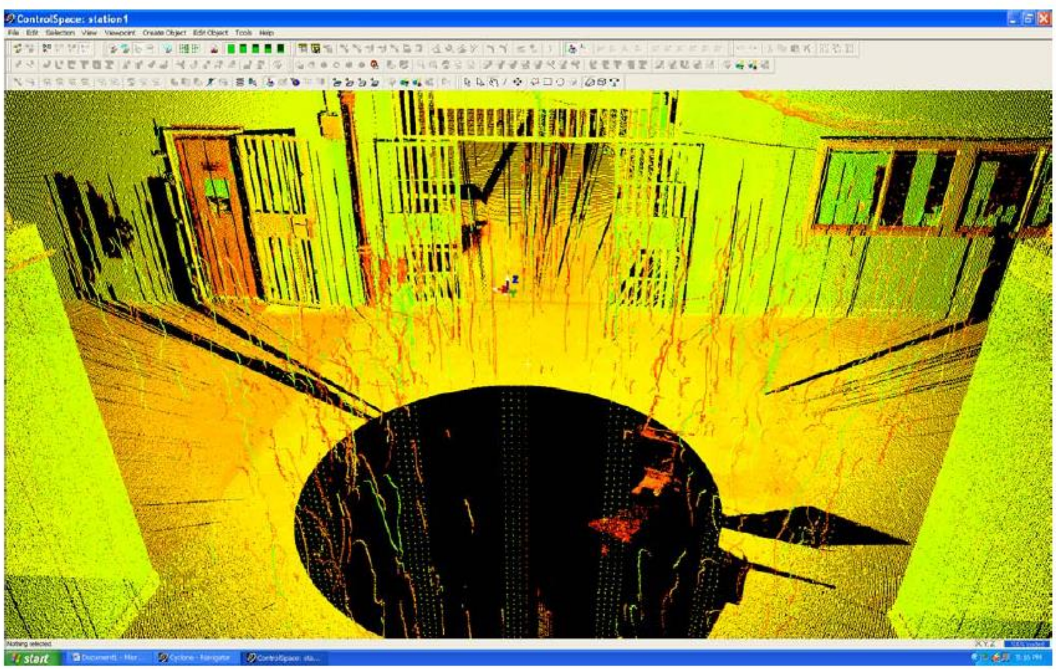


Figure 16 Point clouds in station1 being viewed from instrument position

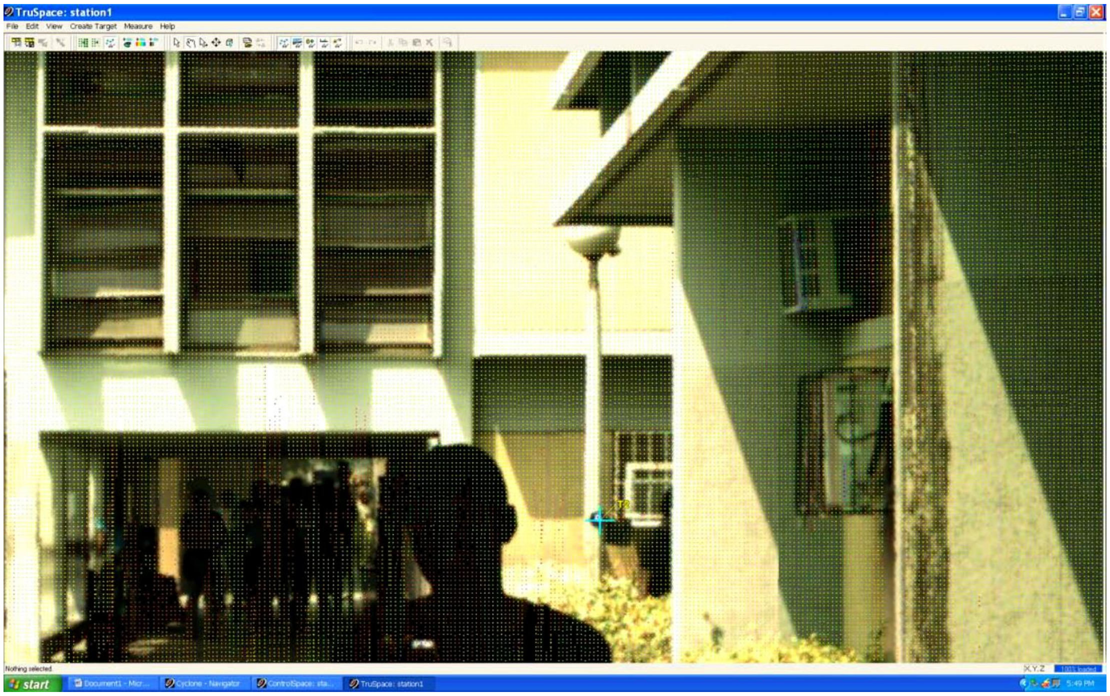


Figure 17 A target (T2) being shown in 'true space

Contiguous and overlapping scan worlds were registered together to form a single and seamless scanworld. The coordinate system of individual ScanWorlds are transformed into a common coordinate system; this is similar to **'relative orientation' in photogrammetry**. The desire was to combine all the scanworlds into one single scanworld through registration but, there was problem of not having a computer that was fast enough to take on such a huge task.

The result of the registration process was also a new scanworld, having the harmonized point clouds from the two individual scanworlds. The new scanworld known as ScanWorld [Surveying and Geo Office] and it is shown below

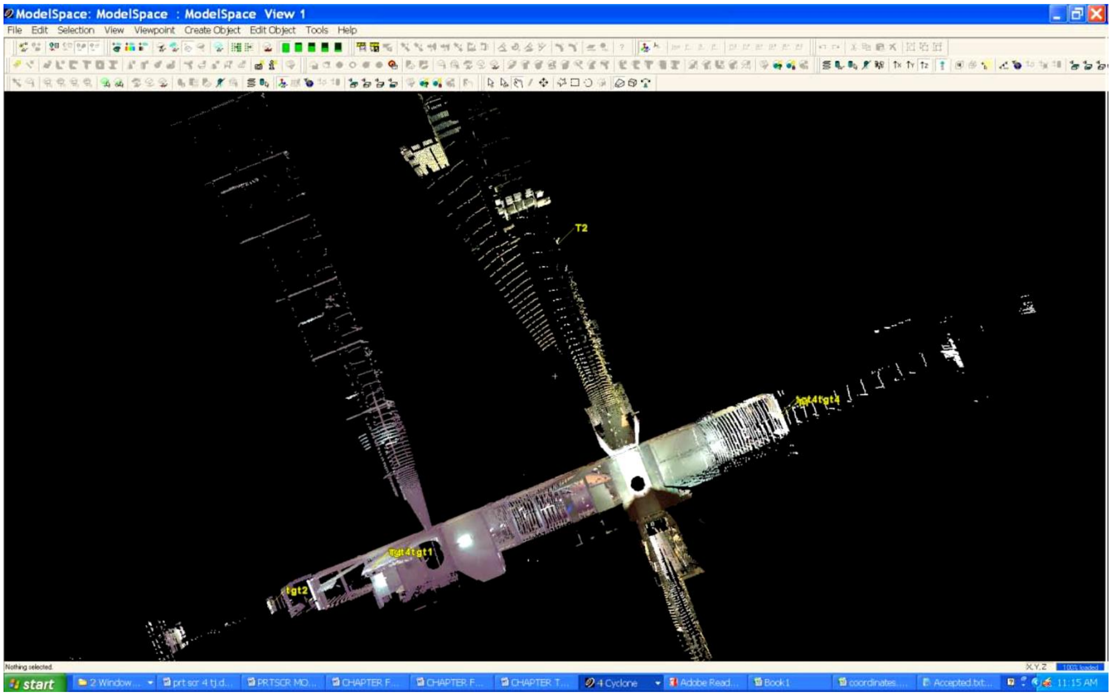


Figure 18: showing the two stations from a single scan world, showing the registered scan worlds.

Figure 19 showing the registered scanworld from another view (still connecting the two scanworlds)

As said earlier, the coordinates were transformed into real life coordinates through points measured on the structure. The figure below shows the real life coordinates in the lower left corner and 'reduced level' picked point could also be displayed.

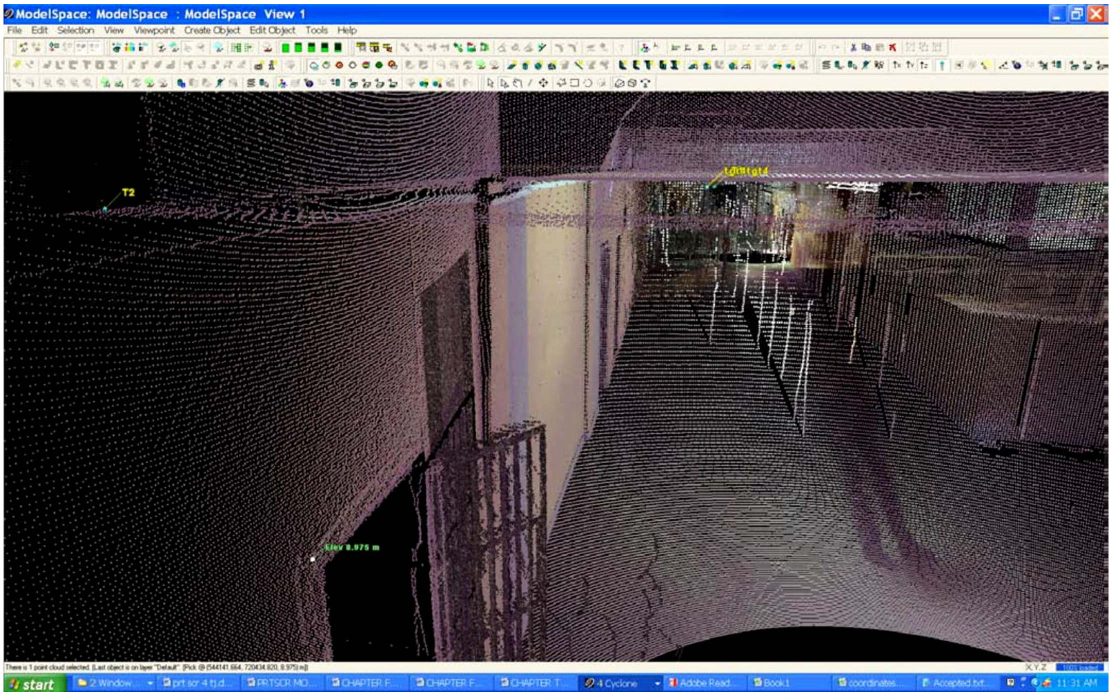


Figure 20: showing the registered scanworld in real life coordinates.

The result of the complex meshing process gave a 3D model of the registered scanworld in real life coordinates. Screen shots of the mesh from different angles are given below

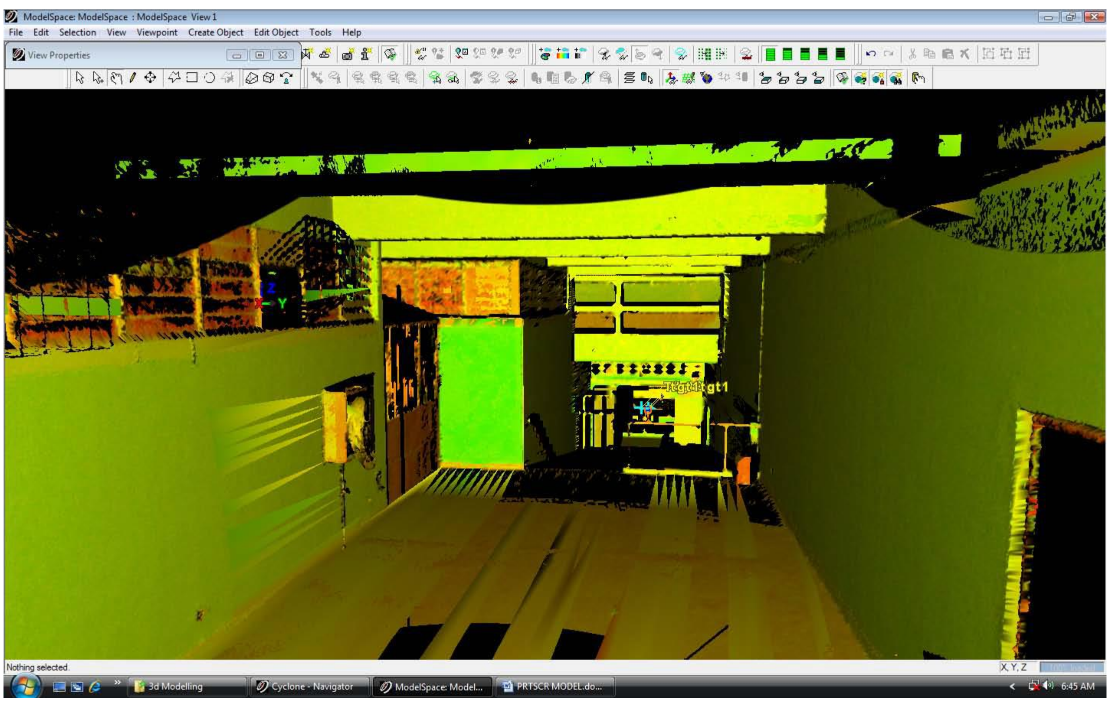


Figure 21: Showing the 3D model from one end (towards the engineering mezzanine)

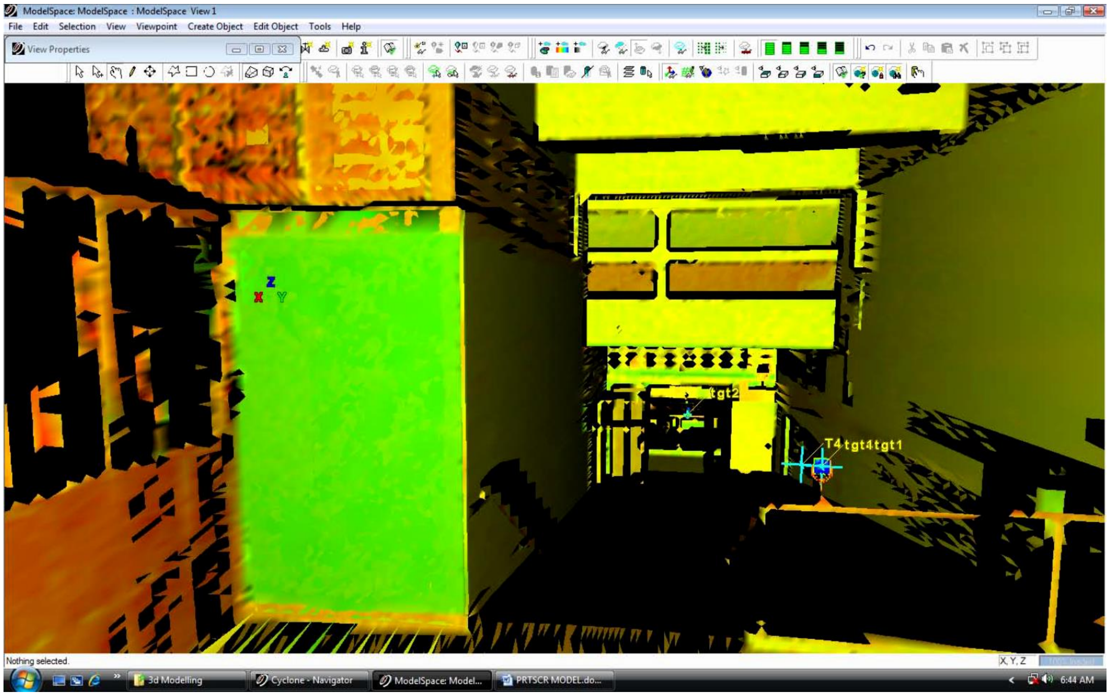


Figure 22: Showing a more closed up view of the same area in the 3D model

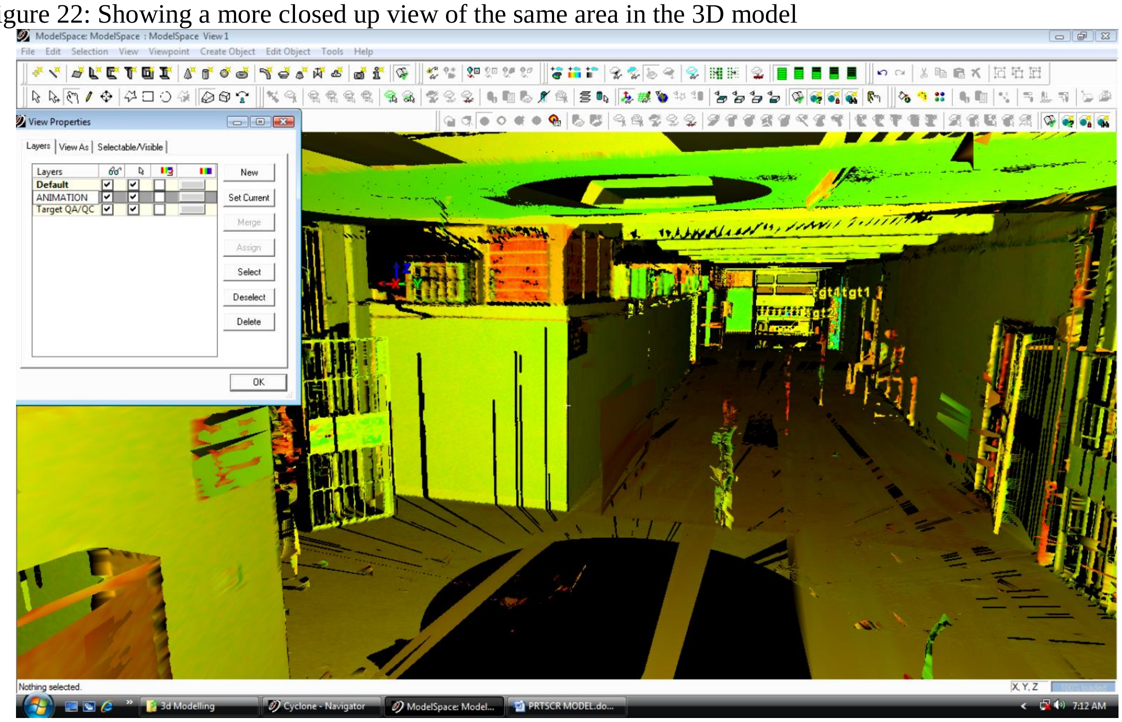


Figure 23: Showing the corridor that connects Diploma classroom, Departmental Office, Faculty Library, female students' toilets etc

ANALYSES

The registration process from scanworld to scanworld can actually be done in various ways. These are Target constraint alone, Cloud constraint alone or hybrid method. Cloud constraint alone was adopted for this project.

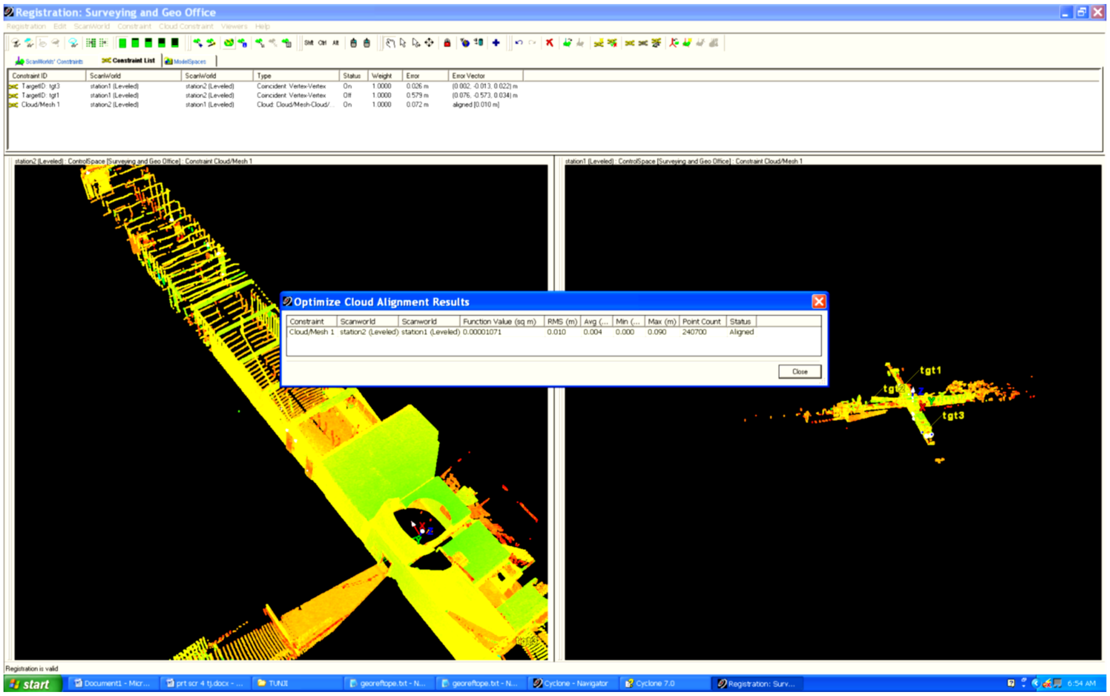


Figure 24: Cloud optimization result.

During the coordinate transformation stage, only three points were used to reorient the scanworld into real life coordinate system (ala absolute orientation). The points used were tagged Georef_8, Georef_7 and Georef_12 as points 1, 2 and 3 respectively. However, other points were also bisected with the total station on the field. All the points that were acquired on the field using the total station were also converted and imported into cyclone as targets.

Checking was done in two ways. Firstly, points of known coordinates on the structure were picked in the scanworld, and the coordinates obtained from cyclone was checked against the corresponding downloaded sets of coordinates from the total station.

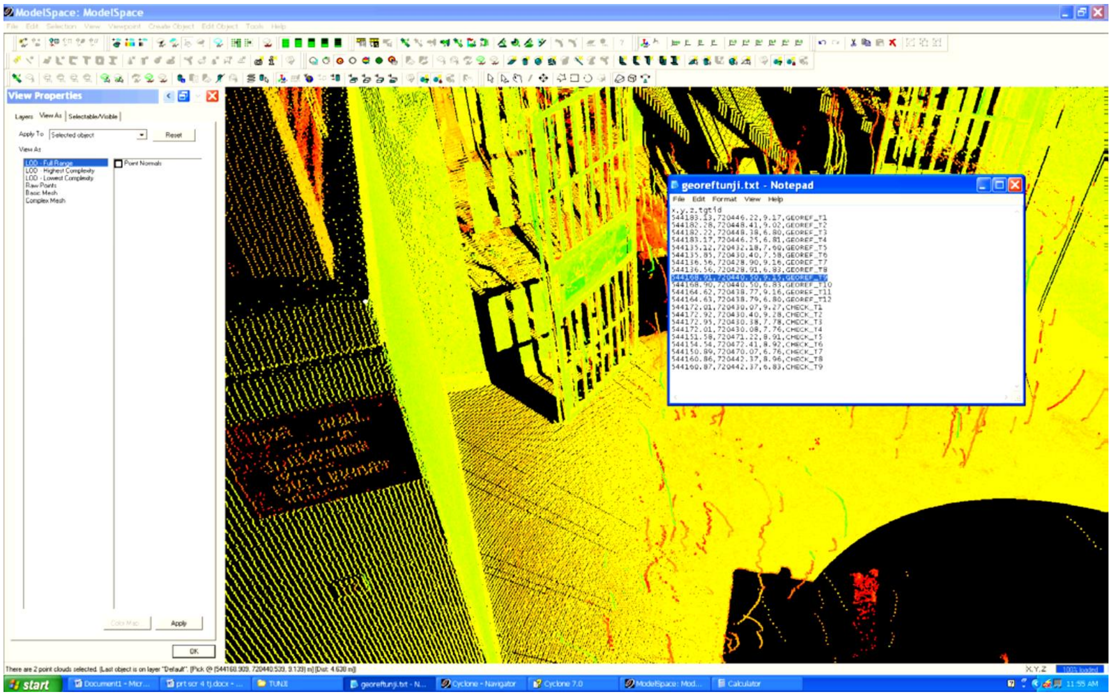


Figure 25: Showing the picked point on the scan against the corresponding coordinated point on ground

From the figure above, the picked point on the scan is having coordinates showing on the lower left corner of the window and the total station coordinate is also shown as an overlay. The table below shows the comparative coordinates for point ID GEOREF_T9.

Point Cloud Easting (m)	Total Station Easting (m)	Difference in Easting (m)	Point Cloud Northings (m)	Total Station Northings (m)	Difference in Northings (m)	Point Cloud Height (m)	Total Station Reduced Level (m)	Difference in Height (m)
544168.909	544168.91	0.001	720440.539	720440.50	0.039	9.139	9.15	0.011

Table 3: check point analysis

Secondly, the imported ‘targets’ (i.e. field coordinates) were overlaid on the point clouds in the scan; from which approximate description or label was given to specific point clouds

Some measurements were taken with the linen tape and checked with the ones obtained in the scanworld. Two of such points are tabulated below;

Scanworld Measurement	Tape measurement	Station description
4.816m	4.82m	Width of corridor
0.960m	0.98m	Width of entrance to Departmental office

Table 4: showing measurement comparison.

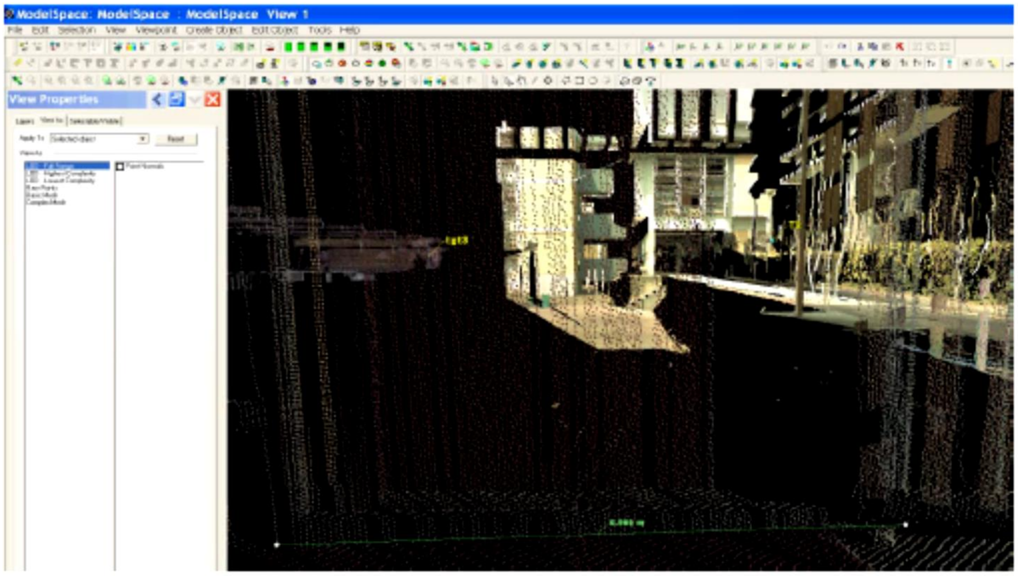


Figure 26: showing the measured distance in the scanworld

Other measurements were taken from the point clouds to query distances and heights. For example, in the figure below, one can compute the average breadth of the louvers by the window frame.

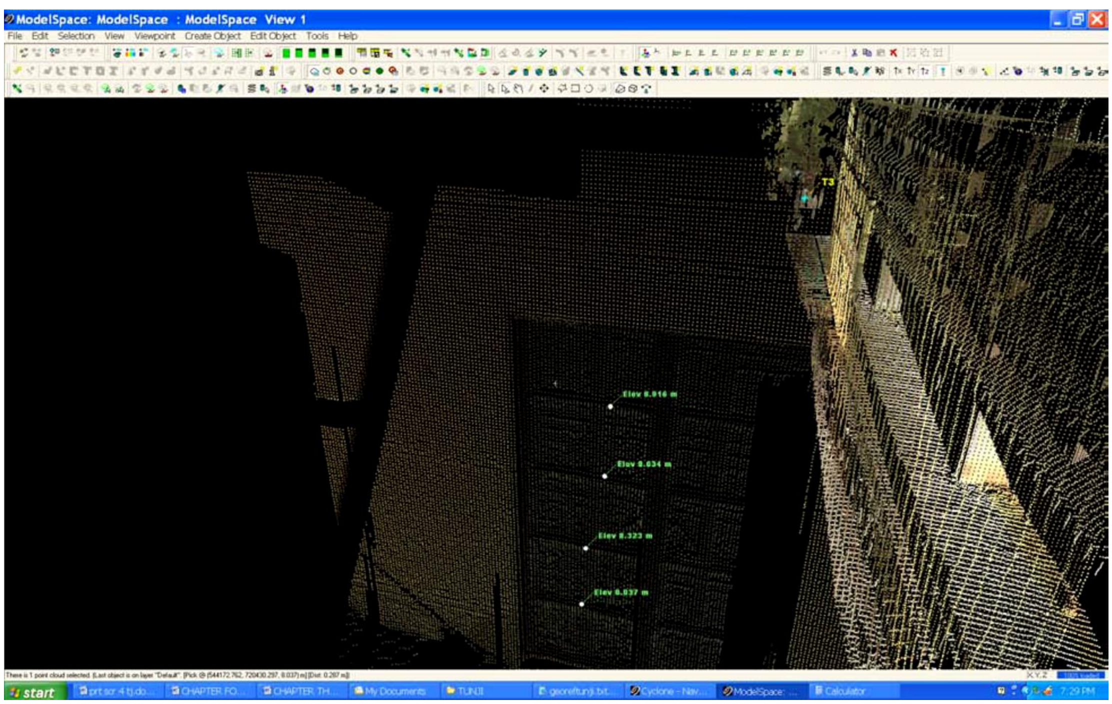


Figure 27: showing the measurement technique of 'elevation of point' to obtain heights

From the figure above, the average height of the glasses in the window section above could be deduced by the elevation of each point. It is obtained by the relationship (1/2([E1-E2]+[E3-E4])), where E(i) = Elevation point number.

E1=8.916m, E2=8.634m, E3=8.323m and E4=8.037m

Therefore, average height of Louvre = ½[(8.916-8.634)+(8.323-8.037)]m

= ½[0.282+0.286]m

= 0.284m

CONCLUSION

3D terrestrial laser scanning has been shown to be a very effective and time efficient technology for data capture. The time spent on the field is much shorter with greater data acquired than regular survey methods. When also likened to close range photogrammetry, the time spent on data processing makes terrestrial laser scanning more efficient.

Another aspect of the technology is the user friendliness of the software environment. On this project, we have been able to discover easy usage and interpretation of data. The direct logging of data and near real time processing is also of a great advantage

On measurements, we have been able to show that the point cloud coordinate are about the same as total station survey. Also, queried distances on object have been found to be in units of centimeter variation with that obtained from using the linen tape

REFERENCES

Alba M, Fregonese L, Prandi F, Scaioni M, Valgoi P, 2005, Structural Monitoring Of A Large Dam By Terrestrial Laser Scanning, Close Range Sensing: Anaylsis and Applications, Commision 5,Viewed 11 March 2008, < http://www.isprs.org/commission5/proceedings06/paper/1271_Dresden06.pdf.

Atkinson, K.B., Close Range Photogrammetry and Machine Vision, Whittles Publishing.

Bae K, Lichti D, On-Site Self-Calibration Using Planar Features for Terrestrial Laser Scanners, Viewed 12 April 2008, www.spatial.curtin.edu.au.

Baker A, Bannister A and Raymond S, 1998, Surveying, 7th Edition, Longman Publishing, London.

Balzani, M., Pellegrinelli, A., Perfetti, N., Uccelli, F., 2001: A terrestrial 3D laser scanner: Accuracy tests. Proc. 18th Int. Symp. CIPA 2001, pp. 445-453.

Behr J.A, Kenneth, Hudnut K.W and King N.E, 1999, Monitoring Structural Deformation at Pacoima Dam California Using Continuous GPS, Seismological Reasearch Letters, Vol. 69, Issue No. 4, pp299-308, Viewed 7 April 2008, http://pasadena.wr.usgs.gov/office/hudnut/SRL/.

Boehler W, Marbs A, 2004, Investigating Laser Scanner Accuracy, Viewed 5 April 2008, www.leica-geosystems.com.

Jacobs G. 3D Scanning: Getting Easier, Part 2// Professional Surveyor Magazine, 2008.

Jaszczak, P. J. (2006). Terrestrial Laser Scanning for landslides deformation monitoring.

Kager, H., Rottensteiner, F., Kerschner, M., Stadler, P., 2002. ORPHEUS 3.2.1 User Manual.

Leica Geosystems, www.leicageosystems.com

Leica HDS6000, A new generation of ultra-high speed laser scanner, 2008, Product brochure, www.leica-geosystems.com

Lichti D.D, Stewart M.P, Tsakiri M, A. J. Snow A.J, 1999, Benchmark Tests on a Three-dimensional Laser Scanning System, www.cage.curtin.edu.au

Lijing B., Zhengpeng Z. (2008). Application Of Point Clouds From Terrestrial 3D.

McLean A.G, 1988, Silo Design: Current and Future, Viewed 13 April 2008, Price W.F and Uren J, 2006, Surveying for Engineers, 4th Edition, Palgrave McMillan, London.

Photogrammetrists, Falls Church, VA, (1980).

Photogrammetry for the Modelling of Mouldboard Plough Surfaces, Biosystems Engineering (2005) 90 (4), p.397–407. Range Photogrammetry and Machine Vision, 9-51.

Roberts G, Hirst L, 2005, Deformation Monitoring and Analysis of Structures Using Laser Scanners, Commission 6 – Engineering Surveys, FIG Working Week 2005 / TS38 – Using Laser Scanning in Engineering Surveys, Viewed 6 April 2008, www.fig.net

Van Gosliga R, Lindenbergh R and Pfeifer N, 2007, Deformation Analysis Of a Bored Tunnel By Means Of Terrestrial Laser Scanning, www.ipf.tuwien.ac.at

Vosselman G. and Maas H.-G. Airborne and Terrestrial Laser Scanning// Whittles Publishing, Scotland, UK, 2010

W. Boehler, M. Bordas Vicent, A. Marbs, Investıgatıng Laser Scanner Accuracy, Orıgınally Presented At The Xıxth Cıpa Symposıum At Antalya, Turkey, 30 Sep – 4 Oct 2003.

ASSESSMENT OF INSECURITY CHALLENGES IN NYANYA AREA OF ABUJA, NIGERIA

V. E MATINS, S.O MEDAYESE, G. DANLAMI, S.I SHAIBU and C.B OHADUGHA

Department of Urban and Regional Planning, Federal University of Technology Minna

Insecurity is a major phenomenon plaguing many regions in Nigeria. However, the situation is more intensified in the northern part of the country where Boko-Haram insurgency has thrived unabated. Insecurity is not only caused by a single factor but a combination of factors such as armed robbery, burglary (house and shops), terrorism, cult activities, among others. The aim of this study is to assess the incidence of insecurity and its effect on residents of Nyanya, Abuja. Nyanya has 40232 households, 10% of the households population where used to carry out this study using multi-stage systematic random sampling method Nyanya was divided into six (6) neighbourhoods and questionnaire where distributed according to the number of household in the neighbourhood. The study discovered that Nyanya has 51.4% of armed robbery occurrence on monthly basis, 41.2% incidence of shop burglary on daily basis, 30.4% incidence of house burglary on weekly basis, 55.8% cases of false pretence on daily basis and 51.4% occurrences of unlawful possession on daily basis; and these crimes are mostly caused by unemployment and under-employment, poverty, low and lack of formal education, lesser penalty for offenders, lack of parental care, peer pressure, poor social amenities among others. However, as risen the level of insecurity and fear in Nyanya from 30.6% in 2013 to 67.4% in 2015. In view of these, many crime prevention measures have been taken by the residents and the government among which are effective police patrol, several military check points, and restriction of movement. The research therefore recommended that Government should strengthen its security forces in areas like the Nyanya village, Nyanya market area and Mararaba junctions respectively to reduce the level of crime occurrence and there should be a joint security service between the government security and the resident's security providers to help contain crime activities in the area.

Keywords: *Insecurity, Security, Crime, Safety, Fear, Terrorism.*

m.samuel@futminna.edu.ng

Matins et.al. (2016). **ASSESSMENT OF INSECURITY CHALLENGES IN NYANYA AREA OF ABUJA, NIGERIA** Sustainable Built Environment and Climate change; The challenges of Post 2015 Development Agenda. School of Environmental Technology Conference, SETIC, 2016

INTRODUCTION

Insecurity can be seen as a situation where the life and property of citizens in a particular country or a society is not adequately protected (Online Dictionary, 2015). The word security emanated from the Greek word Se-Cura, meaning “to be in a state of no fear”. This state of being free from any threat within or without underscores the importance of putting in place actions and structures that can ensure the shelving of a people away from any harm. There is no doubt that security has been a subject that has attracted a rapidly growing interest and concern among the scholars in social sciences whereby a wide spectrum of issues on the subject – security have been studied and new breakthroughs and findings have been made. The experience of the world in recent times emphasise a paradigm shift in security discourse. Any internal or external threat challenging the authority of the State in monopolising violence was considered as a security threat (Worcester, 2015). Fear, on the other hand, is a strong uncontrollable, unpleasant emotion caused by actual or perceived danger or threat (British Dictionary, 2015).

Nigeria, no doubt is an inimitable country where thousands of people who are multi-ethnic, multi-cultural and multi-religious co-exist. However, competition for the control of socio-political and economic authorities among the various ethnic groups has led to series of violence and civil unrests (Ojo and Ayesoro, 2013). The problem of insecurity is not only a sectional or a regional problem rather it has become a global phenomenon that has attracted the attention of every stakeholder in the world today (Michael, 2008). However, poor urban planning, design and management play a significant role in shaping of urban environments that put citizens and property at risk (Akukwe, 2013). The dangerous dimension of the insecurity challenge has become a great source of worry to security experts as they have predicted that, what is on ground has shifted to the realm of terrorism, a global phenomenon where no one is safe (Haruna, 2012). It is regrettable, however, that the security organizations have failed to tackle the challenges, even as they have become the target of terrorists who have never hidden their disdain for the intelligence and law enforcement community (Alozieuwa, 2012).

In Nigeria however, the most pronounced terrorist activities are the Niger Delta militants and the dreaded Islamic extremist group popularly known as the Boko Haram which have its official name as *Jama’ atu Ahlis Sunna, Lidda’ await Wal-Jihad*. This literally means “people committed to the propagation of the prophet’s teachings and Jihad”, with the goal of maiming activities in the north-eastern part of the Nigeria living some other parts of the country with terrorist activities such as kidnapping, armed robbery, and many others. These have introduced fears among the populace of the country (Bello, 2012).

Nyanya is a satellite town in the FCT it is known for its high commercial activity and this has attracted population to the area; this has in turn caused crime such as theft, armed robbery, prostitution, and other social delinquencies are common found in the area. The most pronounced incident that occurred is the twin bombing of the motor park that took place on 1st and 14th April 2014 that led to the death of 94 persons according to This day online news of April (2014). However, the insecurity challenge facing the north-eastern part of the country in recent times has triggered the movement of people into the town thereby making the town congested.

In the discourse of security in Nigeria, Okorie (2011), Jega (2002), Salawu (2010), Onyishi (2011), Ezeoha (2011), Lewis (2002), have identified several causes of security crisis in Nigeria that pose serious consequences to national development. Highest among them is ethno-religious conflicts that tend to have claim many lives in Nigeria.

STATEMENT OF PROBLEM

Abuja metropolis was designed to accommodate a total population of about 3 million by the year 2010 and a maximum population of 4million well into the 21st century in 2012 the population of Abuja was 2,245,000 (NPC 2012) but today, Abuja have a population of Abuja today is over 5millinon people with over 3million commuters that come into the city on daily basis. This growth has adversely affected the study area in the aspect of spill over population (Abuja Today Online, 2015).

Rapid urbanization is said to have led to the twin bomb blast that was later claimed to be perpetuated by the dreaded Islamic sect (BOKO HARAM) who took the advantage of the motor park located along the Abuja Keffi road these act led to loss of lives and properties. This is in consonance with the view of Ojo and Ayesoro (2013) who argued that uncontrolled urbanisation has the proclivity of security challenges. This has however possess fear amongst the dweller of Nyanya and also to the socio-economic activities of the satellite town and has also threatened the mutual co-existence of the inhabitants of Nyanya. Also as a result of these blasts, traffic congestion has increase making the journey of 10 minutes the journey of hours.

AIM AND OBJEVTIVES

The aim of this study is to assess the Challenges of insecurity in Nyanya Abuja. The main objectives of this study are to:

I. Identify areas within Nyanya that are presently facing high security challenges;

II. Examine the efficiency of the security agencies responsible for maintaining a secured environment;

III. Appraise the effect of insecurity on the socio-economic activities of residents of Nyanya Abuja; and Evaluate the role of residents in managing security challenges

LITERATURE REVIEW

The present study relies heavily on the theory of social disorganisation. The theory was formulated by Shaw and McKay in 1942, following a research conducted in Chicago to examine the location of security threatening factors in the residential areas in the city (Shaw and McKay, 1942; Seepersad, 2010; Ojo and Ayesoro, 2013), believing ‘that an ecological theory of social disorganization could explain the patterns of criminality’ (Lewis, 1996). By using maps to carry out ‘crime mapping’, Shaw and McKay (1942) noted that the distribution and rate of crime did not owe origin spatio-temporal factors in the city. The theory posit that crime occurs more in ‘particular areas of the city, and importantly, remained relatively stable within different areas despite continual changes in the populations who lived in each area’ (Ojo and Ayesoro, 2013; Seepersad, 2010). In areas of the city where crime persists, for example, the rates of crime continue to be comparatively high irrespective of which racial or ethnic group are the dominant residents of that area at that particular time, with a corresponding decrease in the rate of crime as the residents migrate to areas with low rate of crime (Ojo and Ayesoro, 2013; Lewis, 1996). These observations led Shaw and McKay to the conclusion that crime was likely a function of neighbourhood dynamics, and not necessarily a function of the individuals within neighbourhoods (Seepersad, 2010).

Shaw and McKay (1942) also noted that, aside from the lack of behavioral regulation, socially disorganized neighborhoods tended to produce “criminal traditions” that could be passed to successive generations of youths. This system of pro-delinquency attitudes could be easily learned by youths through their daily contact with older juveniles. Thus, a neighborhood characterized by social disorganization provides fertile soil for crime and delinquency in two ways: through a lack of behavioral control mechanisms and through the cultural transmission of delinquent values (cited in Seepersad, 2010). The present study adopts this theory in order to justify the assertions of social disorganization theory in the Nigerian context. This follows the standpoint of Ojo and Ayesoro (2013) who noted that this theory is of immense relevance to the success of any study that deals with the issues of security threats in the urban areas.

MICRO-SOCIAL THEORIES OF AND EXPLANATIONS OF INSECURITY

The micro-social theory of security threat is one of the many theories developed to explain the reason behind people’s violent actions. One of the main developers of this theory is Collins (2007). The theory specializes in explaining violent situations in general, as opposed to the generaslly practiced approach which takes an individualistic approach to explaining violence (Collins, 2007). He argued that in trying to explain violence, it is important to "seek the contours of situations, which shape the emotions and acts of the individuals who step inside them” stressing that “it is a false lead to look for types of violent individuals, constant across situations”. Hence, in the opinion of this theory, though violence is an attribute of young men, not all young men are violent; but that middle-aged men, children, and women are violent too. However, though poverty, marginalization, divorce or separated parents, and so on, in the appropriate situations, are major causes violence (Collins, 2004; Collins, 2007; Ojo and Ayesoro, 2013), this may not Always be the case (Collins, 2007).

Summarily, this theory posits that in an attempt to proffer countermeasures to violence, there are at least three methods for getting at situational details of violent interactions: recordings (where violent scenes are mentally recorded and written), reconstructions (where a thorough situational analysis is carried out through analyzing prevailing and historical events), and observations (through a sociological, psychological and economic in-depth study); and these "are most useful when used in combination" (Ojo and Ayesoro, 2013; Collins, 2007).

INSECURITY IN NIGERIAN CONTEXT

Nigeria in recent times has witnessed an unprecedented level of insecurity. This has made national security threat to be a major issue for the government and has prompted huge allocation of the national budget to security (Achumba, et al 2013). Consequently, Azazi, (2011) observed that in order to ameliorate the incidence of crime, the federal government has embarked on criminalization of terrorism by passing the Anti-Terrorism Act in 2011, installation of Computer-based Closed Circuit Television cameras (CCTV) in some parts of the country, to enhance surveillance as well as investigation of criminal related offences, heightening the physical security measures around the country, which is aimed at deterring or disrupting potential attacks, strengthening of security agencies through the provision of security facilities, the development and broadcast of security tips in mass media. Despite these efforts, the level of insecurity in the country is still high. To corroborate this assertion, GPI (2012) has stated that Nigeria has consistently ranked low in the Global Peace Index, signifying a worsened state of insecurity in the country. Hence, Adagba, et al (2012), Uhunmwuangho and Aluforo (2011) argued that the efforts of government have not yielded enough positive result.

RESEARCH METHODOLOGY

This study covered six (6) neighbourhoods in Nyanya Abuja namely: Nyanya Area 'A', Nyanya Area 'B', Nyanya Area 'C', Nyanya Area 'D', Nyanya Area 'E', and Nyanya Village. This research adopts a cross sectional research design method this type of research design is confined in a particular place at specific point in time. Cross sectional surveys are studies aimed at determining the frequency (or level) of a particular attribute, such as Specific exposure, disease, or the effect of a phenomenon in a defined population at a particular point in time (Wikipedia, 2015).Similarly, a cross-sectional research is an observational one. This means that researchers record information about their subjects without manipulating the environment (Winter, 2009). In line with the above definitions, this research begin with reconnaissance survey of the study area, data collected from the civil defence corps and police on areas that has attracted high level of policing, personal interview was carried out on some of the residents on their perception on the problem of insecurity in the area, GPS reading (coordinate) was taken from the areas identify as criminal hideout and the blast scene of April 1 and 14 2014.

In carrying out this research work, the multi stage systematic random sampling method was adopted to sample 138 households in the study area for the research. This sampling method was used to eliminate subjectivity and impact in the research by giving every member in the surveyed population an equal probability of an individual in the sample to be selected (Singh, 2006 and Kothari, 2004). The data collected were analysed in descriptive terms, following the fact that security challenges are recurrent in the study area.

DATA ANALYSIS AND PRESENTATION OF RESULTS

This assessment was carried out to know the street in the study area. The survey that was carried out shows that Area 'A' have 14.5% of respondents, Area 'B' have 21.0% respondents, Area 'C' have 14.5% respondents, Area 'D' have 6.5% respondents, Area 'E' have 36.2% respondents and Nyanya village have 7.2% respondents. See figure 4.10.

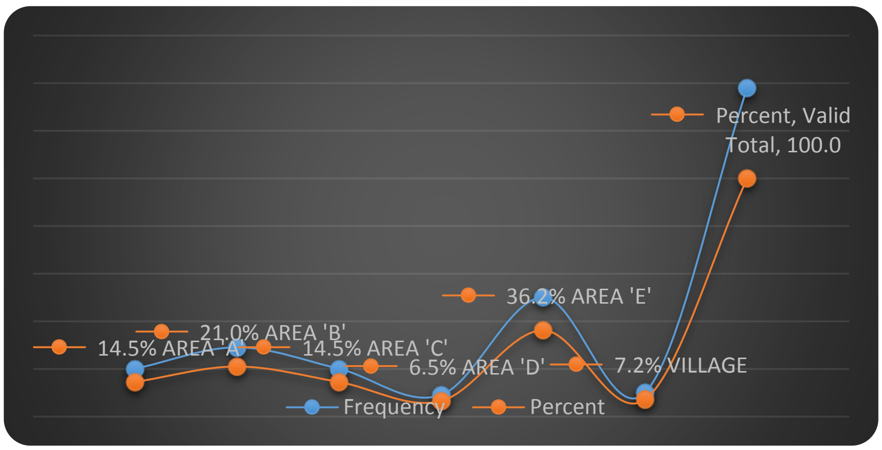


Figure. 4.1 Street Name of Respondents
Source: Field survey 2015.

This assessment in figure 4.2 was carried out to be able to determine the Areas that is highly faced with security challenge. It was discovered 15.2% of the areas are highly faced with insecurity, 60.9% are moderately faced with insecurity, 19.6% are merely challenge and 4.3% are not faced with any security challenge.

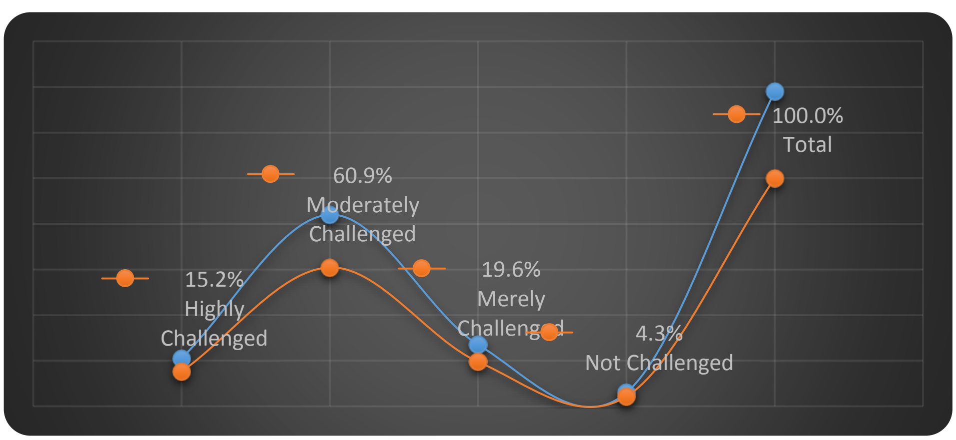


Figure. 4.2 Streets That Are Highly Faced With Insecurity
Source: Field survey 2015.

Figure. 4.3 shows the assessment was done in order to know the level of security in the study area. The study discovered that 18.1% of the respondent are feeling highly secured, 47.8% are having a feeling that they are moderately secured while 23.9% are merely secured and 10.1% are not secured.

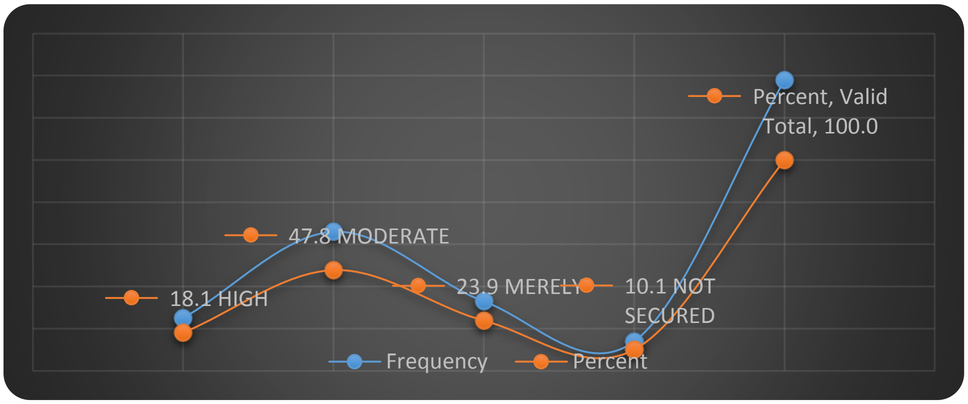


Figure. 4.3 Level of security
Source: Field survey 2015.

This was asked bring the research to the limelight of the security providers in the study area. The research find out that 48.6% of securitization is provided by the government, 23.9% is provided by private individuals while 21.0% is provided by the community (vigilante group) and 6.5% did not choose any of the aforementioned options (Table 4.1).

Table 4.1 Security Providers

Security Providers	Respondents	Percent
Government	67	48.6
Individual	33	23.9
Community	29	21.0
None Of The Above	9	6.5
Total	138	100.0

Source: Field survey 2015.

Table 4.2 seeks to know the special distribution of security agencies in each of the phases in the study area. The result of the survey carried out shows that 55.8% of the respondents have a police post or any other security post in there street while 44.2% of the respondents do not have.

Table 4.2 Spatial Distribution of Security Agencies

Options	Respondents	Percent
Yes	77	55.8
No	61	44.2
Total	138	100.0

Source: Field survey 2015.

Table 4.3 below, sought to know the level of patrol in the study area. The surveyed result shows that 2.9% of the respondents did not answer the question, 38.4% of the respondents answer was that they see them daily, 13.0% see the patrol team weekly, 5.1% see them monthly and 40.6% only see them when there is information about crime.

Table 4.3 Level of Patrol

Level of Patrol	Respondents	Percent
Not Answered	4	2.9
Daily	53	38.4
Weekly	18	13.0
Monthly	7	5.1
Only When There Is Information About Crime	56	40.6
Total	138	100.0

Source: Field survey 2015.

The rate of murder occurrence in the study area was assessed so as to avail the research the opportunity to ascertain the level of fear. The surveyed data revels that 3.6% of the respondent said the crime occur on daily basis while 8.0% experience murder on weekly basis in the study area, 9.4% experience murder on monthly basis and 79.0 experiences murder on yearly basis. Table 4.4.

Table 4.4 Level of Murder Occurrence

Level of Occurrence	Respondents	Percent
Daily	5	3.6
Weekly	11	8.0
Monthly	13	9.4
Yearly	109	79.0
Total	138	100.0

Source: field survey 2015

SUMMARY OF FINDINGS

It can be summarized from the data collected and analysed that Area ‘E’ is presently faced with high security challenge with 36.2% level of insecurity compare to other neighborhoods like Area ‘A’, ‘B’, ‘C’, and ‘D’ who have 14.5%, 21.0%, 14.5%, 6.5% and level of insecurity challenge. It was also deduced that 15.2% of the respondents who are highly challenged lives around Nyanya market, Nyanya village, Mararaba gate areas respectively this is because these areas are densely populated and can also be characterized by busy commercial activities while areas that are moderately challenged with 60.9% stay in area ‘A’ ‘B’, ‘C’ and ‘D’ whereas, 19.6% that are merely challenged lives around Mobile police Barracks and Nyanya labour camp respectively. However, areas that are highly secured are Nyanya Mopol Barracks area, with 18.1% while areas that are moderately secured are the Nyanya labour camp of Area ‘A’, Area ‘B’, C and D with 47.8% moderate security level. Mararaba gate, Nyanya village and the Market Area are having 23.9%, and 10.1% which makes these areas merely secured. The research finds out that both private individuals and government agencies forms the largest security providers in the study area with 48.6% and 23.9% security proving research findings also discovered that the spatial distribution of security agencies is done at 55.8% yet the residents still feel the sense of insecurity.

The effectiveness of policing in the study area is at 44.2% level of efficiency while the vigilante group has 39.9% level of effectiveness. It was noticed that street gates are not effective in the study area but human guard/watch man constitutes 28.3% level of effectiveness, more so, road bumps are have 51.4% level of ineffectiveness and security/guard dogs has 37.7% level of ineffectiveness with 30.4 level of effectiveness. It was also gathered that neighborhood security alarm also have an ineffectiveness level of 49.3% and 24.6% level of effectiveness while street light have low level of ineffectiveness of 17.4% and 37.5% level of effectiveness. The research also find out that military personnel provides 41.3% security in Nyanya. Consequently, the use of surveillance cameras are not effective in the study area the level of the ineffectiveness is 69.6% warning signs/ caution signs are also not effective with 56.5% level of ineffectiveness, but findings also came up with 44.2% check point effectiveness.

CONCLUSION

In conclusion, the major effect of insecurity in Nyanya Abuja, presents its self in three dimensions these dimensions can be highlighted to be; rapid urbanization which is the major cause of insecurity in the study area, as well as poverty/ low economic status, lack of parental care, social class among others if carefully taken care of will lead to a reoccurrence of bomb blast in the study area

RECOMMENDATIONS

The research has shown that there is a geometric increase in the level of insecurity and fear from 32.6% in year 2013 to 67.4% in year 2015. In view of this, the research recommends the following planning measures to curbing insecurity in Nyaya:

I. Government should strengthen its security forces in areas like the Nyanya village, Nyanya market area and Mararaba junctions respectively to reduce the level of crime occurrence in those areas.
II. There should be a joint security service between the government security and the resident's security providers to help contain crime activities in the area.

REFERENCES

Abuja Today Online (2015). *Explosive Rocks Nyaya.* Abuja Today Online News

Achumba, I. C., Ighomereho, O. S. & Akpor-Robaro, M. O. M. (2013). "Security Challenges in Nigeria and the Implications for Business Activities and Sustainable Development." *Journal of Economics and Sustainable Development, Vol.4, No.2,* 9-99

Adagba, O., Ugwu, S. C. and Eme, O.I. (2012). Activities of Boko Haram and Insecurity Question in Nigeria, Arabian *Journal of Business and Management Review, Vol. 1, No.9*, 77-99

Azazi, O. A. (2011), *Northern Nigeria, the Prosperity Agenda and National Security.* A Paper Presented At the Northern Transformation Impact Submit Sponsored By Arewa Transformation and Empowerment Initiative at the Arewa House, Kaduna, Kaduna State on May 10 – 12

Bello, V. (2012). The Impact of Urban Crime on Property Values In Akure, Nigeria.*Cities and Security, 4(1)*.1-14.

Ezeoba, S. L. (2011). Causes and Effects of Insecurity in Nigeria. *The National Scholar, 8(2)*, 28 -38.

Global Peace Index (GPI, 2012). *Global Peace Ranking.* Institute For Economic and Peace

Jega, I. (2002). Tackling Ethno- Religious Conflicts in Nigeria. *Newsletter of Social Science Academy of Nigeria, September, 5(2),* pp.35-38.

Lewis, D. A. (1996). Crime and Community: Continuities, Contradictions, and Complexities. *Northwestern University Cityscape: A Journal of Policy Development and Research, 2(2),* pp. 95-12.

Michael, O. O. (2008). *Boko Haram Crisis and the Socio-Political Development of Nigeria (A Case Study of Niger State).*

National Population Commission (1991). *Abuja Population and Housing Census*. National Bureau of Statistics

National Population Commission (2012). *Abuja Population and Housing Census.* National Bureau of Statistics

Ojo, S.S. and Ayesoro, A. S. (2012). Migration, Urbanisation and Crime Rates in Nigeria Cities: A Study of Lafia Metropolis. *Journal of Social Science and Policy Review Volume 4,* December 2012.

Online Dictionary (2015). *Insecurity, Security, Fear*

Salawu, B. (2010). Ethno-Religious Conflicts in Nigeria: Causal Analysis and Proposals for New Management Strategies. *European Journal of Social Sciences, Volume 13, Number 3,* pp.345-353.

Shaw, Clifford R., and Henry D. Mckay. 1942. *Juvenile Delinquency and Urban Areas.*Chicago: University Of Chicago Press.

Weerasekera, D. R. (2015) *Longitudinal Vs. Cross-Sectional Analysis.* Department Of Statistics, University Of Colombo

ASSESSMENT OF THE EFFECT OF COMMUNAL CONFLICTS ON RESIDENTIAL SEGREGATION IN KADUNA METROPOLIS, KADUNA STATE, NIGERIA

Dalil, M, [1] Sulyman, A. O.[1] and Dantudu, A. S. U. [2]
[1] Department of Urban and Regional Planning, Federal University of Technology, Minna, Niger State Nigeria
[2] Department of Urban and Regional Planning, Kaduna Polytechnic, Kaduna State Nigeria

This research focuses on the assessment of the effect of communal conflict on residential segregation in Kaduna metropolis, Kaduna State Nigeria. It assesses the socio-spatial and economic characteristics of the residents and their pattern of intra-city movement. The study also assessed the role of physical planning agencies responsible for physical development in the study area. To obtain field data required, 390 (2.5%) households out of 15,378 existing in the study area were selected using stratified simple random sampling technique. Four settlements; one in each of the four local government areas that made up the metropolis out of the 33 settlements were selected using a simple random technique they are: Narayi-bayan dutse in Chikun, Unguwan Muazu in Kaduna south, Rafin guza in Kaduna north, and Hayin naiya in Igabi Local Government Area. The research showed that there was a significant movement of residents who changed location within the metropolis due to communal conflict; this resulted in ethnic and religious segregation, such that Kaduna north, accommodates about 75% Hausas and other tribes whom are 90% Muslims and Kaduna south accommodates people from southern Kaduna origin, Igbo, Yoruba and other tribes; 73.02%, 7.14%, 1.11% and 8.13% respectively, constituting 91.05% Christians. Unguwan Muazu exhibits an element of coexistence among the various ethnic groups; Hausas, southern Kaduna, Yoruba, Igbo and other tribes: 48.83%, 12.68%, 32.39%, 4.2% and 1.88% respectively. The study shows that people can still coexist, given the right atmosphere and through concerted planning efforts and enlightenment. The study, therefore, recommends a framework for planning and controlling the physical development in Kaduna metropolis and the inclusion of residents in planning decision making for sustainable development.

KEYWORDS: Communal Conflict, Economic Characteristics, Intra-City Movement, Residential Segregation and Socio-spatial.

dalilmusa@gmail.com

Dalil et. al. (2016). **ASSESSMENT OF THE EFFECT OF COMMUNAL CONFLICTS ON RESIDENTIAL SEGREGATION IN KADUNA METROPOLIS, KADUNA STATE, NIGERIA** Sustainable Built Environment and Climate change; The challenges of Post 2015 Development Agenda. School of Environmental Technology Conference , SETIC, 2016

INTRODUCTION

Developing countries the world over are diverse in nature in terms of religious, ethnic, political affiliation and economic endowment. These diverse affiliations and endowments are expected to be tools for the development of these countries instead they have become agents of discontent, disharmony and hatred. Urban areas of these developing countries are supposed to be the nucleus for development activities where ideas and innovations are formed and diffused to other sub-communities they are supporting rather, the development of the centers have taken a downturn because the urban areas have become canters where discontent and disharmony among communities of these centers and governments are being exhibited because desired services that are required for sustainable development cannot be provided. As a result of this, in Africa, over 201 state conflicts have occurred in various urban areas between 1989 and 2009. Countries where these conflicts occur include; Sudan, Rwanda, Somalia, Ethiopia, Hema and Lendu in the Democratic Republic of Congo and Nigeria among others.

Nigeria has experienced numerous communal conflicts arising from electoral, religious, political ethno-religious land and economic crises since 1999. Elaigwu (2011) stated that more than 600 communal conflicts with triggers related to the issues above have occurred in Nigeria. Swanstrom and Weissman (2005) said conflict is present when two or more parties perceive that their interests are incompatible, express hostile attitudes, or take pursue their interests through actions that damage the other parties. These parties may be individuals, small or large groups, and countries.

Conflict is an intrinsic and inevitable aspect of social change, Swanstrom and Weissman (2005); it is an expression of the heterogeneity of interests, values and beliefs that arise as new formations generated by social change come up against inherited constraints. But the way we deal with conflict is a matter of habit and choice. It is possible to change habitual responses and exercise intelligent choices. Communal conflict was considered by Oyewole (2010) as a conflict that occurs between two or more communities. It is described as a conflict involving two or more communities engaging themselves in disagreement or an act of violence over issues such as claims for land ownership, religious and political difference leading to loss of lives and destruction of properties. Communal violence (sometimes inter-communal violence) is a situation where violence is perpetuated across ethnic lines, and victims are chosen based upon ethnic group membership. Dzurgba (2006) was of the opinion that communistic violence is that which occurs between two or more communities over territorial land. To Ekpeyong (2011), conflict simply means “that I want something and you also want the same, but we both cannot have it all. According to Fernandez in Ekpeyong (2011) conflict can be viewed as a difference in perspectives: what one sees, think, feel, and believe may be different from what another sees, think, feel, and believe. From the above assertion, it therefore means that conflict is a part of all human interactions, and it can have a positive influence. Hence, we can say conflict is inevitable as it is present in daily, public and private life.

Violent conflict usually erupts in places where the government is an instrument of group domination and where the channel for articulating demands is closed. This type of ethnic conflict is very complex and very notorious to manage. It entails clash of cultures, as well as of interests in all ramifications, and always expressed in a cruel manner. This form of conflict ranges from riot to secession to civil wars. The hard view of ethnic conflicts sees ethnic groups as, inscriptive group, firmly bounded entities based on a strong sense of commonality, producing considerable loyalty, persisting over time, providing large effective reward to group members, inclined to ethnocentrism and to hostility and to a desire to dominate outsiders, liable conflict behavior based on passion, and endangering great willingness on the part of group members to sacrifice for collective welfare (Oyewole, 2010).

Conflicts can become violent when parties go beyond seeking to attain their goals peacefully, and try to dominate or destroy the opposing parties' ability to pursue their own interests Conflicts become manifest when these unacknowledged contrary interests become conscious and voiced (Swanstrom and Weissman, 2005). Conflict itself is not always negative. Indeed, conflict is one of the most powerful positive factors in a society. Writing about the positive impacts of ethnic conflicts, Nnoli (1993) argued that since the political demands of many ethnic movements concern liberties and justice, conflict arising there from "contributes to democratic practice by its emphasis on equity and justice in social-political relations ". This shows that ethno-religious conflict in plural societies can neither be wished away nor eradicated and, at the same time, cannot be left alone because they are capable of destroying states.

Most of the violent conflicts that have rocked Nigeria over the years and intensified in recent times are part of the consequences of a failed development process. If Nigeria had realized the potential of its huge human and material resources, much of the discontent that has resulted in violent conflicts would have been avoided. The following factors have been identified by Nehi (2013) as the root cause of social conflicts in Nigeria:

Communities and ethnic groups within and across the boundaries of states and local government council areas lay claim to land as original owners (settlers) or „aboriginals‟ and on this basis, those regarded as intruders are fought against. It is nothing new that farmers and pastoralists, fishermen and pond owners, foresters and timber loggers clash throughout Nigeria often over disputed use and exploitation of land and water resources. Commenting on the above resource based conflicts, Otite (1999) writes: And since the 1960s, and particularly since the 1990s, communities in Nigeria's deltaic areas have clashed with one another over claims in territories in which oil exploration companies operate and for which royalty and amenities and development projects are expected.

Power is also a main source of conflict in societies since it has the ability to achieve something successfully. It is also the ability to cause things to happen rapidly. It is the capacity to reward complaints, persuade recalcitrant, coerce intransigent and punish offenders. Thus, power gives the ability to control the behaviour of others, even against their will such as deviants, sociopath, delinquents, dissenters and rebels. By using power one can also control resources, political processes, social institutions, cultural institutions and development. Thus, power decides and chooses those who will gain and those who will lose in any given situation. Power is always in limited supply. Hence, the gains for one individual or group are often associated with the losses for the other individual or group. This is why power has become a major source of conflicts not only in Africa, but also in many other nations (Dzurgba, 2006).

The aim of this research therefore, is to assess the effects of communal conflicts on residential segregation in Kaduna metropolitan area with a view to evolving appropriate solution to identified problems. The objectives of the research are:

1. Assess the socio-spatial and economic characteristics of residents.
2. Assess the pattern of intra – city movement of the residents

The Study Area

Kaduna is the capital of Kaduna State in northwestern Nigeria; Kaduna was founded by the British in 1913 and became the capital of Nigeria's former Northern Region in 1917. Kaduna retained this status until 1967. It is located at latitude 10°′23″N and 10' 43"N and longitude7°′17″E and 7 37"E, see (Figure 1). It is a trade centre and a major transportation hub for the surrounding agricultural areas with its rail and road junctions.

The symbol of Kaduna is the crocodile, called *Kada* in the native Hausa language. Ethnic groups include Hausa and Kurama in the north and northeast, Kamuku, Gwari and Kadara in the west, Jaba, Kaje, Kataf, Marwa are some of the ethnic groups found in the southern part of the state. The Hausas and Fulanis in the north practice Islam while the majority of the southern people are Christians, there are also Gbagyi, Ibo and Yoruba ethnic groups (Nigeria Galleria, 2004).

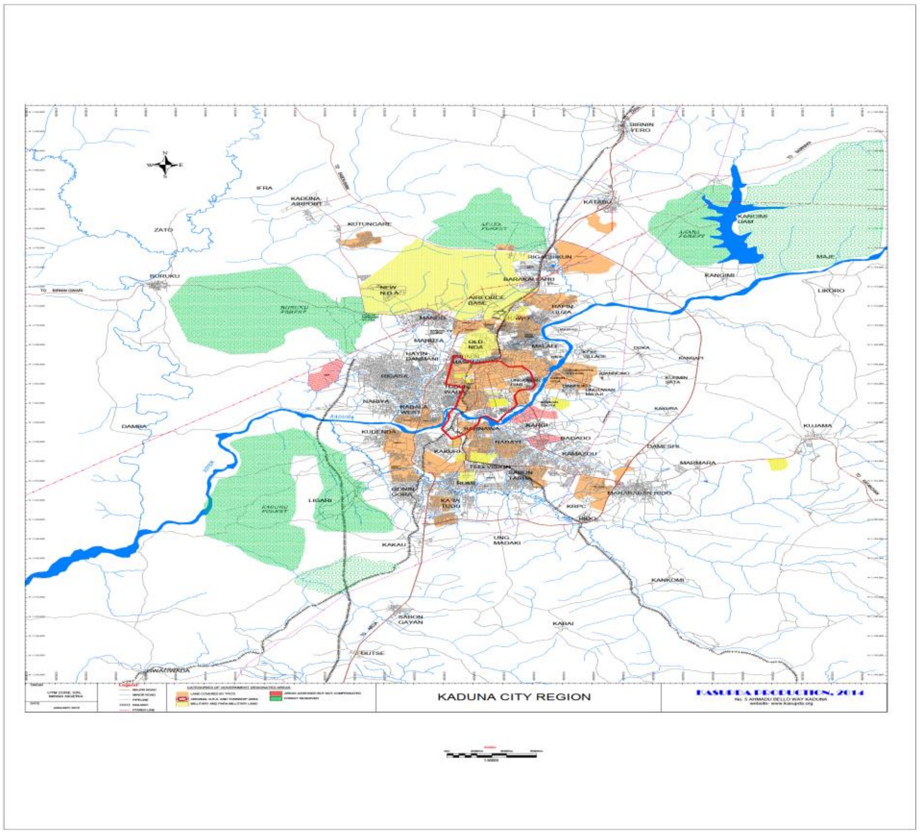


Figure 1: Location of the Study Area
Source: Kaduna Master Plan – Max Lock (2010)

MATERIALS AND METHODS

Population Sampling and Data Collection Technique

The study focused on the persons in the affected areas of the conflicts within Kaduna metropolitan areas. It covers the heads of households in the sampled settlements and the physical planning agencies (Kaduna State Urban Development Authority and Ministry of Lands Surveys and Country Planning).

Sample Frame

The sample frame for this study consists of the list of all the districts in the Kaduna metropolis after the year 2000 conflict. This can be seen in Table 1.

Sample Size

The sample size for the study was 12% of the 33 settlements being four settlements; one each from four of the local government areas that make up the metropolis as follows: Kaduna north – Rafin guza; Kaduna south – Anguwan mu'azu; Chikun – Narayi – Bayan dutse and Igabi – Hayin Naiya. The sample size of 390 (2.5%) of the households was taken using an average household size of 8 persons. The Yamane's formula was used to determine the sample size for the survey:

Yamane's Formula:

$$n = \frac{N}{1 + (Ne^2)}$$

Where:-

n = Sample Size,

N = Population

e = Level of Significance (0.05)

The population of the selected settlements is as follows:

Narayi/Bayan Duste, 42,089; Hayin Na'iya, 4,306; Rafin Guza, 9,584; Ung. Mu'azu/Kabala West, 67,048.

The total number of persons in the sampled settlements is 123,027.

Therefore, 123,027/8= 15,378 Households.

Using an average household of 8 persons per household, the sample size derived is 390 used for the survey using Yameni's formula.

Table 1 shows the distribution of the sample population, according to households.

Table 1: Population and Household Distribution of the Sampled Settlements

A LGA	B Districts	C 2012 Pop.	D Average h/hold Size	E Sample Frame	F Sample Size	G %
Chikun	Narayi/Bayan Duste	42,089	8	5,261	133	34.21
Igabi	Hayin Na'iya	4,306	8	538	14	3.5
K/North	Rafin Guza	9,584	8	1,198	30	7.79
K/South	Ung. Mu'azu/Kabala West	67,048	8	8,381	213	54.50
Total		**123,027**		**15,378**	**390**	**100**

Source: Author, 2012

Sampling Technique

The stratified random sampling technique was used for the study. First, the total number of households was stratified according districts in the local government areas (Table 1). Simple random sampling was used to select the sample from the stratified districts by writing the names of districts on paper and then shuffling to pick the sample without replacement, until the required sample was picked. The sample is then shared proportionally among the selected districts as presented in Table 2.

Table 2: Distribution of Samples in the Study Areas

LGA	Districts	Population	No. of Households	No. of Sampled Household	Percentage (%)	Ratio
Chikun	Narayi/Bayan Duste	42,089	5,261	133	34.21	1:40
Igabi	Hayin Na'iya	4,306	538	14	3.50	1:38
K/North	Rafin Guza	9,584	1,198	30	7.79	1:40
K/South	Ung. Muazu	67,048	8,381	213	54.50	1:39
	Total	**123,027**	**15,378**	**390**	**100**	

Source: Author, 2012

Data Collection Procedure

Secondary data were sourced from Institutions and Governmental Organizations relevant to the study. These include publications such as the Master Plan for Kaduna, reports, land use maps, and population data on Kaduna for the period under review which was obtained from the National Population Commission. The land use maps, and topographical maps, were obtained from the Ministry of Lands and Surveys and the Federal Surveys Kaduna.

The survey instrument for data collection used is the questionnaire with structured questions directed to the heads of households to gather socioeconomic characteristics of the residents. Physical planning agencies comprising of Kaduna State Urban Planning and Development Authority, Ministry of Land, Survey and Country Planning were interviewed. Data processing used involves the use of descriptive statistics to summarize the data collected from the first hand survey and subsequently inferential statistics. Statistical Packages for Social Sciences (SPSS) such as percentages are used for the analysis. The information collected during the field work and interview formed the data for the statistical analysis.

RESULTS AND DISCUSSION

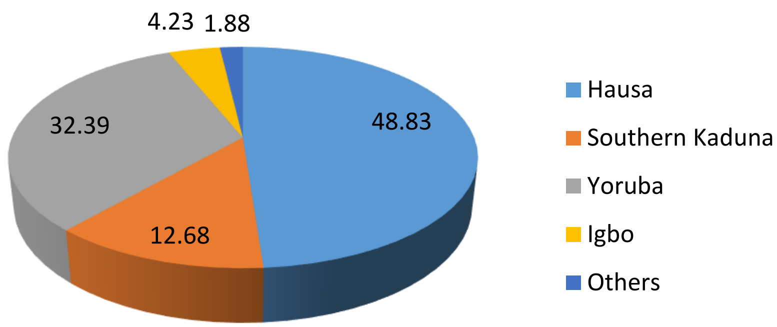


Figure 2: Ethnic Background of Residents in Narayi/Bayan Duste
Source: Field survey 2012

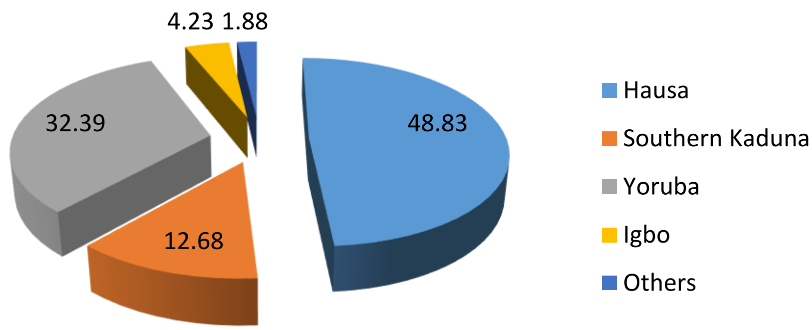


Figure 3: Ethnic Background of Residents in Unguwan Muazu
Source: Field survey 2012

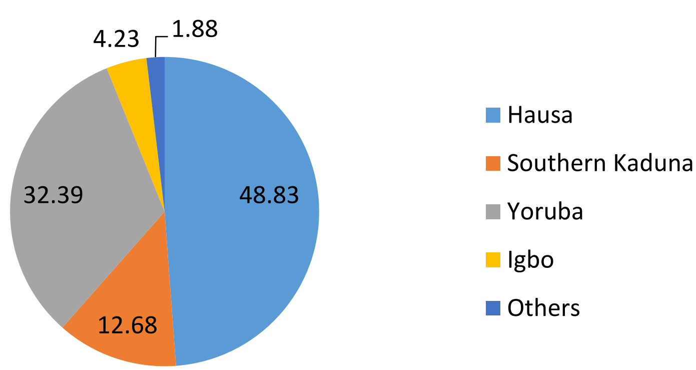


Figure 4: Ethnic Background of Residents in Rafin Guza
Source: Field survey 2012

From the results in figures 2 to 4 it can be deduced that there are more southern Kaduna tribes in Narayi/Bayan Duste with 73.02% while the Hausa’s dominate Hayin Na’iya, Rafin Guza and Ung. Mu’azu/Kabala West with 76.20%, 73.30% and 48.83% respectively. This implies that there is ethnic stratification within Kaduna metropolitan areas, with the Hausas residing in the Northern part and southern Kaduna tribes in the Southern part of the Metropolis, suggesting segregation along ethnic groupings.

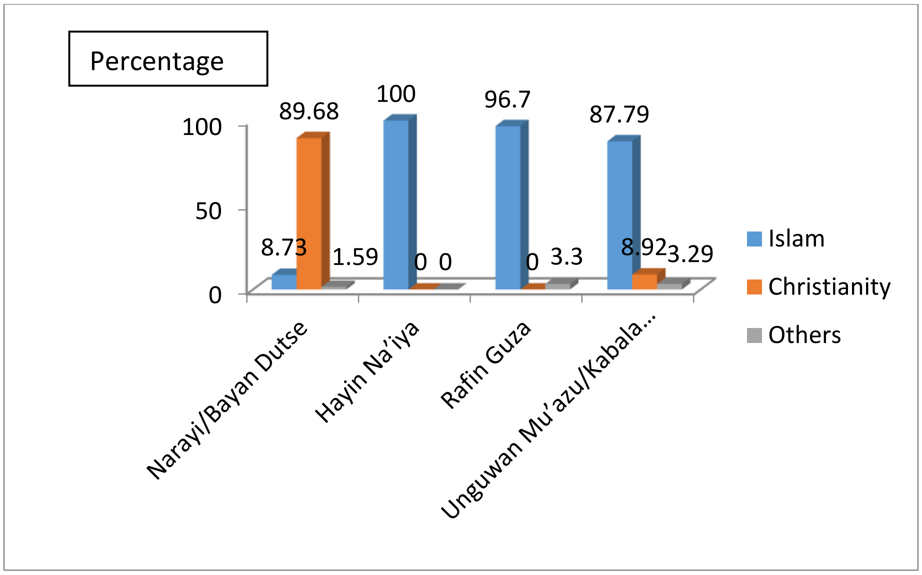


Figure 5: Religious Background
Source: Field survey 201210

Presentation in Figure 6 shows that there are more Christians with 89.68% in Narayi/Bayan Duste than the remaining settlements with Muslims having an average size of 8%. This implies that there is religious segregation in Kaduna metropolis which contradicts the Nigerian constitution that encourages coexisting irrespective of religious background. The research also shows that the respondent’s choice of residence before and after the conflicts in Narayi/Bayan Duste and Unguwan Mu’azu has changed from being cheaper with 43.65% and 42.72% to more secured with 78.57% and 69.48%, respectively; while in the case of Hayin Na’iya and Rafin Guza, it has changed from owned residence with 52.20% and 33.40% to more secure with 38.00% and 53.30% respectively. This implies that security of live and properties are the major determinant in the choice of residence in these study areas.

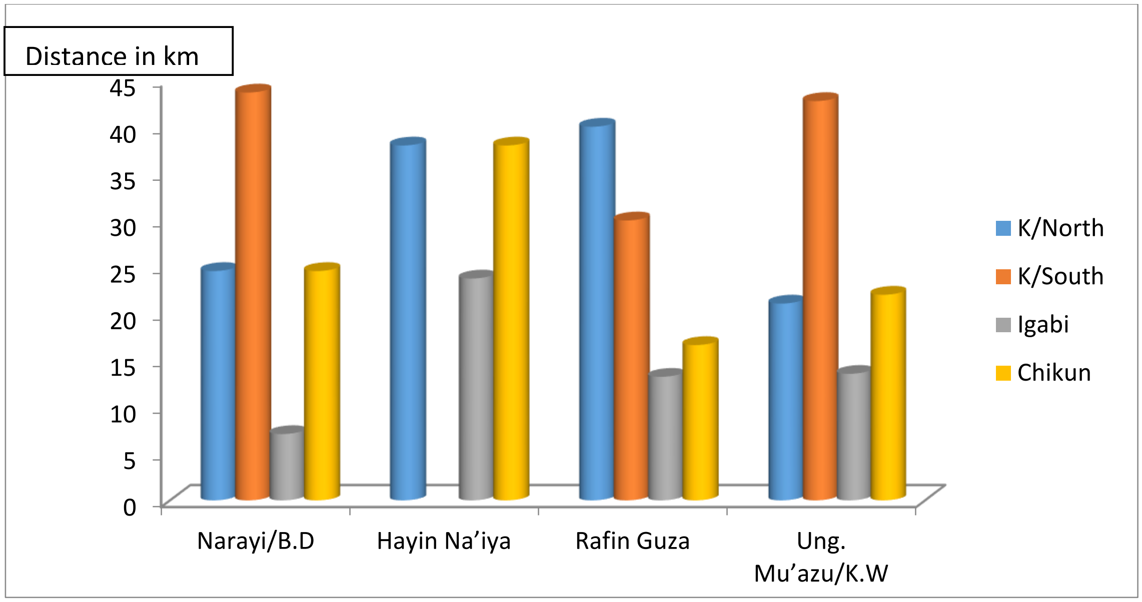


Figure 6: Places of Work Before the year 2000 Conflict
Source: Field survey 2012

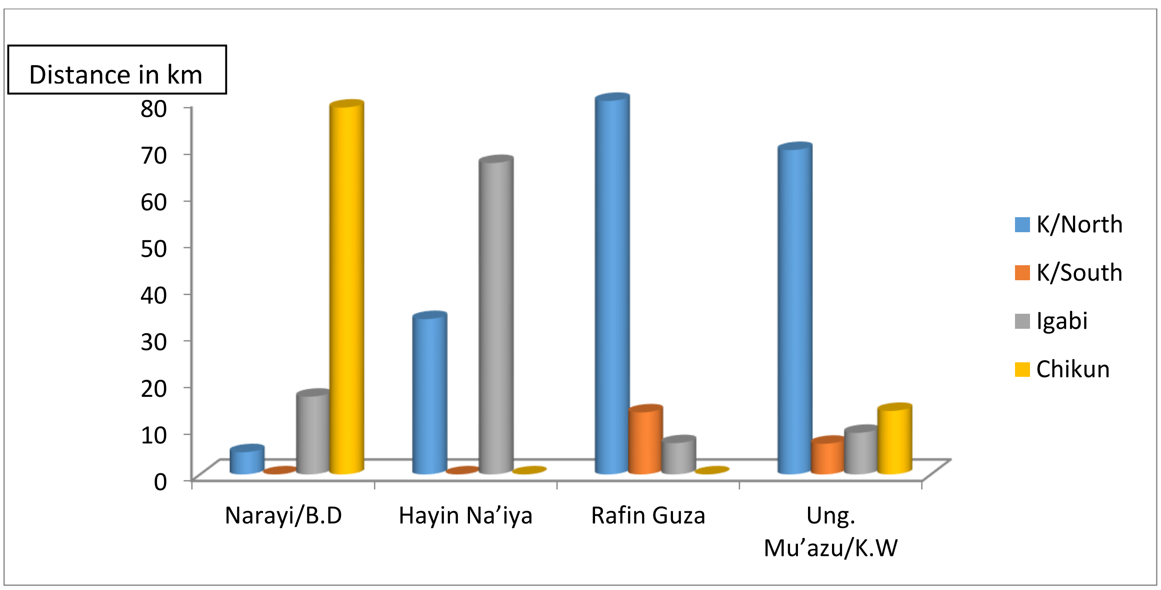


Figure 7: Places of Work After the year 2000 Conflict
Source: Field survey 2012

Results in Figures 6 and 7 reveal the relationship to place of work before and after the year 2000 conflict. Residents in Narayi/Bayan Duste work in Kaduna south (43.65%) before the year 2000. This later changes to Chikun (78.57%) after the year 2000; on the other hand, shifted from Chikun (38.00%) before the year 2000 to Igabi (66.70%) after the year 2000. Rafin Guza maintained the status quo with 40.00% (before) and 80.00% (after) being the highest while in Ung. Mu'azu/Kabala West, there is a change in relationship from Kaduna south (42.72%) to Kaduna north (69.48%) being the highest. This shows that there is a shift in place of work of respondents to places nearer to their areas of residence.

Table 3: Reasons for the choice of Place of work before and after the 2000
Source: Field survey 2012

Reasons	Narayi/B.D Before		After		Hayin Na'iya Before		After		Rafin Guza Before		After		Ung. Mu'azu/K.W Before		After	
	F	**%**	**F**	**%**	**F**	**%**	**F**	**%**	**F**	**%**	**F**	**%**	**F**	**%**	**F**	**%**
More Secured	9	7.14	37	29.37	21	100	7	33.30	12	40.00	10	33.30	77	36.15	67	31.46
As a Result of Conflict	1	0.79	62	49.21	-	-	14	66.70	9	30.00	18	60.00	6	2.82	132	61.97
Job Transfer	65	51.59	21	16.67	-	-	-	-	4	13.30	-	-	14	6.57	3	1.41
Better Income	41	32.54	6	4.76	-	-	-	-	5	16.70	2	6.70	102	47.89	8	3.76
Others	10	7.94	-	-	-	-	-	-			-	-	14	6.57	3	1.41
Total	**126**	**100**	**126**	**100**	**21**	**100**	**21**	**100**	**30**	**100**	**30**	**100**	**213**	**100**	**213**	**100**

Survey findings in Table 3 revealed that the choice for the place of work in Narayi/Bayan Duste has shifted from job transfer (51.59%) before the year 2000 to 'as a result of conflict' (49.21%) after the year 2000. On the other hand, it has shifted from 'more secured' (100%) to 'as a result of conflict' (66.70%) in Hayin Na'iya; while in Rafin Guza, it has shifted from 'more secured' (40.00%) before the year 2000 to 'as a result of conflict' (60.00%) after the year 2000. Ung. Mu'azu also experience a change from 'better income' (47.89%) before to 'as a result of conflict' (61.97%) after the year 2000. This implies that the conflict had affected the choice for the place of work in the sampled study area, because people feel more secured working close to where they reside.

Physical Planning Agencies

The agencies responsible for physical planning and control of physical development in Kaduna metropolis are; Ministry of Lands, Surveys and Country Planning and Kaduna State Urban Development and Planning Authority (KASUPDA) respectively. The Ministry of Lands, Surveys and Country Planning is the agency that initiates and prepare physical planning schemes in the State while KASUPDA is responsible for implementation, monitoring and control of physical development.

The result of the research indicates that the initiating Ministry has not prepared any physical planning scheme to cater for the population that changed location even when the demand became high, indicating inadequacy of fund as reason for non-initiation of plans. In the areas of plan preparation, implementation, control and monitoring the agencies had minimal influence after the crisis of the year 2000, as such individuals prepared layouts and sell plots to developers, and permissions were granted to the developers by the planning agencies who develop without due consideration to required standards and planning regulation. This action resulted in the unplanned nature of the sampled settlements.

Conclusion and Recommendation

The occurrence and recurrence of the conflict brought about a movement of people from various parts of the metropolis to areas where they feel secure. There is ethnic and religious stratification within Kaduna metropolitan areas with the Hausas, whom are mostly Muslims dominating the Northern part and southern Kaduna tribes, mostly Christians occupying the Southern part of the Metropolis.

Based on the field data analysis, the following recommendations are therefore, made:

- Planning decisions and politics should encourage coexistence of segregation through assurance of equity and fairness in the provision of facilities and services.
- Comprehensive land use planning and policies should be encouraged through prompt preparation of plans and monitoring so that development can be guided without being left at the discretion of individual developers.
- Religious and opinion leaders should be made to participate in decision making on planning issues, this will assist in creating awareness about physical development control and protection of the environment.
- There is a need for the formalization and integration of private layout so that this will enable enforcement of development control policies and create awareness of the activities of the planning agencies.
- The policy instruments and tools to tackle the issue of urban spatial segregation must be multi-dimensional. This should include; Massive provision of serviced land at affordable prices and at appropriate locations and upgrading of informal settlements.
- Frameworks in the form of an action plan should be prepared to guide and control the development of the settlements in the metropolis.

REFERENCES

Dzurgba, A. (2006). *A Prevention of Conflict*. Ibadan: Loud Books Publishers.

Ekpeyong, O. E. (2011). Social and Political Roots of Conflict in Nigeria. The Role of The church. *American Journal of Social Issues and Humanities*, 1(2), 117 – 136. Retrieved April 12, 2013 from:http:www.ajsih.org

Elaigwu, V. A. (2011). *The Military and the Management of Civil Crisis in Nigeria 1960 – 1993*.Kaduna, Nigeria: Nigerian Defence Academy Press.

Nehi, I. (2013). Discover Nigeria: 5 Causes of conflict in Nigeria. Ebonyi/Benue Land Dispute of June, 2012. Credit Comoadeoline New World Encyclopedia. Retrieved June 29, 2013 from: http://www.newworldencydopedea.org/entry/conflict-theory.

Nigeria Galleria (2004). History of Kaduna State. Retrieved June 29, 2013 from: www.nigeriagalleria.com/Nigeria/State_Nigeria.html

Nnoli, O. (1993). *Ethnicity and Democracy in Africa: Intervening Variables.* Lagos: Malthpuse Press limited.

Okoye, F. (2000). *Victims: Impact of Religious and Ethnic Conflicts on Women and Children in Northern Nigeria*. Kaduna, Nigeria: Human Rights Monito.

Otite, O. (1999). Ethnic Pluralism and Ethnicity in Nigeria. Paper Presentation at Union for African Population, Fifth African Population Conference, Anusha Tanzani–2007.

Oyewole, F. P. (2010). Intra Ethno-Conflict and the Dilemma of Sustainable City Development in Nigeria: The Case of Ogun State. Being a Paper Presentation at the 41st NITP Annual Conference.

Swanstrom, L. P. and Weissman, S. (2005). Conflict presentation and conflict management beyond a conceptual exploitation. Concept Paper. Retrieved April 12, 2013 from: http:www.silkroadstidiness.org/new/docs/concept–paper- Conf Prev.pdf.

Tubiana, J. (2007). Danfur A War for Land. In A. De Waal (Ed.), *War in Dafur and the Search for Peace*. London: Global Equity initiative, Haward University, Justice Africa.

Ullah, H. (2000). Perspectives of Sharia, Federalism, and Religious Associations in Nigeria: An Urban case study of Kaduna and the riots of 2000, University of Michigan. Retrieved June 29, 2013 from: http://socsci2ucsdedu/~aronates/scrrtreat/Ullah Haroon.doc.

Van Kempen, R. and Özüekren, S. A. (1998). "Ethnic Segregation in Cities: New Forms and Explanations in a Dynamic World." Urban Studies What Researchers mean by….Cross – Sectional vs Longitudinal Studies. Retrieved June 29, 2013 from:https://www.wh.on.ca/wrmb/cross - sectional-Vs - Longititudinal Studies.

Yusuf, A.(2004). Nature of Waste Generation and Management of Kaduna Refinery And Petrochemical Company on the Environment of Kaduna South, Kaduna Metropolis. An Unpublished BSc. Dissertation, Department of Geography ABU, Zaria.

TENURE SECURITY DUE TO UNRESOLVED RESIDENTIAL LAND DISPUTES IN KADUNA: CHALLENGES AND WAY FORWARD

MAMMAN Matthew, SAIDU A. Umar & M. B. NUHU

Department of Estate Management and Valuation, Federal University of Technology, Minna

Maladministration of urban land, urbanization, population growth, and many other factors are causing numerous land disputes over allocated residential plots within Kaduna Metropolis thereby posing serious tenure security threats to statutory title holders. This study used survey research design to ascertain how tenure security of statutory land title holder were threatened by many unresolved land disputes at four (4) selected residential layouts within the metropolis namely; Kinkinau, Mahuta, Unguwan Dosa and Unguwan Boro layouts. The population of the study includes 3,970 statutory title holders of residential lands; 87 senior technical staff of Kaduna State Lands Ministry; 38 professional lawyers and 48 Estate Surveyors and Valuers dealing with the Ministry. 100 statutory right of occupancy holders were administered questionnaires at each at the four selected layouts. The study revealed that fraudulent practices of Kaduna State Ministry of Lands officials, land touts and agents had caused land disputes threatening the tenure security many statutory title holders to lose the huge funds they paid to purchase their residential lands. The study concluded that there exist serious threats to tenure security of holders of statutory titles over residential plots within Kaduna metropolis. The state Government should as a matter of urgency set up a task force to include civil society groups, law enforcement agents, lawyers, land experts and members of staff of Kaduna State Lands Ministry to curb the menace of touts, agents and fraudulent staff of the Lands Ministry.

Key Words: Land dispute, tenure security, land allocation, dispute resolution.

mamman16ali@gmail.com

Mamman et. al. (2016) **TENURE SECURITY DUE TO UNRESOLVED RESIDENTIAL LAND DISPUTES IN KADUNA: CHALLENGES AND WAY FORWARD** Sustainable Built Environment and Climate change; The challenges of Post 2015 Development Agenda. School of Environmental Technology Conference, SETIC, 2016

Introduction

Land is the main ingredient needed for housing development and other forms of development and therefore should be equitably allocated to urban developers in the face of rapid population increase due to both natural growth and immigration. But land allocation of late has increasingly posed challenges to policy makers and implementers in the face of competing demand for limited land resources (Ja'far, 2003). State Department of Lands and Surveys find themselves in a difficult position in attempting to satisfy such a high (and competing) demand (Yahaya and Shekamang, 1986). No one seems satisfied with the procedure for obtaining statutory title to land. For those with the necessary resources, it is slow and cumbersome; and opportunities for corruption abound (Mortimore, 1986).

Kaduna State Lands Ministry were said to have recorded sixty five unresolved land disputes on just one residential layout called Kinkinau layout as at December, 2007. This is a serious threat to tenure security of residential title holder. Tenure insecurity caused by land disputes exposes residential statutory holders to the risk of eviction making them vulnerable to loss of their assets or inability to enjoy the benefits from their housing investments. In order for Kaduna State Lands Ministry to succeed in improving the security of statutory title holders, there is the need to explore the tenure security challenges associated with the disputes over allotted residential lands within Kaduna Metropolis.

Aim and Objectives of the Research

The aim of this study is to ascertain the tenure security threats posed by multiple residential land disputes over State allocated plots within Kaduna Metropolis with a view to establish the challenges and to chart the way forward.

To achieve the stated aim, the study pursues the following objectives:

1. To identify the aspects of land disputes on residential layouts within Kaduna Metropolis for a period of five years (2003 – 2008).
2. To find out the consequences of the land disputes on allocated residential layouts within the metropolis
3. To examine the methods of resolving land disputes on residential layouts within the metropolis.

Concept of Land Tenure

Land is conceptualised as "including the surface of the earth, the subsoil and the air space above it as well as things that are permanently attached to the soil even streams and ponds. However, the law does not distinguish between the owners of the soil and the owner of the fixtures thereon because the principle of law is Quic quid plantatur solo solo cedit. In Nigeria, the right under this principle does not extend to mineral and mineral deposits found in, under or upon the land. An individual group or institution can acquire absolute ownership of land or right to land through purchase, grant or self help. Such right to land may be permanent and may be transmissible to his successors. The rights which an individual may hold over community land which he occupies vary from place to place. He may acquire permanent rights which is equivalent to ownership, permanent rights which is only occupational rights or rights may be allocated to him for a limited duration.

Evidence of title to land has become a source of land dispute especially with the various methods of land ownership / acquisition which have been developed within the indigenous land tenure system in Nigeria owing to strong population pressure, the application of the Land Use Act and outright sale. Over the years, the factors affecting land tenure systems are socio-economic, cultural and institutional. Demographic changes influence land tenure as land possesses economic value by virtue of competition for its use between different individuals and groups. This rise in the value of land has become increasingly a source of conflict among individuals and communities. The flexibility of land tenure system is also affected by the religious beliefs of the local people who believe in the sacredness of lands. This belief has been modified with the advent of colonialism and Christian Missionaries, Land tenure is also affected by the excessive sub-division of lands as a consequence of inheritance systems and the traditional use of land as an ideal form of collateral because of its immobility and immunity to damage. This results in the fragmentation of holdings and a high number of small plots leading several cases of land alienation. These patterns of land endowment have caused people to live in scattered hamlets with title to land often undefined and cadastral surveys not available and as such, boundary disputes have become frequent. This is a big problem to land use, agricultural development and land resource conservation. Land tenure system structures the distribution of property rights within a society. From the inception of the colonial period when the colonial occupiers deprived the nationals of legal ownership and user rights to their customary lands, the relationship between family structure, the declining authority of the elders over land matters and the patterns of acculturation and inheritance rights has made land to be the root of many quarrels and disputes. Land tenure highlights grievances over land often manipulated to displace people, titling of land which often dispossess secondary right holders and grievances over land issues expressed in many forms ranging from formal legal proceedings, squatting to open resistance. Land disputes can be associated to the following:

Land Alienation – Land alienation is a cause of land dispute. In ancient times, land alienation was not in practice because it was believed that land was held by the present owners in trust for future generations. The attachment to land was so strong that ownership was not parted with rather only occupational rights were granted. Presently alienation of land which may take different forms such as sale, absolute gift, conditional gift, land borrowing, pledge etc is a practice in many communities. Alienation of land through sale involves the transfer of permanent rights over land for a monetary consideration and the transfer of the totality of the interest of the vendor. Alienation of land creates problem when title is in a group or where a person who has no title purports to alienate land or where the owner of land has mischievously granted same title to same land to several persons. This is the prevalent practice by vendors. It is very critical for a purchaser of family land to know the owners of the land and the proper persons who act on behalf of the community or family.

Insecurity of Title - One of the factors responsible for land disputes is insecurity of titles to land resulting from the absence in most cases of documents evidencing such titles. A grant of an interest in land must be made by deed or in writing but historically; customary law being unwritten did not require writing for transactions in land. Evidence of title usually consisted of oral traditional history handed down from generation to generation or of acts of ownership with living memory. From the point of security of title, these types of evidence are unsatisfactory because two or more families with equal honesty may claim ownership of the same piece of land. Presently, purchasers of land insist on a written document evidencing the sale or transfer of land. Writing provides an unequivocal evidence of the transaction. Some purchasers also insist on survey plans which have the special value in imparting greater certainty to the title by providing precise description of the boundary of the land. The land is also registered by the purchaser. Registration of the land makes it admissible in evidence in a court of law if there is dispute and litigation over such land. In Salami v. Lawal, the Supreme Court stated the five ways of proving title or ownership of land. They are by traditional evidence, by production of documents of title duly authenticated and executed, by acts of ownership extending over a sufficient length of time numerous and positive enough to warrant the inference of true ownership, by acts of long possession and enjoyment and by proof of possession of connected or adjacent land in circumstances rendering it probable that the owner of such connected or adjacent land would in addition be the owner of the land in dispute. In Carrena v. Akinlase, the Supreme Court held that a person who has title over a piece of land though not in defacto physical possession is deemed in law to be the person in possession. The law attaches possession to title and ascribes it to the person who has title.

Boundary Issues – Boundary issues are a cause of land dispute. Often the dispute about the boundary may arise where parties indisputably own adjoining lands. Boundaries give rise to frequent disputes because generally they are fixed with reference to natural objects like trees, hills and ditches etc which are capable of being confused with one another. It is possible that after a long time parties are likely to disagree as to the particular one that marked the boundary. Probably, the older persons who knew the boundary may be dead leaving younger ones who may identify the boundary with a different object. It is in this state of uncertainty regarding titles and boundaries that many transactions in land are carried out. An intending purchaser in this circumstance may have no means of verifying conclusively the truth of the traditional story upon which the vendor’s title is founded. Even when the traditional story is supported by acts of ownership, this may be inconclusive since there may be also acts of ownership on the part of the rival claimant. In Odunze v. Nwosu the court held that where the parties to a land dispute own land on either side of a common boundary, the boundary features along it must be clearly shown and proved. The plaintiff must prove the areas over which he claims with certainty and the two methods of identifying the land in dispute with its boundaries are adducing oral description of the land that a surveyor acting on the strength of the description can make a plan of the land or a plan showing the land in dispute with its boundaries..

Family Distribution System- In most systems of customary law, the family head plays a vital role in family affairs. He is charged with the administration of the unpartitioned family property and with the power to make vital decisions including the mode of distribution of property when there is a dispute. The selection or appointment of a family head is therefore a consensus of opinion because on the death of a founder or head, the proper person to succeed becomes a cause of dispute. The court in

Lewis v. Bankole held that the proper person to head the family is the Dawodu or eldest surviving son. It is after the death of the Dawodu that we begin to find several variations. For example, the other sons of the founder of the family begin to take in turn and then the sons of the Dawodu and other son's sons- the headship being kept in male line.

Loss of Title to Land – Loss of title to land leads to dispute. Title to land may be lost in certain circumstances e.g. by act of the parties or by operation of law. The rights of persons enjoying permanent occupational rights in land may be extinguished by forfeiture upon misconduct, abandonment or extinction. A customary grantee of land is only entitled to occupy the land duringhis good behaviour unless the grant is an absolute one. Acts amounting to misbehaviour include challenge of the overlords title e.g. refusal to pay rent or tribute or to render customary services stipulated. Refusal to pay tribute is misbehaviour if it is viewed as a challenge to the overlord's title. The challenge must be such that the court will infer assertion of title. Denial of title may be express e.g. where the grantee claims the land as his or asserts a title in some other person. Cases of implied denial are where the grantee alienates his holding to a stranger. By this, he has by implication set up a claim of ownership. The clearest example of alienation is sale and these days several cases of alienation by sale occur. Misbehaviour make the culprits land liable to forfeiture but this can be resisted by application to court claiming immediate reversion of the forfeiture in order for the claimant to resume possession. Also, the right of occupation can be lost where the person who possesses such a right abandons his holding by quitting the land or expressly surrendering possession to another or where there is adverse possession.

The Tenure of Stool Land – Stool land is a special one vested in the chieftain as a corporation sole. The admixture of British and Native systems produced a new dimension in the transfer of land rights in Nigeria e.g. in Northern Nigeria, the British Colonial Government enacted the Land and Native Rights Act in 1916 which declared all land in Northern Nigeria as native land under the colonial governor who had power to grant rights of occupancy. For the South, the British Government gradually obtained control of the land by series of piecemeal treaties and this led to the enactment of the Native Land Acquisition Act 1917. These laws relating to land rights were criticised as not guaranteeing security of title and made difficult and cumbersome acquisition of land for public / private use. In 1977, a Panel known as the Land Use Panel was inaugurated to examine these lapses and this led to the enactment of the Land Use Act 1978 by the Obasanjo led Military Administration. The belief is that the Land Use Act as an existing law virtually confiscated all the undeveloped lands in Nigeria from its community and private owners. It took away from every Nigerian the right of ownership and vested in the Governor of each State the ownership of land in that State. Indeed, land in each State except land vested in the Federal Government or its agency solely vests in the Governor who holds such land in trust for the people and would be responsible for allocation of land in all urban areas. Absolute ownership of land is no longer possible in Nigeria by virtue of section 1 of the Land Use Act.

RESEARCH DESIGN

The study employed survey design. It seeks to find out the conditions or relationships that exist, opinions that are held, processes that are going on, effects that are evident or trends that are developing (Akwuezuito, 1993). Survey is the commonest tool of social science research. It is reliable and transparent and it allows large number of people to be questioned quickly and cheaper, and because responses are specific and limited, result can be systematically quantified and analysed (Talor, 2003). Specifically, Focus Group Discussion (FGD) and questionnaire methods were employed in seeking the opinion of land allottees/statutory title holders of residential plots within Kaduna Metropolis on the reality, aspects, resolution and negative results of land disputes that occur on their layouts. FGD equally referred to as “group depth interviews” is a group interview consisting of limited number of persons ranging from a minimum of six to eight people who are brought together by the researcher to express their views on a specific set of questions on residential land disputes, and the dispute resolution measures. The contact tends to the intensive with extensive proving questions. In addition questionnaires were distributed to obtain the opinions of technical staff members of Kaduna State Ministry of Lands and Kaduna based private practicing professional Lawyers and Estate Surveyors. Interviews were also carried out to obtain some detailed information from some Ward Heads, three Directors in the Lands Ministry and four displaced famers.

Population of the Study

The population for this study includes Three Thousand Seven Hundred and Ninety Seen (3,797) land allottees/statutory title holders from fourteen residential layouts within Kaduna Metropolis. These layouts are listed in the table 1.1 below;

Table 1 State Residential Layouts within Kaduna Metropolis

No table of figures entries found. S/N	Layout	Location (LGA)
1.	Malali Layout	Kaduna North
2.	Hayin-Banki Layout	“
3.	Unguwan Dosa Layout	“
4.	Doctors Quarters Layout	“
5.	Unguwan Mu’azu Layout	Kaduna South
6.	KTL (Barnawa) Layout	“
7.	Unguwan Television Layout	“
8.	Unguwan Romi Layout	“
9.	Hayin Dan-mani Layout	Igabi
10.	Trade Fair Layout	“
11.	Barkallahu Layout	“
12.	Mahuta (National Eye Centre)	“
13.	Tsaunin Kura Layout	Chikun
14.	Unguwan Boro Layout	“

Source: Ministry of Lands and Surveys Kaduna 2015

Also there were eighty seven (87) senior technical staff of Kaduna State Lands Ministry listed on the Ministry's staff disposition list; and thirty (38) professional lawyers listed from the name of lawyers frequently dealing with Kaduna State Lands Ministry; forty eight (48) professional Estate Surveyors listed on their state branch directory of their Professional Association which forms total population of the study area.

Sample Size and Sampling Technique

In each of the four Local Governments that made up Kaduna Metropolis, namely Kaduna South, Kaduna North, Chukun and Igabi L.G.A., one State residential layout was selected from the list of Kaduna State's residential layouts, using random sampling technique i.e., using "lucky dip". These four layouts selected are Unguwan Dosa, unguwan Mu'azu, Mahuta and Unguwan Boro Layouts located at Kaduna North, Kaduna South, Igabi and Chikun Local Government Areas respectively. On each of the selected layouts six (6) land allottees/statutory title holders that had experienced land dispute were then selected for FGD using snowball sampling technique. The membership of the Focus Groups are not usually chosen through some rigorous sample selection process, as such they cannot be said to be statistically representative of any meaningful population (Babbie, 2001). While random sampling technique was employed using table of random numbers to draw forty (40) respondents from the senior technical staff of Kaduna State Lands Ministry; and Thirty (30) respondents each from private practicing professional Lawyers and Estate Surveyors practicing within Kaduna Metropolis. Also accidental sampling technique was employed to administer hundred questionnaires to statutory title holders on each of the four selected layouts. The quantitative data collected from field survey was duly examined, categorized and analyzed using descriptive statistics, precisely percentages; and qualitative data collected were explained.

DATA PRESENTATION AND ANALYSIS

Various Aspects of Land Disputes

The causes of these land disputes include double allocation, encroachments, corrupt practices of fraudulent lands officials, re-planning of layouts, withdrawal of grant of statutory right of occupancy, technical mistakes in the survey of residential layouts and action of touts and speculators. Statutory title holders/land allottees interviewed at the four layouts under study, gave their accounts of some of the dispute cases they could remember and the number of such land dispute cases on each of the layou8ts and their causes are shown on the table 2 below.

Table 2: Types and Number of Land Dispute Cases

Layouts	No & %	Causes of land disputes							
		Double Allocation	Encroachment	Corrupt Practices	Re-planning of layout	Withdrawal of Grants	Technical Mistakes in Surveys	Land Touts Action	Total
Kinkinau Layout	No.	8	9	27	6	7	0	24	81
	%	10	111	34	8	9	0	29	100
Unguwan Dosa Layout	No.	5	2	15	0	0	1	6	29
	%	17	7	30	0	0	3	23	100
Mahuta Layout	No.	4	1	31	5	0	6	3	50
	%	8	2	62	10	0	12	6	100
Unguwan Boro Layout	No.	8	6	1	0	0	2	16	33
	%	23	17	3	0	0	7	50	100

Source: Field Survey 2015

From table 2 above it is obvious that corrupt practices of lands officials was the main cause of land dispute on three of the four layouts, namely Kinkinau, Unguwan Dosa and Mahuta Layouts, followed by the ones caused of touts and speculators.

Fraudulent acts of Kaduna State lands official was more pronounced on Mahuta, Unguwan Dosa and Kinkinau residential layouts. The cases mentioned by the discussants at Mahuta Layout revealed that Kaduna State lands official hid some of the resettlement certificates of the farmers that are allocated lands in lieu of compensation. These Lands officials and other members of the compensation committees shared such resettled plots among themselves and sold them later. These cases became exposed when these stolen plots are offered for sale. Several Disputes between old settlers, buyers of such lands and the corrupt members of staff of Kaduna State Lands Ministry arose during such sales. Actually, more than 50% of the statutory title holders discussed with had their titles already exchanged hands more than twice before they acquired them. This was an indication of active land market and the lucrativeness of land sales in the various areas. This phenomenon was occurring more at Unguwan Dosa, Kinkinau and Unguwan Boro Layouts. At Kinkinau and Unguwan Dosa Layouts, land values were observed to be rising at an average rate of 200% per annum from 1998 to 2004 and increased to close to 300% per annum from 2004 to date. This could be the obvious fact that touts mostly in the name of agents and speculators were actively operating in the three layouts mentioned.

Some of the land owners that experienced disputes in these areas were due to the double dealings or multiple sales of a plot by these touts or agents. In most of the layouts they have offices or sheds from where they operate. Very few of them were said to be doing a legitimate business. At Kinkinau layout a tout was said to have enjoined the gains he made in the sale of a plot in the area and gradually cornered more than hundred plots; re-planned the area, allocated some land suing Local Government's Lands documents; and also sold so many. He started by obtaining a court injunction against some of the state land allottees who tried to developed their plots. He used the court injunction and law enforcement agents to bar people that stepped in to the area, except those he sold the land to. Figure 1 below indicated the area affected (part of TPO 473F Unguwan Mu'azu Layout or Kinkinau Layout). The area was declared no-go-zone by the police until when the case is determined in the High Court.

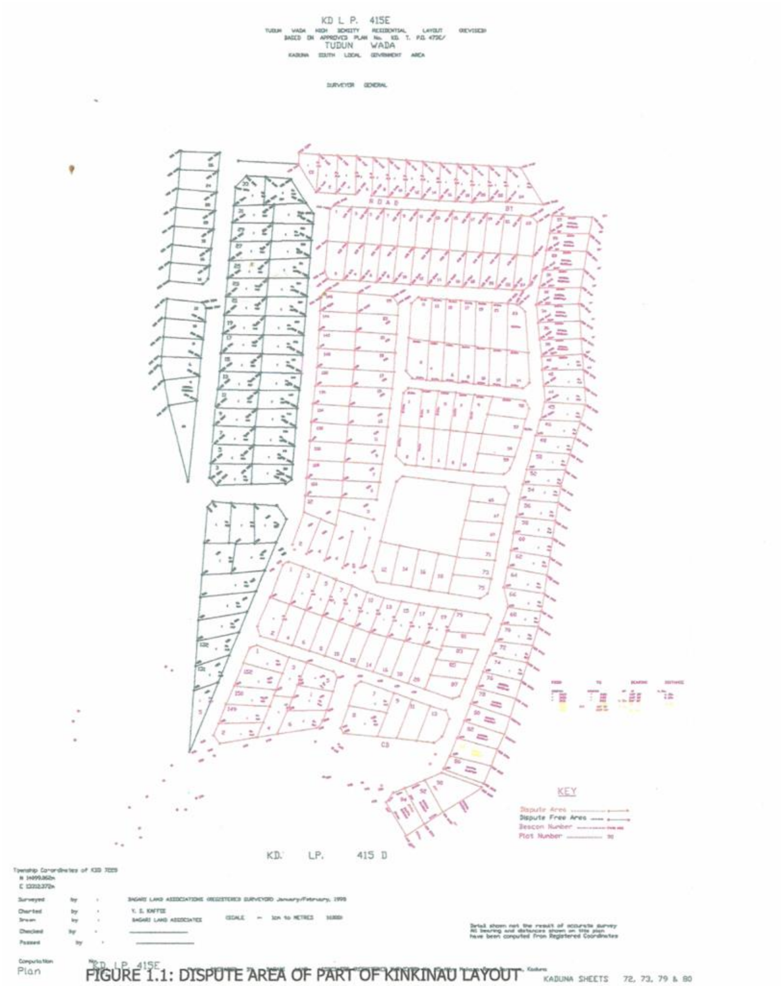


FIGURE 1.1: DISPUTE AREA OF PART OF KINKINAU LAYOUT

Land Dispute Resolution

Section 30 of the Land Use Act (1978) recognizes only disputes that arose due to non-satisfaction on computed amount of compensation payable to those whose lands were compulsorily acquired could be resolved by the Kaduna State Land Use and Allocation Committee. But from the foregoing a lot of disputes other than those on the issue of compensation do arise on state residential layouts within Kaduna Metropolis and the study showed land disputes over allocated state residential plots were being resolved by the Lands Ministry and through some other means like dialogue, mediation and the courts. The table below shows that various means employed by land allottees/statutory title holders who experienced disputes.

Table 3: Types and Number of Land Dispute Cases

Layouts	**No. of percentages**	**Means of residential land disputes settlement**				
		Kaduna State Lands Ministry	**Dialogue**	**Mediation**	**Law Courts**	**Total**
Kinkinau Layout	No.	33	34	6	8	81
	%	41	42	7	10	100
Unguwan Dosa Layout	No.	12	16	0	1	29
	%	41	56	0	3	100
Mahuta Layout	No.	21	25	1	3	50
	%	42	50	2	6	100
Unguwan Boro Layout	No.	14	17	0	2	33
	%	42	52	0	6	100

Source: Field Survey 2015

From the table above it is obvious that the means of land dispute resolution most patronized by residential plot owners who experienced dispute was dialogue. Followed by the lands ministry, then the law courts and the least means patronized was mediation. The Lands Ministry has a standing committee on residential lands dispute headed by the Deputy Director (Residential). The committee chairman indicate that some land allottees/statutory title holders in residential plots happened to be in dispute most at times lack the patience to allow the committee enough time to carry out a detailed investigation, as a result they turned to other means of settlement.

Findings

The results from the analysis of field data collected for this research indicated the following:

1. The major causes of residential land disputes were the corrupt practices of Kaduna State Lands officials and the fraudulent actions of land touts.
2. Land allottees and statutory title holders who experienced land dispute had suffered trauma and fear of not only losing the plots they were allocated or the ones they purchased as the case may be, but also the fear of losing the huge money they spent to acquire their plots.
3. Kaduna State Land allottees had been variously attacked and chased away by farmers whose farm lands were compulsorily acquired for preparation residential layouts but without been paid of due compensation.
4. The public had also loss confidence and trust in the Government because of its direct or indirect involvement in land disputes.
5. Dialogue was the most workable and frequently employed measure by those people having land disputes over state residential plots within Kaduna Metropolis

Conclusion

There exist serious threats to tenure security of holders of stator titles over residential plots within Kaduna Metropolis. Many disputes exist and are re-occurring mainly due to maladministration of state lands. The disputes are now mainly caused by unethical and fraudulent acts of Kaduna State Lands Ministry officials and land touts instead of the previous known disputes on non-payment or inadequate payment or compensation by Government. But tenure security is supposed to be maintained and enhanced by the staff of Kaduna State Lands Ministry who are employed by the state to operate, protect and perfect the land administration system. Even though Kaduna State Lands Ministry had recorded some achievements in resolving land disputes, there was a clear indication that it is losing public confidence due to its inability to aptly resolve majority of the land disputes that arose in most of its residential layouts.

Recommendations

1. Kaduna State Lands Ministry officials should be audited and those with records of misconducts should be punished immediately.
2. The Lands Ministry should proceed with immediate computerization of the whole process of land allocation in Kaduna State. This will maximally reduce technical errors and enhance efficiency in the entire land allocation process.
3. A radical way of halting the activities of Land touts should be evolved by Kaduna State Government. This can be done by establishing a special task force under the Ministry that will include law enforcement agents, Civil Defense Corps and staff of Kaduna State Lands Ministry. Such task force should ensure that touts' offices on various residential layouts within the metropolis are dismantled and their networks broken.
4. Alternative Dispute Resolution Mechanism (ADR) should be encouraged by Kaduna State Lands Ministry by registering organized reconciliation and mediation associations

that will be formed by statutory title holders and various community leaders such as District Heads. Such dispute resolution bodies should be given due recognition and adequate legal and technical support by Kaduna State.

REFERENCES

Abdullah, J.H. Hamza I. (1998). Women Need Independence Ownership Rights: Women and Land in Northern Nigeria. Unpublished Conference Paper presented at International Workshop of Women and Land in Africa at Kampala, Uganda.

Aboki, Y. (2003). Land Use Policies and legislative Development in Nigeria. In Land Tenure Systems in Nigeria. Landnet Nigeria.

Aboki, Y. (2001). Introduction to Statutory Land Law. Lecture Notes and the Land Use Act, 1978, (Unpublished) revised Edition

Ajanlekoko, J.S. (2001) Sustainable Housing Development in Nigeria – The Financial and Infrastructural Implications, an International Conference Paper on Spatial Information for Sustainable Development Held in Kenya.

Alkali, L.S.J (2004). Planning Sustainable Urban Growth in Nigeria; Challenges and Strategies, a Conference paper on planning sustainable urban growth and sustainable architecture held in UN Headquarters, New York.

Babbie, E. (2001), The practice of social research, 9th Edition. Wadsworth/Thomson Leaning.

Bailliet C. (2001). Between Conflcit and Concencus: Conciliating Land Disputes in Guetemala. University of Oslo, Norway.

Bukar, B. (2002). Research Methodology in research reports: What is what it contains? Unpublished Workshop paper on Enahcnign and Improving the skill of Teachers for Supervising Student's Projects, Kaduna Polytechnic.

Ega, A.L. (1987): The Need to Redefine rights Under Customary land Tenure in Northern Nigeria, in Perspective on Land Administration and Development in Northern Nigeria, Department of Geography, BUK.

Egute, A.M.R., Ode. I. O., and Kur, J.J. (2004). Land Rights and Mechanism for Resolving Land Disputes in Benue State, in Access to Justice Programme, Nigeria. Benue State Univeristy, Makurdi.

Federal Republic of Nigeria (1978), No. 6 – Land Use Decree 1978 (Official Gazette Extraordinary) Vol. 65 No. 14.

Francis, P. (1984): for the use and Common Benefit of all Nigerians: Consequences of the 1978 Land Nationalisation: Africa 54(3) PP. 28

Ikejiofor, C.U. (2004) Informal Land Delivery Processes and Access to Land for the Poor in Enugu, Nigeria, University of Birmingham

International Institute for Environmental Development (IIED), (1999): World Resources, UNEP

Ja'afar, D.A. (2003). An Analysis of Residential Land Allocation, Procedures and Problems in Kano, Unpublished M.Sc. Thesis Submitted to the Department of Geography BUK.

Jibrin, B. B. (1999): Some Outstanding Issues from the Implementation of the Land Use Decree of 1978 in Kano Metropolis, M.Sc. Land Resource Thesis Submitted in the Department of Geography, Bayero University, Kano

Jumare, I. (1995), Land tenure in Sokoto Sultanate Northern Nigeria, Unpublished Ph.D Thesis, York Univeristy, Canada

Kaduna State of Nigeria, (1981): Report of the Land Investigation Commission. Vol. I and VII Kaduna Government Printers

Koehen, H.P. (1983). State Land Allocation and Class formation, a Journal of African Studies.

Koehen, H.P. (1983). State Land Allocation, in State and Local Policy and Administration, West View Press Inc.

Koehen, H.P. (1990). State Land Allocation, in State and Local Policy and Administration, West view press Inc.

Land Use Act Cap 202, Laws of the Federation of Nigeria, 1970.

Macdowell, C.M. (1966), An Introduction of the Problems of Land Ownership in the Northern Nigeria. institute of Administration A.B.U. Zaria (1996).

Mollel, L. (2007). Urban-specific Land use Conflicts and their effect on Land Management, Good Governance and the Environment, DILAPS, Tanzania.

Mortimore, M. (1986). The Lands of Northern Nigeria, Some Urgent Issues, in Perspective on Land Administration and Development in Northern Nigeria, BUK.

Omirin, M.M (2003), Issues in Land Accessibility in Nigeria, Proceedings of a National Workshop on Land Management and Property Tax Reform in Nigeria, Dept of Estate Management, University of Lagos.

Omirin, M. M. and Antwi, A.Y. (2004). Informality, Illegality and Market Efficiency: A Case for Land Regulation in Accra and Lagos, RICS Research Series, Foundation, London.

Olawoye, C.O. (1981). Titlte to land in Niogeria, Evans Brothers Limited, Nigeria.

Rakodi, C. (2005). Land for Housing in African cities: Are Informal Delivery Systems Institutionally robust and Pro-poor? Global Urban Development Magazine Vol. 3. Pp.6

Riskin, L. & James, E. W. (1997), Dispute Resolution and lawyers. West Publ.

Salawu, M.B., Dugeri T.T., (2008). Investigation of Phenomenon of Tenure Insecurity in Kaduna Metropolis. Unpublished Conference Paper Presented at the 5th C.E.S. Annual Conference, Kaduna.

Shaw, F. (1905) A Tropical Dependency. An Outline of the Ancient History of the Western Sudan, with an Account of the Modern Settlement of Northern Nigeria, London: James Nisbet & Co.

Tailor, W.R. (2000). Urban Development Policies in Nigeria: Planning, Housing, and Land Policy, in Current Trends of Urban Planning and Development in Nigeria.

Udo, O.G. (2004): A Guide to Modern Research, Institute for Development Studies, Enugu.

Umar M.A (2006): Focus Group Discussion, in Readings in Social Science Research, BUK.

Umeh, J.A. (1973): Compulsory Acquisition of Land and Compensation in Nigeria. Sweet and Maxwell, London.

Yahaya, and Shekamang (1986): Problems Associated with Urban Land Acquisition, Compensation and Allocation, in Perspective on Land Administration and Development in Nigeria, BUK.

Yakubu, M.G. (1985): Nigeria Land Law, London: Macmillan Publishers

DESIGN CONSIDERATION FOR CROWD CONTROL IN RELIGIOUS BUILDINGS: A CASE STUDY OF MOSQUE BUILDINGS IN NIGER STATE, NIGERIA

OYERINDE, Babatunde Rasheed
Department of Architecture, Federal University of Technology, Minna, Niger State, Nigeria,

It has been observed overtime that problems occur when a large crowd of pedestrians are trying to move in or out of places of gatherings especially sporting, religious, cultural and other crowd intensive events. These problems are due to lack of crowd control considerations in terms of design, information technology and management to adequately control crowd situations. In Mosque for instance, at peak periods on Fridays and Eid days, crowd control is a problem especially after the prayers when people are trying to find their ways out of the mosque premises. Therefore, the importance of the design consideration for crowd control in mosques and other such buildings cannot be over-emphasized. As a result, this paper aims to evaluate the openings (ingress and exits) as a design consideration for crowd control in selected mosques in Niger state. Secondary source was used to gather relevant information, and an observation schedule was also used as a research instrument to get important field data. Data gathered on the type, size (width) and direction of swing of the door openings were analysed and presented in form of tables and chart. The findings show that 100% of the door used in the research areas are single swing door. Similarly, 100% of these doors swing to the direction of exit.

Keywords: *Crowd-Control, Design-Consideration, Friday, Mosque, Muslims, Pedestrian, Prayers.*

rasheed.oyerinde@yahoo.com

OYERINDE, Babatunde Rasheed (2016). **DESIGN CONSIDERATION FOR CROWD CONTROL IN RELIGIOUS BUILDINGS: A CASE STUDY OF MOSQUE BUILDINGS IN NIGER STATE, NIGERIA**
Sustainable Built Environment and Climate change; The challenges of Post 2015 Development Agenda. School of Environmental Technology Conference, SETIC, 2016

INTRODUCTION

Religious gatherings venues and places like the mosques are similar to entertainment centres in that they are places designed to host and cater for a large number of individuals and crowd at a particular time and period. Crowd according to the Oxford Advanced Learners Dictionary can be defined as: a large number of people gathered together in a public place, for example in the streets or at a sports game. In other words a crowd as a sizeable or large number of people gathered at a specific place for a given period of time with common goals and behaviours. According to Still (2010), crowd dynamics can be define as the study of how and where crowd form and move above critical density of more than one person per square metre. At high density there is the potential for overcrowding and personal injury. It is therefore important to understand the dynamics of crowd, how crowd understand and interpret the information system and how management system affects crowd behaviour.

This research was undertaken in view of the number of injuries and deaths occurring world-wide as a result of large public gatherings, which include; sports, concerts, dramas, and traditional festivals, majority of which lack effective or efficient crowd control and most current is the multiple casualties and death recorded recently in Saudi Arabia where about 717 individuals lost their lives and a about 823 sustained injuries. In many gatherings and social events as well as religious gatherings, there is always a problem of controlling and managing the crowd such that when such population is not properly handle could lead to chaos, stampede and eventually death of people. According to Monica (2011), crowd incidents occur under different circumstances and in varieties of venues. However, the most common crowd incident occur in sporting events, entertainment events, religious gatherings, food and aid distribution, riots or demonstrations. For example in January 2005, people numbering about 340 died in a stampede in a temple in Satara district of Maharashtra. In September 2006, about 50 people were also killed and injured in a stampede at a stadium in Yemen. Also in 2006, in a night club at Buenos Aires (Argentina), a fire disaster killed 174 people and injuring about 400, because all the exit gates were locked from the outside, the stampede that resulted to more deaths than the fire. (Franaszek, 1986). In March 2014, about 10 people were killed at Nigeria's National stadium Abuja in a stampede during a Nigerian Immigration Service recruitment exercise (vanguard, 2014). Most recently is the stampede in Saudi Arabia that killed 717 people and injured above 800 individuals (The guardian, 2015). With stampedes often killing a large number of people in events and public centres due to little or absence of crowd control and management techniques, there is need to seriously consider and put in place effective crowd control techniques both at the designing stage and post designing stage in these centres to prevent further occurrence of these avoidable tragedies.

The challenge posed by crowd control is such that crowd management professional and processes must take into account all the elements of an event especially the type of event (religious, circus, sporting, theatrical, concert, rally, parade,), characteristics of the facility, size and demeanour of the crowd, methods of entrance, communications, flow rates, signage and queuing. As it is in all management, it must include planning, organizing, (staffing,) directing and evaluating. Particularly critical to crowd management is defining the roles of parties involved in an event, the quality of the advance intelligence, and the effectiveness of the planning process. Therefore the problem observed here is the inadequate and inefficient monitoring and management of crowds in terms of circulation and exits. After an extensive and critical observation of religious centres, the research shows that the first step towards a well monitored and managed crowd is to evaluate the points of entrances and exits of these centres.

Therefore, this research work is aimed at evaluating the entrances and exits of some selected mosques in Niger state, Niger State as design considerations for crowd management and control in mosques. This will be achieved by the evaluation of door types, direction of door swings, door sizes and number of doors in the selected Mosques.

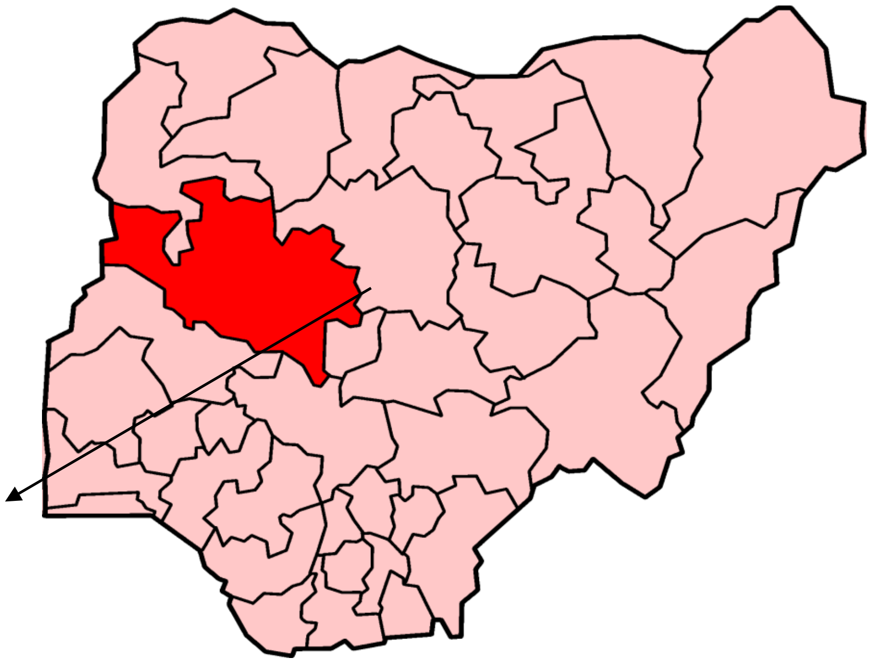
GENERAL OVERVIEW OF CROWD MANAGEMENT

Overtime in crowd situations, problems occur where pedestrians move in or out of places of large gatherings especially sporting, religious, cultural, food and aid distribution and other crowd intensive events. These problems are due to inadequate crowd control and management techniques in design construction and organisation. The management of crowds at these events and even in the day-to-day movement of public in and out of religious buildings is a major problem with great consequences for the safety of human life if it is not managed successfully. Geis (2000) explained that most fatalities and property losses occur during events as a result of inappropriate and inadequate designs which contribute to the problem rather than solving it. To minimize the impacts of emergencies in events and hazards in buildings, the initial building design needs to take into cognizance the circulation of the building occupants as well as, structural, environmental and dimensional factors. To this end, any building that will cater for and host a large amount of people at a particular time is and should be of serious importance so as to minimise to the barest minimum the fatalities and casualties that occur in mosques and other religious buildings .As more and more mosques are being built to accommodate and cater for Muslim faithful on Fridays and other days of religious activities that may be hosted in the mosque, crowd control and management are now very important issues in this industry (Norazlina, 2000). However, in most cases these recorded fatalities and hazards could be averted except for the fact that proper design procedures are not usually employed in building these mosque and public centres. For example: physical layout, crowd circulation, movement of people in and out of the venues, number and position of entrances and exits, capacity of the centres and also seating types and arrangement are not given due consideration. And these factors form a larger part of the causative agents of the fatalities and casualties under discussion. Therefore for the success of any event, gathering and congregation prayers as always occurring in mosques; there is need for proper management and control of the crowd after the appropriate and necessary design considerations and factors are met and catered for.

METHODOLOGY

The Study Area

Niger state was created on the 3rd of February 1976, from the former north–western state. It is situated strategically in the North-Central geo-political zone of Nigeria. Minna is the capital of the state and the state covers a total land area of 74,108.58 sq km. This is about 9.3% of the whole country land area.



Niger State

Map of Nigeria Showing Niger State
(Source: Encanta Dictionary 2010)

The scope of this research work will be religious gatherings and in particular some selected Mosques in the three political zones of Niger State.

DATA COLLECTION

The method employed in the sourcing for materials and data for this study is essentially the primary method of data collection in the form of personal observations, interviews and visitations to some built mosques. And augmented with the secondary data sourcing method in the form of holistic reviews of documented or published research works, as well as consultation with experts and researches in the area of interest of the present study.

DATA ANALYSIS

For the analysis a total of four central and jum'ah mosques were visited and these mosques include:

a. *Minna central mosque, Minna, Niger State.*
b. *Unguwar madawaki central mosque, Kontagora, Niger State*
c. *Bida central mosque, Bida, Niger state*

d. Chanchaga central mosque, Minna, Niger state.

These mosques represents the central mosque and the central meeting points in these major cities of the State under study hence they are statistical viable and represents a random representation for other available mosques within the state.

The parameters employed in the assessment of these mosques for this research are as below:

i. Area and Capacity of Mosque:

Table 1.1 Capacity of the Mosque in the Study Area

research areas	AREA OF INTERNAL SPACE (m2)	CAPACITY (number of people)
Minna Central Mosque	1350-1600	1500-2000
Kontagora Central Mosque	1000-1200	700-1000
Bida Central Mosque	1200-1500	1200-1700
Chanchaga Central Mosque	1200-1500	1200-1700

Source: Author's Survey, 2015.

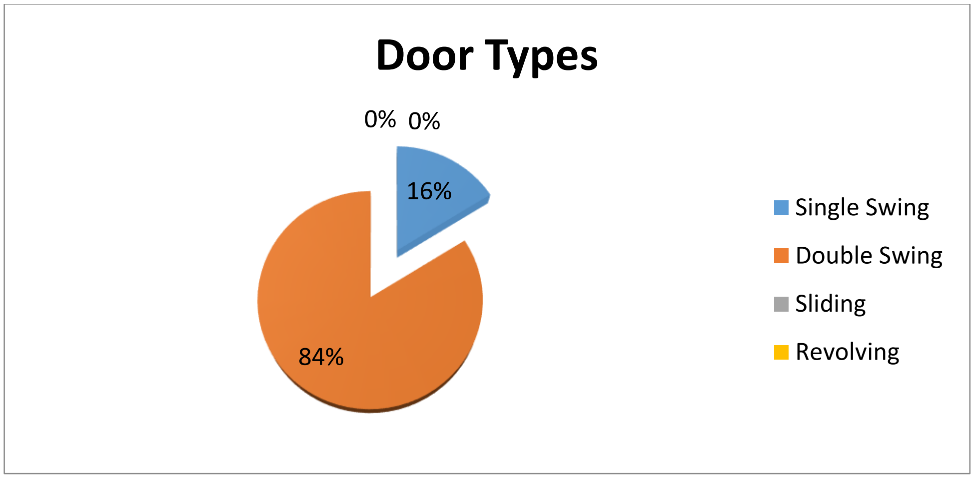
ii. Evaluation of types of doors:

The table below represents the frequency of the available doors and their percentage. The idea of percentage is it is a general knowledge that all these mosques have doors but the contention here is the adequacy and efficiency of the available doors.

Table 1.2 Types of Doors Available in the Studied Mosques

Study Areas	Door Types				Total
	Single swing	**Double swing**	**Sliding**	**Revolving**	
Minna Central Mosque	0	6	0	0	6
Kontagora Central Mosque	1	4	0	0	5
Bida Central Mosque	2	12	0	0	14
Chanchaga Central Mosque	2	4	0	0	6
total	5	26	0	0	31

Source: Author's Survey, 2015.



Source: Author's Survey, 2015.

In table 1.2 above, it is clear that double swing doors are mostly essential in the control of crowd management as the use of double swing door amount to 84% of the available doors used in the study areas. Only 16% of the available doors are single swing doors most of which were located in the imams' exit where the flow rate is very low as it is mostly used by the imams' crew. The table also shows that sliding and revolving doors where not found in the study area due to the fact that they do not account for effective crowd control systems. The figure above shows a graphical representation of the doors available in the study areas.

iii. Evaluation of sizes of doors:

Below is tabular representation of the width of doors as that is the most important regarding population movement and crowd control when compared to height of doors.

Table 1.3 Door Sizes in the Study Areas

Study Areas	Door Sizes						Total
	750	**900**	**1200**	**1500**	**1800**	**2400**	
Minna Central Mosque	0	0	0	0	0	6	6
Kontagora Central Mosque	0	1	0	4	0	0	5
Bida Central Mosque	0	0	2	0	12	0	14
Chanchaga Central Mosque	0	2	0	4	0	0	6
Total	0	3	2	8	12	6	31

Source: Author's Survey, 2015.

From the table above, door sizes of 750mm were not used for the exit doors, 9.7% of the exit door were found to be 900mm size doors, 6.5% of the exit door account for 1200mm size doors, 25,8% of the exit doors were of 1500mm sizes while 38.7% were of 1800mm sizes and only 19.4% were 2400mm sizes.

iv. **<u>Openings on perimeter fence:</u>**

The table below highlights frequencies of sizes of openings on the perimeter fence of these mosques.

Table 1.4 Openings on the Perimeter Fence

sizes of openings on perimeter fence (mm)	**frequency**	**100**
750-1500	2	9
1600-2400	2	10
2500-4000	10	48
<4000	7	33
TOTAL	21	100

Source: Author's Survey, 2015.

From the above all the ranges of sizes compared and observed were 25% each whereas from (2500-4000) mm and 4000mm and above should have at least been about 75% of the available openings.

FINDINGS

The findings from above analysis indicated that the design consideration for crowd control and management in terms of door sizes, types of doors, frequencies of openings on the perimeter fences, sizes of corridors and walkways, direction of swings of the doors and number of available doors is grossly poor. That is because in all the parameters observed and studied the only that is fair but not good is the sizes of the walkways and corridors.

CONCLUSION

The crowd control and management mechanism, techniques and parameters put in place during the designing stage and design consideration of these mosques and (and as random representation) in all the Central Jum'ah mosques in Niger state are in adequate, inefficient and extremely poor. And therefore needs immediate attention to prevent any future and eventual occurrence of stampede and injuries.

REFERENCES

Akel K., Latif A., Craig A., (2015), Design Criteria for Mosques and Islamic Centres Kindle Edition

Azra A., (2007), Generic mosque Design principles for mosque design, http://tdd.elisava.net/coleccion/24/aksamija-en, retrieved 2015/09/14

Faris A. M. , Ahmad S. H., (2011) (Mosque layout design: An analytical study of mosque layouts in the early Ottoman period. Retrieved 2015/09/15

Kendra W. (2015), https://www.khanacademy.org/humanities/art-islam/beginners-guide-islamic/a/introduction-to-mosque-architecture. Retrieved 2015/09/15

LONAARD, (2012), Art and Architecture Magazine - London, Issue 8, Vol. 2. Retrieved 2015/09/15

Mohammad Y., Yasser A., (2014), Crowd Management with RFID & Wireless Technologies.www.researchgate.net/.../224100449_Crowd_Management_with_RFID__Retrieved 2015/09/15

Ojeme. V., onoyume. J., Mosadome. W., & Umoru, H. (2014, March 16). Immigration Job Test Tragedy. *The vanguard*, pp. 1. Retrieved from http://www.vanguardngr,com/2014/03/immigration-job-test-tragedy

Shaheen, K. (2015, Octorber 9), Hajj Stampede Death Toll Raised to 1,453. Theguardiannews, pp. 1, 2. Retrieved from http://www.the guardian.com/world/2015/oct/09/hajj-stampede-death-toll-raised-to-1453.

Still G.K. (2010). Crowd Density Considerations, cabinet office, emergency planning college. SERCO.

THE MOSQUE, http://scholar.lib.vt.edu/theses/available/etd-050599 103655/unrestricted/ch14.pdf. Retrieved 2015/09/15

EVALUATION OF USER SATISFACTION IN SELECTED STUDENTS HALLS OF RESIDENCE, UNIVERSITY OF IBADAN, NIGERIA

AKINLUYI, Muyiwa Lawrence & NASAMU, Raphael

Department of Architecture, Joseph Ayo Babalola University (JABU), Ikeji-Arakeji, Osun-State.

The study evaluated the physical qualities and satisfaction in students' housing in selected Students' halls of the University of Ibadan. Through survey method, eight hostels were purposively selected to capture variation in gender, level of study and hostel design. The sampling frame showed that 5605 students at UI were found in 2,147 rooms. One out of every 10 (10%) of the rooms were selected which amounted to 215 students selected. The result shows that the functional qualities of the hostels were perceived among the students to be well above average (55.3%). Similarly, both aesthetics (95.8%) and structural (89.3%) qualities of the hostels were perceived to be excellent among the students. Also, respondents were satisfied with various services and amenities provided in the Halls of Residence (54.4%) and 35.3% expressed neutral satisfaction. The study concluded that, Physical qualities and Satisfaction are important in the study of Students' Housing Design.

***Keywords**: Physical quality, Satisfaction, Students' Housing, University*

akinluyi_muyiwa@yahoo.com
raphaelnasamu@yahoo.com

AKINLUYI, Muyiwa Lawrence & NASAMU, Rapheal (2016). **EVALUATION OF USER SATISFACTION IN SELECTED STUDENTS HALLS OF RESIDENCE, UNIVERSITY OF IBADAN, NIGERIA** Sustainable Built E nvironment and Climate change; The challenges of Post 2015 Development Agenda. School of Environmental Techno logy Conference, SETIC, 2016

1.0 INTRODUCTION

The study of the physical qualities and satisfaction in students' housing for the University is an important aspect of housing study because globally, Students' housing is a living and learning types of accommodation consisting of shared housing facilities and amenities for the community residents who use it. They are normally built on-campus, owned by the university, provided for inexpensive chargeable rooms, and administered to accommodate the undergraduate or postgraduate students. Students' housing sometimes draws upon the model of the conventional family house, (Nurul ,Yusof&. Osman, 2011). Students' housing is a major types of accommodation for university students who are in a transitory stage of life and very little is known about this category of users with respect to dwellings, (Gifford, 1997). Susilawati, (2001) &Khozaei, (2010) define student housing as a building with many rooms in which each room contains several beds. According to this definition, students' housing provides sleeping and living quarters, usually without private bathrooms, for a large number of people and such housing is furnished and rented by the students. In addition, students' housing goes by many names, such as halls of residence, (Amole, 2005), student dormitory (Kaya and Erkip, 2001), catered halls (Price *et al.*, 2003), University housing (Bland and Schoenauer, 1966) and Hostels (Dahlan, 2009; Khozaei , 2010). Students' housing signifies the house built with some institutional or formal characteristics. There are two form of students' housing: We have On-campus and off-campus types of Students' housing. The On-campus type is usually inside the campus while the Off-campus type is situated outside the campus. The major need addressed by such facilities is dwelling, but it should be argued that the desire to interact and socialize with friends or to attain a desired social status may explain why individuals demand some housing facilities. The students' complex offers rooms that are equipped with complete facilities and services, but the space can also encourage friendships and provide a silent study environment. The Students' Housing facilities consist of Study-bedrooms, bathrooms and laundry rooms, Pantry, Leisure Rooms (i.e., study areas, computer centres, television lounges, meeting rooms and other Support Services (i.e., parking lots, cafeteria, mini markets, surveillance systems and Security Guards), (Nurul , Yusof&. Osman, 2011). However, it is also important; to assess how certain aspects of physical characteristics contribute to satisfaction, (Aragones, Francescasto & Garling, 2002). It has been shown that evaluating student housing with physical qualities allows us to gain knowledge about specific actions that can maximize residential satisfaction and reduce dissatisfaction as much as possible. This is important for students' well-being and academic performance. Residential satisfaction from multi-dimensional perspectives is especially important because it emphasizes that most interventions aimed at remedial actions are likely to succeed only to the extent that they address all the relevant domains, not just one, (Aragones, Francescasto & Garling, 2002). Residential satisfaction research, when properly set up, allows for detailed analysis of the relative contribution of specific elements, characteristics, and features of the complex system which we refer to as housing and creating conditions congruent to its inhabitants' aspirations. This study is designed to evaluate the physical qualities of the students' hostels (functional, aesthetic, structural qualities) and satisfaction in the selected hostels for the University of Ibadan, Oyo-State.

2.0 RELATED LITERATURE REVIEW

2.1 Theoretical Perspectives of Residential Satisfaction

A more robust view of Residential Satisfaction was developed by Francescato, *et al.*(1989) who conceptualized Satisfaction as an attitude and a multi-faceted construct which has cognitive, affective and behavioural dimensions. They assert that this definition of satisfaction is more comprehensive and that it accounts for the low productive strength of the construct.

2.1.1 The cognitive approach**:** This has typically taken the form of residents' evaluation of both specific and general aspects of residential quality.(e.g. Carp and Carp,1982; Bonaiuto *et al*, 2004). Also the concept of Residential Satisfaction expressed by residents depends on the comparisons they make between the situation they experience and their expected or aspired standards, (Caanter and Ress 1982).

2.1.2 The affective approach: The definitions in term of the affective component viewed Residential Satisfaction as the experience of pleasure or gratification derived from living in a specific place, and the feeling toward such a place (Bonaiuto, 2004).The concept is a function of the pleasure derived from encounters with the dwelling (Weidemann& Anderson, 1985). Also an evaluation of the affective component has taken the form of two constructs, namely: The affective qualities of places and places attachment, (Guiliani, 2003). It is a global representation of the affective response of people to their Social-physical environment.

2.1.3 The behavioural approach: Although the concepts of housing satisfaction concerning the behavioural component are less frequent, the studies of the behavioural aspect explore the behavioural intentions, the 'attitude' of residents. Within the perception process, it is understandable that when residents like their neighbourhood, they are less likely to move out. As a result, residential satisfaction can be seen as an intervening variable to help understand residential mobility, (e.g. Marans, 1976; Speare, 1974). The two approaches commonly adopted in the studies of users 'responses are: The aspiration-gap approach, (Galster 1987, Amole and Mills-Tettey 1998) and the purposive approach (Canter and Rees, 1982; Oseland, 1990). The aspiration-gap approach views satisfaction as: a measure of the gap between the users' actual and aspired needs. The purposive approach conceives satisfaction as a measure of the degree to which the environment enhances or inhibits the goal of the users.

Residential Satisfaction has also been conceptualized based on the notion that it is a composite construct of the indices of satisfaction which respondents perceive with dwelling-unit features and support services; public facilities, social environment and neighbourhood facilities. According to Amerigo and Aragones (1997), objective attributes of the residential environment, once they have been evaluated by the individual, become subjective, giving rise to a certain degree of satisfaction. Subjective attributes are influenced by the subject's socio-demographic and personal characteristics as well as residential quality pattern of individual which form the basis of Residential Satisfaction of the inhabitants, (Mohit, Ibrahim& Rashid, 2010).

Residential satisfaction is also conceptualized as a multi-dimensional construct. Various attributes of housing to which users respond in relation to satisfaction are categorized along a number of dimensions. Canter and Rees (1982) referred to these attributes as the referent of interaction while Francescato (2002) referred to them as the domain of the environment. Generally, these attributes have been categorized in the literature as *social/psychological Management/organizational and physical management,* (Amole, 2008). Residential Satisfaction is an important concept in the study of student housing.

2.2 Physical & Social Attributes Predicting Student Housing Residential Satisfaction

Studies have shown that, there are different factors that contribute to Student's Satisfaction with the residence halls experience: namely the physical environment or physical features such as overcrowding "the number of people per structure", (Spencer, 1979) is another physical factor that has been shown to negatively impact students' housing satisfaction with the residential environment. Abdullah, (2009) found that student's perceptions of residence hall environment were more, when the organizational elements of the residence halls, the group living situations, the social activities and the academic environments were highly rated as some of the factors predicting students housing residential satisfaction, (Abdullah, 2009). Among the studies that investigated the influence of physical attributes of campus accommodation on students' satisfaction is Kayas' and Erkip's (2001) research on students' housing setting at Bilkent University, Ankara. The study found out that, the students living on the highest floor perceived their rooms larger and found them less crowded in comparison to those on the lowest floor. The study postulated that students' perception of their privacy led to an increase in the level of students' satisfaction with their living condition. Privacy, feeling of crowding and control over space have also been the focus in a variety of studies in students' housing as an important predicting factor of satisfaction. These studies found that the physical factors of the 'built environment' affect the people's perception of privacy and crowding. Similarly, the study of Karlin, *et al* (1979) posited that hostel room size can indeed influence students' level of satisfaction. For instance, their study found that students who lived in triple sharing rooms were less satisfied and unhappier with their living conditions than students residing in double sharing rooms. In the study conducted by Khozaei, Ayub & Hassan, (2010) to investigate the most factors predicting students' satisfaction with University Hostels in Malaysia, the result of the study suggests that satisfaction with fees, distance from University facilities, room safety, room size, hostel security, and hostel facilities are the most important factors which predict undergraduate students' satisfaction with their hostel. This study also reveals that there was also a significant difference in the satisfaction level between inside and outside students' hostels. It also confirmed that most important factors that influenced students' satisfaction levels were distance from the university facilities, the exterior condition of the Hostel, Hostel population and Satisfaction with transport, hostel security, room size, and room safety. The authors concluded that the understanding of Factors Predicting Students' Satisfaction can assist universities to undertake changes to increase satisfaction among them, (Khozaei, Ayub & Hassan, (2010). Most of the previous scholars have argued and tended to concentrate on the physical attributes of Students' Housing as the main determinant of student residential satisfaction. Therefore, the overall student residential satisfaction does not only depend on physical attributes alone but other potential factors. Social attributes can be identified as the influential sources in determining the overall student housing residential satisfaction. A few studies declared that variability of students' social attributes, for instance, gender, economic status, duration of staying, sense of sharing, ethnicity, relationship with friends, and individual's home experience are also important and should not be ignored, (Nurul, Najib, Yusof & Osman ,2011).

2.3 Physical Qualities: Studies have shown that, the three main concerned of architecture are: functional, aesthetic and structural qualities of the hostels. This study refers to these as 'Physical Qualities/Attributes'. *The functional qualities* are: the quality of the hostel generally, the location of the hall in the university, the access between the blocks in the hall, the location of the buttery and reading room, the location of the sanitary facilities and kitchenette, the number of persons in the hall, privacy in the room, the number of persons in the room, the size of the room, the arrangement of fixtures and fittings in the room and the arrangement of rooms on floor. The *aesthetic quality* indicators refer to; the beauty of the hostel, the attractiveness of the hostel generally, how impressive the hostel is and how much you do like the look of the hostel. The *structural quality* indicators of the hostels refers to; the quality of the construction, safety from slippery and indoor injury, the finishes and fitting in the bed room generally, the finishes and fittings in the hostel.

3.0 Study Area: Oyo-state is an inland state in the south-western, Nigeria. It covers an area of approximately 27,249 square kilometers and lies between longitude 3^o 35' & 4^o 42' and latitude 8^o 15'& 9^o 00' as indicated in figure 2.1. Oyo-state consists of private and public Universities. The city of Ibadan is located approximately on longitude 3^05^1 east of the Greenwich Meridian and latitude 7^023^1 North of the Equator at a distance of 145kilometres North east of Lagos as indicated in figure 2.2. The University of Ibadan is an old generation University and the oldest degree awarding institution in Nigeria. It is located 8 kilometres from the centre of the city, south Western Nigeria as indicated in figure 2.2. The University was founded on 17 November, 1948 as a college of the London University and became an autonomous University in 1964. The University has over 12,000 students and besides, the College of Medicine, there are ten other faculties.

4.0 Methodology

Primary data were obtained through survey method. University of Ibadan (UI) was the University of Study. Eight (Kuti, Mellanby, Sultan Bello, Queen Elizabeth, Queen Idia, Tafawa Balewa, Abdusalam Abubakar and Awolowo) hostels were purposively selected to capture variation in gender, level of study and hostel design. The sampling frame showed that 5605 students were found in 2,147 rooms. One out of every 10 (10%) of the rooms were selected which amounted to 215 students sampled. Secondary data was obtained from the Physical Planning Department of UI. The data collected were analyzed using descriptive and inferential statistics.

Table 4.1: Sample frame at UI.

S/N	University of Ibadan			
	Hall selected	**No of Rooms**	**No of students per Hall**	**No of Students selected**
1	Kuti	207	557	21
2	Malanby	208	565	21
3	Idia	299	956	30
4	Elisabeth	218	580	22
5	Tafawa Balewa	186	207	18
6	Abdulsalam	280	700	28
7	Awolowo	577	1618	58
8	Sultan	172	422	17
	Total	2,147	5,605	215

5.0 Results and Discussions

This study presents the research findings obtained on the socio-economic characteristic of the students who reside in the selected halls of residence at UI, Oyo State. The socio-economic characteristic of the students obtained are represented in the table 5.0. With regards to the gender of all respondents in this study, among the students, 56.3% were males while 43.7% were females. The summary is depicted in the table below. Selection was at random and everyone has equal chance of being selected for this study. This finding shows that more male students were sampled when compared to her female counterpart. The summary is depicted in the table 5.0. Li *et al.* (2007) opined that the tendency to have greater satisfaction with the overall campus student housing experiences is higher among the female students if compared to male students.

Also, 47.4% were between 15 and 20 years, 38.1% were between 21 and 25 years, 11.5% were between 26 and 30 years while 2.8% were above 30 years old. The summary is tabulated in the table 4.0. The majority of the students interviewed are between the ages of 15-20 years. Francescato *et al.* (1979), refers to age of respondents as the objective characteristics of the residents when defining residential satisfaction as a function. Therefore, age is an important social attributes of overall student's residential satisfaction. It is noteworthy that none of the respondents was divorced, separated or widowed as all were either single or married. About 94.9% of all respondents enrolled for the study were single while the remaining 5.1% were married. Numerically and statistically, there is a wide difference between the proportion of respondents who were married and the proportion that were single. These findings show that majority of the students interviewed at UI are not married. Table 5.0 shows the summary of the marital status of respondents. Also, 34.4% of UI respondents were in the first year, 10.7% were in the second year, 16.3% were in the third year, 14.9% were in the fourth year, 2.3% were in the fifth year and the remaining 21.4% were the postgraduate students. The postgraduate students include the MA, M.Sc, M.Ed, M.Phil and Ph.D students. The finding implies that, the majority of the students interviewed were postgraduate students. Table 5.0 shows the summary of the respondent's level of study. Amole (2009), supports the fact that student's level of study is an important factor in the study of residential satisfaction.

Table 5.0: Socio-economic characteristics of the Users

Socio-economic characteristics	Frequency n(215)	Percentage %
Gender		
Male	121	56.3
Female	94	43.7
Age		
15-20	102	47.4
21-25	82	38.1
26-30	25	11.6
30 and above	6	2.8
Marital Status		
Single	204	94.9
Married	11	5.1
Means of sponsorship		
Parents	171	79.5
Self	25	11.6
Family	16	7.4
Co-operative	3	1.4
Experience of boarding house		
Yes	110	51.2
No	105	48.8
Opinion on Accommodation Fees		
Too high	105	48.8
Good	85	39.5
Indifferent	25	11.6
Number of People per Room		
One	17	7.9
Two	66	30.6
Three	50	23.3
Four	36	16.7
Five	46	21.4

However, means of sponsorship is an important socio-economic question aim to know the financial status of each of the respondents which is more likely to determine his/her taste. With regards to sponsorship or who is responsible for the respondents' schooling expenses, among the respondents, 79.5% of selected students were being sponsored by their parents, 11.6% were sponsoring themselves, 7.4% were being sponsored by their family while less than 1.4% was being sponsored by cooperatives. This finding is an evidence that majority of the students who resides on campus purposely built hostels in UI are being sponsored by their parents. The summary is depicted in the table 5.0. Means of sponsorship have been identified as one of the Socio-economic status of residents, which have been demonstrated to have an impact on subjective evaluation, due to differences in expectations. (Baba & Austin, 1989). When asked if respondents ever lived in the boarding house before, 51.2% responded in the negative compared to 48.8% of respondents who responded in the affirmative. The result is depicted in the table 5.0. From the findings it was noted that, over half of the students sampled have not lived in a boarding house before. This finding is an evidence that majority of the students who resides in the on-campus purposely built hostels have lived in a boarding house before. Also, respondents of UI were asked the average amount of money they have as pocket money or schooling maintenance money. This question gives an idea of the financial standing of students and determines their economic power and taste, 4.2% of selected students reportedly collected less than #2000, 17.2% collected between #2000 and #5000, 45.6% collected between #5000 and #10000, 17.7% collected between #10000 and #15000, 11.6% collected between #15000 and #20000 while 3.7% collected #20000 and above per month. Table 5.0 show the summary of the assumed financial capability of respondents. It is therefore, concluded that, the students of UI are of better financial status. Monthly income level is important in determining student's residential satisfaction. Good economic background may ensure that, students can conquer everything they wish and aspire hence, they can live enjoyable lives. Parkes *et al*. (2002) and Smets &Uyl (2008) stated that, individuals with higher income can afford to live in the affluent residential areas. Student's income level can be judged through their family backgrounds or other financial supports such as scholarship, study loan or part-time work. Amole (2005), posited that students with higher or good economic status (family support or scholarship) could afford to rent rooms with better qualities provided in the student housing as they desire. Curtis and Klapper (2005), explained that students who come from wealthy families usually choose to stay in rented houses or flats rather than in the university's student housing. This scenario shows that students with good economic status may have to choose what they like. Respondents were asked to state their course of study but analysis renders it a bit difficult to comprehend because they were so many. Therefore to make it more meaningful, they were categorized into faculties, 18.6% of selected respondents were in the faculty of sciences, 21.9% were in the faculty of engineering, 22% were in the faculty of education, 18.6% were in the faculty of agriculture, 10.7% were in the faculty of health sciences while the remaining 10.7% were in the faculty of social sciences. Table 5.0 shows the summary of the student's faculty, majority of UI students sampled are from the faculty of Education and Engineering. Respondents were also asked the amount of money they paid for the spaces they were allocated in the hostels. This question was asked to see if they buy from each and at what price the market value. University of Ibadan undergraduate respondents paid #14000 and #15000 per session for the spaces to include other related fees while the postgraduates counterparts paid between #20000 and #25000 per session to include other related fees. This gives an average of #17,500. The average preferred cost of the accommodation by University of Ibadan is #7500 (approximated to the nearest hundreds). It can therefore be concluded that, the official accommodation fees paid for bed spaces by the students in UI is of higher cost between 14000-25000. Larger proportion of students sampled complained about the high rate official accommodation fees paid for their bed spaces

Moreover, 46.0% of the respondents were spending their first session in the hostel, 18.6% were spending their second session there, 22.8% were spending their third session, 7.9% were spending their fourth session and 6.0% were spending their fifth year in the hostel. Majority of the students sampled had spent between 1-2 sessions in their various hostels. See table 4.0 for detailed explanations. However, 7.9% of respondents selected for the study were officially allocated to single person room, 30.6% were officially allocated to two-person room, 23.3% of respondents room were officially allocated to three person, 16.7% were officially allocated to four persons, 21.4% of respondent room were officially allocated five persons. The result is depicted in the table 4.0. This question was asked particularly to investigate if the number of the students allocated by the management stays in these hostels. Finding shows that six or more people staying in a room are not common in UI. Also, one, two and three bedded rooms are more common in UI, these is a reflection of the postgraduate students sampled in the university. However, the number of people per room is one of the factors that influenced students' residential satisfaction levels (Khozaei, Ayub& Hassan, 2010).

5.1 Functional quality at the University of Ibadan Hostels

The assessed functional qualities of the halls of residence are largely poor with about 38.7% of respondents reporting poor functional quality. Also about 31.6% reported a fair level of functional quality, 6.0% reported a very poor functional quality while a paltry 7% reported very good. Four important questions were responsible for this. They are: the number of persons in the hall, number of persons in the room, privacy in your room and the location of the hostel in relation to other buildings in the university. This depicts that the functional quality of the hostel in being defeated by ever increasing population of students in the undergraduates hotels. This is supported by Amole (2005) who claims that students assess residential satisfaction based upon the level of crowding and privacy in their rooms.

In summary, only 55.3% of UI respondents evaluated the functional quality of the hostels slightly above average. Therefore, the level of functional quality is poor generally. The above information is represented in the table 5.1

Table 5.1: Functional qualities of the Hostels at UI

		University of Ibadan		Total poor functional quality	Total good functional quality
Score	**Qualities**	**Freq**	**%**	**%**	**%**
10 – 18	Very poor	13	6.0	6.0+38.7	
19 – 26	Poor	83	38.7		
27 – 34	Fair	68	31.6		31.6+16.7+7.0
35 – 42	Good	36	16.7		
43 – 50	Very good	15	7.0		
Total		215	100	44.7	55.3

5.2 Aesthetic quality at the University of Ibadan hostels

The assessed aesthetic qualities of the halls of residence are largely good with about 53% of respondents reporting good aesthetic quality and another 18.6% reporting very good. Also about 24.2% reported a fair level of aesthetic quality while a paltry 3.7% reported poor aesthetic quality of the hostel. In summary, the aesthetic quality of the hostel is very good with 95.8% of respondents giving a favourable aesthetic quality. The above information is represented in the table 5.2

Table 5.2: Aesthetics qualities of the Hostels at UI

		University of Ibadan		Total poor Aesthetic quality	Total good Aesthetic quality
Score	**Qualities**	**Freq**	**%**	**%**	**%**
5 – 9	Very poor	1	0.5	0.5+3.7	
10 – 13	Poor	5	3.7		
14 – 17	Fair	52	24.2		24.2+53.0+18.6
18 – 21	Good	114	53.0		
22 – 25	Very good	40	18.6		
Total		215	100	4.2	95.8

5.3 Structural quality at the University of Ibadan Hostels

About 53.5% of all UI respondents reported that the structural quality of the hostel is good, 30.7% reported that it is fair, 5.1% reported very good structural quality of the hostel. Only 9.3% and 1.4% reported poor and very poor respectively. In conclusion, 89.3% of UI respondents have favourably assessed the structural quality of the hostel compared to 10.7% of respondents who are not. Table 5.3 summaries the information above.

Table 5.3: Structural qualities of the Hostels at UI

		University of Ibadan		Total poor Structural quality	Total good Structural quality
Score	**Qualities**	**Freq**	**%**	**%**	**%**
4 – 7	Very poor	3	1.4	1.4+9.3	
8 – 10	Poor	20	9.3		
11 – 13	Fair	66	30.7		30.7+53.5+5.1
14 – 17	Good	115	53.5		
18 – 20	Very good	11	5.1		
Total		215	100	10.7	89.3

5.4 Satisfaction with the hostels Services and Amenities at the University of Ibadan

At the University of Ibadan hostel, the level of satisfaction with various amenities provided in the hall of residence is averagely high with about 47.9% of respondents reporting so, also a high proportion reported a neutral level of satisfaction (35.3%), 6.5% reportedly very satisfied, 8.8% of respondents reportedly dissatisfied while 1.4% reportedly very dissatisfied. Conclusively, a high percentage (54.4 %) gives a favourable level of satisfaction as against 10.3% who reported otherwise and 35.3% who reported neutral satisfaction. The above information is represented in the table 5.4

Table 5.4: General Satisfaction with the hostels Services and Amenities at U.I

		University of Ibadan		Total dissatisfied	Total Satisfied
Score	**Qualities**	**Freq**	**%**		
10 – 18	Very dissatisfied	3	1.4	1.4+8.8	
19 – 26	Dissatisfied	19	8.8		
27 – 34	**Neutral**	**76**	**35.3**		47.9+6.5
35 – 42	Satisfied	103	47.9		
43 – 50	Very satisfied	14	6.5		
Total		215	100	10.3	54.4

6.0 RECOMMENDATIONS AND CONCLUSION

This study has examined the socio-economic characteristics of the students in the halls of residence in the selected halls of residence at University of Ibadan; evaluated the physical attributes (functional aesthetic and structures) and examined satisfaction in selected students' housing for University of Ibadan. The study of socio-economic characteristics is an important aspect of this research work, because it explores the behavioral characteristics of human life. The socio-economic characteristics of the students considered in this research reveals that, a total number of 215 sampled male students future more in the study. Most of the students that reside in hostels range between the ages of 15-20years. This study has also revealed that, most of the students sampled are single from different levels of study and course of study, majority of the students sampled are being sponsored by their parents and most of them collected money between #5,000 - #10,000 per month at home. It is therefore, concluded that, the students of UI are of better financial status. However, the official accommodation fees paid at UI is between 14000-25000. Larger percentage of the students sampled expressed good opinion about their official accommodation fees for their bed spaces. This research also found out that, most students have even experienced staying in the boarding house before and most of them have spent between 1-3sessions in their various prospective halls of residence now. Moreover, this study also evaluated the physical attributes (*functional, aesthetics and structural)* aspects of design. The functional qualities of the hostels were perceived among the students to be above average. Similarly, both aesthetics and structural qualities of the hostels were perceived to be excellent among the students. Based on the following facts, the following recommendations were made:

- Nigerian University hostels management style should be improved on by adapting the same method of hostels management styles used in the University of Ibadan. Although more could still be done to enhance better design and management qualities across all universities in Nigeria, which could ultimately improve the learning process of the students.
- For optimal performance of student housing, the design requires more attention from the university authority. This will definitely improve the overall standard of student's residential satisfaction across the universities in Nigeria.
- Hostel designers should be more concerned with gender and number of people per room as a factor in the overall students' hostel design. The hostel managers should monitor and supervise the number of people allocated per room by ensuring that each room were allocated according to what the architects designed it to accommodate.

It is, therefore, concluded that the design qualities of the hostels perceived at UI were generally good and all respondents of the hotels were satisfied with various services and amenities provided in the Halls of residence generally (54.4%) and 35.3% expressed neutral satisfaction. All these physical attributes should be considered in the evolution of new hostels design for the universities. This will definitely improve the overall standard of student's residential satisfaction across the universities in Nigeria.

REFERENCES

Abdullah, F. (2006). Measuring service quality in higher education: three instruments compared. *International Journal of Research Method in Education,* 29, 71-89.

Amérigo, M., &Aragonés, J. I. (1997). A Theoretical and methodological approach to the study of residential satisfaction. *Journal of Environmental Psychology, 17,* 47-57.

Amole, B.,& Mills-Tettey,R. (1998).Income and housing satisfaction: A study of FESTAC housing estate in Lagos, Nigeria. *Ife Journal of environment Design and Management*, 182, 27-41.

Amole, D. (2005). Coping strategies for living in student residential facilities in Nigeria. *Journal of Environmental Behaviour,* 37, 201-219.

Amole, D. (2008). Residential satisfaction and levels of environment in students' residences. *Journal of Environment and Behaviour,* 41, 866-879.

Aragonés, J. I., Francescato, G. & Garling, T. (2002). Residential Environment, Choice Satisfaction &Behaviour. In Aragonés, J. I., Francescato, G. & Garling, T (Eds.).Bergin & Garvey. Westport, Connecticut .London. pp. 2-33.

Baba, Y. &Astin, M. D. (1989). Neighbourhood environmental satisfaction, Victimization, and Social participation as determinant of perceived Neighbourhood safety. *Environment & Behaviour*. 21, 763-780.
Bland, J. &Schoenauer, N. (1966) *University Housing in Canada*. Montreal: McGill University Press.
Bonaiuto, M. (2004). Residential satisfaction and perceived residential environment quality.In
Spielberger (Ed).*Encyclopaedia of applied psychology* 3, 267-272. San Diego, C.A: Academics Press.
Canter, D., & Rees, K. (1982). A multivariate model of housing satisfaction. *International Review of Applied Psychology*, 31, 185–208.
Carp, F.M.& Cap, A., (1982). Perceived environmental quality of neighbourhoods: development of assessment scales and their relation to age and gender. *Journal of Environmental Psychology*, 2 ,245-312.
Dahlan, N.D., Jones, P. J., Alexander, D.K., Salle, E. & Alias, J. (2009). Evidence base prioritisation of indoor comfort perceptions in Malaysian typical multi-storey hostels.Built. Environment, 44, 2158-2165.
Francescato, G., Weidemann, S., and Anderson, J.R. (1989). Evaluating the built environment from the users point of view: an attitudinal model. In W.F.E. Preiser (ed.) *Building evaluation*, 181-198,London: Prenum Press.
Galster, G. (1987).Indentifying the correlates of dwelling satisfaction: an empirical Critique Environment And Behaviour,19,539-568.
Giuliani, M.V. (2003). Attachment and place. In Bonnes, M., Lee,T. & Bonaiuto (Eds.), *Psychological theories for environmental issues.* Aldershot,UK.Ash gate, 137-170.
Karlin, R. A., Rosen, L. S., & Epstein, Y. M. (1979). Three Into Two Doesn't Go: A Follow-up on the Effects of Overcrowded Dormitory Rooms. *Personality and Social Psychology Bulletin, 5*, 391-395.
Kaya, N. &Erkip, F.(2001). Satisfaction in a dormitory building: The effects of floor height on theperception of room size and crowding. *Journal of Environmental Behaviour*. 33, 35-53.
Khozaei, F., Hassan, A.S. &Khozaei, Z. (2010). Undergraduate students' satisfaction with hostel and sense of attachment to place: Case study of university sains Malaysia. Am. *Journal of Engineering and Applied Science*, 3, 516-520.
Khozaei, F., Hassan, A.S., Razak, N.A.,(2011). Development and validation of the student accommodation preferences instrument. *Journal of Building Appraisal*, 6, 299–313.
Khozaei, N. Ayub, A. S. Hassan & Z. Khozaei,(2010a). “The Factors Predicting Students' Satisfaction with University Hostels, Case Study, UniversitiSains Malaysia,” *Asian Culture and History*, 2, 148-158.
Li, L., Maximova, E., Saunders, K. Whalen, D.F. & Shelley, M.C. (2007). “The Influence of Custodial, Maintenance, and Residence Life Services on Student Satisfaction in Residence Halls,” *Journal of College and University Student Housing*, 34, 43-52.
Marans, R. W. (1976). Perceived quality of residential environments: Some methodological issues, in K. H. Craik& E. H. Zube (Eds) *Perceiving environmental quality: Research and applications* (New York: PlenumPress).
Mohit, M. A., Ibrahim, M. &Rashid, Y.R. (2010).Assessment of residential satisfaction in Newly designed public low-cost housing in KualaLumpur, Malaysia. *Habitat Int*., 18-27.
Najib, N. U., Yusof, N.A., Osman, Z. (2011a). “Measuring Satisfaction with Student Housing Facilities,” *American Journal of Engineering and Applied Sciences*, 4, 52-60.

Najib, N. U., Yusof, N.A., Osman, Z. (2011). The Influence of Socio-Economic Backgroundstowards Satisfaction with Student Housing Facilities: *American Journal of Engineering and Applied Sciences*, 58, 478-483.

Oseland, N.A., (1990). An evaluation of space in view homes. Proceedings of the international Association of People-Environment Studies (IAPS) conference, Turkey.

Price, I., Matzdorf, S F., Smith, L. &Agahi, H.(2003).*The impact of facilities on student choice.*(pp. 22-41).

Speare, A. (1974). Residential satisfaction as an intervening variable in residential mobility, Demography,11, 173–188.

Susilawati, C., (2001). Student dormitory development plan with linear programming method. *Proceeding of the PRREs 7th Annual Conference, (PRREsAC' 01),* Surabaya, Indonesia,1-8.

Weidemann, S. & Anderson, J. R. (1985).*A conceptual framework for residential satisfaction, in: Altman, I and Werner, R. Home Environments*,153–182 (New York: Plenum Press).

THE ADEQUACY OF RELAXATION SPACES FOR STUDENTS IN SELECTED FACULTY BUILDINGS IN NIGER STATE

Afolabi O. M., Mustapha M., S.K. Goshi & A. I. Anunobi

Department of Architecture, Federal university of Technology, Minna. Niger State, Nigeria.

With concerted efforts geared towards the campaign for increased youth literacy and education around Nigeria, there has been a significant boom in the population of students in many of the country's tertiary institutions. This has lead to an overload of scarce resources, overcrowding and pressure on the urban-environmental equation to the detriment of the students. The importance of a student's mental health in an institution is usually downplayed in the Nigerian educational system in favour of physical wellbeing- it is hardly even mentioned in publications. Consequently, the provisions of relaxation spaces are not high priority to designers of Educational institutions. Open relaxation spaces within and around faculty buildings will go help to provide a controlled environment for student rest and meaningful social interactions. The aim of this paper is to assess the provision of open-air relaxation spaces in faculty buildings in Niger state. It seeks to assess the adequacy of the spaces provided. A combination of the Post-occupancy evaluation (POE) and descriptive approaches will be used to determine the adequacy of the open spaces provided in faculty buildings student relaxation, the end-user perception of the satisfaction derived and the importance of open spaces in saving energy. A total of 10 faculty buildings in 6 higher institutions across the state were chosen with selective bias as study areas. Questionnaires were administered to 150 students from these institutions. The data will be analysed using SPSS analytical tool and presented in tables and charts. Results will reveal a pattern of dissatisfaction from majority of the students in the faculties investigated and that students generally craved more open green areas to help them relax.

Keywords: *Adequacy, Faculty Buildings, Open Relaxation Spaces, Mental Health, Satisfaction.*

afolabimtosin@gmail.com

Afolabi O. M., Mustapha M., S.K. Goshi & A. I. Anunobi (2016) **THE ADEQUACY OF RELAXATION SPACES FOR STUDENTS IN SELECTED FACULTY BUILDINGS IN NIGER STATE** Sustainable Built Environment and Climate change; The challenges of Post 2015 Development Agenda. School of Environmental Technology Conference, SETIC, 2016

INTRODUCTION

Students of tertiary institutions are involved in specific fields of learning – targeted at acquiring advanced knowledge. Away from the classrooms, they also have to interact with other students, visit offsite learning areas, carry out sports and recreation etc. This combination of activities may result to stress in the students if they neglect physical and mental relaxation. Stress, according to Hans Selye (1936) is defined as a phenomenon that occurs when the human body gives a negative reaction as its way of requesting for a change or complete stop to the conditions experienced in its current activity. Stress in students of most tertiary institutions may be avoided through proper scheduling, good learning conditions and in some cases a conducive environment.

It is not uncommon to see students of a tertiary institution hurdled in or around a corner-shop or kiosk, congregating on walkways or basically loitering around the school complex during school hours. The time seemingly wasted in doing these unproductive activities could be advantageously channelled into relaxing or better still; interaction, but in a proper environment or space. On the other hand, a closer inquiry will show you that these students might just be waiting for the next lecture period or attempting different types of social interaction with one another in these places which could be beneficial to participants.

Barrett and Zhang (2009) states that substantial facts show that there is an indisputable relationship between the physical characteristics of the spaces of school buildings, and educational outcomes. Poor school conditions make it more complicated for lecturers to teach and for students to assimilate. Concerted efforts should therefore be made in the design stage to create the ideal conditions for learning to take place.

Relaxation spaces therefore are defined spaces within a building – open air or built-up which are specifically defined to augment mental health and encourage relaxation in humans. A few examples relative to tertiary institutions include lawns, nap rooms/sleep pods, cafes, meditation rooms, green parks amongst others. The benefits of relaxation spaces are numerous and important. In Nigeria, there is little or no consideration given to relaxation areas in institutional buildings, because there are no statutory regulations supporting stress prevention and management.

The advantage of relaxation in a proper nuanced environment during school peak lecture periods is immediately visible as the brain benefits from proper "controlled rest" (Barett et al, 2009).

The aim of this study is to assess the provision of open relaxation spaces in faculty buildings of tertiary buildings across Niger state through the following specific objectives: to determine the presence of open relaxation spaces in faculty buildings and to assess the perception of user satisfaction of these energy conserving spaces.

FACULTY BUILDINGS

The tertiary institution can be known as the 3rd stage, third level or post-secondary education. It is an institution that teaches specific capacities of higher learning such as colleges, technical training institutes, colleges, monotechnics and polytechnics, research and learning centers. Tertiary institutions in Nigeria are broken down into faculties both at the administrative and academic levels to achieve the specificity of knowledge they impart in students. This means that a faculty is typically an entity within the tertiary institution which offers courses of a similar nature (Aganbi, 2013).

Faculty building houses the different departments existing in the faculty, such as Faculty of Arts or School of environmental Studies in the case of a university of technology). It is clear that there is an existing body in the National Universities Commission that oversees the structures and planning of campuses, this department is called Physical Planning Department established in 2011. The core value of this department is to give the campuses in tertiary institutions a well-planned and maintained campus according to the Nigerian national university commission.

STRESS IN STUDENTS OF TERTIARY INSTITUTIONS

Numerous surveys repetitively show an increasing number of university students who are experiencing significant stress due to educational workload, interpersonal conflicts, self-esteem problems, financial constraints, time constraints, frustration and emotional problems (Andersson et al., 2009; Chambel and Curral, 2005; Misra and Mckean, 2000; Mosley et al., 1994).

Stress relates to a distinct disparity between work demands and human response capabilities in reaction to that work and it has been repeatedly linked with physical ailing health by (Chida and Hamer, 2008; Miller et al., 2002; Sagerstrom and Miller, 2004) and deteriorated mental health conditions (Hammen, 2005).

Stressful academic activities in tertiary institutions have been known to threaten student's academic performance (Hamaideh, 2011). In this sense, designing buildings for an institution goes far beyond providing a place for learning. It should also encourage healing—serving functional as well as physical and mental needs. Strange et al (2002) also stated that "although features of the physical environment lend themselves theoretically to all possibilities, the layout, location, and arrangement of space and facilities render some behavioural patterns much more likely, and more probable than others."

EFFECTS OF SPACES ON HUMAN BEHAVIOUR

The influence of physical spaces on human activities has been researched from both psychological and physical perspectives. The study of environmental psychology explores topics such as attachment to places, psychological comfort with space, and the motivational and stirring effects of space. Those who study space from a physical viewpoint are interested in the effects on activity of light, temperature, and indeed, physical closeness (Graetz and Goliber, 2003).

Research in environmental psychology has identified that architecture can affect human mental health through stimulation (Evans and Mccoy, 1998). Architectural stimulation describes the quantity of information available in an enclosed space that influences users. Human beings function optimally with moderate levels of stimulation. For moderate or proper stimulation, the layout, circulation, control, flexibility, responsiveness, privacy, spatial syntax and certain symbolic elements are key architectural factors (Evans and Mccoy, 1998; Garling et al., 1986).

Nowadays, university designers recognize the importance of addressing two big issues when developing and updating campus master plans. One, is the importance of integrating the campus into the community and two, is creating spaces for students that allow for outdoor and social activities (Neil, 2002)

Plate 1: Courtyard, FUTMinna
Researcher's fieldwork, 2015.

Plate 2: Student Lounge, FUTMinna
Researcher's fieldwork, 2015.

TYPES OF OPEN RELAXATION SPACES IN TERTIARY INSTITUTIONS

Open spaces or open-air spaces located in or around faculty buildings and the surrounding environment provide a sense of bearing in a campus by combining and organizing different places and elements; they also can offer an aesthetic sense by involving attractive surroundings and creating visual delights. Many creative and innovative ideas are conceived in outdoor environments, a world away from formal classes. The natural scenery and a relaxing atmosphere in open spaces encourage spontaneous meetings and interactions, and offers high air quality for stressed students (Payne, 2009).

Nowadays, university designers recognize the importance of addressing two big issues when developing and updating campus master plans. One, is the importance of integrating the campus into the community and two, is creating spaces for students that allow for outdoor and social activities (Neil, 2002).

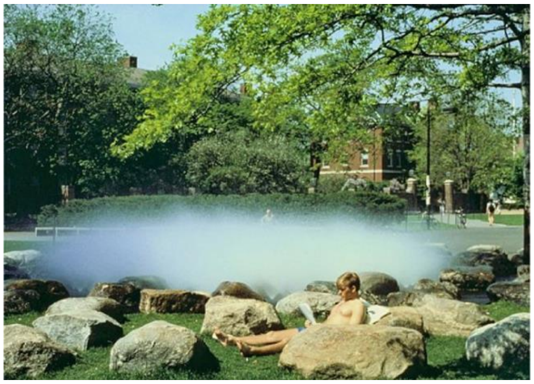


Plate 3: Tanner Fountain, Havard University

Source: Science direct, 2014.

Plate 4: Lily pond, Hong Kong University main building.

The spaces in the plates above depict examples of open spaces that are green, airy and aid student relaxation in their various institutions. Open-air recreation and access to outdoor spaces is an important part of many people's daily lives, and research has shown that outdoor activities provide possibility for relaxation, refreshment, escape from the daily hassles and an opportunity to form social interactions (Macnaghten and Urry, 2000).

Plate 5: University of Michigan, Duderstadt, Mujo' Café
Source: Science direct, 2014

These informal outdoor spaces are the pathways, gathering and dispersal spots, points of interactions amongst learning spaces. Their purpose is to a make faculty or campus support chance encounters of great value and social exchange. These spaces, when they serve their purpose of design, reduce the need to build indoor relaxation/interaction spaces, effectively reducing the long term cost of construction and maintenance. Most importantly, they help in saving valuable energy as it is powered exclusively by nature's forces.

R. Holeton (2000) reports student requirement for informal outdoor relaxation spaces as flexibility, pervasive technology, comfortable and ergonomic seating, and noise free zones:

adding that these spaces are communal and may require access to alternative learning resources such as wireless internet network, books, newspaper and magazines.

In addition to being flexible, outdoor spaces must be designed with safety and economic considerations in mind. Students in faculties are spending so much time in classrooms and in front of computers that their health can be put at risk. The major recommendation is to permit change-change in posture and movement; mobility brings a myriad of opportunities (US department of labour).

RESEARCH METHODOLOGY

The researcher employed a combination of approaches in this study; questionnaires along with a descriptive approach utilising an observation schedule derived from the literature review to collect data. Sample selection is based on type of ownership; federal or state-owned combined with type of tertiary institution; university, polytechnic and college. There are 26 recognized tertiary institutions in Niger state but only tertiary institutions with a formal faculty system or structure (where departments are grouped accordingly into faculties and have separate buildings for teaching). The questionnaires were administered to a total of 150 students of 10 faculties across 6 tertiary institutions in Niger state. However, only 105 of these questionnaires were returned and deemed valid representing 70% of the total administered. The faculty buildings selected were picked from the following tertiary institutions: Federal university of technology, Minna; Ibrahim Badamosi Babangida University, Lapai; State College of education, Minna; Federal Polytechnic, Bida; State Polytechnic, Zungeru; Federal College of education, Kontagora. At least one faculty was selected from each institution with FUT Minna having 3, Federal Polytechnic, Bida and Federal COE, Zungeru having 2 faculties selected. Secondary data was also obtained from internet sources, journals, textbooks.

FINDINGS AND DISCUSSIONS

The number of relaxation spaces found in each faculty

This figure includes all spaces provided within the faculties that are designated for or adapted for student relaxation. The spaces considered include defined spaces such as lounges, corner shops, courtyards, parks, cafes and any other room where students interact or rest. Rooms shared between students and staffs were excluded. Table 1 below shows the provision of these spaces.

Table 1: Number of student relaxation spaces per faculty

INSTITUTION	AVG NUMBER OF RELAXATION SPACES/FACULTY
IBB UNIVERSITY	4
STATE POLY ZUNGERU	3
FUT MINNA	7
FEDERAL POLY BIDA	2
COE MINNA	2
FED COE KONTAGORA	3

Source: Researcher's field work, 2015.

The table above show that relaxation spaces, whether adapted or purpose-built were provided for students in all the faculties. The number provided varies from institution to institution.

Type of Relaxation space

Table 2 below shows the type or nature of the space provided; the options include Open-air or built-up, this is easily discernible using the nomenclature of the space types. The number of each type provided is recorded thus.

Table 2: Type of relaxation space provided

INSTITUTION	OPEN AIR	BUILT-UP
IBB UNIVERSITY	1	3
STATE POLY ZUNGERU	1	2
FUT MINNA	1	6
FEDERAL POLY BIDA	1	2
COE MINNA	0	2
FED COE KONTAGORA	0	2
TOTAL	4	17

Source: Researcher's field work, 2015.

Table 2 above show that approximately 81% of the student relaxation spaces provided in the faculty buildings were built-up spaces while a smaller percentage – 19%, were open spaces provided in the faculties. The findings show that the built-up spaces were favoured by designers of faculty buildings.

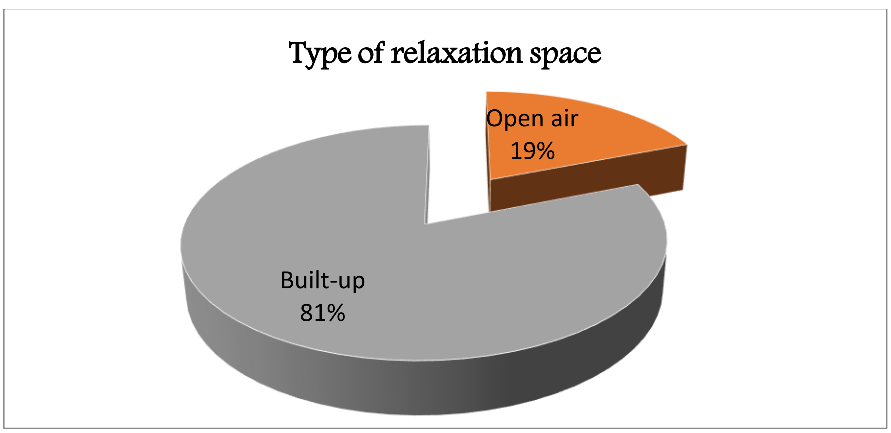


Figure 1: showing types of relaxation spaces
Source: Researcher's field work, 2015.

Type of Open-air relaxation space provided within the faculty

Figure 2 below shows the distribution of the 4 open spaces observed during field work.

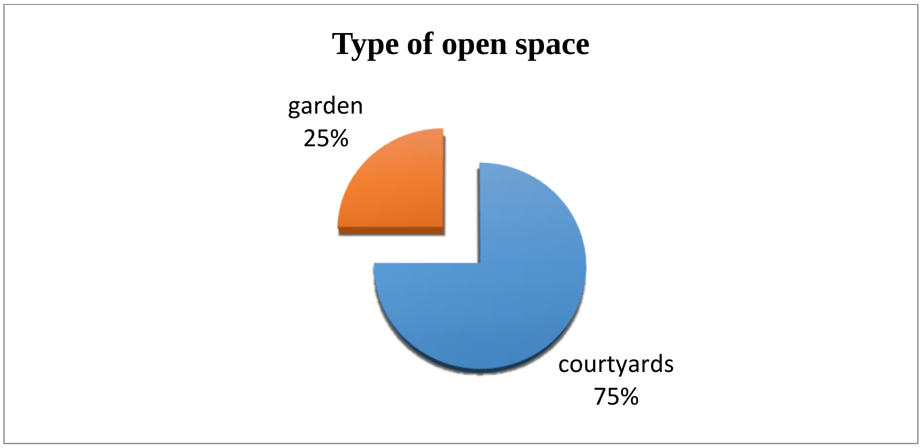


Figure 2: types of open space

Source: Researcher's field work, 2015.

Figure 2 above shows that there are only 2 types of open-air relaxation spaces in the faculty buildings inspected. These include 3 courtyards and 1 garden. This shows a dearth of implementation of the various types of open spaces available for consideration during design. These spaces were not really designed for the purpose of student relaxation evident by lack of suitable furniture and shading.

Location of relaxation space within the faculty building

Table 4 provides data that shows student's opinion/satisfaction of where the open-air relaxation space is located within the faculty building, its proximity to lecture rooms, access roads and especially if it is private and serene enough. It tells how well the relaxation space is sited. Table 4 below shows the responses recorded.

Table 3: Location of relaxation space

INSTITUTION	SUITABLE (%)	INDIFFERENT (%)	UNSUITABLE (%)
IBB UNIVERSITY	50	35	25
STATE POLY ZUNGERU	67	20	13
FUT MINNA	60	24	16
FEDERAL POLY BIDA	20	50	30
COE MINNA	7	26	67
FED COE KONTAGORA	15	15	70

Source: Researcher's field work, 2015.

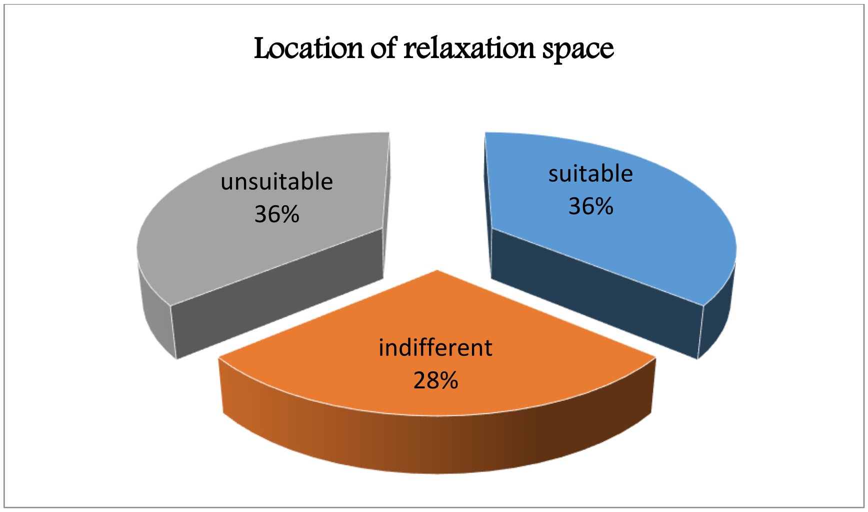


Figure 3: showing student perception of location of relaxation spaces
Source: Researcher's field work, 2015.

Results show that less than a 3rd of respondents were not concerned about where the relaxation spaces provided were located, they didn't think it was an important factor. The same percentage, 36% responded that it was either suitable or the opposite. This shows that location of relaxation space is ranked low on design considerations for the design of student relaxation spaces.

Provision of adequate suitable furniture in relaxation spaces

Table 4 below shows student's opinion of the suitability of furniture provided in the relaxation spaces. The furniture provided must suit the specific function of that particular type of relaxation space. It is a function of how adequate the furnishing is to end users.

Table 4: Adequacy of furniture provided

INSTITUTION	ADEQUATE (%)	AVERAGE (%)	INADEQUATE (%)
IBB UNIVERSITY	25	50	25
STATE POLY ZUNGERU	20	13	67
FUT MINNA	24	48	28
FEDERAL POLY BIDA	45	30	25
COE MINNA	13	13	74
FED COE KONTAGORA	30	35	35

Source: Researcher's field work, 2015.

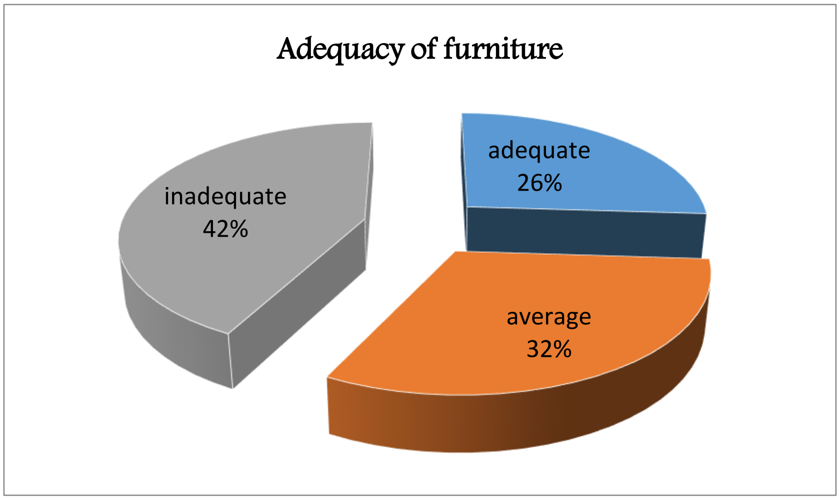


Figure 4: showing student perception of furniture adequacy
Source: Researcher's field work, 2015.

Overall student perception of comfort derived from use of open-air relaxation spaces

This information could be seen as a sum total of all intangible elements of the various considerations that make a relaxation space comfortable; these include but are not limited to texture of the room, form, multimedia, colour, ambience amongst others. It is a subjective value depending on specific preferences of the respondents across the selected institutions. Table 5 below contains their responses.

Table 5: end-user comfort

Institution	Very Comfortable	Comfortable	Uncomfortable	Very Uncomfortable
Ibbu	10%	35%	10%	45%
State Poly Zungeru	20%	13%	33%	33%
Fut Minna	36%	4%	20%	40%
Fed Poly Bida	35%	5%	10%	50%
Coe Minna	20%	13%	20%	47%
Fed Coe Kontagora	5%	30%	10%	55%

Source: Researcher's field work, 2015.

Results show a distinct high rate of dissatisfaction of the relaxation spaces amongst students of all the faculty buildings. Most of the dissatisfaction stems from improper design of relaxation spaces. This pattern stands out and as already established that there is a problem to be addressed.

CONCLUSION

This research has shown that open relaxation spaces are few and even when present, are poorly designed, poorly located and fail to perform their primary functions. The students do not avail themselves to the use of those provided as they do not satisfy their needs for positive interaction and meditation. It also shows that there are no standard design considerations for open relaxation spaces to be utilized by designers of faculty buildings in Niger state as a viable alternative to built-up spaces.

RECOMMENDATIONS

Relaxation has been proven to improve student mental health and performance in tertiary institutions, therefore utmost importance must be put into design of student spaces and by extension, student relaxation spaces: in this context, those within the faculty building, because students spend most of their productive hours there.

Great care must be taken to ensure that a combination of options; open and built-up, with the suitable furniture are provided for students to use depending on their relaxation or interaction preferences and at their discretion. The spaces should also be made larger and located in more serene parts of the faculty buildings.

Design elements such as scenery, shading, ambience, air quality and proximity to lecture rooms must be included as design considerations in designing faculty buildings. All of these have effects on the cognitive ability of students. This will go a long in improving student comfort which is seen to be lacking in the study area.

Open spaces should be further developed as energy-saving, cheaper and healthier options for student relaxation of meaningful interactions. In existing faculty buildings, existing spaces external spaces and courtyards could be adapted or retrofitted to provide the lacking facilities while the design considerations earlier listed should be considered when designing new faculty buildings to contribute to the mantra of climate change.

References

Aganbi D. A. (2013) Occupational Stress among Academic Staff of State University, Ado-Ekiti *European scientific journal February edition* 9(4), 15-24.

Hammen, C. (2005), Stress and depression, *Annual Review of clinical psychological, 1,* 293-319.

Hans Selye (1936). A syndrome produced by diverse nocuous agents. *Nature, 138,* 32.

Gary W. Evans and Janetta Mitchell McCoy(1998) When buildings don’t work: *The role of architecture in human health. Journal of Environmental Psychology.* 18(1):pg 85-94.

Hamaideh, S. H. (2011). Stressors and reactions to stressors among university students. *International Journal of Social Psychiatry,* 57(1), 69-80.

Ken A. Graetz and Michael J. Goliber, “Designing Collaborative Learning Places: Psychological Foundations and New Frontiers,” in *The Importance of Physical Space in Creating Supportive Learning Environments: New Directions in Teaching and Learning*, Nancy Van Note Chism and Deborah J. Bickford, eds., no. 92 (Winter 2002) (San Francisco: Jossey-Bass, 2003), pp. 13–22, <http://www.josseybass.com/WileyCDA/WileyTitle/productCd0787963445.html>.

Macnaghten, P. and Urry, J. (2000) 'Bodies in the woods', Body and Society 6 (3 - 4) pp. 166 - 182.

Maria Jose Chambel and Luis Curral (2005), Stress in academic life: *Work characteristics as predictors of student well-being and performance. Applied psychology 54(1)*, 135-147.

Miller, G.E., Cohen, S., Ritchey, A.K., 2002. Chronic psychological stress and regulation of pro-inflammatory cytokines: *a glucocorticoid-resistance model. Health Psychol. 21*, 531–541.

Misra, R., Mckean, M., 2000. College students' academic stress and its relation to their anxiety, time management, and leisure satisfaction. Am. J. Health Stud. 16, 41–52.

Mosley, T.H., Perrin, S.C., Neral, S.M., Dubbert, P.M., Grothues, C. A., Pinto, B.M., 1994. Stress, coping, and well-being among third-year medical students. Acad. Med. 69, 765–767.

Peter Barrett and Yufan Zhang, “Optimal Learning Spaces”, *Design Implications for Primary Schools,* SCRI report, Design and Print Group, University of Salford, Maxwell 100, Salford, M14 5WT, England. (October 2009)

Sagerstorm S. C., Miller G. E. (2004). Psychological stress and the human immune system: A meta-analytic study of 30 years of inquiry. *Psychological bulletin, 104,* 601-630.

R. Holeton, “Student Design of a Community Learning Space,” 2000. http://www.stanford.edu/~holeton/presentations/StudentDesign3.pdf. retrieved on 4th January, 2015.

R. Holeton, “Smart Lounges and Team Spaces: The future of Public Technology Spaces,” presentation at the 2004 ResNet Symposium, Princeton, N.J., http://www.stanford.edu/~holeton/presentations.html

Yoichi Chida and Mark Hamer(2008), “Chronic psychological factors and acute physiological responses to laboratory-induced stress in healthy populations: *A quantitative review of 30 years of investigations.”* PsycINFO database record, c 2012.

INTEGRATION OF OUTDOOR RELAXATION SPACES IN HOSPITAL BUILDINGS IN ABUJA FOR STAFF SATISFACTION

YUSUFF, Taiwo Qasim, ONWUKA, Bridget Nneoma & ADEDAYO, Olatunde Folaranmi

Department Of Architecture, Federal University of Technology, Minna

Relaxation can be said to be any type of activity carried out by a person for the purpose of relieving stress. These activities which range from physical to mental could be carried out indoors or outdoors. Hospitals are a place where the nature of the activities results in stress for staff hence requiring a place to relax within the hospital environment. The provision of outdoor relaxation spaces in hospitals for staff has not been the focus of hospital designers in combating stress and coping with climate change within hospital environment in Abuja city. The aim of this paper is to examine how the relaxation spaces outside the hospital can help staff cope with climate change challenges in the hospital while relaxing. The research method adopted for this study is a combination of method with the use of questionnaire and physical observation of the relaxation areas in hospitals to see how spaces are used. The data obtained with the aid of Statistical Package for Social Scientists (SPSS) for analysis and the results presented in charts and tables. The results would reveal that outdoor relaxation areas in hospitals for staff is of great importance and that the elements used would help reduce the heat gain around the building. In conclusion the paper would recommend how the design of hospitals could be achieved to include outdoor relaxation area that are environmentally friendly.

Keywords: *Climate, Hospital, Outdoor, Relaxation, Spaces, Staff.*

tqyusuff@gmail.com

YUSUFF et. al. (2016 **INTEGRATION OF OUTDOOR RELAXATION SPACES IN HOSPITAL BUILDINGS IN ABUJA FOR STAFF SATISFACTION** Sustainable Built Environment and Climate change; The challenges of Post 2015 Development Agenda. School of Environmental Technology Conference, SETIC, 2016

INTRODUCTION

A hospital as a place where people go to receive a form of medical attention or the other is usually characterised by a lot of activities all round the clock. It is characterised by pressure and an excessive demand for performance of the hospital staff. This need for performance and excess pressure on the staff results in a staff population that is stressed most of the time. As defined by Ricardo, Amy and Rohit (2007), stress is an experience by person, it is personal in nature and it is caused by a person's perception of inability to cope in a circumstance or as a result of pressure caused by an excess demand on a person for specific performance. The centre for Disease Control CDC (2008) stated that stress in workplace is a significant concern in the healthcare and hospital industry and this has resulted in errors in patient diagnosis treatment and the overall satisfaction and recovery of the patient. Hence it can be said to be a certain reality that staff of health facilities are usually under immence pressure that result in them being stressed while on the job, a consequence of which is the overall treatment, recovery and satisfaction being hindered.

Relaxation can be said to be the various activities or settings that have been put in place or carried out as a means to relieving tension from an individual, in other terms tension can also be referred to as stress. The question then beckons, if adequate provision is to be made to cater for the stress or tension that is experienced by staff in a hospital, one of the various ways by which this experience can be reduced or totally ameliorated is by the provision of relaxation activities in a hospital, from the perspective of an architect it would then be the provision of relaxation spaces. These spaces could be indoors or outdoors. The integration of outdoor relaxation spaces in hospital buildings in Abuja for staff satisfaction and how this can be a means to coping with the resultants of climate change in hospital environment is what this paper intends to address and proffer means on how it can be better achieved.

Concept of Relaxation in Hospitals

The hospital is a place where healthcare is delivered, it is characterised by emergency healthcare, inpatient health care and outpatient healthcare. A study of emergency rooms of hospitals shows that emergency rooms are usually busy for well over six hours of the 24hr day while in down periods the emergency unit is usually catering for trauma associated injuries (Mchugh, Dyke, McClelland and Moss 2011). At the inpatient department it is a 24hr cycle as the nurses and doctors work around the clock to ensure healthcare is delivered to the patients that have been admitted. At the outpatient department there is usually a beehive of patients seeking treatment for minute and non-life threatening situations. The Outpatient department is usually busy 12 hours in a day from the above presented logic It would be safe to deduce that the hospital staff is on his or her feet at least average 4 hrs in a day depending on the shift pattern of the hospital.

Selye (1936) first defines stress as the body's non-specific response either human or animal to an such demand for change, Rice(2010) also reiterated this definition. With Selye and Rice's premise it is therefore apparent that stress is the means by which the body responds to any kind of demand made of it, this demand could be physical or mental and the level of stress which is non-specific is as a result of the level of demand been placed on the body. With the demand the hospital environment places on both the patient and the staff, it is of no surprise that the Hospital is a location where all parties undergo stress, therefore for a better hospital environment, there needs to be a means to relieving the stress that the staff and patients of the hospitals undergo. For the purpose of this paper Relaxation spaces would be explored as a means to relieving stress in Hospitals.

Outdoor Relaxation and Hospitals

In a research conducted by Franklin and her team in 2012, of 100 Architects of hospital residences, eighty two percent of her study population agreed that outdoor spaces is one of the most important design components in assisted living spaces. This revealed an emerging trend for an increasing realisation of needs for effective outdoor spaces in hospital buildings. This need is however usually targeted towards patient of the hospital and the staff usually ignored as most research is targeted towards the healing potentials of outdoor gardens for hospital patients.

Marcus and Barnes (1995) were surprised on a research when they realised that visits by stressed patients to outdoor hospital gardens was matched by visits by hospital employees, further interview of the employees revealed that the employees also depend very much on the greenery of the hospital as a means to get over stress. This research then paved way for further researches into the development of gardens in hospital taking into account the hospital employees.

Other researchers such as Yucel in their various literature in the 21st century have continually reiterated the need for gardens that are enhance general feelings of wellness in hospital employees and patient alike. Yucel 2013 stated that outdoor natural environments provides social support, a feeling of wellbeing, stress relieve, for staff and patient. He then went further to reiterate, that outdoor spaces have special importance for hospital staff, because this persons spend a majority of their time within the hospital interior, hence they a space that is accessible and is designated for outdoor activities such as wandering and simple playing as a means to adjusting to stress.

Outdoor Relaxation Components and Climate Change

Depending on the intended use of an outdoor space, the components of the space would vary. For an outdoor relaxation space, the following components are regarded as most important in designing and providing outdoor relaxation space

Green: Green areas such as gardens, orchards, tree conurbation and edge layout are an important aspect of out spaces, while the large components such as trees serve as cover for shade in tropical areas, it also serves as wind breakers in less tropic regions and shield individuals. The green in outdoor space is an important part of outdoor relaxation because of their healing and soothing effects on occupants or users of such spaces (Ulrich 2003)

Water: Water components such as fountains and artificial streams have been known to help in dropping temperature where they are used especially in tropical regions. Fountains created also add aesthetic feel to the space. Water as a component is the life of an outdoor space as it is what keeps the garden alive, care must though be taken to ensure it also doesn't destroy the garden (Jewett 2013)

Furniture: Furniture for outdoor relaxation includes chairs, tables, beach stretchers and floor platforms, for the purpose of sleep, sitting, reading and gaming.

Walkway: More often than not, people want to walk or jog within outdoor spaces, as a means of exercising or relieving stress. This makes walkways a very important component for outdoor spaces outdoor spaces

Asides the established contribution that outdoor spaces and gardens in general contribute to human health research has proven that they contribute positively to mitigate the effects of climate change. Nardozzi and Barbra (2015) highlighted that an estimated 70 percent of the world population would live in citites by 2050, hence significantly increasing the heat production of our cities. If residents, building owners and designers, provide 80 percent green outdoors around buildings and container gardens are created on roof tops, we would have a cooler cityscape, cleaner air, reduced water pollution and generally reduce effects of climate change.

Research Methodology

This research was carried out on Hospitals in The Federal Capital Territory, From the 18 government owned hospitals in the FCT, 8 were chosen by the means of geographical sampling. One hospital chosen from each area council, it was realised that the hospitals so chosen were FCT owned hospitals, therefore the need to add Federal Government Owned Hospitals so as to balance the sampling scale arose. This paper then seeks to ask how the hospital staff will best want to relax outdoors and how this outdoor relaxation can help to mitigate the effects of climate change. The Data utilised for this paper was generated by the construction and administration of questionnaires to employees of the hospital. With the aid of paid research assistants 30 questionnaires were administered in each sample area, giving a total of 240 administered questionnaires. Of the 240 questionnaires, only 221 questionnaires were returned and of this number 12 invalid questionnaires were recorded. This leaves the number of valid questionnaires at 209. This implies that of the 240 questionnaires administered, 87%% were valid for use as data. The data so generated was analysed using SPSS (Statistical Package for Social Scientist) and the result of the analysis were inputted into Microsoft Excel for the design of Charts that would be used for result discussions.

DISCUSSION OF RESULTS

Staff Relaxation Habit

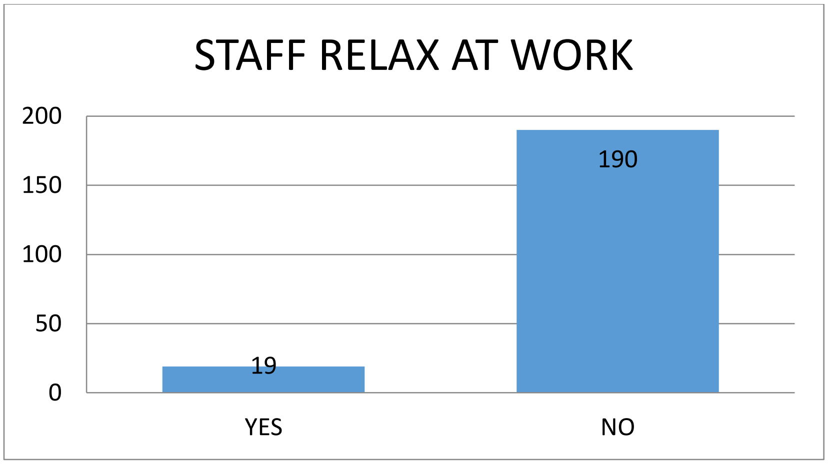


Figure 1. Relaxation of Staff at Work Source: Authors' field work, 2014

Taking inception from the relaxation habit of hospital staff, the staff were posed with questions about how they would want to relax at work, and if they do relax at work. Figure 1 showed that 190 of the 209 respondents revealed that they do not relax at work, it can then be said that 90.9% of the hospital staff do not relax at work. In Figure 2 198 of the 209 respondents revealed that they would like to relax at work, this represents 94.7% of the population. The revelation here is that a phenomenon exists here where the hospital employees want to relax but they do not relax while at work. If the hospital employees, want to relax at work but they do not currently relax at work, form the stand point of a planner, it can be postulated that the reason for this phenomenon is that facilities have not been provided for relaxation purposes.

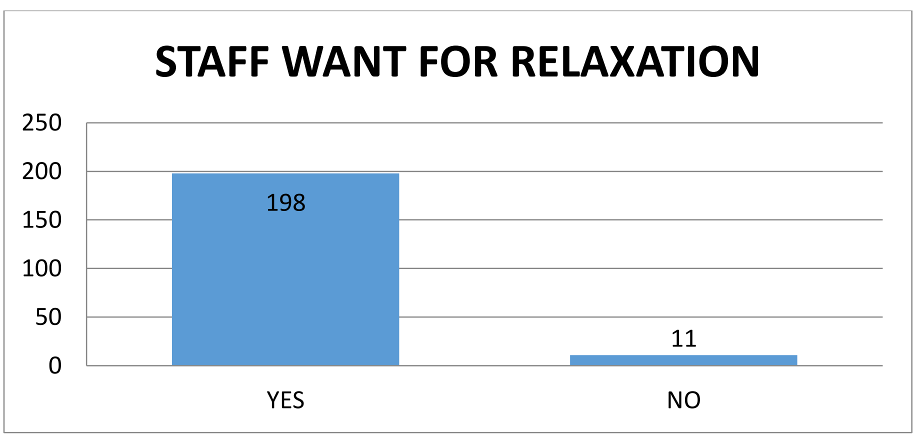


Figure 2. Want for Relaxation at Work Source: Authors' field work, 2014

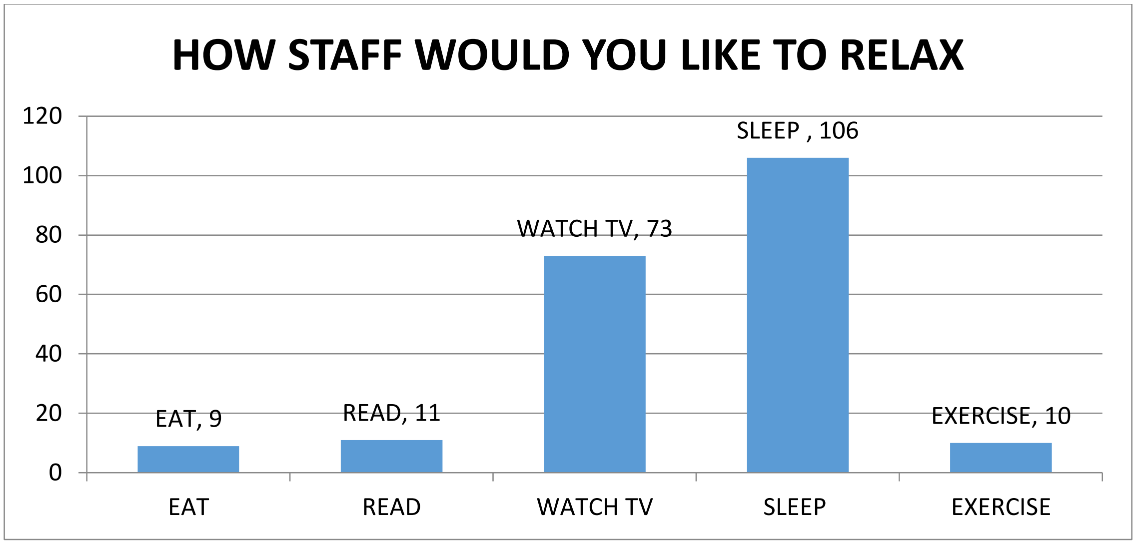


Figure 3. How Hospital Staff Would Like to Relax Source:Authors' field work, 2014

Figure 3 shows that what majority of hospital staff would like to do as a form of relaxation in the hospital is sleeping or watching television. As seen 106 of the 209 respondents prefer to sleep as a form of relaxation, representing 51% of the respondents, this relaxation need was closely followed by the need to watch television, representing 35% of the respondents. While this forms of relaxation has been revealed to be the most wanted form of relaxation amongst hospital staff, a challenge is then posed to establish if this need is what is wanted both indoors and outdoors.

Outdoor Relaxation Wants of Hospital Staff

Outdoor relaxation can definitely not be neglected in the realms of relaxation. The result as shown in Figure 4 below tells an interesting story. Of the 8 hospitals visited, only 2 provided outdoor space for relaxation purposes, representing a mere 25% of the study area, revealing that a larger percentage of the hospitals in Abuja do not provide exterior spaces for relaxation purposes.

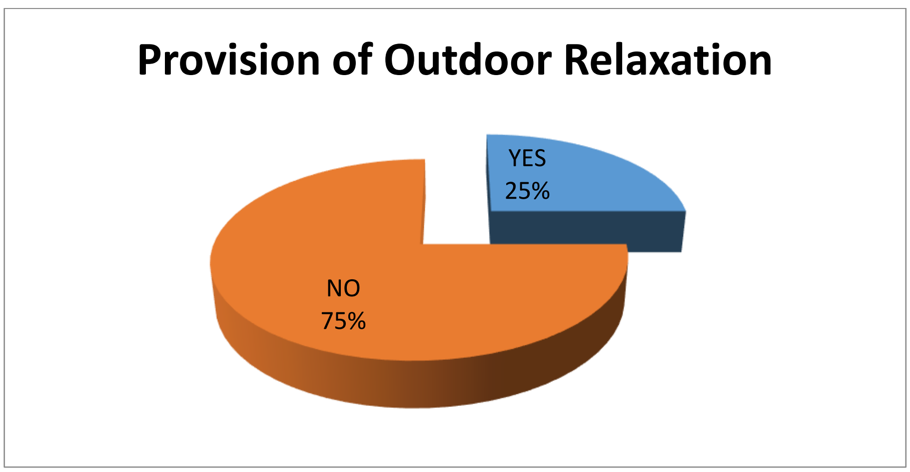


Figure 4. Provision of Outdoor Relaxation in Hospitals in Abuja
Source:Authors' field work, 2014

The information revealed in figure 4 above in its own reveals that outdoor relaxation spaces have not been provided in the hospitals visited, but the need for the outdoor relaxation space is yet to be established, hence the study went ahead to find out if the staff of the hospitals would want to relax outdoors. Figure 4 below shows that in the hospitals visited, 86% of the hospital staff would want to relax outdoors, this represents 180 of the 209 respondents. This then totally justifies the need for outdoor relaxation spaces in hospitals as previously stated. It can then be established that hospital staff in Abuja would want to relax outdoors at their work place, but their need for relaxation is not satisfied as majority of the hospitals in Abuja have not made provision for outdoor relaxation spaces in the hospitals

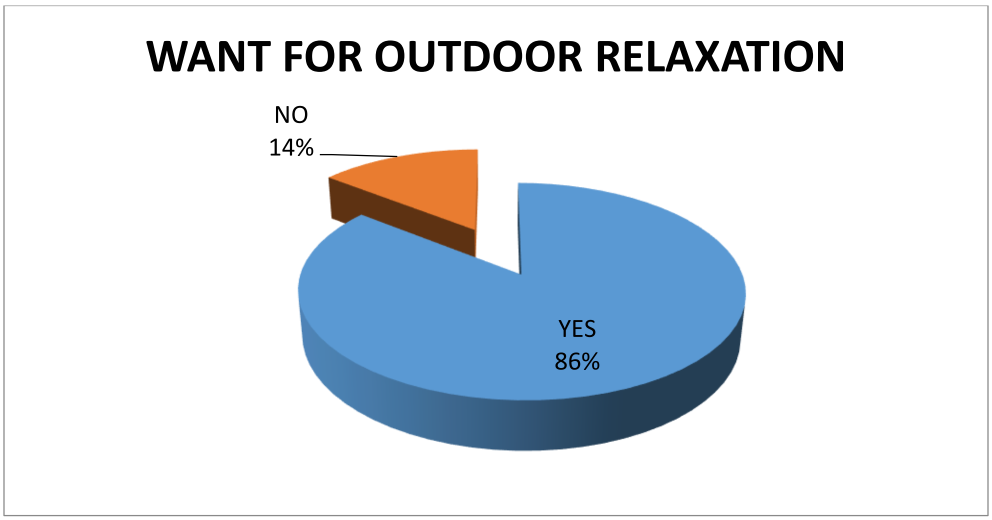


Figure 5. Want for Outdoor Relaxation in Hospitals in Abuja
Source:Authors' field work, 2014

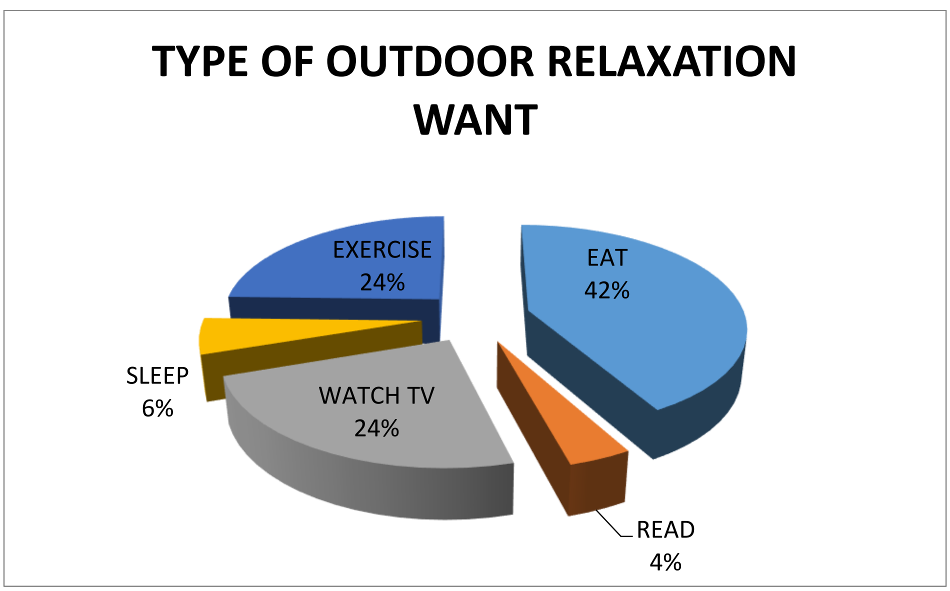


Figure 6. How Hospital Staff Would Like To Relax Outdoors
Source:Authors' Field Work, 2014

It would not be enough just to establish the need and availability of outdoor relaxation spaces for hospital employees. It is also imperative that the type of outdoor relaxation activities required by the hospital employees. This paper posed the question to the hospital employees in the study area, and it was revealed as shown in figure 6 above that while relaxing outdoors 42% of the hospital staff want to relax outdoors by eating , 24% want to exercise, 24% want to watch television, 6% want to sleep and 4 % want to read. Hence to have a staff that is satisfactorily relaxed outdoors in the hospital, priority has to given by planners and designers to spaces for eating, watching television and exercising as this activities are the most sorted by hospital employees for outdoor relaxation. This data in relation to data provided by figure 3 shows that relaxation needs indoors differ from outdoors

OUTDOOR RELAXATION COMPONENTS AND CLIMATE CHANGE

Plate 1. Outdoor Relaxation at Kuje
Source:Authors' field work, 2014

Plate 2. Outdoor Space at Maitama
Source:Authors' field work, 2014

As previously highlighted, if outdoor components is to be used to improve human comfort and reduce the effects of climate change, and make buildings more sustainable 80% of outdoor spaces in and around buildings have to have some form of green cover on its land scape. Plate 3, plate 4 and plate 6, shows an extensive green cover on the landscape of the various hospitals visited. Plate 2 and Plate 5 shows an extensive space that could have been green cover but for the need for parking in the hospital facilities are paved for cars, there by reducing the percentage of ground cover. While the need for parking spaces cannot be underestimated, it is worthy of note that the extensive spaces used for parking can be said to be a major reason for reduced green cover in spaces around hospitals. This is a factor militating against the attempt to reduce the effects of climate change, or any attempt to make the buildings sustainable from the outside by the use of outdoor components

Plate 3. Outdoor Space at Maitama
Source:Authors' field work, 2014

Plate 4. Outdoor Space at Gwagwalada
Source:Authors' field work, 2014

Plate 5. Outdoor Space at Abaji
Source: Authors' field work, 2014

Plate 6. Outdoor Space at Federal Staff Hospital
Source:Authors' field work, 2014

Green cover, water bodies, furniture for relaxation and walkways have been identified as major components of outdoor relaxation, environmentally friendly land scape and sustainable buildings and environment. Plate 1 shows outdoor sitting furniture at Kuje General hospital, although meant for relaxation purposes, due to its location and inadequacy of other facilities, the furniture and space is now used as waiting area for consultation rooms located along the quadrangle. Of the hospitals visited it Kuje general hospital was the only hospital hospital that provided outdoor furniture for relaxation purposes. Worthy of note is Bwari general hospital as shown in plate 7 and 8 below, even with the expanse of land, very little attention has been paid to the green cover around the hospital. The visit to this location was done in the 3rd quarter of 2014, been the rainy season in the Nigerian climate, the grass should be greener and cover more area, showing that green cover is totally neglected. Plate 8 shows individuals relaxing on the corridor floors of the hospital, a well planned outdoor relaxation space would have provided relaxation outdoor relaxation not just for the hospital employees but for the hospital visitors alike

Plate 7. Outdoor Space at Bwari
Source:Authors' field work, 2014

Plate 8. Outdoor Space at Bwari
Source:Authors' field work, 2014

Conclusion

This study has revealed that while relaxation spaces both indoors and outdoors have not currently been provided in hospitals in Abuja, the hospital staff want to relax while at work. A good majority of them also want to relax outdoors as means to relieving stress, and satisfying their relaxation wants. It was also revealed that majority of the hospital employees prefer sleeping indoors as a form of relaxation eating as a form of relaxation outdoors, followed by exercising and watching television is the preferred form of relaxation outdoors. In conclusion, it was realised that most of the hospitals do not have a large green cover around the buildings making it difficult to use that medium to reduce the effects of climate change around the buildings, or have sustainable environment and in placed where green cover have been significantly used, relaxation furniture to support the use of the green spaces for relaxation was not provided.

Recommendation

From the perception revealed by the staff of the hospital and observation made at the hospital on visitation, this paper would hereby make the following recommendations:

a. The design of hospitals have to incorporate relaxation spaces for both staff
b. The relaxation spaces provided in the hospital should effectively cater for outdoor relaxation
c. Relaxation spaces provided should be able to cater for multiple relaxation activities(i.e eating, watching television and exercising)
d. To mitigate the effect of climate change, the hospitals should have a large green cover around the buildings, and underground parking could be a means to achieve this
e. The green areas should be designed to accommodate outdoor furniture to cater for the various relaxation activities

References

Centers for Disease Control and Prevention (2008). *Exposure to Stress: Occupational Hazards in Hospitals*. Department Of Health And Human Services, National Institute for Occupational Safety and Health. 1-4.

Cooper, M.C. and Barnes, M. (1995). *Gardens in Healthcare Facilities: Uses, effective methods*, UMHHS.7, 2-3.

Franklin, D. (2012) *How Hospital Gardens Help Patients Heal Retrieved* from http://www.scientificamerican.com/article/nature-that-nurtures/ on 10th of December, 2015 10.10am.

Jewett, A. (2013) *Climate Control: Work With Nature's Elements for the Best Outdoor Space* Retrieved from http://www.houzz.com/ideabooks/7915258/list/climate-control-work-with-natures-elements-for-the-best-outdoor-space on 12th of December , 2015 11:55 pm

McHugh, M., Dyke, V. M., McClelland, M. and Moss, D.(2011). Improving Patient Flow and Reducing Emergency Department Crowding: A Guide for Hospitals Agency For Healthcare Research And Quality AHRQ Publication No. 11(12)-0094 .

Nardozzi, C. and Richardson, B. (2015) *Make a Green Resolution: Gardening to Reduce Global Warming and Climate Change* Retrieved from **http://www.nationalgardenmonth.org/index.php?page=storyline-resolution/** on 1st of January , 2016 1:01 am.

Ricardo, B., Amy, K. & Rohit, L(2007), Stress at Work, A report prepared for The Work Foundation's Principal Partners.1-11.

Rice, V. H.(2010).Theories of Stress and Its Relationship to Health. 2-4.

Selye, H. (1936). A syndrome produced by diverse nocuous agents. *Nature*, *138*, 32.

Ulrich, R.S. (2003). Health Benefits of Gardens in Hospitals, Paper for conference, *Plants for People*, International Exhibition Floriade. 1-6.

Williams D. A. and Carey M. (2003), You really need to relax: Effective Methods, UMHS. 2-3.

Yucel, G. F. (2013) *Hospital Outdoor Landscape Design* Istanbul: Architecture Department Istanbul Aydın University, Istanbul, Turkey.

ASSESSMENT OF PASSIVE SECURITY DESIGN CONSIDERATIONS IN SHOPPING COMPLEXES IN MINNA, NIGER STATE.

YISA, Emmanuel Yisa & Anthony I. Anunobi
Department: Architecture, Federal University of Technology, Minna, Niger State, Nigeria

The Security implications of climate change impacts are far reaching, as they may increase the severity of existing stressors, political instability environmental degradation, and contributing to poverty, providing enabling environments for terrorist activity in the country. Nowadays, shopping complexes are largely used in so many different applications for the convenience and ease of use by operator. The storage, exchange of goods and services within complexes require high security measures. Maintenance of high level security is therefore an utmost priority for the designers. The current security practices do not provide sufficient protection to support building sustainability in the event of terrorist act. This paper is therefore set out to assess the status of passive security measures shopping complex buildings, comparing existing passive security measures with standard practices, suggesting functional solutions for sustainable environment. The study employed the use of Descriptive Survey method on sample size of 4 shopping complexes in the selected areas which is approximately 24% of the total sampling frame of 17.The primary data was obtained by means of direct observation schedule from the selected research areas. The secondary data was obtained from related journals, books and seminar papers. The data obtained were analyzed with simple descriptive statistics. This research revealed that most of the shopping complexes are vulnerable to security threats within the research areas. Some shopping complexes with inadequate security measures command security threats with relatively lower rental values and exchange of goods and services than some with availability of security measures. This research recommended that government by way of Public Private Partnership should embark on adequate implementation of passive security measures at the design stage of shopping complexes to improve property value and social life within the study areas.

Keywords: *Public Buildings, Security Measures, Security Threats, Shopping Complex, Sustainability*

Email: emmanuely.yisa@gmail.com

YISA, E. Y. & Anunobi A.I. (2016). **ASSESSMENT OF PASSIVE SECURITY DESIGN CONSIDERATIONS IN SHOPPING COMPLEXES IN MINNA, NIGER STATE.** Sustainable Built Environment and Climate change; The challenges of Post 2015 Development Agenda. School of Environmental Technology Conference, SETIC, 2016

INTRODUCTION

Several shopping complex buildings in Niger State, FCT Abuja and Nigeria as a whole have been under severe security threats which have culminated in bombings of whole or parts of a structure leading to loss of lives and properties. Some of the Public buildings in Nigeria that have been attacked at different times include: Eagle Square, Nigerian Police Headquarters, Thisday Newspaper House, Nyanya Park, Emab Shopping Plaza and several churches just to mention but a few, Levinus, (2014). According to a similar study by Sani (2013), the security situation in Nigeria is at a steady decline as public buildings have since become prime targets for terrorism. Not only public buildings are targeted, but also public places with large crowd are also points of target by suicide bombers.

In recent times, security threats to public buildings are perpetrated by both car and suicide bombers. Based on a similar study by Chidiebere and Uchenna (2010), car and suicide bombings both have catastrophic effects on public buildings in Nigeria. For instance, the suicide bombing of the Emab Shopping Plaza, Abuja burned down cars, so many causality in and around the premises, and collapse of some part of the structure. Furthermore, the explosion that occurs as a result of a bomb blast results in fire outbreak that further reduces the strength of materials used in the construction of public buildings.

Therefore, without adequate security measures and poor emergency evacuation techniques, public buildings become more vulnerable to attacks and with the high population of people always in shopping complexes, high rate of loss of lives is often recorded. More so, a similar study by Dickson (2012) revealed that the current state of insecurity in Nigeria as a whole has posed great challenges to the peace and stability of Nigeria leading to loss of lives, infrastructures, properties and most importantly, the displacement of both foreign direct investment and local macro-economic investment.

Li (2006) looked into two basic measures of combating insecurity especially for public buildings. Active security measures according to the study involves the use of several technologies such as surveillance cameras, alarm systems and bomb detectors together with the aid of highly trained security experts to reduce the possibility of security threats to public buildings. While the passive security measures according to Hole (2012), involves design and planning technologies that are meant to complement active security measures necessary to reduce the possibility of security threats to buildings. These include design measures such as: choice of building materials, building perimeter setbacks and stand-off zones, width and height of stairs, corridors and doors.

Recent studies from existing situations according to Peterside (2014) revealed that security breaches in public buildings are perpetrated by two basic means which are: the use of bomb laden vehicles to forcefully gain entry into public buildings and the use of suicide bombers to sneak into public buildings amidst crowd. Both active and passive security measures are used to eliminate totally, the possibilities of carrying out these natures of attacks. However, passive security tends to act as a preventive and protection measure that can be implemented right at the design stage of public buildings (Sudhir, 2013). Lowee (2008) described passive security as being more effective in reducing security threats to public buildings because it serves as both a preventive measure and counter measure if active security measures were Furthermore, passive security measures also reduces emergency evacuation duration in order to allow public building occupants scamper to safety in the eventuality of a fire outbreak as a result of a bomb blast.

Shopping complex are public buildings meant to provide storage, goods and services necessary to provide a form of transaction between the buyer and the seller. With the spate of insecurity in Nigeria, especially in northern Nigeria, Shopping complex Buildings are considered as prime targets for bombings. This paper therefore seeks to study selected Shopping complex Buildings with a view to assess passive security measures in the design and construction.

SECURITY IN BUILDING

UN (2010) defines security as a degree of protection to safeguard a country, group of people, person and property from danger, destruction, attack and crime. Institute for Security and Open Methodologies (2006) defines security as a means of protecting an asset which are largely classified into lives and properties from a potential threat. For a country to enjoy development and progress, security has to be put in place. The concept of security is related to the concept of safety, continuity and reliability. Security takes into consideration the actions of people planning to cause the attack.

Institute for Security and Methodologies (2006) defines building security as the degree in which a building, its facilities and users are protected from potential threat that can cause any form of damage to the building and its users. Building security goes beyond installing high tech electronic gears in a building to identify threat entering into or within a building but it is first of all a process of planning and design, hence architects should design having in mind the range of factors affecting security. The cost of ensuring building security and maintaining building security components will be unbearable if sustainability is not considered in the choice of the security component used in the building. Again, the role of architects in planning and specifications of components is paramount to ease the work of the facilities managers who are responsible for sustainability of buildings, facilities and users. Building security can be approached in two ways: Active security measures and Passive security measures.

Active Security Measures in Buildings

Active security measures are measures that use proven systems and technologies designed to prevent, identify, report and respond against threats (Terrence, 2005). This will involve the use of security personnel, installation of surveillance systems, motion detectors, smoke detectors, sprinklers. Generally, active measures covering access control, security screening, and surveillance. This has been the most used in Nigeria since the insurgence of terrorism in the country. This is seen in the use of security personnel at check points, installation of surveillance system in public area and buildings and screening entrances of public facilities. This measure is key in curbing insecurity challenges but is not sufficient considering that terrorism is a whole different level of insecurity in terms of the amount of possible casualties, loss of properties and amount of attention drawn to it and also for the fact that with all the active security measures put in place, insecurity still thrives in Nigeria. For security to be effective, a blend of active and passive security measure need to be achieved so as to complement each other.

Passive Security Protection

Passive security protection provided by the site and structure is the most basic and permanent of security measures. Structures should always provide levels of structural and system integrity specified by building codes (Jackson, 2013). According to Terrence (2005), Passive security measures are measures that involve the effective use of architecture, landscaping and lighting to achieve improved security by deterring, disrupting, or mitigating potential threats. The basic concept of passive security measures to address an explosive threat considers the establishment of a protected perimeter, the prevention of progressive collapse, the design of a debris mitigating façade, the isolation of internal explosive threat that may evade detections through the screening stations or may enter the public space prior to screening and the protection of the emergency evacuation, rescue and recovery systems (Lowe, 2008). These protective measures are generally achieved through principles of structural dynamics, nonlinear material response and ductile detailing. Building design is important in addressing passive security measures. The hazards of an explosive blast include the destruction of assets within a facility, structural damage to the facility itself, and injuries or fatalities. In addition, explosions may start a fire, which may inflict additional material damage, injuries, or fatalities due to direct exposure or to heat, smoke, and fumes. An explosion is an instantaneous or almost instantaneous chemical reaction resulting in a rapid release of energy. The energy is usually released as rapidly expanding gases and heat, which may be in the form of a fireball (Chesbro, 2012).

MINIMUM STANDARD OF PASSIVE SECURITY MEASURES.

Jean (2005) summarized minimum standard practices necessary for adequate integration of passive security measures in public buildings and categorized them in to six namely: setback distances, access control, parking system, perimeter fencing and escape corridors and staircases.

Passive Security Measure for Enhancing Building Security

Passive security measures can be addressed in two basic ways; site issues and building issues.

Site Issues

Site issues are those passive security planning issues that addressed in site planning. These issues include:

I. Setback Distance

The distance between an asset and a threat is referred to as the setback distance. “The minimum setback of the building from the parking space is 20 meters”. It is also determined by the type of threat, the type of construction, and required level of security protection. Large setback distance gives opportunities for future upgrading of shopping buildings to meet increasing threats or to cater for higher levels of protection” (Russell, 2002).

It may be essential to provide further protection by introducing the concept of a setback next to the structure for high-risk buildings. “The setback aids monitoring of the immediate area and visual detection of attacks. When the setbacks are implemented, it may be necessary to implement other anti-surveillance measures. At this point, active measures become complimentary” (Russell, 2002).

II. Access Control

In the design of high risk facilities, controlled access zone is a key method that can be adopted in achieving required protection. “These zones define minimum distances between a public building and potential threats through the installation of barriers (such as bollards, planters, fountains, walls, use of kerbs, crash beams and fences). The minimum height of crash beam is 90mm, thickness of crash beam should not be less than 90mm and material used for crash beam. For height of crash beam and thickness of crash beam, they should be sufficient to stop an intruder vehicle. The barriers are designed to withstand assaults by terrorist vehicles; however, their placement must be designed to allow for access by fire and rescue vehicles in the event of an emergency. Selection of barriers is based on operational considerations related to vehicle access and parking” (Russell, 2002).

III. Parking system

Restricted parking can help keep potential threats away from a public building. Mitigating the risks associated with parking requires creative design measures, including parking restrictions, perimeter buffer zones, barriers, structural hardening, and other architectural and engineering solutions. (British Standards Institute, 2009).

IV. Perimeter fence

Fences provide the first line of defense to the building and the site as a whole. There are different types of fences for different purposed. It can either be for security purpose or for privacy. For security, the level of threat expected or the sensitive nature of what is in the build will also influence the type of security fence used or installed. For public buildings, the use of heavy steel gauge should be used.

Building Issues

I. Avoid Using Scissors Staircases

Avoid using scissors staircase type in tall buildings. A scissors type Staircase is basically an arrangement of putting two sets of stairs into a single stair hall. This is done usually to save space. However, in a situation where the stair hall gets damage in an event of Security Bridge, it is likely both stairs will be disabled.

II. Provide Emergency Evacuation Measures

It is essential to provide self-luminescent marking for emergency lights and exit signs so the evacuation is made easier in the event of a security bridge.

III. Protection against Flying Glass

Many buildings today are designed with a significant amount of glazing finishes. This usually shatters into sharp and high velocity fragment in the event of a blast and injure occupants and passers-by so the many of the casualties are as a result of this effect Protection against flying glass is usually achieved by adopting an anti-shatter film of glass and apply a transparent polyester to it or installing a blast resistant secondary glazing on the inside of the existing exterior glazing.

THE NEED FOR ASSESSING PASSIVE SECURITY MEASURES IN SHOPPING COMPLEXES IN MINNA, NIGER STATE, NIGERIA.

Van and Reed (2013) emphasized the need to adequately integrate passive security measures in public buildings such as state liaison office buildings such as due to the numerous benefits such as:

1. Better blast resistance: the use of external barriers and reinforced perimeter fencing in shopping complex buildings tend to provide better blast resistance according to the study.

2. Better traffic management: structural measures that reduce access of unscreened vehicles or slow down speedy vehicles contribute to better traffic management within the perimeter of shopping complex according to the same study.

3. Improved hostile vehicle mitigation: adequate planning of entry and exits points into shopping complex improves hostile vehicles access.

4. Better Oversight: clear lines of sight and building orientation help achieve better oversight in shopping complex.

According to Crown (2012), passive security measures also offer protection of lives and not just properties of building users in the eventuality of a successful security threat on a public building because adequate escape staircases, corridors and security doors constitute passive security design. The fore mentioned benefits can be easily achieved by implementing standard passive security design measures such as: adequate thickness of fence, crash beams, elevated planters, minimum standard of setbacks, stand-off zones, corridors and escape staircases.

RESEARCH METHODOLOGY

This research was conducted by first gathering literature on security, passive security and related topic which then gave a clear concept of passive security and its scope. These concepts then formed the criteria used to investigate the study area as regards the subject matter in gathering data. Primary and secondary sources were explored in sourcing data for this research.

Primary data was collected using a structured observation schedule in the research area and building professionals focusing on passive security measures that are site planning related in this research. Secondary Data was review of relevant literatures provided the bases for comprehensive theoretical background of the research. Information obtained were analyzed and provided the bases for the parameters for observation, planning and design criterion for Passive Security Measures in Public building especially shopping complexes. The information gathered will be used to establish recommendation for Passive Security Measures in shopping complex.

The data collection instrument used in carrying out this research is a structured observation schedule. A sample size of four (4) shopping complex buildings in Minna, Niger State was drawn from a total population of Seventeen (17) Shopping complex buildings within the study area. The Four shopping complex buildings were selected in Minna Central Business District.

Observation being the primary source of gathering data for this research was carried out by taking photographs and taking physical measurement of the existing passive security measures where provision were made in the research areas and also showing existing condition that put these facilities in a vulnerable position to security threats. Data collected were analyzed using a simple descriptive statistical technique on Microsoft excel simply by tabular presentation and picture photographs used as plates against standards establish from literature reviewed, text books, journals, e-books, interviews and relevant publications on the internet.

FINDINGS AND DISCUSSION OF RESULT

The analysis of the data obtained through observation schedule was done using simple descriptive statistics as an assessment tool. They are presented in table 1.0, 2.0, 3.0 and 4. 0. In table 1.0, the distance of the selected shopping complex buildings from the access road were measured in order to determine whether the existing setback are adequate, based on minimum standard as discussed in the introductory part of the paper.

Table 1.0: Existing Setback of Shopping complex buildings (Metres)

SHOPPING COMPLEXES	0.0-5.0	5.1-10.0	10.1-15.0	15.1-40.0
OBJ COMPLEX	0	1	0	0
PENIEL	0	0	0	1
SHEHU USMAN	0	0	0	1
BAHAGO	0	1	0	0

Source: Author's Fieldwork (2015)

The sizes in Table 1.0 were gotten by physical measurement using steel tape, of the distance between the shopping buildings and the access road. The table further shows that some of the shopping complexes do not meet the standard setback discussed earlier.

As shown in Table 2.0, the various thickness of the crash beams are measured in millimetres in the selected shopping complex buildings is analyzed. The table illustrates the shopping complex buildings with the most frequently used crash beams and shopping complex building without crash beams. The size that is most frequently used from the table range from 51-100mm while many shopping complex buildings do not use crash beams, thereby making the building vulnerable to terrorist attack. Access control provides space far away as possible from the main building structure to allow for security checks for vehicles entering the premises and for defining the pathway for vehicle to move around the premises. At the main entrance gate, passive security measure may include crash beams, speed bumps, gates and stoppers. In many cases as also observed in the research areas, access control was addressed in a reactive manner rather than as a proactive manner as it should be.

Table 2.0: Showing thickness of crash beam (Millimeters)

SHOPPING COMPLEXES	0.0-50	51-100	101-150	151-200
OBJ COMPLEX	0	1	0	0
PENIEL	0	0	0	0
SHEHU USMAN	0	0	0	0
BAHAGO	0	0	0	0

Source: Author's Fieldwork (2015)

Fences provide the first line of defense to the building and the site as a whole. Table 3.0 reflects what the researcher observed in the research areas, heavy steel gauges are most frequently used since it is utilized in two shopping complex buildings.

Table 3.0: Showing thickness of fence (Millimetres)

SHOPPING COMPLEXES	STEEL FENCE	75-150	151-225	225-300
OBJ COMPLEX	0	0	0	0
PENIEL	0	0	1	0
SHEHU USMAN	1	0	0	0
BAHAGO	1	0	0	0

Source: Author's Fieldwork (2015)

The basic contrast in the fence design in the study areas and what standards have specified is that fences in public buildings should be see-through fences made from heavy steel gauges. See-through fences aid security in a critical way by creating multiple views into the premises to spot intruders and a breach of security around the site.

It was observed that the type of stairs adopted in the design of the shopping complex building in the research area was the regular type and not the scissor type as shown in table 4.0. This will reduce the pressure in the case of an emergency evacuation compared to if it were to be a scissors staircase.

Table 4.0: Showing type of staircase for easy of movement

SHOPPING COMPLEXES	REGULAR	SCISSOR
OBJ COMPLEX	1	0
PENIEL	1	0
SHEHU USMAN	1	0
BAHAGO	1	0

Source: Author's Fieldwork (2015)

From Table 4.0, it observed that regular (dog leg) staircase was adopted in the shopping complexes but it is also observed that there no emergency evacuation measures such as self-luminescent light or marking to facilitate emergency evacuation of these facilities.

CONCLUSION

In conclusion, the study has shown that Passive security measures is a broad subject of discuss covering both site issues which are best described as protective measures and issue that are building related which can be described as building resistivity or protective measures. For the purpose of in-depth study, the research has been narrowed to focus on a few site planning related issues and a few building related issues.

Passive security measure is not the solution to security challenges in Nigeria but plays a critical role in combating insecurity as we know it today in Nigeria and around the world. As earlier stated, passive security measures will not be effective in isolation of active security measures therefore striking the balance between passive and active security measure should go a long way to give the desired result of curbing insecurity and its effects in the build environment.

RECOMMENDATIONS

The paper emphasizes the need to integrate passive security measures in the design and construction of existing and future shopping complex due to the fact that they are often prime targets for perpetuating security threats. The following recommendations are therefore necessary:

- **Setback** should be defined clearly such that any bridge will be obvious. Landscape elements such as bollards, kerbs and elevated planters should be used to define setback.
- **Access control:** Landscaping element such as bollards, kerbs, and hedge plants should be used in defining access within and around the premises of public buildings. Use of crash beams should be mounted on every access area. Distance between bollards should not be more than 900mm and same with height. Kerbs should have a minimum of 300mm height from finished surface.
- **Emergency exit and staircases:** Adequate provision of emergency exits, staircases and corridors with luminescent light should be wide enough to suit the capacity of building occupants is necessary.
- **Planning the site:** The main building should be taken away from the direct line of access from the main entrance into the site while cars should be parked and made to move outside the setback zone.

REFERENCES

British Standards Institution, (2009). *Impact test Specifications for vehicle security barriers, 66-125.* Retrieved from http://www.shop.bsigroup.com/product detail/?pid

Chesbro, M. (2012). *Explosive Device Stand-Off distances, 1-4*. Retrieved from http://www.chesbro.net/images/Explosive_Device_Stand-Off_Distances.pdf

Chidiebere, O & Uchenna, A. E. (2010). The Morality of Suicide Terrorism and Boko Haram Challenges in Nigeria. *Journal of Arts and Humanities, 17-77*. Retrieved from http://www.unn.edu.ng/publications/files/images/IJATE%20Vol%209%20No%201.pdf

Crown C. (2012). *Protecting Crowded Places: Design and Technical Issues, 21-47*. USA: Home Office publishers. Retrieved from https://www.gov.uk/government/uploads /system/uploads/attachment_data/file/97992/design-tech-issues.pdf

Jean, P. P. (2005). Implications: Perimeter Security for Public Spaces. *Journal of design and human behavior research, 1-8*. Retrieved from http://rs.informedesign.org/_news /dec_v03r-p.pdf

Levinus, N. (2014*). Abuja, Boko Haram attacks and the elusive $470 million CCTV cameras*. Retrieved from Vanguard website: http://www.vanguardngr.com/2014/06/abuja-boko-haram-attacks-elusive-470-million-cctv-cameras/ *On 30th October, 2015 11:30pm*

Lowe, F. (2008). *Securing Building and Saving Energy, 1-10.* Boston: McGraw Hill Publishers. Retrieved from https://www1.eere.energy.gov/femp/pdfs/security _sustain_whitepaper_final_12aug.pdf

Li, P. (2006). *School planning and management, 1-3*. Canada: Education Group Publication. Retrieved from http://www.cityofportsmouth.com/school/centraloffice/eefc/4d.pdf

Peterside, B. Z. (2014). A Threat to National Security: The Case of Boko Haram in Nigeria. *Academic Journal of Interdisciplinary Studies, 3(4), 1-7.* Retrieved from http://www.mcser.org/journal/index.php/ajis/article/viewFile/3101/3057 *On 30th October, 2015 11:30pm*

Russell, J. (2002). *Designing for Security: Using art and design to improve security, 4-8.* 2nd Edition. Retrieved from http://designtrust.org/publications/designing-security/preview/293/

Sani, N. (2013). *Insecurity in Nigeria: Causes and Resolutions*. Retrieved from Daily Trust: http://www.dailytrust.com.ng/weekly/index.php/top-stories/34-letters/letters/14514-insecurity-in-nigeria-causes-and-resolutions *On 30th October, 2015 11:30pm*

Sudhir, K. (2013). *A Handbook of Planning of Office Buildings, 16-57*. India: Central Public Works Department Publishers. Retrieved from http://cpwd.gov.in/Publication/ Handbookofficebuilding.PDF

Terrence, J. G. (2005). Assessment and mitigating of risks to physical security, information Security and operational security. Retrieved from http://www.facilitiesnet.com/ security/article/Taking-Security-To-the-Next-Level-Facilities-Management-Security-Feature--2566. On 30th October, 2015 11:30pm

Van, D. W. & Reed, L. (2003). *Perimeter security for historic buildings: Technical pilot, 5-31*. General Services Administration, Center for Historic Buildings. Retrieved from http://www.gsa.gov/portal/mediaId/121330/fileName/PerimeterSecurity_Revised_Report_060209.action

ASSESSMENT OF EXPLOSION PROTECTION MEASURES IN COMMERCIAL COMPLEXES IN ABUJA, NIGERIA

LAWAL Mohammed & AHMED Salawu
Department of Architecture, Federal University of Technology Minna, Niger State, Nigeria

The rise and spread of terrorist activities around the world, with Nigeria featuring prominently among the countries with most astounding human casualties and building destructions, has become a worrisome trend now occupying defensive thinking, militarily. But lately, Abuja, the capital city of Nigeria has had a series of explosive attacks with the utilization of Improvised Explosive Devices in parked or penetrative suicidal vehicular operations with varying degrees of decimations, which calls for the occupation of our defensive thinking as well, architecturally. Commercial complexes happen to fit into the considerations necessitating the need for their protection to mitigate terrorist attacks and ensure building survivability and safety of occupants. This paper set out to assess the blast resistance measures (defensive levels) in commercial complexes in order to come up with protective architectural design methods for new buildings or retrofit methods for existing structures to make them blast resistant buildings. This study utilized primary and secondary data sources. The primary data sources incorporated the utilization of observation schedules in field work, which were analyzed utilizing the SPSS software and the results exported to Microsoft Excel to produce pie charts to determine percentages of the imputed data. The paper studied the generation and reflection of blast wave, which is the chief damage mechanism in an explosion, to understand its behavior. It also used studies of building forms in terms of geometric shapes of buildings and some elements of the building envelope, and use of materials to exploit their energy absorption/reflection capabilities. As part of sustainable design, the effectiveness of the use of plants to reduce blast load impact is presented. The key finding is that the commercial buildings in Abuja are not architecturally in conformity with explosion protection designs and therefore need to be retrofitted to make them blast resistant.

Keywords: Terrorism; Explosion; Commercial Complexes; Blast Resistant Buildings; Building Form

laawaal@yahoo.com

Ahmed Salawu & Lawal Mohammed (2016). **AN ASSESSMENT OF EXPLOSION PROTECTION MEASURE S IN COMMERCIAL COMPLEXES IN ABUJA, NIGERIA** Sustainable Built Environment and Climate change; The challenges of Post 2015 Development Agenda. School of Environmental Technology Conference, SETIC, 2016

INTRODUCTION

Terrorism is portrayed as brutality intentionally unleashed on an objective populace with the aim of ingraining a feeling of fear, shock and outrage in their psyches (El-Domiaty, Myers, and Belarbi, 2002). Terrorism has been described as a phenomenon that is highly concentrated and yet globally distributed (Global Terrorism Index Report, 2015). The Global Terrorism Index additionally has it that 75% of lives lost because of terrorist exercises occurred in five nations – Iraq, Afghanistan, Pakistan, Nigeria and Syria. Until recently, Nigeria appeared to have been invulnerable to terrorist activities. The successive gruesome acts of terrorism suffered in the hands of local dissentient forces so far have thoroughly punctured our false sense of immunity (Oyebode, 2011). Our National security environment is now a reflection of the global security challenges (Think Security Africa, 2011).

Subsequen**t** to 2009, terrorists have dispatched assaults on commercial and government structures with the utilization of explosive devices mostly in the Northern parts of the nation, particularly, in and around Abuja the capital city, bringing about the devastation of such buildings and loss of lives or injuries to the occupants of the buildings. Some attacked locations include: the Police Headquarters building on 16 June 2011; the United Nations building on 26 August 2011; Nyanya Motor Park on 14 April 2014 and the Emab Plaza on 25 June 2014. The effect and decimations of/from those blast situations point to the troubling reality that the terrorists are turning out to be progressively more sophisticated and brave in their assaulting abilities and outreach (Human Rights Watch, 2012, Barna, 2014). Plates 1 and 2 below show some bomb blast incidents in the federal capital city of Abuja.

Plate 1: *Emmab Plaza bomb Blast, Abuja*
Source: Mail Online
www.dailymail.co.uk/news/article-2669538/Explosion-rocks-mall-Nigerian-capital.html

Plate 2: *Thisday office bomb Blast, Abuja*
Source: The Christian Science Monitor
www.csmonitor.com/World/Africa/2012/0426/
Separate-bomb-blasts-rock-Nigeria-s- newspapers

Shopping centers, in light of their trademark nature to be swarmed, are potential focuses for terrorist assaults on account of the capacity to exact mass losses, cause gross monetary harm and inculcate fear (US Department of Homeland Security, 2014). Shopping malls are specifically vulnerable to terrorist assaults as a result of ease of accessibility and dense convergence of individuals. Thus this vulnerability has resulted high risk of attacks, with more than 60 terrorist attacks at shopping malls happening all through the world since 1998 (LaTourrette, Howell, Mosher, and MacDonald, 2006).

The larger parts of commercial buildings in Abuja were built preceding the consolidation and arrival of terrorist exercises into the federal capital city. This made this study appropriate to discover the congruity of those structures to blast resistance methodologies, with a specific end goal of improving what is functional in them or acquaint new techniques or installations to make them blast resistant to mitigate terrorist attack.

Aim of the Paper

The aim of this study is to assess the explosion protection measures in commercial complexes in Abuja to ascertain their conformity to explosion protection design, construction and use of materials.

Explosion Protection Dilemma

The components of buildings largely utilized for their aesthetics purpose, particularly glass and ornamental elements, if not properly used will likewise make them vulnerable as they turn into high speed projectiles during explosion events (Lavy and Dixit, 2010). Therefore, balance should be struck between protection and aesthetic choices. Blast protection objectives should also be practicable as it would be irrational, because of restrictive expense, to have a building, other than a hardened military facility to withstand, unscathed, the impact of a bomb directly before it. The main objective of protection design is to minimize damage to the building to ensure its survivability and the safety of occupants (FEMA, 2003b).

Threat Identification

The US Department of Homeland Security (2014) specifies terrorist threats of concern to large shopping malls to include:

- Explosives
- Arson
- Biological agents
- Chemical agents
- Hostage/blockade, and
- Indiscriminate shooting of persons.

This paper focused on threats from explosives. The conventional explosive devices that are utilized in terrorist activities targeted at buildings are called improvised explosive devices (IEDs). IEDs are of diverse sorts depending on their size, design, and composition. The type and degree of harm an IED can cause depends on the means by which it is conveyed to a target. Either of two conveyance mechanisms is typically utilized: vehicle-borne or man-portable devices (Engineering Security, 2009).

Vehicle-Borne Improvised Explosive Devises

A vehicle-borne improvised explosive device (VBIED) has the capacity to carry substantial amount of explosive material capable of significantly damaging or even destroying a building. Because the magnitude of damage a VBIED can inflict depends largely on its closeness to a target, terrorists choose to detonate VBIEDs in vehicles parked outside of buildings, within garages, or in vehicles that ram into buildings.

Man-Portable Improvised Explosive Devises

Man-portable improvised explosive devices (MPIEDs) are mostly used to target people rather than buildings. They tend to be significantly smaller in size than VBIEDs, thus concealable in backpacks and suitcases, making them easier to deliver into a building. Victims of such attacks often get injured by shrapnel, projectiles, furniture fragments and shattered glass, rather than building collapse as in the case of VBIEDs.

The Explosion Phenomenon

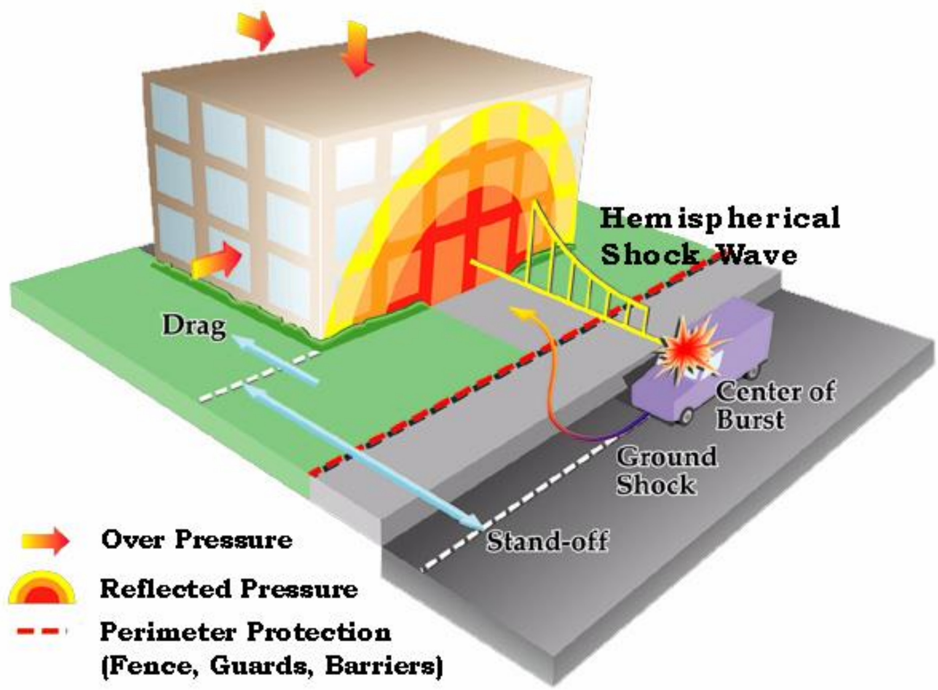


Figure 1- Schematic of vehicle weapon threat parameters and definitions
Source: FEMA427 (2003b): Primer for Design of Commercial Buildings to Mitigate Terrorist Attacks

Explosives are broadly classified into two: low and high explosives. In low explosives, the reaction is essentially thermal in nature, that is, a conflagration. In the case of high explosives, the transfer of energy from the exploded to the unexploded material is through pressure shock, that is, an explosion. The second category is the most imperative in this paper (Sakula, 1997).

Experts on explosion protection basically categorize blast attacks into two:

1. **Standoff explosions –** these are blasts that occur at some significant distance from the target.
2. **Contact detonations –** these occur when an explosive device is placed in physical contact or very close to the structure. Each category has a different damage mechanism and requires a different protection strategy (Steven, 2007.)

A blast is characterized as a great sudden burst of energy in the form of light, heat, sound and a blast wave (FEMA, 2003b). FEMA, (2003b) further portrays a blast wave as exceptionally compacted air traveling outward, radially, at supersonic speed away from the impact source and its intensity gets enhanced by a factor of up to thirteen when it comes in contact with an obstacle. An explosion which occurs at ground creates several effects that cause damage and injury. The effects are dependent on the power, quantity and distance of the explosive device (Protecting Crowded Places, 2012).

A building that is subjected to an explosive action is affected by several pressure types that occur in two phases: the positive pressure phase and the negative pressure phase. The positive pressure phase refers to the sudden outward expansion of energy as the shock waves radiate toward the building in all directions from the source of the explosion causing pressure to envelope the structure, loading the sides and the roof; with possible further amplification if the waves are trapped by the structure. The pressures in the positive phase exert pushing effects on the building's exterior and may end up inducing localized failure of exterior walls, windows, floor systems, columns, and girders. The negative pressure phase refers to the period when the low intensity, longer duration causes inward movement of air to fill the void created by the positive phase. The pressures in the negative phase prompts a reversal of the positive phase loading, thereby pulling structural elements towards the source of the blast, which may pull out windows and sloped roof (FEMA, (2003b).

Causes of Fatalities, Injuries and Damage from Blasts

The main causes of fatalities, injuries and damage as a result of an Improvised Explosive Device (IED) are:

- Direct weapon effects including primary fragments, lung blast damage, thermal burns an ear drum rupture;
- Secondary fragments such as glass, spall (flakes of material that are broken off a larger solid body) and other objects thrown by the blast;
- Collapse causing crush injuries; and
- Post-event falling debris (including glazing, façade, internal walls etc) damaged equipment and damaged infrastructure which can hinder the speedy evacuation of buildings (Protecting Crowded Places, 2012).

RESEARCH METHODS

This study is a descriptive research exercise which utilized primary and secondary data sources. The primary data sources incorporated the utilization of observation schedules in field work. The initial sample population for commercial complexes in Abuja obtained from Abuja Environmental Protection Board (AEPB) was two thousand, two hundred and eighty-three (2283) which included hotels, eateries, hotels and shopping complexes. The population got reduced to seventy-five (75) after selecting only shopping centres/malls as the target for the research. Twenty (20) shopping complexes/malls were further selected at random for analysis. The research parameters utilized included five components of the security design: stand-off distances, wall types, building configuration, roofing system and glazing types. Data was collated based on the above checklist and the information tabulated and analyzed using the SPSS software to produce frequency tables that were exported to Microsoft Excel package for plotting of relevant pie charts to determine the percentages of the computed data. Secondary data sources are published and unpublished literary works to study the generation and reflection of blast waves, some geometric shapes of buildings and use of materials to exploit their energy absorption/reflection capabilities.

FINDINGS AND DISCUSSIONS OF RESULTS

The analysis of the data obtained using observation schedules was tabulated under the individual components of the line of defense concept of the protection design strategies, namely: stand-off distance, wall types, building configuration, roofing system and glazing types – and presented in tables 1.0, 2.0, 3.0, 4.0 and 5.0 respectively.

1. Stand-off Distance:

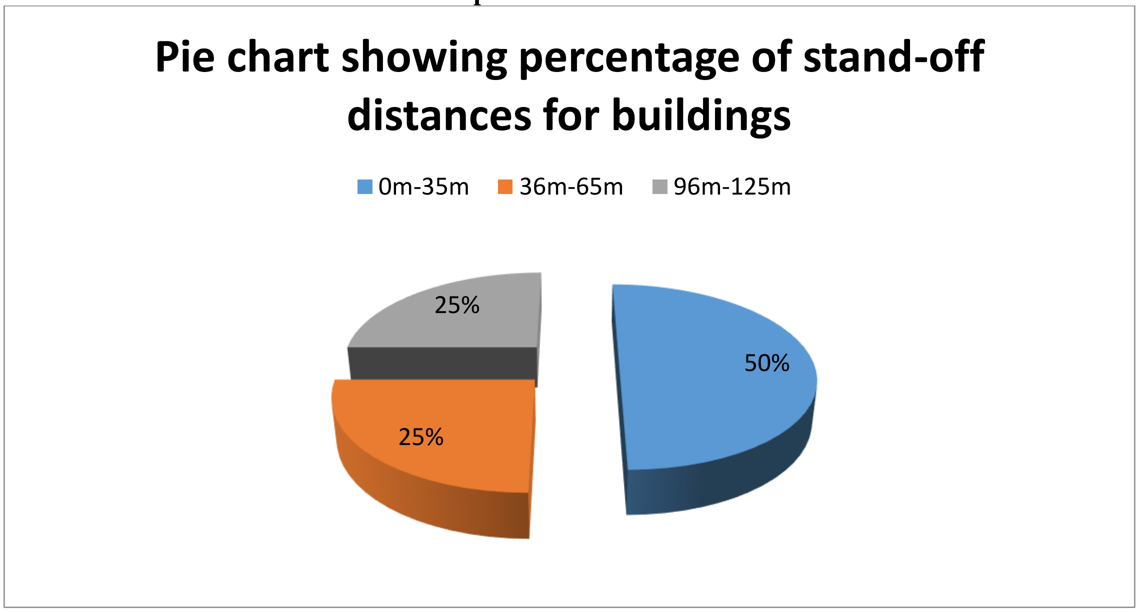
The effect of a blast or impact decreases as distance from it increases. Establishing a separating distance, called stand-off, between a building and possible explosive detonation location is the most effective mitigation measure against explosive attacks (FEMA, 2003b, (LaTourrette, Howell, Mosher, and MacDonald, 2006). This stand-off distance, also referred to as setback zone, is accomplished by setting at the perimeter anti-ram bollards, expansive grower, low level walls, water bodies and different barriers that cannot be compromised by hostile vehicles. However, in urban areas there is much constraint regarding setbacks (PCI Designers Notebook, 2015).

Table 1.0: Distribution of commercial complexes based on stand-off distances

S/N	**Samples**	**0m–35m**	**36m-65m**	**66m-95m**	**96m-125m**	**126m-165m**	**Over 156m**
1	Ceddi Plaza	O					
2	Silverbird Entertainment	O					
3	Next Cash & Carry				O		
4	Shoprite				O		
5	Banex Plaza	O					
6	Sheriff Plaza	O					
7	Asokoro Shopping Mall				O		
8	Metro Plaza		O				
9	2XL Mall				O		
10	Grand Square		O				
11	Pathfield Mall	O					
12	Dunes Centre		O				
13	Omega Centre		O				
14	Area 11 Mall	O					
15	Danziyal Shopping Mall				O		
16	Bassan Plaza	O					
17	Sahad Stores	O					
18	Jinifa Shopping Complex	O					
19	Exclusive Stores	O					
20	Maitama Shopping Mall		O				
	Total	**10**	**5**		**5**		

Source: Author's Fieldwork (2015)

Chat 1.0: Distribution of commercial complexes based on stand-off distances



Source: Author's Fieldwork (2015)

Vehicle Bomb Explosion Hazard and Evacuation Table

Figure 2: ATF Vehicle Bomb Explosion Hazard and Evacuation Table

ATF	VEHICLE DESCRIPTION	MAXIMUM EXPLOSIVES CAPACITY	LETHAL AIR BLAST RANGE	MINIMUM EVACUATION DISTANCE	FALLING GLASS HAZARD
	COMPACT SEDAN	500 Pounds 227 Kilos *(In Trunk)*	100 Feet 30 Meters	1,500 Feet 457 Meters	1,250 Feet 381 Meters
	FULL SIZE SEDAN	1,000 Pounds 455 Kilos *(In Trunk)*	125 Feet 38 Meters	1,750 Feet 534 Meters	1,750 Feet 534 Meters
	PASSENGER VAN OR CARGO VAN	4,000 Pounds 1,818 Kilos	200 Feet 61 Meters	2,750 Feet 838 Meters	2,750 Feet 838 Meters
	SMALL BOX VAN *(14 FT BOX)*	10,000 Pounds 4,545 Kilos	300 Feet 91 Meters	3,750 Feet 1,143 Meters	3,750 Feet 1,143 Meters
	BOX VAN OR WATER/FUEL TRUCK	30,000 Pounds 13,636 Kilos	450 Feet 137 Meters	6,500 Feet 1,982 Meters	6,500 Feet 1,982 Meters
	SEMI-TRAILER	60,000 Pounds 27,273 Kilos	600 Feet 183 Meters	7,000 Feet 2,134 Meters	7,000 Feet 2,134 Meters

Source: Development of a Landscape Vulnerability Assessment Model in a Heightened Security Environment (www. *scholar.lib.vt.edu/theses/available/etd-05092003-220909/unrestricted/thesisfinal.pdf)*

The table in fig.2 provides the stand-off distances required for different explosive risk types or charge weights. From table.1 the farthest stand-off distance is between 96m-125m which represents 25% of the analyzed complexes, that means 75% of the stand-off distances is less than 66m. Impliedly, a water/fuel truck and/or semi-trailer delivering their respective charge weights of explosives can cause blast waves capable of inflicting great damages and lethal injuries to both the structures and their occupants respectively. Such buildings will require hardening measures to make them withstand blast events with minimum damages.

2. Wall Types:

The wall types in the checklist for observation and analysis for conformity with explosion protection include: unreinforced masonry, reinforced masonry, reinforced concrete wall and others. From the findings in table 2:0 all the analyzed complexes were constructed with reinforced concrete structural frames but the external wall are all made of unreinforced masonry. Un-reinforced masonry walls (URM) have a low resistance against blast load impact because of their low flexural capacity and their brittle nature of failure. In this way, failure of URM walls was recognized as one of the significant reasons for material damage and loss of human lives (El-Domiaty, Myers & Belarbi, 2002).

Table 2.0: Distribution of commercial complexes based on wall types

S/N	**Samples**	**Unreinforced Masonry**	**Reinforced Masonry**	**Reinforced Concrete**	**Others**
1	Ceddi Plaza	O			
2	Silverbird Entertainment	O			
3	Next Cash & Carry	O			
4	Shoprite	O			
5	Banex Plaza	O			
6	Sheriff Plaza	O			
7	Asokoro Shopping Mall	O			
8	Metro Plaza	O			
9	2XL Mall	O			
10	Grand Square	O			
11	Pathfield Mall	O			
12	Dunes Centre	O			
13	Omega Centre	O			
14	Area 11 Mall	O			
15	Danziyal Shopping Mall	O			
16	Bassan Plaza	O			
17	Sahad Stores	O			
18	Jinifa Shopping Complex	O			
19	Exclusive Stores	O			
20	Maitama Shopping Mall	O			
	Total	20			

Source: Author's Fieldwork (2015)

Existing unreinforced URM walls may be retrofitted with a coating of polymer spray-on to enhance their blast wave resistance. This creative retrofit method exploits the toughness and resiliency of cutting edge polymer materials to adequately deform and dissipate the blast energy while holding in place the fragmented wall particles. In spite of the fact that the sprayed walls might break in a blast occasion, the elastomer material stays in place and contains the debris. The retrofit for URM to mitigate blasts comprises of an interior and exterior (optional) layer of polyurea applied to external walls and ceilings. The polyurea gives a bendable and strong membrane that catches and holds secondary fragments from the wall as it breaks and gets separated due to the impact of the air blast wave (Watch & Tolat, 2011).

3. Building Configuration:

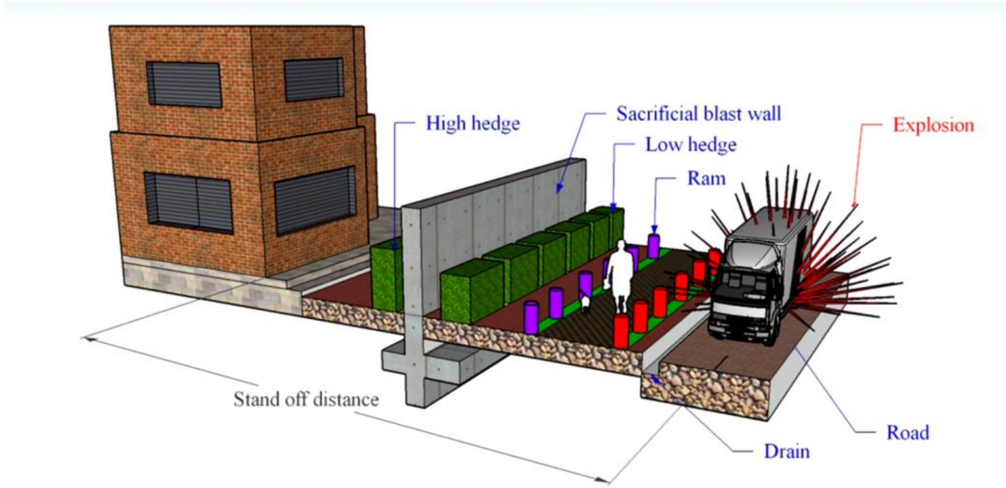
This comprises the different geometrical shapes of the buildings analyzed for conformity with the shapes suitable for explosion protection. They include - Circular, L-Shaped, U-Shaped, Rectangular and Others.

Table 3.0: Distribution of commercial complexes based on building configuration

S/N	**Samples**	**Circular**	**L-shaped**	**U-shaped**	**Rectangular**	**Others**
1	Ceddi Plaza				O	
2	Silverbird Entertainment				O	
3	Next Cash & Carry				O	
4	Shoprite					O
5	Banex Plaza			O		
6	Sheriff Plaza		O			
7	Asokoro Shopping Mall				O	
8	Metro Plaza				O	
9	2XL Mall				O	
10	Grand Square				O	
11	Pathfield Mall				O	
12	Dunes Centre					O
13	Omega Centre			O		
14	Area 11 Mall		O			
15	Danziyal Shopping Mall				O	
16	Bassan Plaza				O	
17	Sahad Stores				O	
18	Jinifa Shopping Complex				O	
19	Exclusive Stores				O	
20	Maitama Shopping Mall				O	
	Total	0	2	2	14	2

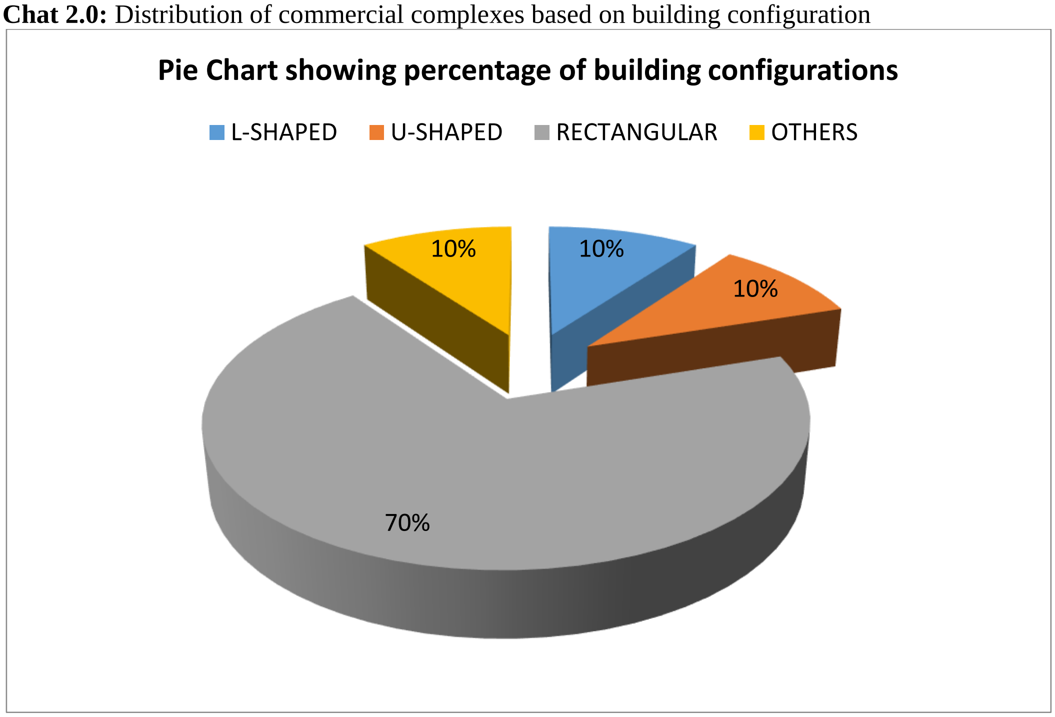
Source: Author's Fieldwork (2015)

Fig.3. Different measures to enhance the protection of building against blast loading



Source: Blast-Resistant Design of Structures
http://www.researchgate.net/publication/262374833

Chat 2.0: Distribution of commercial complexes based on building configuration



Source: Author's Fieldwork (2015)

The configuration of the building can influence the general damage to the structure. For instance, "U"- or "L-shaped" structures might trap the shock wave, which may increase blast pressure locally on account of the resultant complex reflections. Expansive or gradual re-entrant corners have less impact than small or sharp re-entrant corners. By and large, convex as opposed to concave shapes are favored for the building exterior. In a comparative sense, the reflected pressure on a circular building's surface is less intense than that on a flat building (PCI Designers Notebook, 2015). This is based on the fact that the shock front incidence angle on an arched or convex surface increases more quickly from blast than on a planer surface, bringing about decay of reflected pressure all the more quickly for a building with a convex shape (Gebbeken and Doge, 2010). Gebbeken and Doge, further discovered that the blast loading L-shaped structures can be greatly reduced by smoothing out the re-entrant corners in such shapes. From table 1.0 none of buildings analyzed is of circular or convex shape. 70% are rectangular shaped, 10% L-shaped, 10% U-shaped and 10% for others. And they all have sharp edges capable of magnifying the blast wave.

4. Roofing Systems:

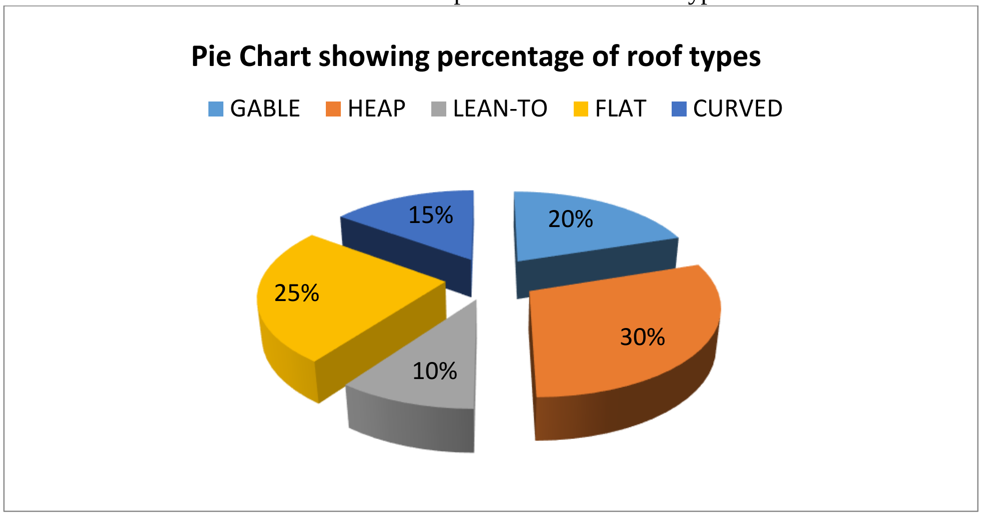
This comprises the different roofing types on the buildings analyzed for conformity with the shapes suitable for explosion protection. They include - Gable, Hip, Lean-To, Flat, Curved and Others.

Table 4.0: Distribution of commercial complexes based on roofing systems

S/N	Samples	Gable	Hip	Lean-to	Flat	Curved
1	Ceddi Plaza				O	
2	Silverbird Entertainment					O
3	Next Cash & Carry	O				
4	Shoprite			O		
5	Banex Plaza		O			
6	Sheriff Plaza		O			
7	Asokoro Shopping Mall				O	
8	Metro Plaza	O				
9	2XL Mall				O	
10	Grand Square					O
11	Pathfield Mall	O				
12	Dunes Centre			O		
13	Omega Centre		O			
14	Area 11 Mall		O			
15	Danziyal Shopping Mall				O	
16	Bassan Plaza	O				
17	Sahad Stores				O	
18	Jinifa Shopping Complex					O
19	Exclusive Stores		O			
20	Maitama Shopping Mall		O			
	Total	**4**	**6**	**2**	**5**	**3**

Source: Author's Fieldwork (2015)

Chat 3.0: Distribution of commercial complexes based on roof types



Source: Author's Fieldwork (2015)

The result from table 3.0 shows the roof types for the analyzed complexes.

In a research conducted by Rahim, Bitarafan &, Arefi (2013) using finite element models to test the compatibility of five different roof types – flat roof, gable roof, conical roof, dome roof and pyramidal roof - the flat roof was discovered to be from those exceptionally compatible with explosion protection designs because less surface is exposed to explosion waves compared to the rest. The other roof types fall under roofs that are inconsistent with explosion protection designs. From table 2.0, only 25% of the buildings have flat roofs, which is the most consistent with protection design strategies.

5. **Glazing Types:**

This comprises the different glass types on the buildings analyzed for conformity with the requirements suitable for explosion protection. They include – Annealed Glass, Tempered Glass, Laminated Glass, and Others.

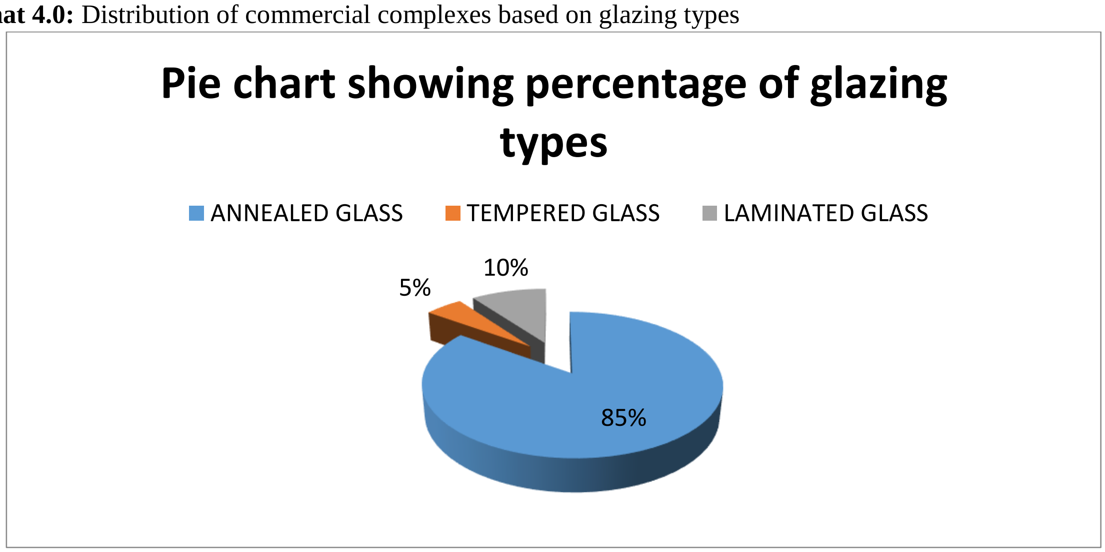
The frequent use of large expanses of glass in the design of buildings for aesthetic reasons has heightened the risk to life from flying and penetrating pieces of shattered glass; making it a cause for greater concern. By nature, glass is very delicate. It is that way since we need to see through it. Being delicate, glass and glazing products are absolutely not able to resist being split, broken, smashed and/or penetrated, contingent on its compositional make-up. Airborne glass pieces propelled in the event of failure of windows and entryways subjected to blast impacts are recognized as major cause of injuries and death (Stiles, 2010).

Table 5.0: Distribution of commercial complexes based on glazing types

S/N	Samples	Annealed glass	Tempered glass	Laminated glass	Others
1	Ceddi Plaza			O	
2	Silverbird Entertainment			O	
3	Next Cash & Carry	O			
4	Shoprite		O		
5	Banex Plaza	O			
6	Sheriff Plaza	O			
7	Asokoro Shopping Mall	O			
8	Metro Plaza	O			
9	2XL Mall	O			
10	Grand Square	O			
11	Pathfield Mall	O			
12	Dunes Centre	O			
13	Omega Centre	O			
14	Area 11 Mall	O			
15	Danziyal Shopping Mall	O			
16	Bassan Plaza	O			
17	Sahad Stores	O			
18	Jinifa Shopping Complex	O			
19	Exclusive Stores	O			
20	Maitama Shopping Mall	O			
	Total	**17**	**1**	**2**	

Source: Author's Fieldwork (2015)

Chat 4.0: Distribution of commercial complexes based on glazing types



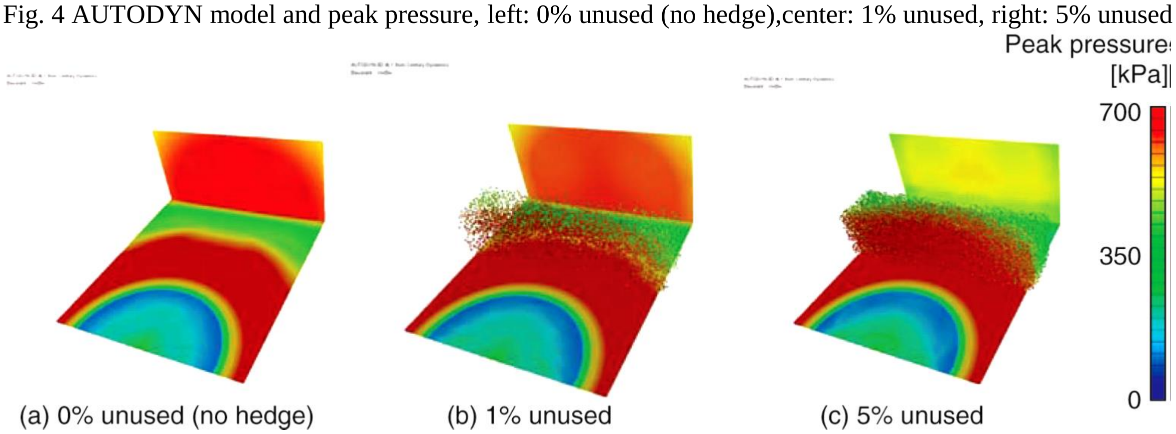
Source: Author's Fieldwork (2015)

It can be observed from table 3:0 that the largest percentage of glass type in use in annealed glass, 85%. Annealed is the most incompatible glazing material in security design because of the great risk it poses to humans; it breaks into large shards with jagged edges capable of serious injuries or death. Tempered glass, with 5% usage, is four times stronger than annealed but equally breaks, though, into smaller pieces. Laminated glass, comprising 10% usage in the table, under the impact of blast wave breaks but is held in place by the polyvinyl butyral (PVB) interlayers preventing it from inflicting lacerations on occupants in the event of a blast (FEMA, 2003a). If annealed glass or tempered glass must be used, then they should be laminated or protected with blast curtains to prevent glass projectiles from harming people during explosions,

6. The Use of Plants:

The use of hedges was largely absent in the complexes visited during the research exercise. In 2010 Nobert Gebbeken and Torsten Doge carried out an investigation on the use of hedges (plants) to reduce blast loads on buildings. The hedge was modeled in AUTODYN where three(3) different models were studied by altering the densities of plants. Model (a) had no plants at all, model (b) had 1% plants, while model (c) had 5% of plants. There was reduction of peak reflected pressures in the models with hedges compared with the model without hedges. Gebbeken and Doge emphasized on the need for further research on this area but the outcome of their investigation can be applied alongside other security measures to mitigate blast effects on buildings and their occupants. Below is the diagram illustrating the models used in their investigation of the use of hedges in fig.4.

Fig. 4 AUTODYN model and peak pressure, left: 0% unused (no hedge),center: 1% unused, right: 5% unused



Source: Author's Fieldwork (2015)

CONCLUSION

In conclusion, the study has shown that majority of the commercial complexes in Abuja are grossly not in conformity with explosion protection design, construction and use of materials, making their defense levels very poor. This non-conformity, yet again, makes the buildings vulnerable to explosive attacks and their construction materials as projectiles constitute great hazard to both the occupants, passersby and those even further away. Therefore, the commercial complexes need to be retrofitted to withstand such attacks to ensure their survivability as well as the safety of their occupants. It is hereby recommended that security strategies be included in the designs of new buildings expected to accommodate large convergence of people as this attracts the attention of terrorists seeking for maximum casualties.

REFERENCES:

Barna J. (2014) Insecurity In Context; The Rise of Boko Haram in Nigeria. Retrieved from www.europarl.europa.eu/RegData/etudes/note/join/2014/536393/EXPO-AFET_NT *(2014)536393*

Centre For The Protection of National Infrastructure, & National Counter-Terrorism Office(2012). Protecting Crowded Places: Design & Technical Issues. Retrieved from www.gov.uk/government/uploads/.../design-tech-issues.pdf

Gebbeken N & Doge T. (2010). Explosion Protection: Architectural Design, Urban Planning and Landscape Planning. Retrieved from http://multi-science.atypon.com/doi/pdf/10.1260/2041-4196.1.1.1 *p. 11*

EL-Domiaty, K.A., Myers, J.J., & Belarbi, A.(2002). Blast Un-reinforced Masonry Walls Retrofitted with Fibre Reinforced Polymers. Retrieved from http: //www.masonrysociety.org/journalfiles/10039.pdf

Engineering Security: Protective Design for High Risk Buildings. Retrieved from http://nyc.gov./html/nypd/.../pdf/.../nypd_engineeringsecurity-full_res.pdf

FEMA (2003a), FEMA 426: Reference Manual to Mitigate Potential Terrorist Attacks Against Buildings, Federal Emergency Management Agency, Washington, DC, December.

FEMA (2003b), FEMA 427: Primer for Design of Commercial Buildings to Mitigate Terrorist Attacks, Federal Emergency Management Agency, Washington, DC, December. Retrieved from

Global Terrorism Index Report(2015). Measuring and Understanding the Impact of Terrorism. Retrieved from www.visionofhumanity.org/.../Global%20Terrorism%20Index20%Report

Hadden, D. & Lee, A.(2005). The Role of External Façade in Protecting Building Occupants against Terrorism & Impacts. Retrieved from www.psdas.gov.uk/.../Day%201%20-%20lr.Dr.%20Andy%20Lee%20-%

Human Rights Watch (2012) Spiraling Violence**:** Boko Haram Attacks and Security Force Abuses in Nigeria. Retrieved from http/www.refworld.org/docid/5085309e2.html p. 40

LaTourrette, T., Howell, D.R., Mosher, D.E., & MacDonald, J.(2006). Retrieved from www.rand.org/content/dam/rand/pub/technical/reports/2006/RAND_TR401.pdf

Lavy F. & Dixit M.K (2010). Literature Review On Design Terror Mitigation For Facility Managers In Public Access Buildings. Retrieved from www.emeraldinsight.com/0263-2772.htm

Mail Online: Thisday Office Bomb Blast. Retrieved from www.dailymail.co.uk/news/article-*2669538/Explosion-rocks-mall-Nigerian-capital.html*

Oyebode A. (2012)**.** Legal Responses To The Boko Haram Challenge: An Assessment of Nigeria's Terrorism (Prevention) Act, 2011. Retrieved from www. *forumonpublicpolicy.com/vol2012.no1/archive/oyebode.pdf*

Steven M.H (2007). The "Explosion" in Blast Resistant Construction. Retrieved from www.masonryconstruction.com/air-entrainment/the--explosion--in-blast-resistant-construction.aspx

Stiles Custom Metal Inc. 2010. Security Glass and Glazing Guide. Retrieved from www.stilesdoors.com/techdata/pdf/Security%20Glass%20and%20Glazing%20Guide%200710.pdf

US Homeland Security (2004). Characteristics & Common Vulnerabilities Infrastructure Category: Shopping Malls. Retrieved from http://info.publicintelligence.net/DHS-Hotel-CV.pdf

Pci Designers Notebook: Blast Considerations Retrieved From www.clarkpacific.com/content/documents/PCI_Designer_Notebook_-_Blast_Considerations.pdf p.4 8/16/2015

Rahim A.K.P, Bitarafan M. and Arefi S.L. (2013). Evaluation of Types of Shapes of Building Roof against Explosion. Retrieved from *http://www.ijetch.org/papers/498-A3243.pdf*

Sakula J. (2004). The Design of Building Façade For Blast Resistance. Retrieved from www.bath.ac.uk/cwct/cladding_org/icbest97/paper12.pdf p.4

The Christian Science Monitor: Separate Bomb Blasts Rock Nigeria's Newspapers, Retrieved from www.csmonitor.com/World/Africa/2012/0426/Separate-bomb-blasts-rock-Nigeria-s-newspapers-at Retrieved on 10/03/2016

Watch D. and Tolat D. (2011). Retrofitting Existing Buildings to Resist Explosive Threats. Retrieved from *https://www.wbdg.org/resources/retro_rstexplo.php*

THE SOCIO-CULTURAL EFFECT OF CHANGING FROM TRADITIONAL TO MODERN ARCHITECTURE IN NIGERIA, 1915- 2015

EZE, Chukwudum J. & ZUBAIRU, S. N.

Department of Architecture, Federal University of Technology, Minna, Niger State, Nigeria.

Traditional ways of building houses have been the order of the day since 1915 - 1950 in the history of Nigerian architecture. Through this period of traditional housing provision, Nigerians with the use of locally sourced building materials have devised a traditional method of self-help whereby people came together with the spirit of mutual co-operation and communal participation to help others to acquire houses of their own at affordable prices or little cost. Modern architecture appeared in Nigeria from 1950 to date as a result of European influence that geared the interest of many Nigerians to copy such style of architecture. This modern style brought rapid increase of urban and rural development but also has its numerous effects in Nigerian architecture such as: fading away of housing identity, loss of traditional architecture, unaffordable housing for the poor, loss of socio-cultural environment and environmental degradation. This paper x-rays the socio-cultural effects of changing from the traditional to modern buildings and proffers ways of encouraging traditional architecture. It suggests that Architects in Nigeria should design houses taking into cognisance the culture and lifestyle of the people through the use of traditional materials.

Key words: affordable, architecture, hybrid, modern, traditional.

ezechucks@yahoo.com

Eze, Chukwudum J. & Zubairu, S. N. (2016). **THE SOCIO-CULTURAL EFFECT OF CHANGING FROM TRADITIONAL TO MODERN ARCHITECTURE IN NIGERIA, 1915-2015** Sustainable Built Environment and Climate change; The challenges of Post 2015 Development Agenda. School of Environmental Technology Conference, SETIC, 2016

INTRODUCTION

Globally, modern architecture in housing provision has journeyed so far into the twenty-first century with its clear ideas of standardization, simplicity, use of invented materials and repetitiveness. This greatly influenced the character of most cities of Europe and America by the beginning of the Second World War. The expression was found in the abstract qualities of materials, design motives, and expressive power of design (Qurix, 2007). The features of modern architecture had become established from America to Japan and from Russia to Italy with a common background which sought to give meaning to the mechanical process of using steel, concrete, asbestos and aluminium.

Modern Architecture was later extended to other parts of the world including Africa as international style which concerns itself with abstract qualities of materials. At a point in time in the seventies, there was a re-examination of the achievements of modern architecture by many architects and the result of their works roughly influenced the framing of the phrase "post-modernism" (Qurix, 2007). In Nigeria, there is evidence that some buildings, mostly offices were already constructed with the features of modern architecture in the sixties. Some of these buildings include: Post Office Building, Marina-Lagos; Cocoa House, Ibadan; Ahmed Talib Building, Kaduna.

In the traditional architecture, the idea of housing came as an objective of fulfilling one of the important needs of a man which are principally to provide shelter, security and comfort. In the actual planning of these homes, the planning and construction takes a pattern or forms which varies from society to society. Moreover, these forms of housing chosen or built offer a direct insight of various cultures and societies of the people. Olotuah and Ajenifujah (2009) attested that housing, a subset of traditional architecture, evolves from the culture of the community in accordance with the lifestyle of its people, the materials of construction available, and technical possibilities open to them. For instance, Nigeria nation is a heterogeneous society consisting of ethno-geographical regions like the north, middle belt (north central), east, west and south. Each of these regions has its own peculiar housing form. Consequently, the housing and spatial form in Nigerian traditional architecture changes from one period to another as a result of civilization, cultural infiltration and technological advancement (Rikko & Gwatau 2011). Nevertheless, the result of these changes has some socio-cultural effect to the people of Nigeria.

During the early times, primitive man after securing daily food had to seek for the provision of a reasonable shelter for protection against the impulse of his environment. The traditional builders (house owners) made use of their available local building materials and self-help effort to provide sustainable and affordable houses for their habitation with ease (Uji & Okonkwo 2007). No one expected any payment because it was predicated on the spirit of mutual cooperation and communal participation. Thus compensation sometimes was in form of meals. This system works well in rural areas and may be small cities that grew slowly, or in old villages incorporated into the urban area. The Igbo traditional houses in the South-East, Yoruba houses in the South-West, the Hausa houses in the North-east, North-central and the Tiv, Nupe, Gwari, Jukun and Idoma houses in the Middle Belt of Nigeria are not exempted. The traditional housing in Nigeria since 1915 has no problem of land acquisition; there were also available building materials and unskilled labour; this made building at the time more affordable.

Generally, Nigerian housing at the traditional period from 1915 to 1950 were made of huts with high pitched thatch roofs on circular, oval, square or rectangular plan. This was later improved to metal roofing sheets, building extensions such as walls and posts, and panels such as doors, were considered as architectural elements. The basic fact is that the structure, facade and placement of buildings can tell much about the social status of their owners, as well as the balance of power in the society that produces them (Nsude 1987).

The vision of affordable housing for all is yet unattainable especially to the poor individuals in the community. Nigeria traditional housing has been devised as a means of solving housing problem earlier before the modern style came on board. The traditional architecture of Nigeria is gradually being lost to contemporary architecture owing to new technology in building construction and influence of European style. Despite all the advantages of traditional architecture which include conducive environment, cheap materials and labour, feeling of nature and conforming to cultural life style, many architects have decided to copy European architecture thereby losing some of the elements of Nigerian traditional housing.

This research is geared towards identifying the effects of changing from traditional to modern architecture in Nigeria. It suggests that architects in Nigeria through amalgamation of traditional and modern building materials during design and construction stage should not allow the Nigeria culture to be eroded.

The aim of this study is to evaluate the socio-cultural effects of changing from traditional to modern housing in order to retain the Nigerian traditional housing identity.

Nigerian Traditional House-Forms

Traditional house forms are the integral part of the traditional architecture among the various ethnic groups in Nigeria. These houses are constructed within the context of communities, in conformity with their available materials, biological and spiritual needs and the lifestyles of the people. According to Olotuah (2002b); and Olotuah (2005), houses made of earthen walls and roofs are found dominantly in villages and small towns, while only few may be found in the cities.

There are three basic forms of Nigerian traditional architecture in earth construction. These house forms and their construction techniques are dependent on the regions in Nigeria and are influenced by people's culture, religion, climate, urbanization and recently professionalism (Rikko and Gwatau, 2011). The three basic forms of traditional earth construction that are used in Nigeria include: Mud obtained by swish-pudding, sun-dried mud bricks and fired or baked clay bricks. These basic forms of traditional earth construction techniques will be discussed under these sub-headings: Southern, Northern and Middle Belt regions of Nigeria. The map of Nigeria in Figure

2.1 shows the geopolitical zones or regions.

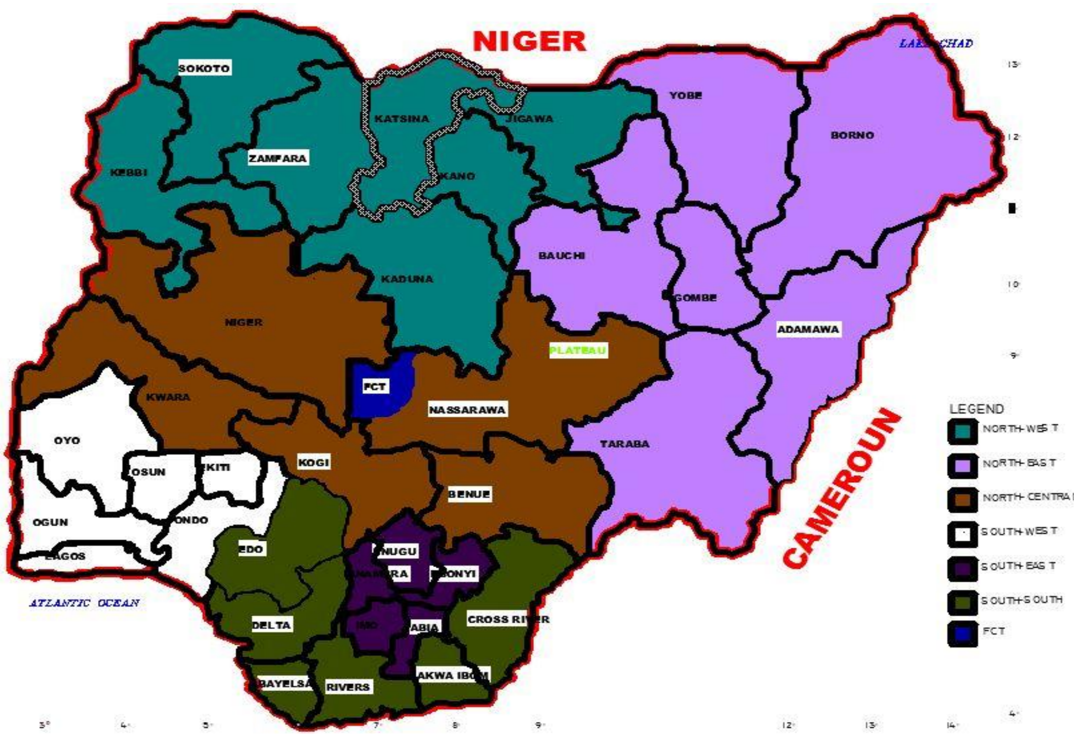


Figure 2.1: Nigeria showing the geopolitical zones or regions and FCT, Source: http://csrwestafrica.com

Traditional House-Forms in Southern Nigeria

In the Southern states where argillaceous clay that is very grainy is most common, mud obtained by swish-pudding is mainly used in building construction. The southern states of Nigeria comprises of the south-west and south-east.

(a) South-West Traditional House-Forms

In the south-west Nigeria, there are two house forms indigenous to the Yoruba's culture. The first form of houses is built around one or more courtyards, more often as four rectangular units facing one another. Other characteristics of south-west Nigerian houses include a single main entrance with rooms opening into a wide veranda which run round a courtyard.

The second type of house form of the Yoruba people is much smaller than the first which is based on simply arrangement of rooms on two rows facing a common hall. This hall serves several domestic purposes and is usually wide enough to accommodate people. There are also out-houses usually built at the back to serve as toilets and kitchens. In comparison, these types of structures are more airy which allow cross ventilation in and out of the rooms; unlike modern houses that has little or no courtyard. More so, the socio-cultural effect of not being together is much felt in modern buildings where each compound is fenced unlike in the traditional buildings. For instance, Olotuah and Ajenifujah (2009) attested that the house forms of the Edo tribes (Bini, Ishan/Esan, Etsako, Iteshekiri) and Urhobo of south-south Nigeria are very similar to those of the Yoruba. This is illustrated in Figures 2.2

The figure 2.2 shows a typical plan of Yoruba Traditional Compound Layout in Western Nigeria with single Courtyard. Rooms (private areas) were arranged round the courtyard (semi-private area), while the veranda form the semi-public area.

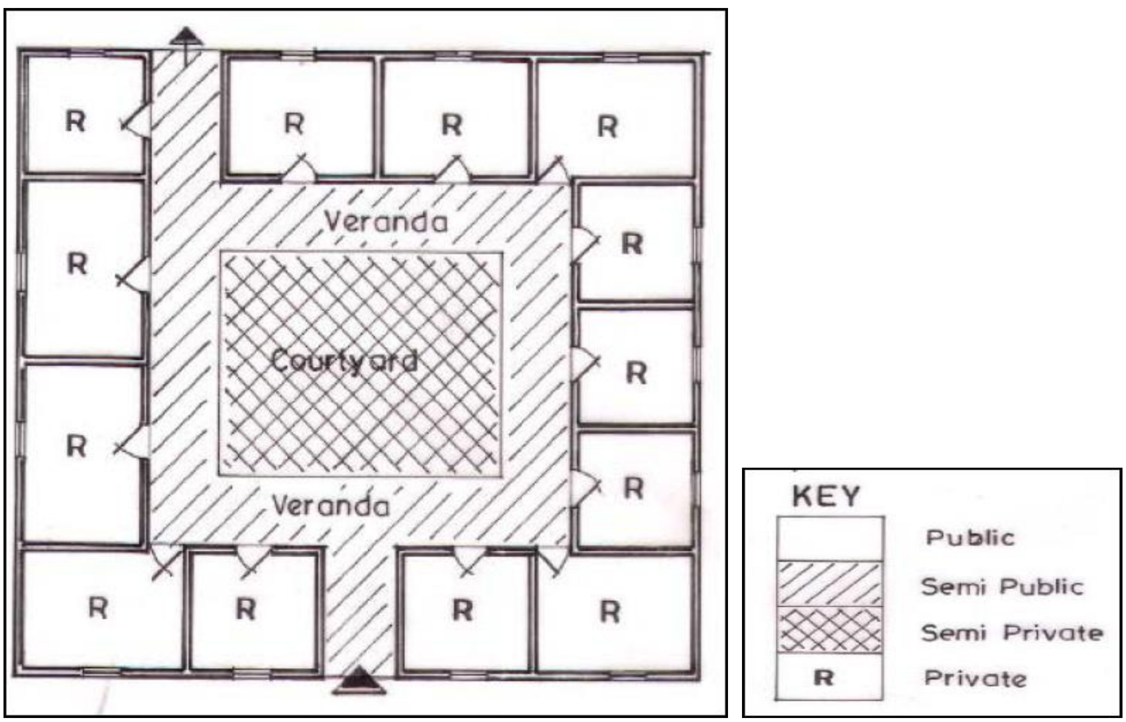


Figure 2.2: A Typical Yoruba Traditional Compound Layout in Western Nigeria with single Courtyard. Source: (Osasona n.d)

(b) South-East Traditional House-Forms

In the south-east Nigeria, the houses of the Igbo are grouped together within a walled compound. The compound usually has a single entrance with a covered porch/veranda. Sometimes defensive device are strongly built on the fence or compound walls. Dmochowski (1990) observed that two or three storey semi-defensive buildings called *Obuna Enu* were also available in some compound.

Other characteristics of Igbo compound include the following: Buildings within the compounds do not have courtyards inside them but rather they are built facing one another thereby creating a common courtyard. There is provision of meeting and shrines houses. The traditional Igbo buildings are usually one or two roomed houses. Normally, the men's section is separated from the women, while the children section is grouped together. The materials used in construction in Igbo land are mud, hardwood timber, palm leaves and midribs, bush twines and pawpaw trunks for constructing a drain for the local tank called impluvium (Rikko and Gwatau, 2011).

Plate I: Traditional Building in Anambra State, Showing Thatch-roof on Load-bearing wall system. **Source:** Tropenmuseum (1967).

Plate II: Traditional Buildings in the South-East, Nigeria showing Wall Decoration and Carved Doors. **Source:** Dmochowski, 1990.

The Northern Traditional House-Forms

A round hut with thatch roof or flat tops is the commonest type of house form of the Hausa, Fulani and Kanuri. Their house form called homestead are built as compounds, which are usually divided in two areas: the inner women restricted area and the outer males' visitor reception area. The division of spaces is as a result of Islamic religious belief that the two sexes should be separated. In Hausa traditional architecture, the outer areas have the reception rooms which serve as elements of security. This boiled down to Rikko and Gwatau (2011) assertion that the housing form has been influenced by climatic, religions and socio-cultural factors of the environment.

The North-Central (Middle Belt) Traditional House-Forms

The Middle belt architecture comprises of Tiv, Nupe, Gwari, Jukun, the taroks, Beroms and Idoma house forms which is usually of circular plan. The middle belt –housing plan generally assumes a concentric pattern and the outer ring forms the base for the load bearing timber columns while the inner circle is for the wall. The structure is a free standing with equal or greater diameter of the buildings than its height.

Other building characteristics include: that Verandahs have common features with the buildings, which often running round the entire building (Olotuah and Ajenifujah, 2009). Walls are constructed with mud and hipped roof with thatch. The north central buildings has cluster of buildings arrangement around a compound.

Plate III: A typical Gbagyi (Gwari) Traditional Building (Middle Belt, Nigeria).

Source: Tripdownmemory (2013)

Overview of the origin of Contemporary Housing in the World

Contemporary housing could be simply described as Modern housing that is in conformity with the modern way of life. At this period of housing, many architects with strands of ideas wanted to break away from the past architecture through the introduction of foreign architecture. A clear grasp of the term was realized after the League of Nations Competition in 1927.The leading architects (Walter Gropius in Bauhaus, Mies Van de Rohe and Le Corbusier) from their strands of ideas of what was to be done, declared that the architecture of the Bauhaus had enough of the arbitrary imitation of historic styles in a continuous development away from architectural whim and slander, and toward the dictates of a constructive logic, learnt in expressing the life of the people in more easy forms (Qurix, 2007).

The League of Nations Competition provided a new dialectic forum on the future of architecture. Its consequences also created an interesting shocking revelation whereby different architects were moulded in experiments that led to a conscious break from the past and with mutually commensurable methods, even if with different points of departure. During the League of Nations Competition, some new methods of design which include low-income housing, recreation and aesthetics among others were discovered and discussed. Finally, the congresses ultimately formed 5 major principles on which the new architecture should be based. The principles are standardization or repetitiveness, space appropriation, simplicity, use of materials and economy.

Precisely, from 1928 – 1960's, these principles literally acted as a "Catechism of Modernism" that created admiration in the minds of architects that embraced them in whose hands the caprice of the style radiated like the crystal symbols of a new faith. Modern architecture proved to have matured in the sixties and its echoes were felt in many parts of the world including Africa.

Research Methodology

A descriptive research method was employed in this work which includes conduction of oral interviews and through observation in the three geopolitical zones in Nigeria namely South-East, South-West and Northern. The choice of study area is based on the fact that the geopolitical zones in Nigeria are grouped into three major ethnic groups namely: Igbo (South-East), Yoruba (South-West) and Hausa (North).

Method of Data Collection

The research examined the various effects as a result of changing from traditional to modern architecture in Nigeria. This was done through conduction of oral interviews, literature review and observation in order to have firsthand information. Information was collected from the rural and urban cities of the selected three geopolitical zones in Nigeria (namely: South-east, South-west and Northern areas) which had a lot of colonial influences and from the peri urban areas regarding their development and forces that shaped them overtime.

Transformation in Nigerian Traditional Architecture

Traditional housing in Nigeria from its inception has experienced a great change from what it used to be to modern architecture. This is owing to the entrance of European style of architecture and new technology in Nigeria. A case study to the Southern (South-West and South-East), North- West and North- Central (Middle Belt) part of the country show that some construction materials have changed over time e.g. zinc has replaced thatched roof while in some areas, traditional materials like mud, loam and clay walls are now being covered with plaster cement (Nsude, 1987). The plates IV, V, VI, VII and VIII give an insight to the remains of traditional houses in various part of the country, while Plates IX , X and XI are modern houses in some geopolitical zones in Nigeria as a result of European influence on traditional buildings.

Samples of Transformation in Some Existing Traditional Housing in Nigeria

Plate IV: Traditional Residential House at Ihite-oha Orsumoghu, Ihiala L. G. A, Anambra State. **Source:** Researcher Fieldwork (2015).

Plate V: Traditional Residential House at Ezem village Lilu, Ihiala L. G. A., Anambra State, Source: Researcher Fieldwork (2015).

Plate VI: Traditional Residential House at Umuoba-Anam Otuocha in Anambra North L. G. A. of Anambra State; Source: Author's Fieldwork (2015).

Plate VII: Traditional Building at Zaria, Nigeria.
Source: http://www.virtualtourist.com/travel/Africa/Nigeria/Zaria-2157752/TravelGuide-Zaria.html

Plate VIII: A typical Gbagyi (Gwari) Traditional Building at Abuja, Nigeria:

Source: Tripdownmemory (2013)

Plates IV, V, VI, VII, and VIII are some traditional buildings found in some geopolitical areas of Nigeria namely: South-east and North. The traditional building elements such as wall decoration, forms, carved doors and the use of traditional building materials (such as mud wall, wattle and daub that were replaced block wall , thatch roof that suddenly replaced with zinc and aluminium) were highlighted in these buildings while some are undergoing transformation. This transformation finally led to construction of what is now called modern houses. It will be important to note that the socio-cultural aspects of what the inhabitants cherished were as well affected in such areas like environmental conduciveness, cheap materials and labour, feeling of nature and conforming to cultural life style.

Plate IX: A four- Bedroom modern detached duplex at Lagos in the Yoruba land, South-west Nigeria. Source: Author, 2015.

Plate IX is a sample of a four- Bedroom modern detached duplex at Lagos in the Yoruba land as a result of European influence on the traditional building. Modern materials like glass, step tiles aluminium, plaster of Paris (POP), paints, burglary proof, marbles and tiles are used. Other modern buildings found in the South-east Nigeria and North Central Nigeria is shown in plates X and XI respectively.

Plate X: Modern housing of the South-east Nigeria built in the year 2000s.

Source: Author's fieldwork (2015)

Plate XI: 2-Bedroom Semi detached Modern residential House in Minna, Niger State (North Central Nigeria

Source: Author's fieldwork (2015).

Discussion of Findings:

Many factors may be responsible for socio-cultural effect for changing from traditional to modern architecture in Nigeria. The researcher after random sampling of opinions and interviews from the three geopolitical zones in Nigeria namely South-East, South-West and North-Central, came out with the following findings:

(i) **Loss of Traditional Architecture**: The coming of modern housing due to copying of European style of architecture has wiped away many traditional housing in virtually all rural areas of the country. This is because some of traditional building elements such as wall decoration, forms, carved doors and the use of traditional building materials are no longer found in the modern houses. The fear is that if care is not taken the architecture and culture of the people will soon get loss completely.

(ii) **Loss of Community Participation in Housing Delivery**: From 1915 to about 1950, houses were constructed traditionally with the available local building materials through communal effort. The women cleared the bush, swept the floor and fetched water for the construction while the men cut timbers, gathered mud or clay and kneaded them ready for use. The men were responsible for erecting the house to a completion. According to Skinner and Rodell (1983) in Uji (2004) and Uji & Okonkwo (2007), a traditional method of self-help with reference to housing has always been understood to mean housing for the low income families constructed with their own unpaid labour. This made housing available and affordable. The changing from traditional to contemporary housing has automatically done away with such community caring and assisting one another

(iii) **Unaffordable Housing:** The cost implication for the construction of contemporary housing is quite high owing to invented and imported building materials when compared with traditional housing. This makes it unaffordable to people in the rural areas.

(iv) **Loss of Socio-Cultural Environment and Housing Identity:** The traditional housing setting promotes the socio-cultural environment. Due to its openness and conducive environment, moonlight play, tales, and other socio-cultural ways of life are achieved. The culture which is the people’s way of life is an attribute of traditional housing; such attribute help one to identify housing with respect to its environmental origin. Therefore, one of the effects of changing from traditional to contemporary housing is that the cultural and housing identity will definitely get loss. This is more rampart in the south-eastern Nigeria.

(v) **Identification of Traditional and Modern building elements and materials that can be combined:** It was observed that there are some traditional building elements and materials that can be combined to modern housing to enable houses to be easily identifiable, affordable and acceptable to the people. Some of these traditional building elements include: wall decoration, forms, carved doors and use of locally sourced building materials (like mud, bricks, bamboo). A typical wall decoration in the northern Nigeria is illustrated in the Plate XII. This decoration makes houses easily more identifiable in any localities especially in the north.

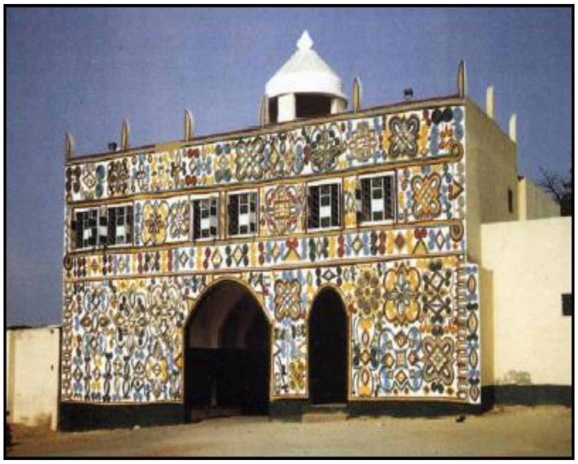


Plate XII Northern Building in Nigeria Showing: "Zanko" and Mural decoration or painting on the facade of the wall. Source: Oluwagbemiga and Modi, (2014)

Recommendations:

Since housing is a subset of traditional architecture that evolves from the culture of the community in accordance with the lifestyle of its people, moving away totally from the culture of the community in building construction may be disastrous. The research therefore recommend as follows:

(i) That housing for a particular set of people in a separate community or region should be in accordance to the culture of the people and their lifestyle or a hybrid of traditional and contemporary housing should be evolved.

(ii) Housing should be made affordable to people by encouraging constructing with their available building materials.

(iii) A good socio-cultural environment should always be maintained, whereby people will continue to relate to one another and not living a separate or isolated life.

(iv) Housing for a particular community should be easily identified through the use of local available building material as well as unique characteristic elements acceptable by such community.

Conclusion:

Since people are identified by their culture likewise their housing should be identified. The copying of European architecture by Nigerians has drastically affected the culture of the people as well as having changed the architecture of Nigeria in such a way that traditional architecture is being lost. A survey of the three geopolitical zones in Nigeria namely South-East, South-West and North-Central shows that the use of thatch roof, mud and clay walls, motif and other decorations are no longer in existence in some regions. In some areas where it appears to be available, it is very meagre, while some of the remains are combination of traditional and contemporary styles. Therefore, Nigerian architecture should not be left to deteriorate as a result of influence by European architectural style, whereby some of the traditional building elements and culture of the people are being eroded. Architects in Nigeria should design houses taking into cognisance the culture and lifestyle of the people. Traditional materials should be used as much as possible in the design of houses.

REFERENCES:

Dmochowski, Z. R. (1990). An Introduction to Nigerian Traditional Architecture: South-Eastern Nigeria- the Igbo- speaking Areas. Vol. 3 Great Britain: Ethnogrphica Ltd.

Nsude, G. C. (1987). The traditional architecture of the Igbo of Nigeria. Ph.D. dissertation, Council for National Academic Awards (United Kingdom), England. Retrieved February 15, 2013, from Dissertations and Theses: A&I database. (Publication No. AAT D-80085).

Olotuah, A. O. & Ajenifujah, A. O. (2009, *April*). Architectural Education and Housing Provision in Nigeria *CEBE Transactions, 6 (1), 86-102. (17)ISSN: 1745-0322 (Online) retrieved on 01/06/2013*

Olotuah, A. O. (2002b). Recourse to Earth for Low-cost Housing in Nigeria. Building and Environment, 37(1), 123-129, retrieved from http://www.elsevier.com/locate/buildenv on 17th July, 2014, 2.45pm.

Olotuah, A. O. (2005). Urban Housing and the Heritage of Earth Architecture in Nigeria. Paper presented to *Conference of International Network for Traditional Building, Architecture, and Urbanism (INTBAU),* 25-27 August, London, UK, and p.16.

Oluwagbemiga, P. A. & Modi, S. Z. (2014). Development of Traditional Architecture in Nigeria: A Case Study of Hausa House Form. *International Journal of African Society Cultures and Traditions*, 1(1), pp.61-74, June 2014 Published by European Centre for Research Training and Development UK .Retrieved online from www.ea-journals.org on 25th January, 2015. 3.00pm.

Rikko, L. S. & Gwatau, D. (2011). The Nigerian Architecture: The trend in Housing Development. In Journal of Geography and Regional Planning 4(5), ISSN 2070-1845. P273-278. Retrieved from http://www.academicjournals.org/JGRP on 17th July, 2014, 2:43pm.

Skinner, R. J. & Rodell M. J. (1983). *People, Poverty and Shelter Problem of Self-Help Housing in the Third World*, London: Methuen and Co. Ltd.

Tripdownmemory, (2013).Traditional Gbagyi Architecture. Retrieved from http://kwekudee-tripdownmemorylane.blogspot.com/2013/11/gbagyi-gwari-people-indegenous-people.html on 7th November, 2014. 2.45pm.

Uji Z.A. (2004). "Squatter Settlement in Nigerian Urban Centres: Do They Really Exist"? *Journal of the Association of Architectural Educators in Nigeria*. 3(2).

Uji Z.A. & Okonkwo, M. M. (2007).*Housing the Urban Poor in Nigeria: Users Involvement in the production Process*. Nigeria: Environmental and Development Policy Centre for Africa (EDPCA). P 1-23

Qurix W.B (2007). *Reflections of Modern Architecture and Post Modernism in Nigeria*. Nigeria: Ahmadu Bello University Press Limited Zaria. P 1-5 http://www.virtualtourist.com/travel/Africa/Nigeria/Zaria-2157752/TravelGuide-Zaria.html, retrieved on 12th January, 2016. 1.15pm.

THEORETICAL EVALUATION OF ART ELEMENTS AND THE RELATIONSHIPS WITH DESIGN ACTIVITIES IN ARCHITECTURE

A.S.ALFA

Department of Architecture, Federal University of Technology, Minna.

Drawing is an essential tool of creativity for architects in the process of documenting imagination, information or ideas in paper for further development. Art elements such as line, shapes, and forms are channels for developing concepts which culminates into an effective presentation of architectural design. It is obvious that the importance of art in design cannot be over emphasized, but the application of these elements of art to achieve a desirable result in design is not well understood by many students of Architecture, most times it is misapplied. The paper is based on literature review as well as 26 years of autoethnographic transactions with students of architecture. It has been observed that students are unable to translate ideas through drawing into design proper. And as such this paper looks into the process of using elements of art as a panacea for solving design problems in architecture. It further goes on to explains how these elements of art can be manipulated by architecture students to produce a pragmatic design

KEY WORDS: Elements of Art, Design Activities, Creativity and Architecture.

alfaray66@yahoo.com

Alfa A.S. (2016). **THEORETICAL EVALUATION OF ART ELEMENTS AND THE RELATIONSHIPS WITH DESIGN ACTIVITIES IN ARCHITECTURE** Sustainable Built Environment and Climate change; The challenges of Post 2015 Development Agenda. School of Environmental Technology Conference, SETIC, 2016

INTRODUCTION

In the realm of design, by contrast, the stage of planning and inventing may take place entirely on the plane of symbol systems, but the actualization of the works involves a dramatic and amazing transformation from the cognitive world to the material world (Krenge, 2015). In the cognitive realm there is no categorical split between the thinking stage and the conversion of ideas into a system of written or pictorial symbols, (Mukerjee & Dabbeeru, 2012). The motive for innovation and creation in art and design is identical (Lindauer, 2011; Spuzic et al., 2016). They are all complementary pairs of ostensibly independent alternatives one has no meaning without the other. They are merely two ends of the same thing two tendencies of the same (Mitrache, 2012). Design is art and art is a representation of figures or forms in other to give an impression or expression. Similarly, Architecture is the art and science of designing and also bringing an idea into reality. However, art elements are important in architecture because it involve the capturing of imaginary idea with varying concept in a design using the graphical elements such as line, shape, form, volume, space, tone, texture, structure, depth, hue, shade, orientation, size, visual inertia, position, perspective and rendering. As such Architecture is viewed as art because it is also involved in aesthetic, nature, symbolism, form and function (Carlson, 2002). Furthermore, architecture also provides opportunity for self-expression which involves the bringing of the inner world into the outer world of concrete reality. Similarly art is a means through which sensuous and concrete expression is given to our ideas and inner feelings, with the focus in creating reality from imagination. It is asserted that the way we perceive or see the world around us, is also how we blend to be part of the whole (Andrews & Gatersleben, 2010; Gibson, 1950)

It therefore means that the understanding of the basic elements of arts are important as means of representing information, data, ideas or feeling externally on paper by giving a vivid description of an object or idea on two dimensional space with three dimensional effect. Art is everything we see, because it is monumental it records every event in history, so it is used to record information, and at the same time exhibit it for its aesthetic or functional purpose. Because sketching which involves the use of elements of art serves as a means for quick recording of information which also serve as an extended memory of visual images in the mind of the architect (Lindauer, 2011; Pérez-Fabello & Campos, 2011). Elements of art give varieties of ways for flexible manipulation of ideas and information to be represented in different forms at different level of development. Drawing produces beautiful objects to look at for visual appeal, appreciation and satisfaction (Augustin, Wagemans, & Carbon, 2012; Dudek, 2011). By extension, architecture is known as visual art (Forty, 2000), simply because it satisfy human needs, both physical, personal and group need. The main needs that visual art satisfy are personal expression and communication (Barnbaum, 2010). And it is obvious that without a proficient skill in drawing which is the main tool of communication in architecture there can be no architecture. Architecture is the art and science of designing and constructing building from macro level of building (Illies & Ray, 2009). Architecture cannot be separated from art; this is because without the skills of art in architecture, it will be difficult to design a building that is aesthetical in appearance and functional in nature. Art as a word and field of study of its own has many parts. For example, drawing elements such as line, shape, form, space, colour and texture, are elements of art which is used in the teaching and practice of architecture. These elements help to create a graphical understanding of design being made by an architect. Without these elements being correctly applied, there will be a poor expression of a design since they constitute the medium of design communication. Moreover, an Architect who has no good background of art will have a poor sense of imagination and will exhibit a high level of rigidity without flexibility. Successful architects need certain characteristics which involve creativity and understanding of elements of art.

PROBLEM OF DESIGN

Architecture students do not seem to be creative enough these days, they prefer to copy existing drawings or others instead of being creative by developing their own individual approach, style and technique of planning and design. This is due to lack of understanding of how to apply the rudiment of art (elements of art), especially in translating ideas into functional design. Moreover it is observed that most of the Architecture students do not understand the tool of expression at the early stage of learning, they only approach design by try and error technique, and as such considerable time is lost

RELATING ARCHITECTURE TO ART

Architecture has to do with the planning, designing and constructing form, space and ambience that reflect functional, technical, social, environmental and aesthetic considerations (Parsaee, Parva, & Karimi, 2014). It requires the creative manipulation and coordination of material technology, light and shadow. Architecture also encompasses the pragmatic aspects of realizing buildings and structures, including scheduling, cost estimating and construction administration. Architecture defines the structure and behaviour of a building or any other kind of system that is to be or has been constructed. Architecture is defined as the Art or Science of Building or that branch of Fine-Arts which has for its object the production of edifices and ideas (Illies & Ray, 2009). Similarly, Architecture also involves activities required for creation and construction of buildings including consultation, analysis and the preparation of graphics that clearly show the intent of the design. This is perhaps why the great masters of design were mostly Artist. The period from 1400 to 1800 BC witnessed the emergence of the Renaissance art and architecture and a new type of designer, the artist architect. The artist such as Leonardo Davinci, Rafael and Michael Angelo had distinguished careers as architects. However, in the period of renaissance, attention was focused on facade treatment through ornamentation and decorative elements, while modernism and post modernism emphasized on forms and symbolism to create magnificent buildings. As such architecture is not an art only but also a science which requires a diversity of knowledge especially the elements of arts. This is because Architects who emphasize only one of these capabilities are not completely equipped and they render imperfect services as architects. Architecture must be a composite work, involving all talents that will aid creative possibilities in design, especially in the knowledge of elements of arts and its application

THE IMPORTANCE OF ELEMENTS OF ARTS IN DESIGN

Drawing is the preferred method of external data representation, in the mind, externally on paper, a computer screen or other media. It is obvious that picture is more vivid in sending message than written description of an object (Berg & Pooley, 2013). Similarly, drawings can group all information together thereby avoiding the wastage of time. Drawings explicitly preserve information about geometry and topology whereas text is only serial in nature. Furthermore drawings are used because they provide an extended memory for visual images in the mind of the architect. Drawing allow for more facile manipulation of ideas. Similarly drawings allow the information to be represented in various forms such as differing views or levels concept. Thus drawings are metaphors for both the real object and the draft object under development. They are also a principal medium of external thinking. They are therefore necessary extension of a designer's cognitive capability for all but the most trivial data representation, constrain propagation, and mental stimulation (Vanwindekens, Stilmant, & Baret, 2013). Drawing serves as an extension of the architect's limited ability to visualize object in their medium. Drawing both utilize and deterring the cognitive units (design features) used in mental image formulation. Thus the architect's cognitive information organization is interdependent with drawing's characteristics during the design process; the design is refined from an abstract concept to a final detailed functional design. The component is refined from drawings that contain primarily functional information to a refined scaled drawing of the final form. Drawing is used to achieve the geometric form of the design. To communicate ideas between architects, builder civil engineer and the quantity surveyor, drawing acts as an extension of the architect's short time memory. Architect often unconsciously make sketches to help them remember ideas that they might otherwise forget (Barlow, Jolley, & Hallam, 2011).

UNDERSTANDING DESIGN PROCESS

Design is the main part of the work of an architect; it involves the process of gathering data or materials information which is known as design brief. The brief determines the content and pattern of the design. It is like a guide that helps to control the plan flow, the design goal, the technique implore and the level of creativity achieved at the end of the design. The architect has to carry out research and take case studies which include site analysis and feasibility or viability study. It also involves taking notes of merits and demerits of the case studies. This amongst other things informs the concept that determines the resolutions of problems identified such that they are not replicated in the new design. The developed brief and the design concept or philosophy are based or determined by the availability of information and the understanding of the Architects (intuition) mind, which should serve as a guide from the beginning of design to it completion. It is important to note that individual thinking affects architectural design in their varied creative formations and as such design process is exhibited in different forms for different client. In view of this, it is believed that design is a personal and creative endeavour which exhibits individual character and approach that helps in modification of different ideas to solving diverse problems with varied conceptions. These varied conceptions are captured by the architect based on the way it is phenomenological experienced (Seamon, 2000). It therefore means that design process is informed by individual experience that is personal looking at solving design problem from different perspective that eventually leads to different approach, style, techniques and at last produce varied out comes. This is what gives room to variety of design plan style and technique which can only be effectively expressed through the use of art elements.

COMMUNICATION THROUGH ART IN DESIGN

The architect's ideas (design) are usually communicated through the use of presentations. It is used as form of records keeping so that ideas conceived in mind are not lost. It is believed that architect conceive the finished product in the mind eye, and visualize the building through the use of working drawing in which every minutes detail are reproduce in reality and specification. This process is known as thinking on paper, because drawing is not just illustration of visual concepts, it is much more than that, it serves as the primary means of discovering and clarifying ideas. Design passes through stages of transitional development and modifications directed by the set goal. It is a procedure of exploring concepts, techniques and imagination that answers the question posed by the design problem through the use of drawing. Drawings in the form of sketches thus become a handy procedure to use. Sketches go beyond realism, it is active and fluid with sense of direction and an intrinsic logic that grows from within, which opens ways for abundant sources of ideas that connote a lot of meaning. Similarly, It coordinate the mind, eyes and hand to roam beyond the sub conscious mind as can be seen in abstract or representational images and symbols discovered or generated. This helps in solidifying the concept of the design after passing through many stages of development guided by the brief of design. Sketches are therefore the compositional drawing that explore the artist's initial creative impulse which is the ingredient for developing new styles, techniques and approaches to design and planning. Spontaneity and originality are the characteristics of a good sketch, and the first step after been given the design brief is to develop the concept which is achieved by using sketching techniques that can vividly communicate information. Since the main goal of using a sketch is to produce a concept to get the germ of the ideas down on paper, concentrating upon the feelings of the images produces guided by the information given helps in the creation of good concept. The concept generated must be able to guide the design from the beginning to the end product, bearing in the mind the aesthetic and functionality of the design. This involves the use of line to draw out the form and the shape of the concept and also use of space which explains the proportion and balance in abstract form help in development of the design. As a requirement of concept development, students communicate with themselves to test design ideas and understand space. Abu-Ghazzeh (1997) stated that teaching design students the means by which space can best be represented and how the general public might respond to this representation is a crucial era of an applied design education and builders as they need to visualize how a space might be realized. For example, before adding new lighting and sound controls, projection systems and other "smart" technologies in a classroom, college administrators need to visualize the aesthetics and functionality of that classroom through drawing completed by designer. For both the design student and practicing professional, design concepts must be developed as an integral part of the work, beginning on graphic representations of space to be presented to the client. Linking design concept development with visual communication has implications for the process by which the designer communicates with self. According to Yee (2012), if drawing and drafting techniques are taught in the context of concept development, then the means of visual communication (drawing tools, techniques and media) addressed in the classroom are effected by their support of the design process. Design student might be taught to begin exploring design concept preliminary sketches using simple drawing tools, and then to utilize more complex manual drafting and computer-aided design techniques as the design process evolves based on the selected concept. In the past, student of interior design typically became involve with the generation of advanced three-dimension drawing in classroom before developing design concepts. This practice brings to light the critical reinforcement of design concept development and visual communication.

As stated by Brown and Wyatt (2015) design is best understood as an outcome of thinking processes. Eggink and Laseau (1982) described the importance of what they referred to as extra-personal communication in conjunction with a freehand sketching approach. This form of communication might also be termed self-conferencing suggesting that in initial stages it is not necessary to have others involved. Experiences in eye-hand interaction that occur in freehand sketching provide support for the interaction thought and visual representation, allowing the student to formulate and test design ideas before presenting them to appropriate recipients. The design student must recognize that self-conferencing is an integral component of design concept development, proceeding from freehand sketching to more specific manual drafting or computer-generated graphic representations as illustrated in Figure 1.

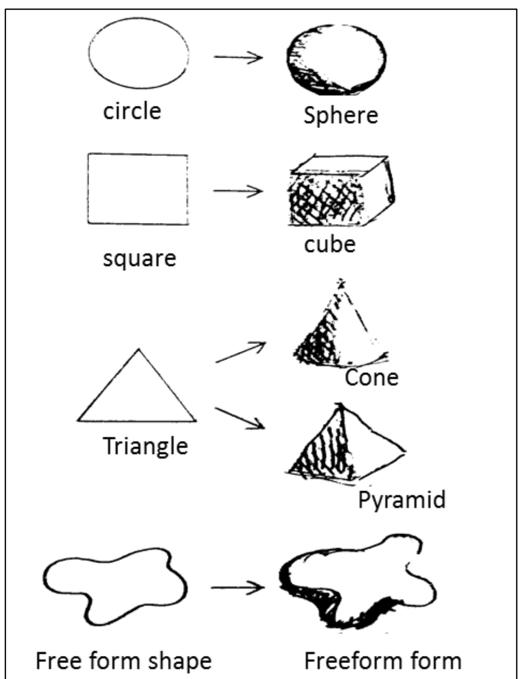


Figure 1: Transformation from basic shapes to 3 dimensional forms

THE USE OF LINES IN DESIGN PROCESS

Line is used to give an idea of the site intended for the design proper; it is rendered in a map form by way of drawing out the shape of the supposed site in its entire outlook and out line.

When we lose the ability to draw, we lose a part of our ability to think (Spuzic et al., 2016). One of the most important objectives of an architect is to develop his own characteristic design process or approach to design, and the main tool for this assignment is use of line. Ragans and Pub (1988) stated that lines are everywhere, because words numbers and symbols are written with the help of line. Similarly, the lines on map help people to find the best route from one place to another". For example, to represent site plan on paper, line is used to convey the message on site in a kind of map that explains the component and characteristics of the site. However different types of lines are used with different meaning to convey messages. This is because lines have different qualities such as thick, thin, delicate or bold, continuous or broken, wavy, curved or straight (see Figure 2). As such they are employed differently to suggest information such as movement, direction or location. Similarly the line is used symbolically to express movement of the wind, the direction of the sun, the form and content of the building

Figure 2: using different types of line to achieve 3 dimensional effects on 2 dimensional planes, Adopted from Ching (1943) pg. 115

It is also the same process when producing floor plan; lines are also the main tool used to render it. But for rendering elevations, combination of lines of different thickness with graphical shading are used to bring out the interplay of light and shade, which gives the design a three dimensional effect or outlook, by defining the shape and if possible the texture more vividly, because it also helps in bringing out the tone value of the work produced.

MANIPULATION OF SHAPES AND FORMS IN DESIGN

Shape, form, and space are closely related and connected in identifying objects or buildings in a design process, which in working together helps to bring out or speaks out the message by expressing one's ideas and feelings. A shape is a two-dimensional area that may have out line or boundary around it or it may be recognized by its area covered. Shapes are found in most design although they are two-dimensional, flat in nature. Shapes classified as either geometric or free form. In design geometric shapes are precise and mathematical formulas that can be put together to create buildings (Özdural, 2000). The basic geometric shapes that are essential in design are, circle, square, and triangle (Clark & Pause, 2012). All other geometric shapes are either variations or combinations of these basic shapes, which make it possible for architect to manipulate drawings in design. These shapes are used for decoration, uniformity, and organization in design. Moreover with the combination of free-form shapes which are irregular and uneven in nature, these help in creation of concept, rendering and in the formulation of irregular area of a design like contours, bend, curves and others. They are used throughout the design process. Forms are objects having three dimensions, like shapes they both have length and width, but forms also have depth which differentiates form from shape. Form is a developed shape after shading has been added implying tonal value, showing gradation of light effect on a shape it now becomes solid form. For example a circle is a shape but a sphere, a triangle is a shape while a cone or pyramid is a solid form derived from triangle. This is because a shape is flat; it is two dimensional while a solid form is three dimensional. These forms are used and manipulated to create different types of buildings in variations of style and techniques, to achieve aesthetic and functional design. Shapes and forms exist in space, which is the emptiness or void between, around, above, below, or within objects. Every object occupies space and it is the space that determines the size and proportion of the object or building in space, either two dimensional or three dimensional spaces. Shapes and forms are defined by the space around and within them. Without space there can be no shape or forms whatsoever, because they depend on space for their existence. It is spatial flow or arrangement that appeals to the eyes for appreciation. Since we have positive and negative spaces, it is imperative for one to understand the way it works. Architects shape space by designing structures that enclose a variety of shapes and forms for different people with different meaning, seeing from different perspective. The eyes and the brain work together in unison to enable one perceive and see three dimensions, length, width and depth as illustrated in Figure 3

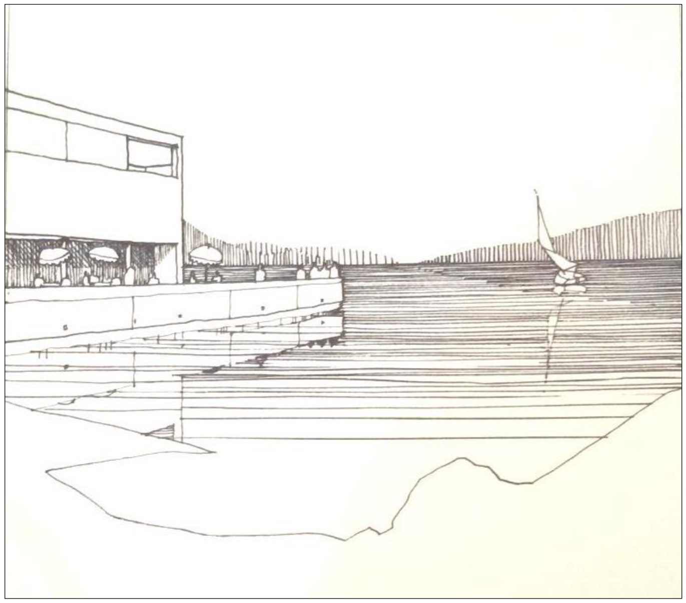


Figure 3: The use of lines to depict different features through optical illusion (Adopted from Ching 1943 page 102)

We see objects from different angles. It is applying these together that tricks the brain into thinking it sees depth, it is called optical illusion, because if one touches the drawing with hand it is flat, but looking at it one feels the sense of distance on a two dimensional space. The shapes and forms that one sees depends on ones point of view, as the object reflects from the eyes to the brain, it exhibits changes in value that can be used to create illusion of three dimensional shapes and forms on a two dimensional surface. Impression of depth and solidity are then impressed on the viewer. Also, the arrangement of light and shadow called chiaroscuro in Italian, which simply means light and dark, is a vital tool used effectively to mould an object or building to a solid state. This is always handy when projecting elevations in design as can be seen in Figure 4.

Figure 4: The use of shading to illustrate light and dark spots in a building (source; Author’s sketch 2015)

This technique is called shading in rendering. The shape of an object or building determines the type of rendering or shading to be applied, but mostly the intensity of light determines the level of solidity. The dark point of a building is usually the part far away from the light, while the lightest point is the direct part facing the light.

SOLIDIFYING BUILDING FORMS IN DESIGN

Combining lines, shading, spatial arrangement, rendering, interplay of shapes and manipulation of forms definitely bring out the three dimensional effect of a planned design, but to drive the point home and achieve a design that is close to reality, the use of Colour and Texture could be exhibited in the exploration of three dimensional rendering (model). Without Colour representation, the work will be only in black and white (monochrome), but to represent reality, Colour and texture speak louder and appeal to our sense of appreciation vividly. Colour is exciting, people react and are sensitive to colour because it appeals directly to our emotions. It is the most expressive element of art. Colours are symbolical; it stands for ideas and feelings. Different building carries different colours according to their purpose and meaning in relation to the message intended. For example green and its different hues can be used for buildings that stand for Agriculture and serenity. Meanwhile we have warm colours like Red, Yellow and Orange, they are loud, they demand to be noticed at once and as such they are used on a building that stands for vigorous activity like market building and sport complex in order to catch the viewer's attention. Colours are also used to create movement and depth. Colours have different symbolical meaning in different cultures throughout history. It is believed that architects should investigate and use the appropriate colour for a particular purpose in line with the lay down belief of a particular culture and custom. Texture is another element of Art that refers to how things feel, or how they look as if they might feel on the surface. We perceive Texture in two ways, sense of touch and vision. We are still using our sense of touch when we look at surfaces. Our sense of seeing transmit something we see and would feel like as if touched. In rendering the inscribed patterns on the surface, creates an illusion of light and dark that reminds us of how those things really feel. This is called visual texture, an illusion of three dimensional surfaces. These textures are two dimensional patterns created by repetition of lines or shapes. These invented Textures are two dimensional patters created by repetition and interplay of light and dark that stimulate our memories of real textures to achieve realism and pragmatic design.

CONCLUSION

The paper did not set out to showcase the importance of elements of art in the training of architecture students. The paper has pointed out that student of Architecture should have a background of Fine-Art or at least take the freehand-sketching class seriously, by trying to understand the application of the elements of Arts because drawing is the main tool of communication and creativity in Architecture. Without a proficient knowledge and skill in drawing it would be difficult to put down ideas accurately and as such the message of the design will be lost. The conditions for the success in achieving a pragmatic design are the revival of the importance of drawing and manipulation of the skill through elements of Art. The study makes it clear that it is possible for the students of architecture to develop individual styles and techniques by applying the Elements of art in diverse ways which in turn helps in the improvement of creativity. Most importantly is that the understanding of the elements of art by architecture students can lead to a better comprehension and presentation of architectural works.

REFERENCES

Abu-Ghazzeh, Tawfiq M. (1997). Vernacular architecture education in the Islamic society of Saudi Arabia: Towards the development of an authentic contemporary built environment. *Habitat international, 21*(2), 229-253.

Andrews, Matthew, & Gatersleben, Birgitta. (2010). Variations in perceptions of danger, fear and preference in a simulated natural environment. *Journal of Environmental Psychology, 30*(4), 473-481.

Augustin, M. Dorothee, Wagemans, Johan, & Carbon, Claus-Christian. (2012). All is beautiful? Generality vs. specificity of word usage in visual aesthetics. *Acta Psychologica, 139*(1), 187-201. doi:http://dx.doi.org/10.1016/j.actpsy.2011.10.004

Barlow, Claire M, Jolley, Richard P, & Hallam, Jenny L. (2011). Drawings as memory aids: Optimising the drawing method to facilitate young children's recall. *Applied Cognitive Psychology, 25*(3), 480-487.

Barnbaum, Bruce. (2010). *The art of photography: an approach to personal expression*: Rocky Nook, Inc.

Berg, Tessa, & Pooley, Rob. (2013). Rich pictures: collaborative communication through icons. *Systemic Practice and Action Research*, *26*(4), 361-376.

Brown, Tim, & Wyatt, Jocelyn. (2015). Design thinking for social innovation. *Annual Review of Policy Design, 3*(1), 1-10.

Carlson, Allen. (2002). *Aesthetics and the environment: The appreciation of nature, art and architecture*: Psychology Press.

Ching, Frank. (1943). *Architectural Graphics*. New York: Van Nastrand Reinhold Company.

Clark, Roger H, & Pause, Michael. (2012). *Precedents in architecture: analytic diagrams, formative ideas, and partis*: John Wiley & Sons.

Dudek, S. Z. (2011). Art and Aesthetics A2 - Pritzker, Mark A. RuncoSteven R *Encyclopedia of Creativity (Second Edition)* (pp. 52-57). San Diego: Academic Press.

Eggink, Harry, & Laseau, Paul. (1982). *Visual Communications Media Handbook*: College of Architecture and Planning, Ball State University.

Forty, Adrian. (2000). *Words and buildings: a vocabulary of modern architecture* (Vol. 268): Thames & Hudson London.

Gibson, James J. (1950). The perception of the visual world.

Illies, Christian, & Ray, Nicholas. (2009). Philosophy of Architecture *Handbook of the Philosophy of Science* (Vol. 6, pp. 1199-1256): 2009 Elsevier BV.

Krenge, Ronith Heymann. (2015). Material-Form-Narrative: The Artistic Process as a Basis of a Model of Evaluation in Art Therapy. *Procedia - Social and Behavioral Sciences, 209*, 234-239. doi:http://dx.doi.org/10.1016/j.sbspro.2015.11.224

Lindauer, M. S. (2011). Art, Artists, and Arts Audiences: Their Implications for the Psychology of Creativity A2 - Pritzker, Mark A. RuncoSteven R *Encyclopedia of Creativity (Second Edition)* (pp. 58-65). San Diego: Academic Press.

Mitrache, Georgică. (2012). Architecture, Art, Public Space. *Procedia - Social and Behavioral Sciences, 51*, 562-566. doi:http://dx.doi.org/10.1016/j.sbspro.2012.08.206

Mukerjee, Amitabha, & Dabbeeru, Madan Mohan. (2012). Grounded discovery of symbols as concept–language pairs. *Computer-Aided Design, 44*(10), 901-915. doi:http://dx.doi.org/10.1016/j.cad.2011.06.004

Özdural, Alpay. (2000). Mathematics and Arts: Connections between Theory and Practice in the Medieval Islamic World. *Historia Mathematica, 27*(2), 171-201. doi:http://dx.doi.org/10.1006/hmat.1999.2274

Parsaee, Mojtaba, Parva, Mohammad, & Karimi, Bagher. (2014). Space and place concepts analysis based on semiology approach in residential architecture: The case study of traditional city of Bushehr, Iran. *HBRC Journal*.

Pérez-Fabello, María José, & Campos, Alfredo. (2011). Dissociative experiences, creative imagination, and artistic production in students of Fine Arts. *Thinking Skills and Creativity, 6*(1), 44-48. doi:http://dx.doi.org/10.1016/j.tsc.2010.11.001

Ragans, Rosalind, & Pub, Glencoe. (1988). *ArtTalk*: Glencoe Publishing Company.

Seamon, David. (2000). Phenomenology, place, environment, and architecture: a review of the literature. *Phenomenology Online, 36*.

Spuzic, S., Narayanan, R., Abhary, K., Adriansen, H. K., Pignata, S., Uzunovic, F., & Guang, Xu. (2016). The synergy of creativity and critical thinking in engineering design: The role of interdisciplinary augmentation and the fine arts. *Technology in Society, 45*, 1-7. doi:http://dx.doi.org/10.1016/j.techsoc.2015.11.005

Vanwindekens, Frédéric M, Stilmant, Didier, & Baret, Philippe V. (2013). Development of a broadened cognitive mapping approach for analysing systems of practices in social–ecological systems. *Ecological Modelling, 250*, 352-362.

Yee, Rendow. (2012). *Architectural drawing: a visual compendium of types and methods*: John Wiley & Sons.

REVIEW OF EFFECTS OF VARIATION ORDER ON TOTAL COST AND SCHEDULE IN REFURBISHMENT PROJECTS

BABANGIDA Ibrahim, ABDULAZEEZ Abdulmumin & IDIAKE John

[1]Department of Quantity Surveying, Federal University of Technology, Minna, Niger State, Nigeria

It is common phenomenon that all construction activities associated with the maintenance and refurbishment projects are often fraught with exceptional risks and uncertainties from inception through completion, irrespective of size or location. These risks can be predictable or completely unforeseeable whereas some emerge from large number of variation orders. Variation to original works simply implies that it is impossible to know in advance every issue or challenge that will be encountered once works began. The only guarantee before actual works began is that unplanned items during the refurbishment works will be discovered. Hence, even the best pre-construction planning may only reduce the number and complexity of the unplanned items but not eliminating them completely. The uncertain nature of refurbishment therefore, means that the risks and uncertainty must be managed and mitigated rather than ignored. This paper seeks to explore the impact of variation orders on refurbishment project. The paper is based on comprehensive literature review supported by semi-structured interviews. The paper establishes a consensus that the most likely solution to counter variation to original works is to design an appropriate contingency modelling which should inform the build-up of contract sum in refurbishment contracts.

Keywords: *Refurbishment, risk, uncertainty, variation.*

i.babangida@futminna.edu.ng

BABANGIDA Ibrahim, ABDULAZEEZ Abdulmumin and IDIAKE John (2016). **REVIEW OF EFFECTS OF VARIATION ORDER ON TOTAL COST AND SCHEDULE IN REFURBISHMENT PROJECTS** Sustainable Built Environment and Climate change; The challenges of Post 2015 Development Agenda. School of Environmental Technology Conference, SETIC, 2016

INTRODUCTION

In every development project be it refurbishment, rehabilitation or new works, there exists a risk or a collection of risks which if not managed properly, may jeopardise the achievement of project objectives. Generally, the construction industry is perceived as a complex environment and its activities are inevitably full of risks. These risks can be predictable or completely unforeseeable and might be caused by a physical element while some could originate from politics, commercial, technical, economics, as well as operational activities (Lock, 2007). In his report, Latham (1994) suggests that the plethora of risks in construction can be managed, minimised, shared, transferred, or accepted, but cannot be ignored. Similarly, Mansfield (2009) opined that risk and uncertainty exist in all projects, irrespective of type, size or location. Failure to deal effectively with risk can lead to significant cost overruns, schedule delays and the inability to achieve the desired project outcomes (Burtonshaw-Gunn, 2009). Thus, the management of risks must be optimised rather than ignored (Cost Engineer, 1993) because risk has become a commercial product that is identified, priced and responsibility legally attributed (Centre for Public Services, 2004).

Much more than new construction project operation, the delivery process of building refurbishment is often assumed to be full of risk and mostly guided by some primary objectives. These are cost, time, quality, safety and more recently, sustainability. It is also worth taking note that, each of the project objectives encapsulates the dynamics of risk and uncertainty. More so, Reyers and Mansfield (2001) and GVAGrimley (2010) claimed that dealing with existing buildings introduces many sources of risks and uncertainties which can affect the scope of work, the total cost and the time or schedules.

Many examples exist of projects finishing well over budget by enormous amounts, finishing late while other projects are being abandoned even before completion (Lock, 2007). This is due in part to the presence of risk and uncertainties in construction (Odeyinka, 2000) as well as the inability of project participants to identify and manage the risks and uncertainties effectively. Perhaps, due to unforeseen circumstances, sometimes changes to original works are instigated to cope with challenges. For example, the refurbishment of the famous Savoy Hotel in London was originally scheduled to take 16 months and budgeted cost of £100m. However, the project ended-up taking nearly 36 months and cost about £220m. According to Kiaran MacDonald (Managing Director of the Hotel) *"our focus was always to restore the Savoy to its former glory and we expected to do that within the £100m budget. But there was only a certain amount of investigative work we could do to ascertain the extent of the work required on the infrastructure while the hotel was still functioning. The opportunity to turn the plumbing off and cut into walls was very limited. We believed we had identified all the problems but once the hotel closed and we started peeling away the layers of the building, its condition was far worse than we had imagined."*

Therefore, the presence of risk and uncertainty elements in refurbishment projects means that the events and tasks leading to the completion of refurbishment projects cannot be predicted with complete accuracy (Lock, 2007). This is evident in the above scenario of the famous Savoy Hotel in London, where there is variance of over £1million in the original contract sum, which means there is both cost and time overruns. Thus, risk can be considered to be the possibility of a forecast variable (for example, refurbishment cost and schedules) being different from that at completion (Mansfield, 2009).

THE CONCEPT OF REFURBISHMENT OF BUILDINGS

The term refurbishment can be taken to imply that an existing building is no longer fit for purpose in its present form (Riley and Cotgrave, 2011). While building refurbishment can be perceived as a well-established alternative to demolition and new-build for many years, it is now more widely recognised that it makes far greater sense to retain and refurbish buildings in preference to demolition and new-build (Gorse and Highfield, 2009), since demolition and new-build place increasing pressure on existing landfills. More so, from an environmental protection perspective, wholesale demolition of buildings can be quite unhealthy as it causes heavy pollution and places more demand upon depleting resources (Zavadskas *et al,* 1998). Similarly, Babangida *et al*. (2012) opined that tearing down older buildings and replacing them with new ones is a sheer waste of economic resources since the older buildings can be retained and upgraded to current demands, regulations and standards. Hence, in a study conducted by Corus (2010), refurbishment is claimed to present a means of improving the value and performance of existing buildings with less demand on the economic and environmental costs associated with new-build construction. Thus, it is widely accepted (Riley and Cotgrave, 2011; Corus, 2010; GVAGrimley, 2010; Mansfield, 2009; Gorse and Highfield, 2009) that a refurbished building can be as functionally efficient and can attain the same environmental sustainability as new-build. This would appear to mean that through reuse of old and aged buildings, less construction waste is generated and less material resources are required (Edward and Turrent, 2000).

Although Refurbishment involves numerous cost saving opportunities, however, there is a wide spread view among researchers which suggests that the schemes are complex to design, implement and manage. Mansfield (2009) opined that refurbishment projects contain more technical and economic risks than an equivalent new-build. Similarly, Babangida *et al* (2012) argued that refurbishment projects contain more risks than an equivalent new-build project where individual risk or a combination of the risks may jeopardise the achievement of project desired outcomes. Hence, the management of global risks should be an intrinsic rather than optional aspect of refurbishment schemes.

NATURE OF CHANGE CONTROL IN REFURBISHMENT

Refurbishment is adjudged to be a complex task and the complexity is said to be largely dependent upon a number of factors. Some of these factors are said to be predetermined at the design stage whilst others are determined during the life cycle period of the building. Anumba *et al* (2004) and Health and Safety Executive (2008) have highlighted the dangers inherent within the refurbishment sector of the construction industry. More so, many authors considered building refurbishment to be the most notorious and hazardous sector of the construction industry (Gorse and Highfield, 2009; Douglas, 2006).

Indeed, managing refurbishment projects is faced with some unique problems in dealing with people, the environment and the project itself (Lam *et al.*, 2010). In considering how complex and uncertain refurbishment can be, quite a number of studies on refurbishment claimed that it contain higher elements of risk and uncertainty than new-build (for example, Babangida *et al* 2012; Rahmat and Ali, 2010; Lam *et al*, 2010; Mansfield, 2009; Reyers and Mansfield, 2001; CIRIA, 1994; Flanagan and Norman, 1993). This is due in part to the extent of deterioration which is hardly obvious at the outset of projects (Babangida *et al* 2012).

Other researchers have also claimed that refurbishment projects are more difficult to manage than new-build projects (Rahmat and Ali, 2010; Zavadskas *et al.* 1998; CIRIA, 1994) and that they require experience and capability to implement and/or manage (Corus, 2010 p.5; Zavadskas *et al.*, 1998), because they contain more technical and economic uncertainties (Mansfield, 2009; Reyers and Mansfield, 2001; CIRIA, 1994), in addition to being fragmented and uncoordinated (Lam *et al.*, 2010), hence the challenges faced on new-build projects may double in refurbishment (Babangida *et al*, 2012). As a consequence, refurbishment projects require collaboration (CIRIA, 1994); it also requires special skills and effective management strategy which may be different from the type employed for new-build projects (Babangida *et al*, 2012). Thus, the management of risk is therefore essential as design information such as specification, duration and costs are largely unclear at inception (Abd Karim et al, 2007).

It could therefore be argued, that all risks inherent in refurbishment projects have the potential to jeopardise the achievement of desired project outcomes. Hence, the fact that refurbishment of modern buildings is largely considered to be a complex operation means that it may require changes to be made before project completion. These changes are usually referred to as variation order. A variation according to JCT 98 applies to both the content of work and the method of doing it. This would appear to mean that variation relates to any alteration or modification of design, quality or quantity of the works. More so, clause 13.1.1 clarifies this further by stating that such alteration or modification includes additions, omissions and/or substitution.

Interestingly, in order to change the specification of proposed work, a contract would, in principle, have to be re-negotiated. To avoid this therefore, most contracts include a clause enabling the employer or his representative to vary the specification. This would appear to mean that there is need for a condition in the contract which will allow any necessary changes to be made by the employer or his representative. Such provisions are usually called variations clause. Indeed, there are three ways in which a variation might occur as highlighted by Mordoch and Hughes (2000) namely:

- Clients may change their minds about what they asked for before the work is complete;
- Designers may not have all of the design and specification work before the contract was given;
- Changes in legislation and other external factors may force changes upon the project team.

Olubodun (2006) justifies the need for a variation clause in a contract in three different circumstances namely:

1. Lack of provision for variation would effectively enable the contractor to negotiate a new contract price for the whole contract every time the employer tried to make a change;
2. If there are no provisions for varying work in a contract, then any attempt by the employer to vary it could be refused by the contractor;
3. Where this happens, a retaliatory action by the employer not to pay the contractor because of his refusal to carry-out variation work would amount to breach of contract by the employer which could also entitle the contractor to terminate the contract.

Olubodun (2006) further suggests that by inserting a variation clause in a construction contract, the employer through the contract administrator can alter the works as and when necessary during the construction processes. However, the negative consequence of a variation clause was argued by Wainwright and Wood (1987) and Murdoch and Hughes (2000) who pointed-out most Architects take advantage of the clause by not crystalizing their intentions on paper because the variation order will allow them to finalize it during the term of the contract. Olubodun (2006) opined that the variation clause should be used as little as possible, and only for unforeseen matters that may arise.

METHODOLOGY

The methodology adopted for this study was based on comprehensive review of international literature which was supported by qualitative data using semi-structured interviews in order to substantiate and validate the literature views. The choice of semi-structured interviews is mainly due to the flexibility it presents when compared to structured interviews as the researcher is presented with the opportunities to explore further areas in order to achieve the research objectives (Babangida *et al. 2014)*. This view is a reverberation of Fellows and Liu (2003) who opined that semi-structured interviews may contain some fixed questions, however, the interviewer can probe further into the responses in order to uncover more facts and opinions. Thus the semi-structured interview was informed by review of literature which opens-up issues for further investigation. The semi-structured interviews were conducted within the Northwest of England construction industry, in various offices of the participants with only seven participants requesting for a telephone interviews due to tight schedules. The interviewees' cut across different professions within the construction industry and were randomly selected based on their experiences on refurbishment projects. 30 refurbishment practitioners were initially contacted for qualitative data collection. However, due to the nature of the construction industry and tight schedules of those contacted to participate, only 19 refurbishment practitioners kindly agreed to participate in a face-to-face interview while others agree for a telephone interview. The participants' organisation profile and respective discipline is presented in table 1.

Table 8: Participants' Profile

Category	Principal Contractor	Specialist Contractor	Sub-contractor	Total
Quantity Surveyor	*2*	*1*	*2*	*5*
Project Manager	*2*	*1*	*1*	*4*
Architect	*2*	*2*	*0*	*4*
Construction Manager	*2*	*1*	*3*	*6*
Total	*8*	*5*	*6*	*19*

The table shows that among the 19 participants, eight works for principal contractor organisations while five works for specialist contractors and six works for sub-contractor organisations respectively. The scales of refurbishment works carried-out by the participant organisations include minor, medium and major refurbishment projects.

INTERPRETATION OF FINDINGS

The interviews were directed first, at understanding the experiences of the participants on effect of change control in refurbishment projects. This relates to:

- Probability of occurrence of large number of variation order on refurbishment projects;
- Where this occurs, what is the likely impact it may have on project cost; and
- Whether in most cases it affects project schedules leading to request for extension of time in order to complete the project.

The study participants where further asked to clearly rate the level of such risks (variation order, cost and project schedule). The list was initially generated before the interview date. Risk level was given ranging from 0 to 4 (quantitative) and No Risk to very High Risk (qualitative). For example, 0 = No Risk; 1 = Low Risk; 2 = Medium Risk; 3 = High Risk and 4 = Very High Risk.

In response to the interview questions, it appears that 14 out of 18 participants have similar views about variation to original works as a risk factor, with almost all believing that its impact is very high. This raises a lot of concerns to me as a researcher which led to asking further questions about its impact and how it can be minimised or avoided. For example, one Project Manager stated that based on his experience of over twenty years on major refurbishment projects, one of the main challenges he faced is the occurrence of large number of variation orders due to unknown nature of the structure or building in question. He further explained that in most of the refurbishment projects he was involved in, there was inherent uncertainty of some works at the inception. That some problems ONLY become apparent during actual construction. As a consequence, the items cannot be shown on drawings, and therefore they are priced as the work proceeds, and this makes it more expensive than bill rates.

Another issue that majority of the research participants highlighted is that when the facility or structure in question has little or no information about its original design and/or composition especially in the area of existing services, the proposed work is often tentative thus leading to change control. This means that when there are changes to one or two work packages; it will invariably affect the contract duration as well as the budgeted cost. One particular research participant gave an example of his experience on refurbishment projects, where the Pre-Tender Estimate value was £4,305,489 but actual final account was £5,295,658 (variance of £990,169). He claimed that the increase in the total cost was mainly due to unforeseen circumstances as a result of uncertainty of the works (due in part to lack of information about original designs as well as lack of understanding the extent of deterioration of the building). This would appear to mean that the inability of the contractors to determine the extents of deterioration and structural defects at inception of the refurbishment works led to several changes. Therefore, in his opinion, pricing of contingencies should always take account of unforeseen and that variation to work is one of the main challenges associated with refurbishment projects which cannot be avoided. As a researcher, it is not surprising to see that most of the respondents have similar views on the impact of variations to original works on refurbishment projects. Hence, this tends to draw attention to the importance of variation clause in refurbishment contracts documents.

Possible solution to large number of variation order on refurbishment projects

Findings from review of existing literature and interviews shows that what all refurbishment projects share in common is a greater risk profile than an equivalent new-build project. This would appear to mean that managing refurbishment works is usually done under uncertainty mainly due to insufficient and incomplete information and also under changing conditions. Much more than new-build operation, refurbishment work is assumed to be complicated and less predictable. This complication and unpredictability is due in part to the extent of deterioration which is hardly obvious at the outset of the project (Babangida *et al.,* 2012). More so, the complexity is said to be largely dependent upon a number of factors some of which are mostly predetermined at the design stage as well as during the life cycle of the building. In terms of risk associated with Health and Safety (H&S), Anumba *et al.* (2004) and the Health and Safety Executive - HSE (2008) have highlighted the dangers inherent within the refurbishment sector of the construction industry. This view is a reverberation of the HSE (2004) who suggests that refurbishment, in its different interpretations, accounts for a substantial proportion of injuries and fatal accidents with almost 41% of construction fatalities. Hence, It is no surprise therefore when (Hughes and Ferret, 2007) posited that safety is a critical risk item and that it should constitute the most crucial investment item a construction firm could make.

Variation to original works simply implies that it is impossible to know in advance every issue or challenge that will be encountered once works began. The only guarantee before actual works began is that unplanned items during the process will be discovered. More so, even the best pre-construction planning will greatly reduce the number and complexity of the unplanned items, but not eliminating them completely. Typical questions in this process may include: Are the “blueprints” for the original facility available? Did the original builder actually construct the facility as it was designed? Have there been unknown or undocumented modifications during the life of the facility?

The most likely solution to counter variation to original works as highlighted by some of the research participants is to design an appropriate contingency modelling which should inform the build-up of contract sum in refurbishment contract. This is known as Contingency Allowance (CA). The CA is a predetermined sum of money designated for a yet to be determined issue that can change the scope of the work during the execution of a refurbishment project. The CA may help in preparing for the financial challenges of discovering the unknowns. In some cases, the CA ranges from five to 10 per cent of the anticipated construction cost. However, in more complex projects such as refurbishment with high level of uncertainty, a higher level of contingency may be required.

Additionally, nine out of 19 research participants stated clearly that a Target Cost Strategy would be a more rewarding option as it enables transparency and effectiveness of the refurbishment processes. What that means is that, under the Target Cost, the contractor is paid for work undertaken on a cost reimbursement (actual cost) basis. The principle benefit of these arrangements is its ability to align the objectives of the parties by creating partnering environment. The contractor and employer work together to control costs by sharing of the risk of over and/or under spend through the pain and gain share mechanism. However, the contractor will usually be required to give the employer access to their accounts and records on an open book policy which helps to build trust between the parties through sharing of information and this makes the strategy attractive. This type of arrangement can be set through competitive tender or negotiation. However, whether in practice this strategy could be beneficial to both parties involved is debatable.

CONCLUSION

Based on the findings of this study, the conclusions drawn are:

1. That when variations exist in refurbishment, achieving all the objectives of cost, time and quality is sometimes difficult. Although it is possible that the highest quality can be achieved, but not necessarily at the lowest cost and within the shortest possible time;
2. That it is far more difficult to produce accurate works budget for refurbishment as opposed to new-build works mostly due to uncertainty of the works at inception. Based on this, producing bills of quantities will be a big challenge. As a consequence, most of refurbishment works have to be priced using drawings and specification. This means that

each tendering contractor will interpret the documents in a different way, and it can also lead to large differences in tender bids;

3. That although it is sometimes difficult to determine the extent of deterioration of an existing building at inception of the proposed project however, efforts should be directed at conducting proper building survey/appraisal. This can greatly assist in understanding the extent of refurbishment work required and the process could also help in minimising risk and uncertainty. The appraisal, if conducted properly should reveal the following issues:
    - Whether the building is in a serious deterioration, which may require major remedial work and/or whether a collapse is possible;
    - Whether or not there are any evident defects in the original design and/or construction that has caused damage;
    - Whether or not it is feasible and viable to use the building for any intended change of use; and
    - Whether a further detailed structural survey is required.
4. That in certain cases where there is high level of uncertainties, clients should be advised to set aside a significant amount of money for any contingencies that may arise during the works as it is clear that there is far greater tendency for refurbishment projects to be completed over the tender price than new-build projects. More so, clients need to develop an internal process to evaluate project contingency needs and to adequately establish an allowance of the right size which is neither too low nor too high.

Indeed, majority of the research participants agree that what may appear to be a useful starting point for any refurbishment proposal is to consider the complexity of the project at the beginning including the scope of work and alternative management options. The extent of deterioration of proposed buildings should also be investigated properly before any informed decision can be made as to viability of the project and contract strategy (Zavadskas *et al.*, 1998). More so, there is a need to develop a risk profile at inception to enable the identification and assessment of all risks. The risk profile is simply a checklist of factors that are used to assess the overall risk of projects. This process will enable the understanding of all the elements of the risk and uncertainty of a project and sensitise the design team to risk.

REFERENCES

Abd Karim, S. B., Kamal, K. S., Ab Wahab, L. and Hanid, M. (2007) Risk Assessment and Refurbishment: The Case of Ipoh Railway Station Perak, *Malaysia, Management in Construction and Researchers Association (MICRA)* Conference, 28-29 August 2007, Shah Alam, Selangor, Malaysia

Anumba, C., Marino, B., Gotfried, A. and Egbu, C. (2004) Health and Safety in Refurbishment Involving Demolition and Structural Instability, Research Report 204, *Health and Safety Executive*, London

Babangida, I. (2014) Hierarchical Structuring and Evaluation of Risks, Uncertainties and Technical Challenges Faced By Building Refurbishment Contractors, *Unpublished PhD Thesis*, The University of Bolton, Greater Manchester, England, UK

Babangida, I., Olubodun, F. and Kangwa, J. (2012) Assessment of Risk and Technical Challenges Associated with Building Refurbishment Schemes, *Proceedings of the Construction, Building and Real Estate (COBRA) Annual Research Conference of the Royal Institution of Chartered Surveyors (RICS)*, Sept 11th – 13th 2012, Las Vegas, Nevada, USA, ISBN: 978-1-84219-840-7

Burtonshaw-Gunn, S. A. (2009) *Risk and Financial Management in Construction*, Gower Publishing Limited, Surrey

Centre for Public Services (2004) *The Private Finance Initiative and Public Private Partnerships: what future for public services?* [Internet] Available at: www.centre.public.org.uk/publications/briefings/pfi_and_ppp.html accessed: October 2011

CIRIA (1994) *A guide to the Management of Building Refurbishment*, Report 133, Construction Industry Research and Information Association, London

Cost Engineer (1993) *RISKMAM – the new European methodology for project risk management*, Vol. 31 No. 1, pp. 16-17

Corus (2010) *Refurbishment solutions for non-domestic buildings*, [Internet] available at: <http://www.colorcoat-online.com/file_source/StaticFiles/Refurbishment%20solutions%20for%20non-domestic%20buildings.pdf> accessed: 30th March 2012

Douglas, J. (2006) *Building Adaptation*, 2nd Edition, Butterworth-Heinemann, Oxford

Edwards, B. and Turrent, D. (2000) *Sustainable Housing: Principles and Practice*, E&FN Spon, London

Fellows, R. and Liu, A. (2003) *Research Methods for Construction*, Blackwell Science Limited, Oxford

Flanagan, R. and Norman, G. (1993) *Risk Management and Construction*, Blackwell Science, Oxford

Gorse, C. and Highfield, D. (2009) *Refurbishment and Upgrading of Buildings*, 2nd Edition, Taylor and Francis: London

GVAGrimley (2010) UK Offices: *Refurbishment VS Redevelopment*, Property Intelligence, London, GVAGrimley, [Internet] available at <www.gva.co.uk/WorkArea/DownloadAsset.aspx?id=2147488580> accessed 24th March 2012

Harmer, J. (2010) *Restoring the Dream at the Savoy Hotel*, [Internet], Available at: http://www.catererandhotelkeeper.co.uk/articles/14/10/2010/335490/restoring-the-dream-at-the-savoy-hotel.htm, Accessed: 01 August 2013

Health and Safety Executive (2008) *1,000 Spots Checks of Building Refurbishment Sites across Great Britain*, [Internet] Available at: www.hse.gov.uk/2008/e08005.htm, Accessed: December 2012

Health and Safety Executive - HSE (2004) Health and Safety Law, What you need to know, Health and Safety Executive Publications, [Internet] Available at: http://www.hse.gov.uk/pubns/law.pdf Accessed April 2012

Lam, E.W.M., Chan, A.P.C., and Chan, D.W.M. (2010) Qualitative Survey on Managing Building Maintenance Projects, World Academy of Science, *Engineering and Technology 65*

Latham, M. (1994) *Constructing the Team: Joint Review of Procurement and Contractual Arrangements in the UK Construction Industry*, Department of the Environment, London, UK

Lock, D. (2007) *Project Management,* 9th Edition, Hampsshire, Gower Publishing Limited

Mansfield, J.R. (2009) the use of formalised risk management approaches by UK design consultants in conservation Refurbishment, *Engineering Construction and Architectural Management,* Vol. 16 No.3, pp. 273-287

Marsh, P. (1983) *the refurbishment of commercial and Industrial buildings,* Construction Press, London

Murdoch, J. and Hughes, W. (2000) Construction Contract Law and Management, 3rd Edition, Spon Press, New York

Odeyinka, H. A. (2000) An evaluation of the use of insurance in managing construction risks, *Construction Management and Economics* **18**(5), 519-524

Olubodun, F. (2006) Construction Contract Procedures and Procurement Lecture Notes, The University of Bolton, Greater Manchester, UK

Rahamat, I. and Ali, A.S. (2010) the involvement of the key participants in the production of project plans and the planning performance of refurbishment project, *Journal of Building Appraisal*, Palgrave, UK pp 273-288

Reyers, J. and Mansfield, J. (2001) the assessment of risk in conservation refurbishment projects, *Structural Survey,* 19(5), 238- 244

Riley, M. and Cotgrave, A. (2011) *Construction Technology 3: The Technology of Maintenance and Refurbishment*, 2nd Edn, Basingstoke: Palgrave Macmillan

Zavadskas, E., Bejder, E. and Kaklauskas, A. (1998) Raising the efficiency of the building lifetime with special emphasis on maintenance, *Facilities,* **16**(11), 334-340

EVALUATION OF PASSIVE COOLING TECHNIQUES IN GOVERNMENT OFFICE BUILDINGS IN MINNA NIGER STATE NIGERIA

MICHAEL, B. U & OLANIYAN, O.A.
Department of Architecture, Federal University of Technology, Minna, Niger State, Nigeria

In a quest to better manage the rapidly depleting natural resources available to man, passive (natural) cooling techniques have been explored to effectively cool buildings without resorting to mechanized processes. In a state like Niger, located in sub-Saharan Africa, where high temperatures may lead to heat loading, it is necessary to find effective means of cooling the built environment without further stretching reliance on non-renewable energies, taking into consideration its finiteness. This paper therefore examined some secretariat buildings within Minna, Niger state. It employed the qualitative research method in analyzing the extent or lack thereof, of the use of passive cooling techniques. It also established suitable passive cooling strategies in Minna, Niger state. In addition to suggesting ways of adopting passive cooling strategies, the need to raise awareness on the comparative long term benefits was stressed.

Keywords: *Natural resources, Passive cooling, High temperature, Heat loading, Sustainable approach.*

arcbenjamin@gmail.com

Michael, B. U & Olaniyan, O.A. (2016) **EVALUATION OF PASSIVE COOLING TECHNIQUES IN GOVERNMENT OFFICE BUILDINGS IN MINNA NIGER STATE NIGERIA** Sustainable Built Environment and Climate change; The cha llenges of Post 2015 Development Agenda. School of Environmental Technology Conference, SETIC, 2016

BACKGROUND TO THE STUDY

Prior to the invention of refrigeration and air conditioning technology, buildings have been kept cool using natural means and techniques. With the advent of mechanization and rapid advancement in technology however, buildings have relied more on mechanization to achieve necessary cooling and thermal comfort.

The use of mechanization to achieve cooling exerts enormous energy demands leading to increased energy consumption. About 40% of energy demands is utilized to achieve thermal comfort (cooling and heating) and is projected to rise to up 60% in the next decade (Residential End Use Monitoring Program-REMP, 2012). Applying passive cooling techniques in buildings can thus significantly lower and reduce energy consumption that would have been otherwise used if cooling was done mechanically.

Poor energy supply and frequent power outages experienced in Nigeria also means power is not always available and even when it is, it is hardly sufficient (Ekpo A, 2009). There is need to articulate passive cooling strategies in built environments of Nigeria to bring about much needed cooling and to also reduce energy demands and improve sustainability since active cooling relies primarily on electric power generation which is neither adequate nor stable in Nigeria.

The aim of the paper is to examine selected public offices in Minna with a view to finding out which passive cooling strategies are in place if any as well as studying its climatic conditions to determine the suitability and efficiency of these strategies.

PASSIVE COOLING STRATEGIES IN BUILT ENVIRONMENTS

Passive Cooling is method or technique that offers a more sustainable and natural solution to the need for cooling, in the event of heat loading– as against active cooling that utilizes mechanical means (air conditioners, fans, air expellers and mechanized ventilation shaft) in providing cooling comfort (Mohammed A, 2012).

Passive cooling can also be described as an approach to design that centers on a minimization of heat gains, and the maximization of heat loss from a building so as to achieve thermal comfort with little or no energy demand (Santanouris M, Asima Kaupolos D., 1996). It generally utilizes natural resources, natural energy with a carefully schemed architectural planning of space, as well as building components rather than machines in achieving desired cooling comfort (Niles, Philip, Kenneth, Haggard, 1980).

Since Air Conditioning is a major contributor to increased energy consumption (Mohammed A, 2012), and also takes up a great majority of energy demands in buildings (Scott A, 2006), then passive cooling if well utilized can lead to a decrease in energy consumption and a reduction in cooling loads. Chris R., and Paul D., (2013) also concur with this position and states that

''this rate could be cut to almost zero in new housing through sound climate responsive design and indeed should be our aspirational goal.''

In order to naturally cool the interior of buildings, it is necessary to prevent heat from entering into the building and this increase cooling loads. This is the first and critical step in designing for passive cooling, as it can drastically reduce that amount of cooling loads (AIA Research and Design Journal, 1979). High levels of comfort can be achieved in buildings if proper care is taken to prevent the solar radiation from entering it (Ajibola K, 2001). This passive cooling method tries to achieve thermal comfort through consideration of natural ventilation, building orientation, fenestration and insulation in its designs (Larsen 1998). External heat gain sources in a building are mainly through its walls, egresses or roofs (Ogunsote O. 1991). Edwards B. (1998) list the following as major sources of heat gain to a building:

i). External surfaces conduction direct solar radiation into the building

ii). through windows and doors

iii). Heat exchange with warm outside air to replace cooled stale air

iv). Occupants and equipment.

The following methods can be used be used in preventing heat gains in a building.

(i).**<u>Solar Shading</u>**: This connotes the shading of the building envelop from direct solar radiation. Since the dry season sun is much higher in the sky, its angle of direct impact is more acute and can be prevented from entering into the building through the provision of solar shading devices.

When solar shading techniques are applied there is a decrease in temperature of the surroundings by 6^0C (Minke G, Bansal N, and Hauser G 1994). Internal building temperature reduction ranging from 2.5 to 4.5^0C is also observed when these devices are used (ibid). This thus means that solar shading devices can be used to maintain or even lower room temperature to achieve thermal comfort.

Some techniques used in solar shading include use of overhangs, Louvre, canopies, trellises and awnings. These building elements when well-designed can mitigate the impact of direct solar heat. Overhangs or eaves of projection need to be adequate enough in length to reduce heat gains. Louvre walls or openings at 45^0 opposite to the direction of solar inclination, awnings at 45^0 opposite to the direction of solar inclination, awnings or window hoods over windows and other egresses by 80% (National Emergency management Agency ,2013). Canopies and trellises can also be used to provide cooling comfort to sit-outs and patio areas in a building.

ii).**<u>Landscaping</u>**: The ambient temperature of the air within the vicinity of a building can also be reduced through the use of a properly planned landscape (Ogunsote O, Prucnal O, Adebgie M, 2010). Deciduous trees can be used to provide shade to the south and north faces during heat load periods. Trees can be especially used to provide cover to the east and west facing windows. Evapo-transpiration effects from trees can also cool the surrounding air, making cooler air available to building occupants.

iii).**<u>Building Orientation/Location</u>**: Orientation of buildings with majority of windows on the North – South axis can reduce heat loads experienced in building. The length of the building should lie along the East – west axis of the building. Orientation is a very important tool in reducing heat load. Once the orientation of the building and its windows are on the North-south axis, other sun shading devices will become ineffective in reducing heat loads due to the solar inclination during morning and evening hours (ibid).

iv).**Choice of building materials/colors**: The choice of color of building materials and building surfaces has a significant impact on heat gain loss. The Arizona solar centre (2014) posits that light colour on materials and surfaces can reflect direct solar radiation, reflective coatings on roofs and other building membranes can also reduce heat loads (house energy, 2010).

Colour	Absorptivity (%)
Perfectly black	100
Ordinary black	85%
Dark green	70
Dark grey	70
Light green	40
Light grey	40
White oil paint	20
New whitewash	12
White emulsion paint	12 – 20

Table 1.Absorptivity of colour. (Source:BRE)

The choice of glazing with low U-value (measure of insulation capacity of a material – low indicating high insulation and high U-value, low insulation capacity) can also significantly insulate the building and result in cooling comforts. The choice of roofing sheets types, wall materials and other building fabrics can affect passive cooling. As a general rule the lower the U-value of a material the better its choice for achieving passive cooling.

v).**Thermal Mass**: This refers to the characteristics of a material to accumulate and keep heat energy within it. Material that requires so much heating to change its temperature are said to have high thermal mass. Such materials are generally poor conductors of heat. Proper articulation of thermal mass into design can significantly reduce the amount of cooling required to achieve thermal comfort (Chris R, Mcbee C, and Geoff M. 2013). Improper application of thermal mass worsens climate excesses and increase heat required during peak solar radiation or absorb all heat required during peak cold periods (ibid). The use of thermal mass is important when there exists a marked variation between diurnal temperatures (ibid).

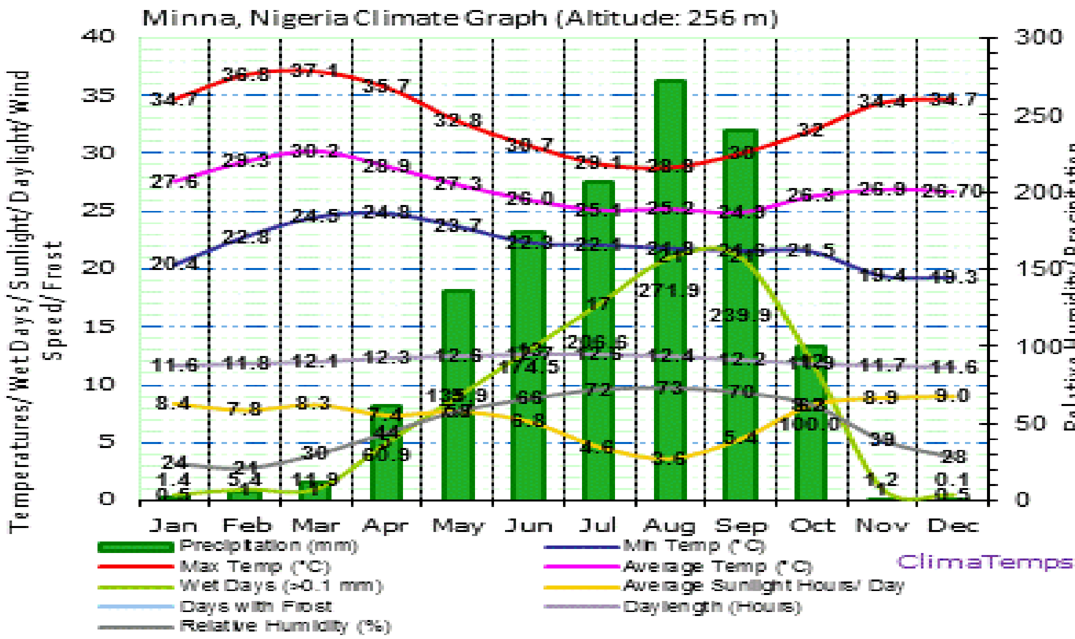
Material	Thermal mass(KJ/m³.k
Water	4186
Concrete	2060
SandScrete	1800
Compressed earth blocks	1740
Rammed earth	1673
Fibre cement sheet	1530
Brick	1360
Earth wall	1300
Autoclaved aerated concrete	550

Table2: Thermal mass of some selected building materials (Source: Baggs, Mortensen, 2006)

MINNA CLIMATE

The climate of a Minna has significant impact on its passive cooling technique in use. The climatic factors of a place determine the passive cooling technique(s) that can efficiently deal with the need to cools buildings (Autodesk sustainability workshop, 2014). For instance, techniques that are adequate for a temperate region may not be sufficient or all together required in an arid region. It is thus crucial that we study the climate of Minna before applying relevant passive cooling strategy in the city.

Minna is located on longitude $10^{0}00$'N and latitude $6^{0}00$'E and lies on attitude 256m above sea level (Climatemps.com, 2014). It has two main seasons; a dry season and a wet season. Its vegetation is Savannah with a kopper-Geiger classification of Aw (ibid). It annual temperature mean is 27^{0}C with a diurnal temperature mean of 5.3^{0}C and an annual mean rainfall of 1,210mm (ibid).



Graph1: Climate graph of Minna. (Source: www.climatemps.com)

PASSIVE COOLING STRATEGIES FOR MINNA NIGER STATE

Passive cooling strategies need to be climate specific to be effective. Of particular interest to passive cooling strategies is both temperature and relative humidity and wind flow (Ogunsote O.O., Prucnal O., Adegbie M., 2010). Climates such as Minna's with a kopper-Geiger classification of Aw need to predominantly focus on cooling during the dry season only as the need for heating is negligible (Chris R., Paul D, 2013). The following passive cooling strategies will be required for Minna based on the extensive work carried out by Chris R, and Paul D (2013) viz:

1. Orientation of buildings should be in such a way as to avoid direct solar influx. Care should be taken to place the major length of buildings along the east-west axis where possible.
2. Egresses need to be well shaded and sufficient in size to encourage air flow. Window types also need to encourage the flow of air. In this regard casement, louvered and pivot windows will be needed to maximize air flow.
3. The location of windows is also of great importance in achieving passive cooling. Bigger windows should be placed on the leeward sides of the buildings and smaller windows on the windward sides so as to create air pull or movement due to pressure difference between the two windows.
4. Extensive use of soft landscape elements capable of shading walls and windows and at the same time providing cooler ambient temperatures into the building.
5. Ventilation paths need to be clear of all obstructions.
6. Since air tends to be lighter at higher temperatures than lower temperatures, heated stale air rises above cooler fresher ones. High level vents in the form clerestory windows, atriums, courtyards, heat chimneys, roof vents and ridge vents need to be provided allow hot air escape out of the building.

7. The roofs and walls should be painted with light colours.
8. Materials with high insulation capacities that can increase heat loss and reduce heat gain should be encouraged. Examples of this are reflective foils in arranged in several strata.
9. The use of materials with low thermal mass should be adopted.

COST OF PASSIVE COOLING IN MINNA, NIGER STATE

Affordability is often cited as a major hindrance to the use of passive cooling. However it has been proven that the operational cost or running cost of active cooling is greater than the initial cost of passive cooling (ibid). The short term cost of setting up passive cooling may be high but on the long term its cheaper, especially when be huge quantities of resources (energy and finance) that will be used are factored (Sanati R., 2012). Chris R. and Paul D. (2013) also found out that for every 1^0C change in thermostat our cooling bill raises by 10%.

Passive cooling can also potentially reduce cooling loads by half (Sanati R., 2012). The Australian Green house office (AGO) (2005), estimates that failure to articulate passive cooling/heating into building design can lead to a surge in heating/cooling energy needs by as much as 50%. The cost of energy required for active systems often exceeds the capital cost of the building itself (Lawal A and Ojo O., 2011).

It can therefore be deduced that although setting up an active cooling mechanism may appear cheaper than passive cooling from the onset, in the long term, it becomes more expensive due to the enormous energy cost that snowballs with continuous use.

In Minna, during the dry season with temperatures as high as 38°C, more cooling appliances are been put to use than during the rainy season. This trend reflects in the energy consumption of the state capital, which is usually higher during the dry season. With passive cooling strategies been implemented in Minna, this trend can be curtailed.

GOVERNMENT OFFICE BUILDINGS IN MINNA, NIGER STATE

The Collins online dictionary defines a government office building as a building belonging to a town or state and used by the public for official government functions. In Minna the state capital, public office buildings are mainly found in 3 categories; federal (15), state (47) and local (4) government buildings. Some of the buildings sampled include;

i. The federal secretariat complex Minna
ii. Abdul Kareem Lafene Secretariat complex, Paiko road.
iii. Chanchaga L.G.A secretariat, Minna
iv. Standard Organization of Nigeria (SON) Bosso road.
v. Radio Niger Building, Shiroro Hotel road

RESEARCH METHODOLOGY

The qualitative research method was used with an observation schedule as the main research instrument. The observations sampled the level of government ownership of the building as well as its era of construction in one section and the passive cooling strategies put in place on another. All of the data gathered were ordinal variables with the exception of one scale variable and one nominal scale variable. The data were analyzed using the SPSS and the Microsoft Excel Software for the computations.

STUDY POPULATION.

The study population samples cover 20 public office buildings in Minna and were selected by stratified random sampling technique amongst the various levels of government ownership. 4 buildings were selected out of the 15 federal government owned office buildings in Minna by simple random sampling. 14 were selected from the from the 47 state owned office buildings in Minna, also by simple random sampling. And finally 2 buildings were selected from the 4 local government owned office buildings. 20 observation schedules were administered and used in the research.

owner of the building		
level of government	Frequency	Percent
Federal government	4	20.0
state government	14	70.0
local government	2	10.0
Total	20	100.0

DISCUSSION OF THE RESULT

From chart 1 below 70% of the office buildings had the orientation of majority of their fenestration supporting passive cooling as being either on the north or the south. The results also show from chart 2 that the building 70% of them also got their building orientation right by placing it along the east-west axis. The use of light shade or white Building colours as a passive cooling strategy in Public Office Buildings was 100% as seen from chart 3. Similarly, chart 7 shows that almost all the wall components used (hollow sandscrete blocks and compact bricks) totaling 90%, were found to encourage thermal mass. Dense vegetation around the buildings needed to create low ambient temperature and cool air was found to be considerably apt to aid passive cooling with a 65% having some form of deciduous vegetation around them (Chart 6).

Chart 5 demonstrates that 70% of the roof eaves were however found to be inadequate of supporting passive cooling. 85% of wall finishes as well as 55% of windows studied were also inimical to passive cooling. The use of heat vents were also grossly under-utilized with 75% of the offices studied having no form of heat vent. The use of air pressure difference strategy to make air flow through the buildings was completely absent from all public office buildings.

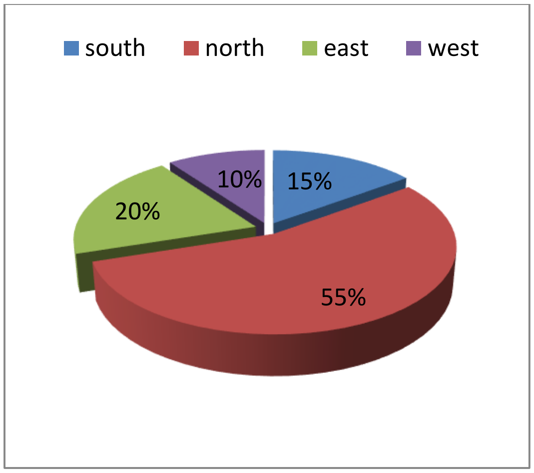


Chart1: showing fenestration orientation of Public Office Buildings in Minna Niger state.

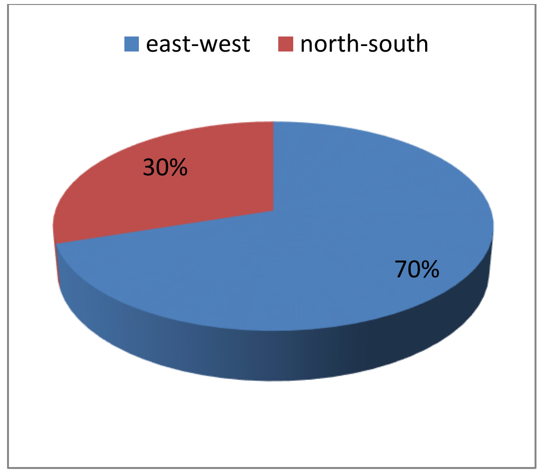


Chart1: showing building orientation of Public Office Buildings in Minna Niger state.

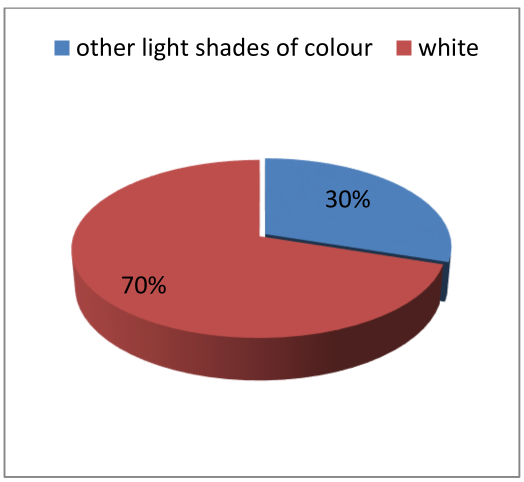


Chart3: showing colour of the buildings of Public office buildings in Minna Niger state.

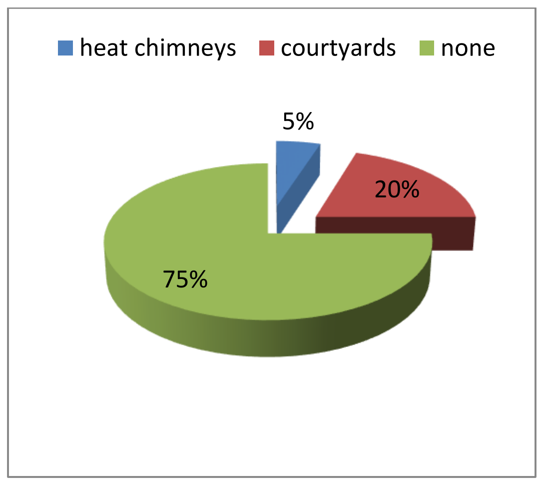


Chart4: showing use of heat vents in public office Buildings in Minna Niger state.

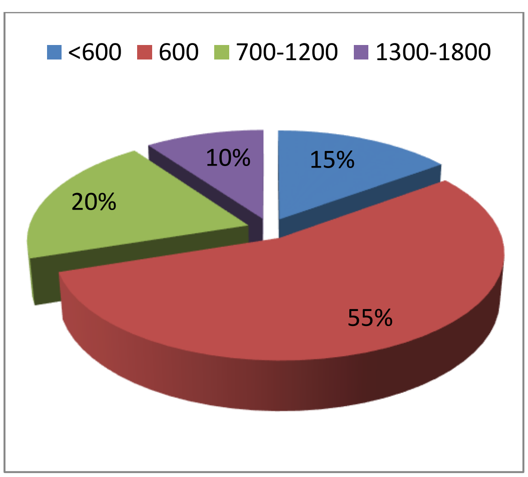


Chart 5: showing roof eaves of projection of Public office buildings in Minna Niger state.

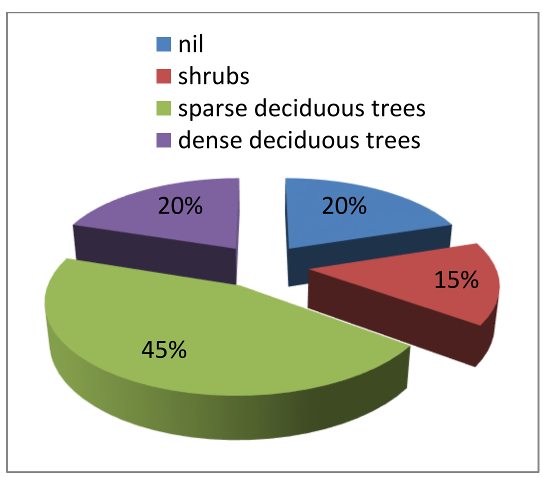


Chart 6: showing vegetation types around public Office buildings in Minna Niger state.

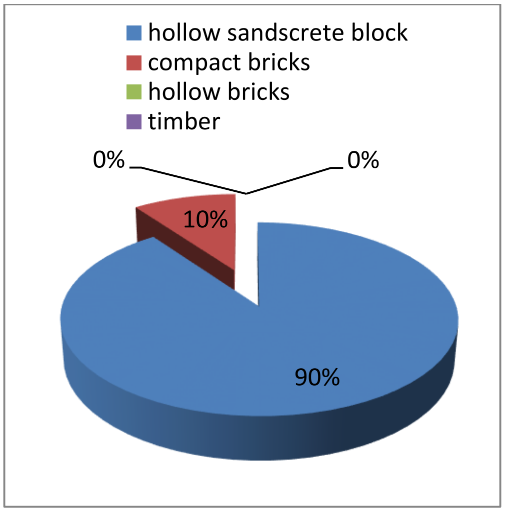


Chart 7: showing wall components (Thermal Mass) in Public Office Buildings in Minna.

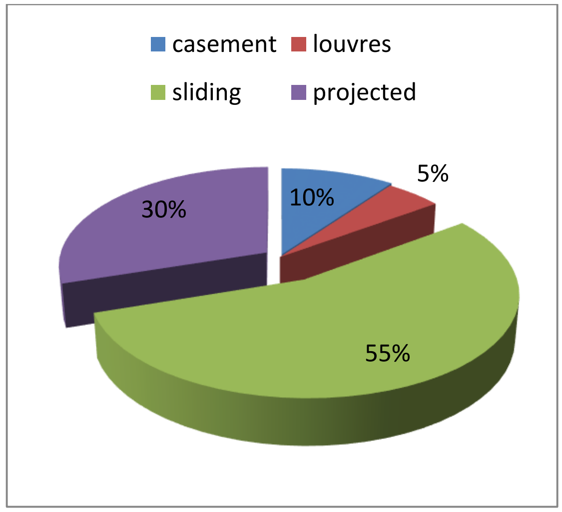
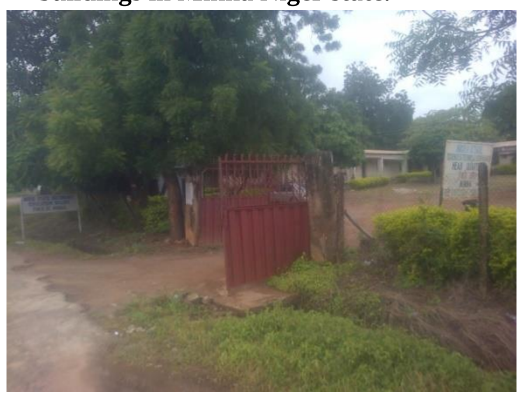


Chart 8: showing window types in public office buildings in Minna Niger state.



Picture1: showing the use of vegetation around public offices to achieve passive cooling.

Pictures: showing the use of AC to achieve expulsion of heat from public offices.

CONCLUSION

The research showed that there is an appreciable level consciousness of passive cooling strategies that minimize heat gain (orientation of buildings, location of fenestration, colors of building, thermal mass and vegetation) through the building envelope of Public Office Buildings in Minna. The study however reveals very little or no strategies in place to maximise heat loss (window types, window size, heat vents and air pressure difference) from Public Office Buildings in Minna.

This means that although there are sufficient preventive strategies in Public office buildings in Minna, they are not sufficient to provide adequate passive cooling as expulsive strategies are grossly inadequate. This is probably due to the more technical nature of the strategies that promote heat loss.

RECOMMENDATIONS

There is a need to hence create awareness among architects, designers and allied construction professionals to incorporate passive cooling strategies that promote passive cooling as well as creating awareness that passive cooling is a cheaper, sustainable and better alternative to active cooling. The effect of this will surely address heat loading problems and also reduce energy consumption in the future, as new buildings begin to reflect these strategies.

But in the meantime, corrective measures that can be taken to address heat loading in government office buildings include;

i. Buildings with non-passive cooling compliant windows such as Sliding windows, should have their windows replaced with windows that have better fenestration, like the Projected, Louvre or Casement windows, which allow for less than 50% air flow obstruction.
ii. Buildings with small size windows should be considered for replacements with larger sized windows.

REFERENCES

Ajibola K.(2001). Design for Comfort in Nigeria- a bioclimaticapproach. *Journal of renewable energy*. Oxford, 23, 57-76

Arizona Solar Centre (2014). Passive solar heating and cooling manual Part 3 of Retrieved from http://www.azsolarcenter.org/tech-science/solar-architecture/passive-solar-design-manual/passive-solar-design-manual-cooling.html

Autodesk sustainability workshop (2014). Retrieved from http://sustainabilityworkshop.autodesk.com/buildings/climate-analysis

Bansal N.K.,HauserG., Minke G. (1994**).** Passive Building Design, A Handbook of Natural Climatic Control. Elsevier, Amsterdam

Chris R., Dick C. (2013). Passive Cooling. Your home: *Australian guide to environmentally sustainable homes.* Retrieved from http://www.yourhome.gov.au/passive-design/passive-cooling

Chris R, Mcbee C and Geoff M. (2013). Passive Design: Thermal mass. *Your home:Australian guide to environmentally sustainable homes.* Retrieved from http://www.yourhome.gov.au/passive-design/thermal-mass

Chris R., Paul D.(2013). Passive design *Your home:Australian guide to environmentally sustainable homes.* Retrieved from http://www.yourhome.gov.au/passive-design/design-climate

Climatetemps.com (2014). Minna climate and temperature. Retrieved from www.minna.climatemps.com/

Edwards, B. (1998). Green Buildings Pay, Spon Press, London.

Ekpo, A. H. (2009). 'The Global Economic Crisis and the Crises in the Nigerian Economy, Presidential Address to the 50th Conference of the Nigerian Economic Society, September, Abuja-Nigeria.

Lawal A.F and Ojo O.J. (2011). Assessment of Thermal Perfomance of Residential Buildings in Ibadan land, Nigeria *journal of emerging trends in engineering and applied sciences (JETEAS) 2(4): 581-586*

Mohammed A. (2012). An overview of Passive cooling techniques in buildings: design concepts and architectural interventions. *Acta technical napocensis: civil engineering and architecture vol. 55, no.1*. Retrieved from **http://constructii.utcluj.ro/ActaCivilEng**

National Emergency management Agency(2013). Extreme Heat Retrieved from http://nema.gov.ng/heat-extreme/

Niles, Philip; Kenneth, Haggard (1980). *Passive Solar Handbook*. California Energy Resources Conservation. ASIN B001UYRTMM.

Ogunsote O. O.(1991). An Introduction to Building Climatology-A Basic Course for Architecture Students. Zaria Ahmadu Bello Press.

Ogunsote O.O., Prucnal O., Adegbie M., (2010). Optimizing passive Cooling Systems in Residential buildings: A case study of Akure, Nigeria. Retrieved from www.sdngnet.com

Research and design(1979). Passive cooling: designing natural solutions to summer cooling loads, *the quarterly publication of the American Institute of Architectsvol.3 no.3* Retrieved From www.**aia**.org/practicing/**research**/**AIA**B090039

Sanati R. (2011). Design Proposal for Taraba House Abuja, Nigeria with Emphasis on Passive Cooling, an unpublished thesis submitted to Federal University of Technology, Minna.

Santamouris, M.; Asimakoupolos, D. (1996). *Passive cooling of buildings* (1st edition). 35-37 William Road, London NW1 3ER, UK: James & James (Science Publishers) Ltd. ISBN 1-873936-47-8.

Scott A. M. (2006). Passive Cooling and zeer pots *permaculture reflections.* Retrieved from http://www.permaculturereflections.com/2006/11/passive-cooling.html

The Collins online dictionary (2014). public office buildings. Retrieved from www.collinsdictionary.com/dictionary/english/public-buildings?showcookiepolicy=true

Residential End Use Monitoring Program-REMP, (2012) A joint initiatives of Australian, State and Territory and New Zealand Governments. Retrieved From http://www.energyrating.gov.au/wpcontent/uploads/Energy_Rating_Documents/Library/General/Residential_Energy_Monitoring

RESIDENTS' INTRA-URBAN MOBILE PHONE USAGE AND TRAVEL DEMAND IN SOMOLU LOCAL GOVERNMENT AREA, LAGOS, NIGERIA

Peter Olulade FOSUDO[1], O.O. AGUNLOYE[2] and O. A. BANJO[2]
1. Department of Urban and Regional Planning, Lagos State Polytechnic, Lagos
2. Department of Urban and Regional Planning, University of Lagos, Lagos

This paper examined the effect of intra-urban mobile phone usage on travel demands of residents in Somolu Local Government Area, Lagos, Nigeria, with a view to reducing traffic on the road. This study examined the socio-economic characteristics of residents in the study area, residents mobile phone usage, residents travel pattern and the relationship between mobile phones usage and travel demand in the study area. A set of structured questionnaire were administered on 178 residents of selected wards in the study area. Systematic sampling technique was used for the study. Data were analyzed using frequency tables, chart, cross tabulation and Pearson product moment correlation coefficient. The study revealed that 30.9% of respondents received less than 10 calls per day while 27.0% respondents made an average calls of 11 - 20 times per day. Besides, 52.8% of respondents spent between N101-N500 on calls per day. The average travel distance of respondents was 10 km and the average travel cost was between N101-N500 per day. The major travel purposes of respondents were official assignment and visitations (38.2%). The study also established that 42.7% of respondents travel mode was through public transit while 52.4% of respondents spent less than 1 hour on trips per day. The average appointment cancelled as a result of mobile phone call was < 5 while trip completed as a result was also < 5 times per day. Also, trip induced was < 5 per day. There was a significant positive correlation between the respondents' received calls and appointment cancelled ($n=178$, $p> 0.01$, $r=0.480$). This suggests that as respondents received calls, the appointment cancelled increases per day. There was a positive relationship between respondents' calls frequency and number of trips completed per day ($n=178$, $p< 0.05$, $r=0.194$). Also, calls frequency by the respondents and travel induced ($n=178$, $p> 0.01$, $r=0.204$). The study recommends that services from network provider should be monitored in order to ensure that reliable and efficient services are made available to subscribers in order to further discourage physical travels which lead to intra-urban traffic delay on daily basis.

Keywords: Residents, Intra-Urban, Mobile Phone Usage, Travel Demands

ladefosudo@yahoo.com
ooagunloye@gmail.com
gboyegabj@gmail.com

Peter Olulade FOSUDO, O.O. AGUNLOYE and O. A. BANJO (2016). **RESIDENTS' INTRA-URBAN MOBILE PHONE USAGE AND TRAVEL DEMAND IN SOMOLU LOCAL GOVERNMENT AREA, LAGOS, NIGERIA** Sustainable Built Environment and Climate change; The challenges of Post 2015 Development Agenda. School of Environmental Technology Conference, SETIC, 2016

1.0 INTRODUCTION

The need for people to move from one place to another is necessitated by the spatial spread of activities within the geographical space (Fadare and Salami, 2004). One purpose of travel is to exchange information. The interaction between travel and information technologies in the last two decades has induced a gradual recognition that both physical transport and telecommunication are subsystems of a communication system (Salomon, 1986).

The concern of transportation planners is to adopt strategies that will reduce the economic, social and environmental cost of travel. The challenge for cities is to manage urban travel demand without degrading the quality of life (De Souza, 2005). Since the dawn of human history, people have devised means of communicating at a distance (e.g., Crowley and Heyer, 2006). At first, we use sound (trumpets, bells, tom-tom drums) or sight (signal flares on hilltops, flags on ships) to exchange information efficiently. The development of tools for written communication (hieroglyphs, alphabets, paper and movable type) increased our ability to telecommunicate many fold, and the brief period of electronic communication that we have experienced so far (radio, telegraph, land-line telephone, television, fax, internet and mobile phone) has raised that ability by several more orders of magnitude. Saving travel has been at least an implicit motivation for the creation of telecommunication technologies from the beginning. By the time the telephone was invented in the latter part of the 1800s, that motivation became explicit: letters and articles appearing in the London Spectator and The Times in 1879 speculated on the potential of the telephone to replace face-to-face meetings (Albertson, 1980; de Sola Pool, 1979), and the science fiction of H. G. Wells ("When the Sleeper Wakes", 1899) and Forster ("The Machine Stops", 1909) imagined video conferencing (or the "kineto-tele-photograph", as Wells put it) accomplishing the same purpose. As far back as the 1960s (Owen, 1962), planners began to explore the potential of telecommunications for reducing travel, and the energy crisis of the 1970s prompted a number of additional studies (e.g. Harkness, 1977). Telecommunications and transportation share similar trait as both help to overcome space (Yuan et al., 2012) and share information among people (Choo and Mokhtarian, 2007). The introduction of information and communications technologies (ICTs) have changed people's daily lifestyles as well as travel behavior (Zimmerman et al., 2001; Choo and Mokhatarian, 2007) hence transforming our society from industrial era to information age. The internet and mobile technologies diminish time-space constraints and give people virtual accessibility to activity centres. The level of spatial and temporal flexibility afforded by the internet and mobile technologies render obsolete the notion of distance as an organizing principle of human behaviour and urban structure (Cairncross, 2001. As noted by Couclelis (2004), internet and mobile technologies have weakened the association inactivity, place and time. However, in a contrary opinion, Zook et al., (2004) argue that space-time constraints are still relevant in information age as most of the ICTs and mobile technology activities is still accommodated in the physical space and virtual spaces are grounded in social and physical spaces. Hence, physical travel of goods, information and people are still important aspects in interaction and communication. There has been an established relationship between information and communication technologies and travel behaviour of people (Salomon, 1986; Mokhtarian, 2009). The development of the internet and electronic gadgets such as computers, mobile telephones and personal digital assistants has changed the travel pattern of individual in cities across the world (Aguiléra, et al., 2012).The use of ICTs has altered the way we conduct business, work, bank, shop, education and health delivery (Golob and Regan, 2001). It is now possible to engage in most of these activities from a remote location without necessarily travelling. Similarly, Yuan et al. (2012) reiterated that these technologies provide their users with more flexibility with respect to when, where, and how to travel. The use of ICTs has the potential of reducing individual travel demand, hence reducing traffic on the highways.

The use of ICTs may lead to the relaxation of some of the space-time constraints that limit people's spatial mobility and activity space. In other words, more time may be available to undertake other activities and more flexible spatial and temporal arrangements of activities and travel may become possible (Kwan, 2007). On the contrary, ICT may reduce the time available for people to engage in other activities and they may spend less time on social activities and shopping trips to stores in the physical world (Kwan, 2002). This suggests that the potential impact of ICT on travel is complex and difficult to understand. Thus, the use of ICTs has the capability of complementing or substituting physical travel. As a result of the improvement in telecommunications, Nigeria has joined the famous countries in Africa with high teledensity of 100 per cent as at January 2015 (NCC). This is a remarkable achievement compared to 0.4 per cent in 2001. Telephenomena encompassing all telecommunication related measures aimed at transmitting messages and information include telecommuting, telework, teleconferencing, teleservices, etc. The major channels through which these activities can be facilitated could be through the use of telephone, internet, radio message and fax. Indeed, in the geographic study of movement of spatial phenomena such as people, goods, information, ideas and news, distance is an important factor. The friction of distance is an implicit determinant of material flows and human spatial behaviour. Be that as it may, the advent of telecommunication devices is aiming to substitute, complement and enhance trip patterns, so the urban movement pattern is bound to be modified. Moreover, with the altering and outright elimination of the constraint of distance, places are becoming more accessible thus reducing intra-urban economic and social inequalities. Consequently, the need to travel within the city and the land use structure is inadvertently altered. In Nigeria presently, and Lagos in particular, the proliferation of telecommunication systems such as fax, Internet and more importantly, mobile phone have imposed a spatial behaviour consistent with ICT age even as a number of studies (Salomon, 1986; Harkness, 1977; Mokhtarian, 1990, 2000, 2002; Mokhtarian and Salomon, 2002; Niles, 1994) have identified the potential relationships between telecommunications and travel: substitution (reduction, elimination), complementarity (stimulation, generation), modification (change time, mode, destination, and so on with respect to a trip or communication that would have occurred otherwise), and neutrality (no impact of one medium on the other, e.g. as many e-mail messages have no impact on travel and conversely). However, some studies of the relationships between telecommunications and travel tend to be conceptual, suggestive, and speculative without empirical analysis. Furthermore, they generally fail to place telecommunications and travel within a more comprehensive framework, considering other factors such as the economy, land use, and socio-demographics.

Numerous empirical studies have also been conducted at the disaggregate level, focused on the impacts of specific telecommunications applications, especially telecommuting, on travel. Those studies demonstrated a net impact of substitution by telecommuting (see Mokhtarian et al., 1995; Mokhtarian, 1998; Nilles, 1988). However, Mokhtarian and Meenakshisundaram (1999) argued that since all those studies were short-term and small-scale, they will underestimate complementary effects by failing to consider the more indirect and longer-term relationships (such as induced demand and residential location effects). One way to partially overcome this shortcoming is through aggregate studies, which broaden the scope of inquiry beyond a small self-selected sample focusing on a single application, in the short run. To date, however, only a few aggregate studies on this subject have been carried out. It is noteworthy that few of these studies fully explain the direct and indirect relationships between the actual demand for travel and mobile phone usage.

Fadare and Agunloye (2014) examined the influence of mobile phone usage on travel behaviour of inter-urban public transport passengers in Lagos, Nigeria. Using a set of structured questionnaire, the study revealed that mobile phone calls have positive relationship on travel behaviour of inter-urban public transport passengers in Lagos metropolis. Wojuade (2014) explore the relationship between telephone usage and travel behaviour among the staff of Obafemi Awolowo University, Ile-Ife, Nigeria and found that most members traveled less than 10km for work, shopping and social trips, spend less than 20 minutes journey time and mostly used private cars for commuting to the activities. The study concludes that there is net substitution and strong complementary effect of telephone usage on travel among the staff.

In urban analysis physical contacts especially day-to- day movement are important in studying the structure of a city, based to this are the day-to-day movements which has to do with activities such as trip making to and from places of work, markets and shopping centers and recreational and educational facilities. As Ayeni (1974) noted, “basic to the use of trips to characterize urban forms are two notions; first, that trips measure interdependence in an urban systems and second that each trips type is role of communication media in reshaping the urban future (Clark, 1973). The impact telecommunication will have on urban morphology and human movement has attracted the interest of scholars such as Nilles (1975), Goddard (1968) and Goddard and Pye (1977); among many others. While some of these scholars recognizes geographical important of communication flow, yet they were unclear about the role of communication as agencies of change in the spatial system. Telecommunications have been used as indices of spatial structures (Nysten and Dyer, 1997) rather than as measures of dynamic process (Clark, 1973).

The advent of new, more advanced communication technologies particularly Global System for Mobile Communications and other internet facility poses a fresh dimension to the scenario. The Growing use of Mobile phone (GSM) may be doing far more than influencing people’s movement in urban space. It has been reported that over 140 million people are telephone subscribers in Nigeria, with about 130.8 million digital mobile lines (NCC official website). Also call centers are on the increase on daily basis (The Punch, 2014). This perhaps may have begun to change the character of activities that occur in spatial system in this part of the world. The questions that now readily come to mind are; has new telecommunications technologies close geographical variation? Has it alter our concepts of time and space? Has it remove the disadvantages of remoteness? All these are worth investigating.

From the afore-said, it is established that there are scanty contemporary research works on intra-urban mobile phone usage and travel pattern and where they exist, no direct work on the study area. Therefore, this becomes a gap to investigate. The statement of research problem for this study is the extent of relationship that exists between intra-urban mobile phone usage and travel pattern of residents in Shomolu, Lagos, Nigeria.

2.0 STUDY AREA AND METHODOLOGY

2.1 Study Area

The study area for this research is Somolu local government area. In this case, the relevant information relating to geographical setting, historical evolution, population characteristics and economic activities of Somolu are discussed.

Geographical Location of Somolu

Somolu is located in Lagos State, Nigeria. It falls within the tropical rain forest zone, located on the longitude 4 east and latitude 8 north. It has an approximate coverage area of 17.355qkm. It is bounded in the North by Kosofe local government Area, in the South Lagos mainland local government area. In the east it is bounded by the Lagos lagoon and in the west by Ikeja Local government area. Major parts of Somolu local government area include Fadeyi, Anthony oke interchange, Bariga, some parts of Akoka as well as Apapa/ oworoshonki expressway areas. Some of the communities in the local government include: Bariga, Ilaje, Apelehin, Seriki Village, Abule Okuta Igbari and some parts of Akoka.

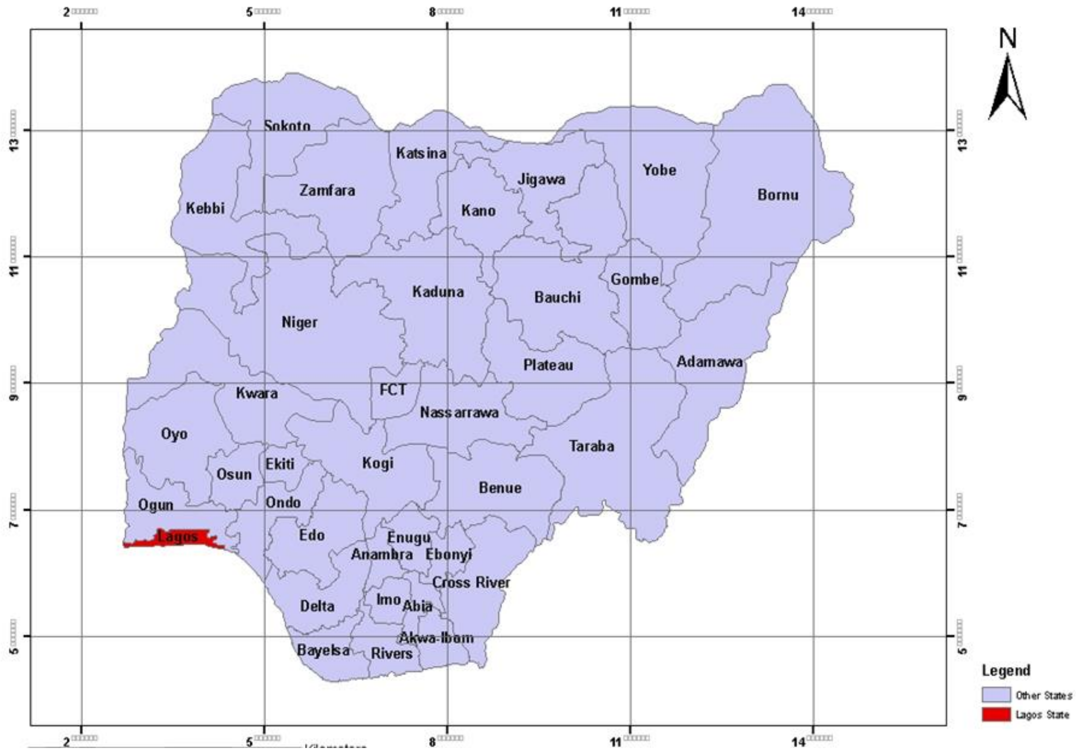
The inhabitants

The major ethnic group that is present in the study area are the Yorubas; among which we have the Ijebus, Aworis and Ilayjes. Other tribes present in the study area are the Ibos, Deltans, Efiks and in some proportions the Hausas and Nigerians, from across the borders of Nigeria.

Population

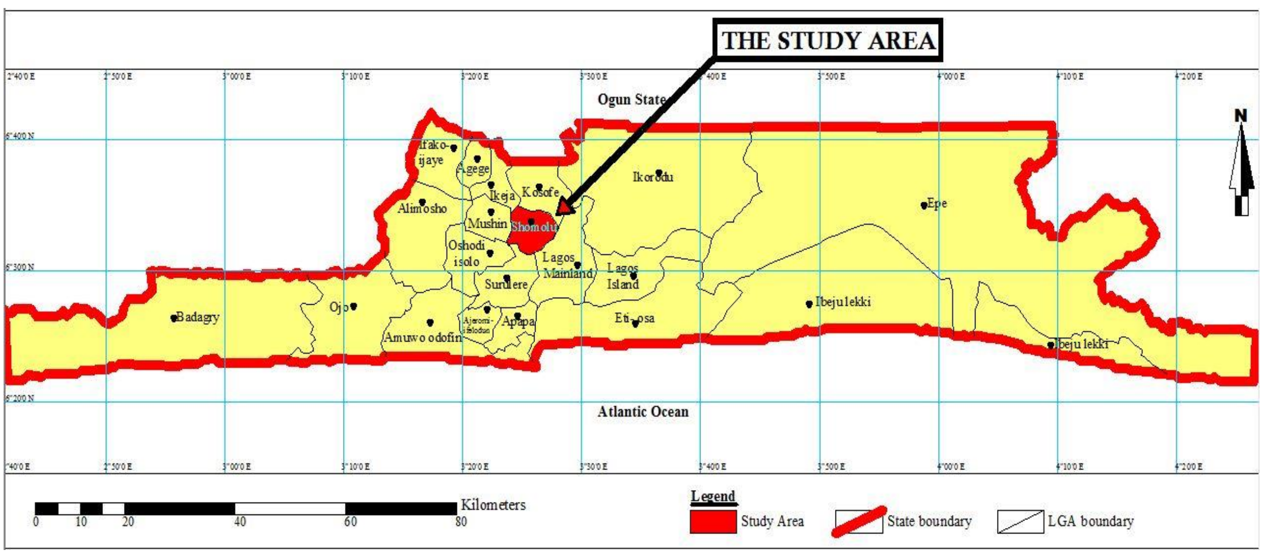
According to the results of the 1991 National census, Shomolu had a population of 486,849 inhabitants and 1,025,123 as at 2006. This is not the case presently, as population migration into Lagos state has led to an increase in the study area. By projection in the area is put at1,238,381 , as at 2012 and 1,361,110 based on an annual growth rate of 1.94% and 3.2%.

Figure 1: Map of Nigeria showing Lagos State



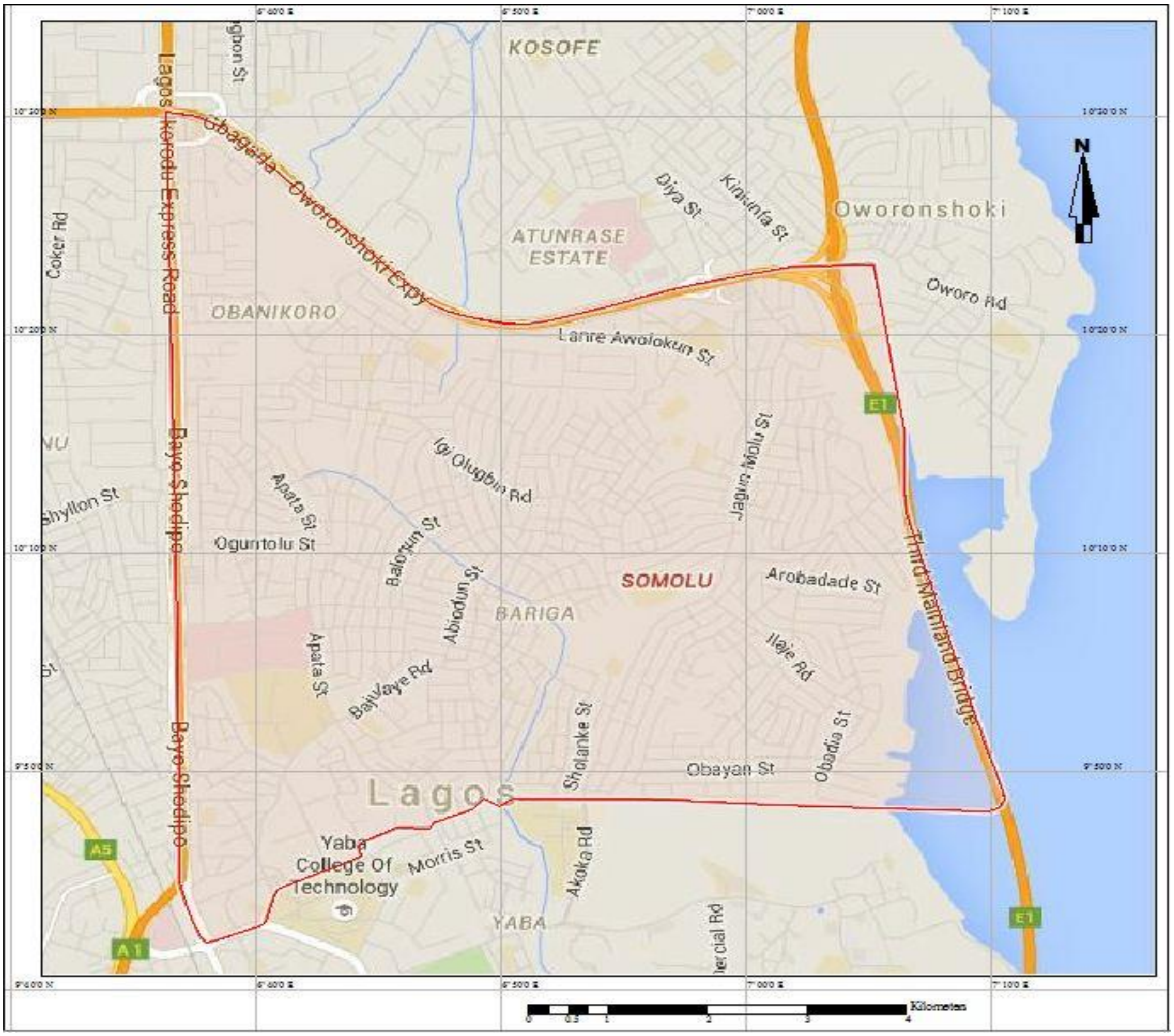
Source: Department of Surveying and Geoinformatics University of Lagos

Figure 2: Map of Lagos State depicting Somolu LGA



Source: Authors' Digitized Map

Figure 3: Map of Somolu LGA Depicting Study Area



Source: Authors' Digitized Map

Socio-Economic Characteristics of the People Somolu

The original settlers of Somolu engaged in subsistent farming and fishing. The Lagos lagoon severed as the main fishing territory for the Ilayjes who were skilled fisherman. The area had swamps and forests that served as hunting ground for the hunters in the earlier times. But as development began to occur, most of the fertile land and even swampy lands were reclaimed and used for building residential houses, construction of roads and building schools. Presently, the areas are populated by traders, artisans, civil servants, skilled and unskilled laborers and unemployed.

2.2 Methodology

The data used for this study were primary and secondary. The primary data were collected through field observation and administration of questionnaire. The secondary data were from existing literature, journals, books, thesis, reports, maps and cords from relevant state agencies and acknowledged authors whose works are relevant to this research. The sample frame for this study evolved from the total number of households' heads in the study area which is Four Thousand Eight Hundred and Fifty (4850). The sample size is the subset of the entire population that is to be sampled. The need to derive a sample size using a method is to understand the phenomenon properly without incurring too much expense, human labour and wasting too much time. Thus, this was done by drawing sample size from the total no. of household in the study area using Watson (2007) model. This estimated traerefore, the f sample size is 178. 70 sets of questionnaire were administered in Ward A, 14 sets of questionnaire were administered in Ward B, 49 sets of questionnaire were administered in Ward C and 45 sets of questionnaire were administered in Ward D. The systematic sampling technique was used. To efficiently analyze the data gotten from the field, the data was coded into Statistical Package for Social Sciences (SPSS) to draw pertinent analysis from the raw data and then analyzed them through descriptive and inferential statistics. Descriptive statistics used included frequency table, line graph, histogram, bar chart, pie chart etc. The inferential analytical tools used in making the inference about the study is Pearson correlation in order to analyze the relationships between residents 'mobile phone usage and travel demands in the study area.

3.0 RESULTS AND DISCUSSION

RESIDENTS' MOBILE PHONE USAGE

Number of Mobile Phone Owned by Respondents

Households' accessibility to mobile phone services as presented in Table 1 showed that 46 (25.8%) of the respondents have access to at least one personal mobile phone. The analysis further revealed that 65 (36.5%) of the respondents have access to two personal mobile phones, while just 36 (20.2%) have three phones while 31 (17.7%) has more than three mobile phones. This suggests a very high accessibility of respondents to telecommunication leads to increased or decreased travel demand.

Table 1: Number of Mobile Phones Owned by Respondents

Number of mobile phone	Frequency	Percentage
One	46	25.8%
Two	65	36.5%
Three	36	20.2%
Four	31	17.4%
Total	178	100.0%

Major Network Service Provider

Results of findings in Table 2 showed that 39 (21.9%) of the respondents use Mtn, 33 (18.5 %) use Glo, 32 (18.0%) use Airtel, 32 (18.0 %) use Etisalat, while 22 (12.4%) of the respondents use Visafone. This shows that majority of the respondents make use of Mtn as their major network service provider. This may be as a result of Mtn providing cheaper tariffs and better network service connection covering both the core urban areas, remote areas and other surrounding areas.

Table 2: Major Network Service Provider

Network provider	Frequency	Percentage
Mtn	39	21.9%
Glo	33	18.5%
Airtel	32	18.0%
Etisalat	32	18.0%
Visafone	22	12.4%
Starcom	20	11.2%
Total	178	100.0%

Calls Received per Day

Result of findings in Table 3 revealed that 55 (30.9%) of the respondents received less than 10 times calls per day, 43 (24.2%) of the respondents received calls between 11-20 times per day, 42 (23.6%) received calls between 21-30 times per day, while 38 (21.3%) of the respondents received calls above 31 times per day. This implies that respondents received more calls which may compliment or supplement travel demands.

Table 3: Call received per day

Call received per day	Frequency	Percentage
Less than 10 times	55	30.9%
11-20 times	43	24.2%
21-30 times	42	23.6%
31 and above	38	21.3%
Total	178	100.0%

Calls make per day

Results in Table 4 depicted that 48 (27.0%) of the respondents make less than 10 times calls per day, 47 (26.4%) of the respondents make calls between 11-20 times daily, 44 (24.7%) of the respondents make calls between 21-30 times daily, while 30 (20.9%) of the respondents make calls more than 31times and above daily. This implies that majority of the respondents makes lesser calls on a daily basis.

Table 4: Calls made per day

Calls made per day	Frequency	Percentage
Less than 10 times	47	26.4%
11-20 times	48	27.0%
21-30 times	39	21.9%
31 and above	44	24.7%
Total	178	100.0%

Amount Spent on Calls per Day

As shown in Table 5, 4 (25.3%) of the respondents spent less than #100 on calls they make per day, 47 (26.4%) of the respondents spent #101 - #300 on their last calls, 47 (26.4%) of the respondents spent #301 - #500, while 39 (21.9%) of the respondents spent #501 and above on their last calls. This reveals that respondents spend average of #101-#500 on calls per day.

Table 5: Amount Spent on Calls per Day

Amount spent	Frequency	Percentage
Less than #100	45	25.3%
#101-#300	47	26.4%
#301-#500	47	26.4%
#501 and above	39	21.9%
Total	178	100.0%

Mobile Phone Usage per Day

The study found in Table 6 that 46 (25.8%) of the respondents make use of mobile phone less than 5 times per day, 48 (27.0%) of the respondents make use of mobile phone between 6-10 times daily, 43 (24.2%) of the respondents make use of mobile phone between 11-20 times daily while 41 (23.0%) of the respondents make use of mobile phone up to 21 times and above per day. From the table, it can be deduce that more of the respondents make use of mobile phone on daily basis either to call, send text messages or chat to compliment or supplement travel demands.

Table 6: Mobile Phone Usage per Day

Variables	Frequency	Percentage
Below 5 times	46	25.8%
6-10 times	48	27.0%
11-20 times	43	24.2%
21 and above	41	23.0%
Total	178	100.0%

Duration of Phone Call per day

Results in Table 7 revealed that 25 (14.0%) of the respondents made less than 5 minutes call duration per day, 56 (31.5%) of the respondents make between 5-10 minutes call durations per day, 43 (24.2%) of the respondents make between 11-20 minutes call durations per day while 54 (30.3%) of the respondents make 16 minutes and above call durations per day.

Table 7: Durations of Phone Calls per Day

Call duration	Frequency	Percentage
Below 5min	25	14.0%
5-10min	56	31.5%
11-20min	43	24.2%
21 and above	54	30.3%
Total	178	100.0%

RESIDENTS' TRAVEL DEMAND

Number of Single Trips per Day

Results in Table 8 found that 63 (35.4%) of the respondents made less than 5 times single trip per day, 45 (25.3%) of the respondents make between 6-10 times single trips per day, 34 (19.1 %) and 36 (20.2%) of the respondents make between 11-15 times and 16 times and above single trips per day respectively. Furthermore this can be explained that majority of the respondents embark on trips less than 5 times per day, whereby engaged on trips from their destination and returned back to their destination on the same day.

Table 8: Number of Single Trips per Day

Trips made per day	Frequency	Percentage
Less than 5	63	35.4%
6-10	45	25.3%
11-15	34	19.1%
16 and above	36	20.2%
Total	178	100.0%

Mode of transport

As shown in 9, 31 (17.4%) of the respondents made use of personal car as mode of travel, 76 (42.7%) used buses, 19 (10.7%) of respondents used motor cycle, 22 (12.4 %) of the respondents use tricycle, while 1 (0.7%) respondents used train as a mode of transport. This implies that majority of the respondents travel by bus to their various activities. Although due to the level of congestion on the roads, the use of buses as modes of transport has not reduce the level of congestion rather increased congestion on the road.

Table 9: Modes of Transport

Mode of transport	Frequency	Percentage
Personal car	31	17.4%
Public bus	76	42.7%
Motor-cycle	19	10.7%
Tri-cycle	22	12.4%
Train	1	0.7%
Others	29	16.3%
Total	178	100.0%

Travelling Purpose

Results in Table 10 showed that 33 (18.5%) of the respondents travelled for educational purpose, 34 (19.1%) of the respondents travelled for visitation purpose, 26 (14.6%) travelled for social purpose, 26 (14.6%) travelled for shopping, 34 (19.1%) travelled for official assignment, 25 (14.0%) travelled for health purpose. It has shown that official assignment and visitation purposes are the major reasons why the respondents travel.

Table 10: Travelling Purpose

Purpose of travelling	Frequency	Percentage
Educational purposes	33	18.5%
Visitation purposes	34	19.1%
Social purpose	26	14.6%
Shopping	26	14.6%
Official assignment	34	19.1%
Health purpose	25	14.0%
Total	178	100.0%

Time Taken To Travel Destination

As shown in Table 11, 90 (63.4%) of the respondents spent less than 1 hour in getting to their destination, 69 (37.6%) of the respondents used 2-5 hours in getting to their destination, while 18 (10.7%) of the respondents used 5-9 hours in getting to their destination. From the table below, it shows that majority of the respondents spends less than 1 hour in getting to their destination.

Table 11: Time Taken To Travel Destination

Time to Destination	Frequency	Percentage
Less than 1hour	90	52.4%
2-5hours	70	36.9%
5-9hours	18	10.7%
9hours and above	0	0%
Total	178	100.0%

Travelling Distance per Day

For the purpose of analysis, travel distance in this study is defined as the distance covered for a journey made within or outside the city to a destination for a particular purpose notwithstanding the number of modal interchange. Result in Table 12 revealed that the 34 (19.1%) of the respondents travelled less than 5km per day, 40 (22.5%) respondents travel between 6- 10 km per day, 25 (14.0%) respondents travel between 11-15 km, 45 (25.3%) of the respondents travel between 16- 20 km per day, while 34 (19.1%) of the respondents travel above 21 km and above per day. This implies that majority of the respondents travel less than 21 km per day.

Table 12: Travelling Distance per Day

Travelling distance	Frequency	Percentage
Less than 5km	34	19.1%
6-10km	40	22.5%
11-15km	25	14.0%
16-20km	45	25.3%
21km and above	34	19.1%
Total	178	100.0%

Cost of Travelling Per Day

Results in Table 13 suggested that 36 (20.2%) of the respondents spend less than #100 on travel per day, 56 (31.5%) spend #101 - #500 per day, 47 (26.4%) spend #501 - #1000, while 39 (8.8%) spend #1001 and above on travel per day. The result of the findings indicate that majority of the respondents travel cost is between # 101- #500 daily.

Table 13: Cost of Travelling Per Day

Cost of travel	**Frequency**	**Percentage**
Less than #100	36	20.2%
#101-#500	56	31.5%
#501-#1000	47	26.4%
#1000 and above	39	21.9%
Total	178	100.0%

Mobile Phone Calls Instead of Going Out per Day

As shown in Table 14, 43 respondents representing 24.2% made less than 5 times phone calls instead of going out on daily basis, 57 (32.0%) makes between 6–10 times calls per day, 44 (24.7%) make between 11–15 times phone calls per day, while 34 (19.1%) of the respondents make calls above 16 times per day instead of going out on daily basis. Furthermore the table reveals that majority of the respondents make calls 6 - 10 times on daily basis rather than going out.

Table 14: Mobile Phone Calls Instead of Going Out per Day

Variables	**Frequency**	**Percentage**
Less than 5 times	43	24.2%
6-10 times	57	32.0%
11-15 times	44	24.7%
16 times and above	34	19.1%
Total	178	100.0%

Appointment Cancelled As a Result of Phone Calls per Day

Results in Table 15 revealed that 61 (34.3. %) of the respondents cancelled their appointments less than 5 times daily, 47 (26.4%) cancelled their appointment between 6-10 times, 34 (19.1%) of the respondents cancelled their appointment between 11-15 times, 36 (20.2%) cancelled their appointment between 16 times and above. From the analysis majority of appointments cancelled by the respondents were less than 5 times per day.

Table 15: Appointment Cancelled As a Result of Phone Calls per Day

Variables	Frequency	Percentage
Less than 5 times	61	34.3%
6-10 times	47	26.4%
11-15 times	34	19.1%
16 times and above	36	20.2%
Total	178	100.0%

Trips Increased As a Result of Phone Calls per Day

The study found in Table 16 that 56 (31.5%) of the respondents trips increased as a result of phone calls was less than 5 times daily, 47 (26.4%) of the respondents trips completed was between 6-10 times daily, 33 (18.5%) of the respondents trips increased were between 11-15 times daily, while 42 (23.6%) of the respondents trips increased were above 16 times daily.

Table 16: Trips Increased As a Result of Phone Calls per Day

Trips increased	Frequency	Percentage
Less than 5 times	56	31.5%
6-10 times	47	26.4%
11-15 times	33	18.5%
16 times and above	42	23.6%
Total	178	100.0%

Cross Tabulation between Trips completed and Call frequency

The results of the findings in Table 17 revealed that 13 respondents who made less than 10 calls per day completed less than 5 trips while 14, 10 and 14 respondents completed less than 5 trips per day respectively. Also, 14 respondents completed 6-10 trips as a result of making less than 10 calls per day while 8, 16 and 7 respondents also completed their trips as a result of calling 11-20, 21-30 and 31 and above times per day. It was also revealed that 10 respondents completed 11-15 trips as a result of making less than 10 calls per day. Also, 10 respondents were able to complete 16 and above trips as a result of making less than 10 calls per day while 12, 21 and 11 completed 6-10, 11-15 and 31 and above trips as a result of calling respectively.

Table 17: Cross Tabulation between Trips completed and Call frequency.

Trips completed	Call Frequency				Total
	Less than 10 times	11-20 times	21-30 times	31 times and above	
Less than 5 times	13	14	10	14	50
6-10 times	14	8	16	7	40
11-15 times	10	14	14	12	44
16 and above	10	12	21	11	44
Total	47	48	39	44	178

RELATIONSHIP BETWEEN URBAN HOUSHOLDS' MOBILE PHONE USAGE AND TRAVEL DEMANDS OF RESPONDENTS IN THE STUDY AREA

Three variables from mobile phone usage (calls received per day, calls make per day and amount spend on calls per day) and three variables from travel demands (trips completed a result of mobile phone calls, trips increased as a result of mobile phone call and appointment cancelled as a result of mobile phone calls) of the respondents were subjected to Pearson correlation analysis. The dependent variables were travel demands while mobile phone usage variables were the independent variables. The results of the findings in Table 18 depicted a strong positive relationship between the respondents' received calls and appointment cancelled (n=178, p> 0.01, r=0.480). This indicates that as respondents received calls, the appointment cancelled increases per day. The results also shows that there is a positive relationship between respondents received calls and number of trips completed (n=178, p> 0.05, r=0.149). This indicates that the more the respondents received calls per day, the more the number of trips completed per day. There is also a strong positive relationship between respondents' received calls and trip induced or increased (n=178, p> 0.01, r=0.592). Which suggest that the higher the respondents received calls per day the more travel is induced or increased. Results of findings in Table 4.25 also shows that there is a positive relationship between the calls frequencies by respondents per day and the number of trips completed per day (n=178, p> 0.05, r=0.194). Which revealed that the more calls frequencies by the respondents the higher the number of trips completed. The results also shows that there is a positive relationship between the calls frequencies by the respondents and travel induced (n=178, p> 0.01, r=0.204). This indicates that the more the respondent calls frequencies per day the longer the length of travel. As shown in the table above the results of the findings also shows that there is also a positive relationship between the amounts spend on calls by the respondents and appointments cancelled (n=178, r=0.199). This indicates that the higher the amount spent on calls by the respondents' the higher the number of trips completed. From the analysis of the bivariate Pearson correlation, it shows that there is positive significant positive relationship between residents' mobile phone usage and travel pattern in the study area, which indicate that the hypotheses is accepted.

Table 18: Pearson Correlations between Resident' Mobile Phone and Travel Pattern

Pearson	Cancelled Appointment	Trips Completed	Trips Increased
Received calls per day	.480**	.149	.592**
Calls made per day	.263	.194*	.204
Amount spent on calls	.269	.199	.258

** Correlation is significant at the 0.01 level (2-tailed)
* Correlation is significant at the 0.05 level (2-tailed)

RECOMMENDATIONS AND CONCLUSION

Recommendations

There is a need to set up e-transaction platform that will help to reduce the observed travel distances that increases as a result of the increased in received calls and calls frequencies. The study revealed that majority of respondents are students, as such, there is need to reduce call tariffs or prices of recharge vouchers and calls to other networks, efficient service delivery and interconnectivity between networks. It is also important to introduce e-learning in the study area in order to reduce the residents' travel as revealed in the study. There is also a need for other modes of transport such as (motor cycle, ferry and tricycle) in the study area to be improved upon so as to encourage patronage by the residents and reduce the level of congestion and travel delay by high level of patronage on buses as revealed in the study. There should be massive awareness by the government, private sector and non-governmental organization on the use of telecommuting through various social platform, electronic platform and media houses. Telecom operators should further increase the reliability of their network as well as reduced the rate per minute call-cost. The Nigerian Communication Commission (NCC) should monitor the activities of the service provider to ensure that the standard of service to customer is maintained. Telecommuting is a major measure to reduce traffic congestion on Nigerian roads, as such, this phenomenon should be integrated into transportation planning policy. NCC should facilitate private sectors participation in communication services delivery, coordinate and regulate the activities of service providers and fair princing. Services from network provider should be monitored in order to ensure that relible and efficient services are made available to subscribers in order to further discourage physical travel which leads to intra-urban traffic congestion on daily basis.

Conclusion

This study has focused on the relationship between telephone usage and travel behaviour. It has been established that the residents travel long distances for the trip purposes. The frequency of visit and official assignment is high while there is high use of public transit for commuting to most of the journey purposes. Furthermore, the journey time indicated that most of the residents travel for less than 1hour to activities area. On the other hand, there has been high telephone usage among the residents which has led to high complemented trips although some trips were substituted as well. However, it was found that while mobile phone is adoptable for some activities, there remain some activities or purposes for which physical mobility is essential. Based on the findings, this study concludes that there is weak positive substitution effect and strong positive complementary effect in the relationship between intra-urban mobile phone usage and travel behavior of the residents in Somolu LGA.

REFERENCES

Adeniji, K. (2000). Transport Challenges In Nigeria In The Next To A Declares. Transport Studies Unit NISER Ibadan. P. 24.Conomics and International Finace.3 (1), 37-45.

Agunloye, O. O. (2011). Analysis of the travels of public transport passengers (road) in Ikorodu, Lagos, Nigeria. Journal of Geography and Regional Planning, 4(7), 443-448.

Agunloye, O.O. (2013). Mobile Phone Usage and Travel Behaviour of Airline Passengers in Lagos, Nigeria. Journal of Engineering and Environmental Studies, 4(1), 33-40.

Choo, S., Mokhtarian, P.L., and Salomon, I., (2005).Does telecommuting reduce vehicle-miles traveled? An aggregate time series analysis for the U.S. Transportation, 32, 37–64.

Choo, S. and Mokhtarian P.L., (2009). Telecommunications and travel demand and supply: aggregate structural equation models for the US. Transportation Research A, 41, 4-18.

Clark D (1973). Communication and the Urban Future. A Case Study of Trunk Telephone Call Patterns In Wales" Reg. Stud., 7(3): 315-321.

Clifton K.J. and C.L. Handy (2001) "Qualitative methods in Travel Behaviour Research" Paper presented at the International Conference on Transport Survey Quality and Innovation, Kinger National Park, South Africa.

European Commission (2013) EU in transport figures: statistical pocketbook.[Online]. Available:http://ec.europa.eu/transport/factsfindings/statistics/doc/2013/pocketbook 2013.pdf (February 21, 2014).

Fadare, S.O. (1987) "Intra-Urban travel characteristics: A study of Socio-economic attributes in Ibadan". Ph.D Thesis submitted to University of Sheffield, England.

Fadare, S. O. (1989) "Analysis of factors affecting Household trip length in the Residential Area of Ibadan". *Ife Research Publications in Geography*, Dept of Geography, O.A.U., Ile – Ife, 3.

Fadare, S. O., and Agunloye O.O. (2014). Influence of Mobile Phone Usage on Travel Behaviour of Inter-Urban Public Transport Passengers in Lagos, Nigeria. Journal of Sustainable Development in Africa (Volume 16, No.4, 2014).

Fadare, S.O. and Salami, B.T., (2004). Telephone uses and the travel behaviour of residents in Osogbo, Nigeria: an empirical analysis. Journal of Transport Geography, 12, 159-164.

Fujiwara, A., Soehodho, S., Hyodo, T., and Montalbo, C. (2005): "Urban travel behaviour characteristic of 13 cities based on Household interview survey data". *Journal of the East Asia Society for Transportation studies. Vol. 6 pp* 23-38.

Goddard JB (1970). Functional Regions within the City Centre: A study of factor analysis of Taxi flows in Central London. Inst. Br. Geogr. Trans., 49: 161-182.

Golob, T.F., and Regan, A.C., (2001). Impacts of information technology on personal travel and commercial vehicle operations: research challenges and opportunities. Transportation Research C, 9, 87-121.

Handy, S., Cao, X., and Mokhtarian, P., (2005).Correlation or causality between the built environment and travel behaviour? Evidence from Northern Carolina. Transport Research D, 10, 427- 444.

Hook, W. (1995). Economic Importance of Non-Motorized Transportation. Trans. Res.Record, 1487: 14-21.

Mokhtarian, P.L., (1990). A typology of relationships between telecommunications and Transportation Research a, 24(3), 231–242.

Mokhtarian, P.L., and Meenakshisundaram, R., (1999). Beyond tele-substitution: disaggregate longitudinal structural equations modeling of communication impacts. Transportation Research C, 7, 33-52.

Mokhtarian, P.L., (2002). Telecommunications and travel: the case for complementarity. Journal of Industrial Ecology, 6(2),43 – 57.

Mokhtarian, P.L., and Salomon I., (2002). Emerging travel patterns: do telecommunications make a difference? In: Mahmassani, H. S, (eds.), in Perpetual Motion: Travel Behaviour.

Mokhtarian, P., (2009). If telecommunication is such a good substitute for travel, why does congestion continue to get worse? Transportation Letters: The International Journal of Transportation Research, 1, 1 –17.

National Population Commission (2007). The national and state provisional population totals 2006. Lagos, The federal government printer, 24, 94.

Osoba, S.B. (2012). Impact of socio-econokic characteristics of Gsm-owner on the use of global system for mobile communication (GSM), journal of Economics and International Finance vol.4 (4), pp.101-106.

Plaut, P.O., (1997). Transportation-communication relationships in industry. Transportation

Salomon, I., (1986). Telecommunications and travel relationships: A review. Transportation Research A, 20, 223–238.

Salomon, I., and Schofer, J.L (1988). Forecasting telecommunication travel interaction: the transportation manager perspective. Transportation Research A, 22(1), 219–229.

Wojuade, C.A., (2014). Telephone Usage and Travel Behaviour in Nigeria. Department of Transport Management, Ladoke Akintola University of Technology, PMB 4000 Ogbomoso, Nigeria. Vol.4, No.20, 2014.

Yuan. Y., Raubal, M., and Liu, Y., (2012).Correlating mobile phone usage and travel behavior- a case study of Harbin, China. Computers, Environment and Urban Systems, 36, 118-130.

Zimmerman, C.A., Campbell, J.L., and Cluett, C., (2001). Impact of new information and communication technologies on transportation agencies: a synthesis of highway practice. NCHRP Synthesis 296, National Cooperative Highway Research Program, Transportation Research Board.

EXPANDED POLYSTYRENE (EPS) AS SUBSTITUTE FOR TRADITIONAL FASCIA MATERIALS.

Hassan, 1. O[1], Sani, D. O[1], Umar, A[2], Usman, B.W[2].
[1]Department of Building, School of Environmental Technology, Federal University of Technology Minna
[2]Department of Architecture, Faculty of Environmental Technology, A.T.B.U Bauchi

Timber and reinforced concrete have been used for the construction of fascia for buildings over the years. However, these conventional materials have their shortcomings hence, the need for better materials. One of such materials is expanded polystyrene (EPS). This research therefore focused on the evaluation of the properties of expanded polystyrene with the view of using it as a substitute for the traditional materials as fascia. Company standards of expanded polystyrene was obtained and compared with those of timber and concrete. Also laboratory tests were carried out to ascertain the effects of moisture on weight, cost benefit analysis and construction requirements were evaluated for the three materials. The susceptibility of the materials to fire was evaluated. It was found that, the cost of constructing reinforced concrete fascia is 46% higher than EPS fascia of comparable size. Also, timber gains 16.67% increase in weight when exposed to moisture while EPS gained only 7.69%. In terms of fire resistance, timber has the least tolerance with a temperature range of 140-180°C followed by EPS with 180-210°C while concrete ranges between 300-650°C. However EPS is normally installed with a concrete cover on the inner phase thereby utilizing the fire resistance of concrete on that face. Thus, expanded polystyrene is an excellent replacement for timber and concrete (conventional materials) in fascia construction.

Keywords: *Expanded Polystyrene; Fascia*; *Reinforced Concrete; Timber;*

i.hassan@futminna.edu.ng

1.1 Introduction

With the evolving technology around the world, there is an invariably commensurate upgrade in the building materials in use in our contemporary society. This change however is fought constantly by the individual professionals in the construction industry. One of such materials that have suffered from this dismal trend to stick to the status co is the expanded polystyrene (EPS) which though, is an innovative and reliable material with alternative uses, have not been truly put to consistent use in the Nigerian construction industry. EPS has a variety of uses which includes walls, ground stabilization, ceiling, cornices, and fillers for light weight floors and in more recent time fascia for roofs.

Fascia is any material usually nailed to or attached to the free end of the rafters or the outer face of the cornice which can be a flat board, band, or moldings of composite or simple material that is designed to sometimes include the gutter and finished in such a way as to enhance the aesthetic outlook of the building.

The word fascia derives from Latin "fascia" meaning "band, bandage, ribbon, and swathe". The term is also used, although less commonly, for other such band-like surfaces like a wide, flat trim strip around a doorway, different and unattached to the wall surface.

EPS is a lightweight material that has been utilized in engineering applications since at least the 1950s. Its density is about a hundredth of that of soil. It has good thermal insulation properties with stiffness and compression strength comparable to that of medium clay (EPG 2013).

EPS is an organic insulation that displays a positive eco-balance. It is a rigid cellular plastic which is made from expandable polystyrene containing an expansion agent, pentane. As a building material, EPS has found applications in many aspects of building works including large structures such as roads, bridges, railway lines and public buildings. In addition to its eco-friendly nature, EPS displays low thermal conductivity, lightweight, mechanical resistance, moisture and chemical resistance, ease of handling and installation and versatility, making it more suitable for building construction than the conventional sandcrete system (Ogundiran and Adedeji, 2012; EPG 2013).

The EPS fascia is an alternative to the conventional concrete fascia and the cast in-situ roof cornices that require formwork for construction. There are two different categories of fascias which are the structural and the nonstructural fascias. The structural is reinforced with wire mesh and shotcreted on the site whereas the non-structural is finished with a thin layer of plaster from the factory. The non-structural fascias are usually used for improved aesthetics only where no load will be imposed.

EPS is a multipurpose plastic material made accessible for a collection of uses. EPS has encountered extensive variety of utilizations attributable to its lightweight, inflexibility, warm and acoustic protecting properties. Initially, EPS was chiefly utilized for protection form for shut hole dividers, rooftops and floor protection. In any case, the application has expanded tremendously in the building and development industry such that EPS is currently utilized as a part of street development, extensions, floatation and wastes. EPS utilized for building development are of changed sorts and sizes with the most widely recognized ones being for divider boards and for section. These boards are built with steel networks. The steel lattice serves as support. The EPS 3D fortified divider framework more often than not exchanges shear and compressive strengths along the divider plane. The divider framework is finished by applying solid layers of worthy thickness on both sides to perform the double elements of securing the fortifications against erosion and for exchanging the compressive powers (Ede and Ogundiran, 2014).

The EPS piece is the first primary item from which every single other item are determined. The piece itself has discovered applications in earth development including soil adjustment, street development, retaining walling and decks (Ogundiran and Adedeji, 2012). The square comes in 1200mm x 600mm x 6000mm. The EPS belt or cornice is one of the subordinates of the EPS piece.

The EPS sash or cornice is a distinct option for the customary solid belt and the cast in-situ rooftop belts that requires formwork for development. EPS sashes are in different shapes and sizes, ranging from 3000mm x 300mm x 300mm to 3000mm x 600mm x 600mm. There are two distinct sorts of EPS belts. These are the auxiliary and the non-structural sashes. The basic belt is fortified with wire network and shotcreted on the site while the non-basic is done with a meagre layer of mortar from the manufacturing plant. The non-basic sashes are generally utilized for upgraded style just where no heap will be forced.


(a)

(b)

Fig. 1 (a) Structural polystyrene fascia reinforced with wire mesh and shotcreted (b) Non-structural fascia finished with a thin layer of plaster

2.1 Methodology

The research design for this study is mainly quantitative in nature with the data been sourced from both primary and secondary sources. The primary data were basically obtained from the test carried out to determine the effect of moisture and heat on the various fascia materials under consideration. The weights of the respective materials were compared before and after absorption by using standard 500mm sample sizes. Furthermore, the effect of heat was also carried out on standard 500mm sample sizes. The secondary data were obtained from documented records of tests and experiments conducted and carried out on the product by the company for the purpose of standardization. These data were made available to the public through brochures and catalogue and published articles in scholarly journals.

Comparative cost analysis of the respective fascia materials was carried with respect to the unit cost and cost of installation.

3.1 Results and discussions

3.2 Comparative assessment of the weight and water absorption of fascia materials

The results of the assessment of the weight of respective fascia materials as presented in Table 1 shows that there is a relatively large amount of load on the structure coming from the reinforced concrete fascia of 500mm length. The weight of 450mm reinforced concrete facia is 12 times greater than that of timber and 33 times greater than that of polystyrene. If this load is not properly handled and transmitted to the foundation, it can cause serious defects to the building in the form of cracks and even in extreme cases, total collapse of the structure. The water absorption of the respective facia materials as presented in Table 1 revealed that timber has higher water absorption which is 11.7% and 9% higher than that of reinforced concrete and polystyrene respectively. This difference in the total absorption can be attributed to the fact that the wood fibers have higher affinity for water absorption when compared to equal section of reinforced concrete. In addition, the thin layer of mortar finishing provided on face of the polystyrene coupled with the fiber mesh are responsible for the 7.7% water absorption. Though the expanded polystyrene has a relatively higher response to water absorption than reinforced concrete, the implication has higher magnitude in reinforced concrete over a long period of exposure due reinforcement corrosion.

Table 1. Summary of the weights

S/N	Particulars	Timber	Reinforced concrete		Polystyrene	
			300mm	450mm	300mm	450mm
1	Weight of 500mm	4.0kg	25.4kg	40.5kg	1.3kg	1.5kg
2	Weight of 1m	8.0kg	50.8kg	80.1kg	2.6kg	3.0kg
3	Total weight on structure	465.92kg	4665.02kg	5958.59kg	151.42kg	174.72kg
4	Water Absorption	16.67%	4.94%	5.91%	7.69%	7.69%

3.3 Comparative costing

The results presented in Table 2 shows that the lowest cost of construction for fascia is that of timber. However, timber has been known to be associated with a lot of maintenance issues within the life span of the building as presented in Table 3. Review of life cycle costing revealed that timber has the highest cost because of its high maintenance cost, followed by concrete which has high initial cost as shown in Table 2. Expanded polystyrene happens to be a fair balance of the two materials cost.

Table 2. showing the cost for the various types of materials

S/N	Type of material	Sample Size	
		300mm	450mm
1	Expanded polystyrene	₦ 176696	₦ 333944
2	Reinforced concrete	₦ 393800	₦ 472560
3	timber	₦ 81850	Nil

Table 3. Summary of cost and benefits incurred in each construction process

s/n	Particulars	Timber	Reinforced concrete		Polystyrene	
			300mm	450mm	300mm	450mm
1	Monetary cost	₦ 81850	₦ 393800	₦ 472560	₦ 176696	₦ 333944
2	Weight on the structure	465.92kg	4665.02kg	5958.59kg	151.42kg	174.72kg
3	Time involved	2days	5days	5days	2days	2days
4	Reaction to moisture	16.67%	4.94%	5.91%	7.69%	7.69%
5	Susceptibility to insect attack	attacked	Not attacked		Not attacked	
7	Possibility of delay in process	Not likely	Very likely		Not likely	
9	maintenance	Replacement	Repainting		Repainting	

3.4 Susceptibility to Fire

Table 3 shows the temperature range at which the various materials under consideration are affected by fire. The information has been put into ranges because it is difficult in practice to ascertain exactly the temperatures at which these various materials are affected due to the variation in the materials properties.

From the data presented, concrete has the highest temperature allowance followed closely by polystyrene and lastly timber. However in practice, the internal face of the installed polystyrene is covered with concrete thereby allowing the installed fascia to exhibit a combined resistance of both the factory installed fire retardant coating and that of cast in place concrete provided in the site.

S/N	Material	Upper Limit (˚C)	Lower Limit (˚C)
1	Timber	140	180
2	Concrete	300	650
3	Polystyrene	180	210

Table 4. Temperature at which different materials are affected by fire

3.5 Other Considerations

From the considerations presented in Table 5 it is clear that the conventional fascia materials have a lot of processes and their associated cost. These processes if not well coordinated and properly handled could lead to disastrous consequences. It can also be noted that there is a lot of supervision required for the installation of formwork, reinforcement and other wood work involved in the installation of the traditional fascia materials. On the other hand; the installation of expanded polystyrene fascia is more of a specialist process that requires very little supervision.

Table 5. Other considerations

s/n	Particulars	Reinforced concrete	polystyrene	timber
1	**Scaffolding**	**Required**	**Required**	**Required**
2	**Formwork**	**Required**	**Not required**	**Not required**
3	**Reinforcement**	**Required**	**Not required**	**Not required**
4	**Bracing**	**Required**	**Required**	**Not required**
5	**Concrete gang/ mixer**	**Required**	**Not required**	**Not required**
6	**Casting of concrete**	**Required**	**Not required**	**Not required**
7	**Curing/ curing time**	**Required**	**Not required**	**Not required**
8	**Striking of formwork**	**Required**	**Not required**	**Not required**
9	**Supervision**	**required**	**required**	**required**

Conclusion

From the array of data available and the preceding discussions, the following conclusions can be drawn

i. The weight of 450mm reinforced concrete facia is 12 times greater than that of timber and 33 times greater than that of polystyrene.

ii. The water absorption of the respective facia materials as presented in the study revealed that timber has higher water absorption which is 11.7% and 9% higher than that of reinforced concrete and polystyrene respectively.

iii. Reinforced concrete facia generally has higher initial cost of installation which is 55% and 116% greater than that of polystyrene and timber respectively. On other hand, timber has higher maintenance cost in comparison to concrete and polystyrene which is as a result of issues relating to insect attack, susceptibility to moisture penetration, repainting and replacement.

iv. Concrete has the highest temperature allowance followed closely by polystyrene and lastly timber. However in practice, the internal face of polystyrene is covered with concrete while the external face is coated with fire retardant mortar thus enabling it to exhibit the fire resistant characteristics of both materials.

Generally, conventional fascia materials have a lot of processes and their associated cost while installation of expanded polystyrene fascia is more of a specialist process that requires very little supervision.

References

Ede, A.N and Ogundiran, A. (2014). Thermal Behaviour and Admissible Compressive Strength of Expanded Polystyrene Wall Panels of Varying Thickness. *Current Trends in Technology and Science* ISSN : 2279-0535. Vol.3(2), pp.110 -117

Fire properties of building materials and elements of structure. Document MP9:1989. Standards Association of New Zealand, 1989.

Huntsman, (1999h) "*Modified Expanded Polystyrene, Standards, Specifications and Regulatory Compliance"* Huntsman Corporation, Texas, USA, Technical Bulletin, No. 8-8.1.

Huntsman, (1999i) *"Huntsman Expanded Polystyrene Performance Characteristics"* Huntsman Corporation, Texas, USA, Technical Bulletin, No. 7-7.7.

Ogundiran, I. A and Adedeji, Y M D. *Urban housing delivery: Expanded polystyrene panels initiative in Abuja, Nigeria* In: Laryea, S., Agyepong, S.A., Leiringer, R. and Hughes, W. (Eds) Proceedings of the 4th West Africa Built Environment Research (WABER) Conference, 24-26 July 2012, Abuja, Nigeria, pp1033-1042

Parker A.J, Beitel J.J. (2006). *Modern materials: Flamability requirements for plastic materials* p. 10-12.

Whalen, W.J. (2004). *Energy efficient building systems using EPS insulation*. Construction Canada Magazine, Vol. 46(4).

Wikipedia; Expanded Polysterene concrete, Retrieved May 20, 2012, from Wikipedia website: http:/www.wikipedia.com.

ASSESSMENT OF THE AVAILABILITY OF LANDSCAPE ELEMENTS IN PUBLIC SECONDARY SCHOOLS IN MINNA NIGER STATE.

ADAMS ESTHER AMAKA

Department of Architecture Federal University of Technology Minna, Niger State

Numerous studies have shown that landscape elements provide a number of health and wellbeing benefit. A common denominator in this is human attachment to nature and how we find identity in landscape. The aim of this paper is to assess the adaptation of landscape elements in public secondary school buildings towards improving the level of attachment to school by user as well as mitigating the effect of climate change for sustainability through the provision of a proper landscape of government secondary school environment in Niger State Minna North Central Nigeria. It was based on the notion that landscape has some benefits on secondary school users. Data was obtained using an observation schedule and a cross section of ten government secondary schools were surveyed in Minna and Chanchaga local government of Niger State. The studies assessed the level of landscape and how attached are users to the environment of government secondary schools in Minna. The conclusion and recommendation highlighted critical areas where attention is needed in order to improve the landscape of government secondary schools in Minna Niger State .

Keywords; climate change, sustainability, landscape elements, secondary schools, availability, users.

esther.adams@rocketmail.com

Adams, E.A. (2016). **ASSESSMENT OF THE AVAILABILITY OF LANDSCAPE ELEMENTS IN PUBLIC SECONDARY SCHOOLS IN MINNA NIGER STATE** Sustainable Built Environment and Climate change; The challenges of Post 2015 Development Agenda. School of Environmental Technology Conference, SETIC, 2016

INTRODUCTION

The importance of secondary education in educational system cannot be overemphasized. Apart from serving as link between primary and tertiary education, it provides opportunity for a child to acquire additional knowledge, skills, and traits beyond the primary level. A major factor that necessitates the acquisition of secondary education in Nigeria is that the education being provided at the primary level is proving to be insufficient for a child to acquire permanent literacy, communicative, and numeracy skills expected from him/her at the end of the training (Chinelo, 2011; Ige,2011; Yusuf, 2009; Osho and Osho, 2000).

From time immemorial, man has always been known to create amenities to meet various needs. These amenities as argued by Bartuska (2011) are intended to serve human needs, want and values. However, in serving mans' needs, Pearce and Vanegas (2002) noted that these amenities overtime create positive and negative impacts that may not be immediately noticeable and whose collective effects need to be minimized in order to meet the needs of man in the present without limiting the ability own needs. Furthermore, the first step towards designing a sustainable built environment as noted by American Institute Architects (2012) is reducing environmental impacts. A sustainable environment is the one in which all plants, animals and other forms of life are able to exist in an ecosystem without any exterior aid or interference; Sustainable Landscape Designs (2010). A sustainable built environment therefore, must be able to provide a physical, social and psychological environment in harmony with the human behaviour as argued by Brandon and Lombardi (2011), in order to improve and not impact adversely on the present or future generations. Pohl (2011) argued that sustainability in the context of the built environment acknowledges the need to protect the environment for the future generations; consequently, what we build today should be sustainable throughout its life span. As such sustainable environment is expected to do less harm.

As noted from the definitions above, Secondary school buildings and their environments should be created through landscaping in order to improve the visual perceptions, aesthetics and health of the individual. On one hand, landscape is a view or picture depicting an expanse of scenery by the free online Dictionary (2012); the view or picture in relation to the built environment could depict mountains, buildings, water bodies, and all features as can be seen in a single view of whose interaction has given rise to various landscapes in the built environment. On the other hand, landscaping as noted from the web and researchers (Dave's garden, 2012; and Atolagbe, 2006) is the beautification or modification of the outdoor terrain by man for functional and supportive roles. As asserts by Beierkuhnlein (2002), landscapes are composed of elements of different nature which interacts to create a non- random organisation in aggregates and pattern. Furthermore, landscape elements have important functions of serving as signal to different areas within a site, contributes to visitor orientation and understanding of the site's circulation patterns and scale (Mount Annan Botanic Garden, n.d). The elements fall into two categories of hard and soft materials and water bodies (Adedeji and Fadamiro, 2011; Atolagbe and Olorunfemi, 2012). The hard landscape include inanimate elements also referred to as inorganic (Raff, 2006; Archidude, 2012); which are structural in nature such as kerbs, stones, bollards, tiles, walkways, asphalt, paving, planters, sculptures. While the soft landscape include animate elements, also known as organic elements (Blake, 1999; Archidude, 2012), such as plants i.e. trees, shrubs, flowers, grasses and water such as pools, pond, and fountains. Integrating these elements not only add to the aesthetics but also aid man's visual attraction and comfort within the built environment making it beautiful and functional.

As argued by Fadamiro and Atolagbe (2006), the 'environment is an interactive, indispensable medium within which man's life performance is carried out as such landscape elements are important within the built environment. Although many of the problems within urban environments are acknowledged by kjellstrom and Mercado (2008) to be part of developmental problems of which Nigeria as a Developing nation is not left out of the effects from the problem.

However, there is the need to tackle some of the problems by improving on the quality of the built environment through landscaping in order to create a healthy learning environment for man. The natural environment has profound effects on the well-being of humans. Obong(2010) and productive life. Supporting this, Akingbohungbe (2006) asserts that a good environmental feature such as quality landscaping and street furniture gives the environment a high status and urban aesthetics. At the same time it is an essential and important contributor to quality of life (Fadamiro, 2000). Therefore, managing the environment as opined by Obong et al (2010) for fruitful, healthy and productive living is vital and central to human activities. Going by the above and in improving the aesthetics of the Nigerian built environment, (Adedeji et al (2010) suggests that for landscaping to be sustainable, landscaping must begin with a design that is functional, cost effective, visually pleasing, environmentally friendly and maintainable.

The importance of School landscape

According to Fadamiro and Atolagbe (2006) there are five overarching outcomes that all Government departments with a vested interest in children's' development should be working towards. These are:

- be healthy
- be safe
- enjoy and achieve
- make a positive contribution
- achieve economic well-being

School grounds can play a significant role in delivering these outcomes, providing safe, stimulating environments where children and young people can learn, explore, play and grow, regardless of their educational needs. As a society, we recognise that our young people are being offered ever fewer opportunities for safe, challenging, active and collaborative play. Lack of these opportunities can lead to health issues, apathy, social and behavioural issues. School ground scan help raise achievement and self-esteem, improve behaviour and health, and help children and young people develop a wide range of skills. School grounds can be designed, built and developed over time to enrich teaching and learning across the whole curriculum. Children's learning can been handed outside – they find lessons outdoors more relaxed, interesting and easier to understand, and they think their teachers are "friendlier outdoors". Teachers report that the grounds provide access to resources not available in a classroom and opportunities to use different teaching styles. Making more use of school grounds can also foster stronger relationships between staff and pupils, and between pupils themselves, leading to significant improvements in behaviour, attitudes to learning and attainment levels. As well as playing a crucial role in delivering the formal curriculum, including much of PE, school grounds should be designed to address both the informal curriculum (social use of the grounds at break time and during the extended day) and the hidden curriculum (the messages and meanings children receive indirectly).The grounds provide wonderful opportunities for children and young people to take an active part in developing and managing their school environment. Through simple outdoor improvement projects they can learn new skills, understand the value of team-working, assess needs, make decisions on priorities and manage projects. School grounds that are interesting and safe will encourage secondary-age pupils to stay on site at break times. Sheltered or semi-sheltered areas can be used as eating areas, when the weather allows, promoting the take-up of healthy school meals. School grounds are also a national environmental resource, integral to the delivery of many of a local authority's wider environmental and social strategies. They provide opportunities for children not only to implement elements of these strategies, but also to learn about key issues and re-connect with the natural environment.

Defining Learning and Outdoor Learning Environments

What is an outdoor learning environment? Many images may come to mind as places, facilities and/or objects that support learning - a bench, a garden, a climbing structure, a wooded ravine, a courtyard. Outdoor learning environments may be placed for "nature study", science experiments, creating and displaying art, playing games, or performing music. For children, and hopefully adults, any environment holds potentials to be a learning environment - but it fosters learning better with qualities and elements one can discover, observe, interact with, and/or connect to other identities, relationships, and processes. Yet when we examine places designed and built specifically for learning - such as schools - their landscapes rarely offer opportunities for discovery and experimentation. This paper focuses on outdoor learning environments as school landscapes and nearby open space that may foster many forms of learning.

Environmental education and school landscapes

David Orr(2000)states that "all education is environmental education. By what is included or excluded, emphasized or ignored, students learn that they are a part of or apart from the natural world" (1992, p. 90)

RESEARCH METHOD

The research method employed to achieve the objectives for the project surveys descriptive survey method. Descriptive survey method which involves the direct observation of the entire population and selection of samples to represent the whole population. Field survey was conducted on ten different government secondary schools selected from the north south east and west of Minna city. The survey examines the variables that make up the landscape of the school such as;

1. The hard landscape; which comprises of paved walkway, defined walkway, gazebo, signage , drainage, site fence, parking lot, site amenities and street lighting.
2. The soft landscape which comprises of trees, shrubs, gardens, fountain, ground cover and indoor plants

Primary data was collected through the general observation of the schools landscape and observation of the type of landscape element present in the ten selected samples in Minna Niger state. The parameters observed during the field survey include all the elements of hard and soft landscape listed above. The observations were carried out using observation schedule instrument of data collection. The data collected was manually analyzed and tabulated using Microsoft excel spread sheet program and spss.

Secondary data was collected from related works that has previously been published on secondary School landscape. All secondary data was obtained from journals, seminar papers, internet sources and magazines.

RESULTS AND DISCUSSION

From careful observation on the field through an observation schedule it was found that government secondary schools in Minna has not adapted sufficient level of landscape elements in their environment. Other issues like availability, adequacy and maintenance of building landscape were not encouraging, and this calls for improvement in most of the studied areas in other to increase the productivity of users.

LIST OF GOVERNMENT SECONDARY SCHOOLS VISITED IN THE STUDY AREA

- Mariam Babangida Girls Science Secondary School Minna.
- Model Day Secondary School Tudun Fulani Minna.
- Day Secondary School Chanchaga.
- Hill Top Model School Maitunbi.
- Day Secondary School Maikukele.
- Ahmadu Bahago Boys Secondary School Minna.
- Government Technical Collage Chanchaga.
- Government Secondary School Minna.
- Day Secondary School Garatu.
- Government Girls Secondary School Minna.

OBSERVATION TABLE

SCHOOLS STUDIED	TREES AND SHRUBS	GAZEBOS	GROUND COVER	DEFINED WALKWAYS	GARDENS	FOUNTAINS	TABLES AND BENCHES	INDOOR PLANT	DEFINED PARKING LOTS	PLANTS AROUND BUILDING	PAVED WALKWAY	DRAINAGE	SINAGE	STREET LIGHTING	SITE AMENITIE (FENCE/TRASH CA
M.B.G.S.S.S MINNA	O O	X	X	X	X	X	X	X	X	O	X	O	O	X	X
MODEL DAY SEC.SCH. MINNA	O X	X	X	X	X	X	X	X	X	X	X	X	O	X	X
DAY SEC. SCH. CHANCHAGA	O X	X	X	X	X	X	X	X	X	X	X	X	O	X	X
HILL TOP MODEL SCH MAITUNBI	O O	X	X	X	X	X	X	X	X	O	X	X	O	X	X
DAY SEC. SCH. MAIKUKELE	O X	X	X	X	X	X	X	X	X	X	X	X	O	X	X
A.B.B.SEC.SCHOOL MINNA	O O	X	X	X	X	X	X	X	X	O	X	X	O	X	X
GOVT.TECH. COLLAGE CHANCHAGA	O O	X	X	X	X	X	X	X	X	O	X	X	O	X	X
GOVERNMENT SEC.SCH MINNA	O X	X	X	X	X	X	X	X	X	O	X	X	O	X	X
DAY SEC.SCH GARATU	O X	X	X	X	X	X	X	X	X	X	X	X	O	X	X
GOVT.GIRLS SEC. SCH. MINNA	O O	X	X	X	X	X	X	X	X	O	X	X	O	X	X

Table 1.0 shows the variables present and absent in the various schools visited.
Source; author's field work.

THE TYPE OF LANDSCAPE FOUND IN THE GOVERNMENT SECONDARY SCHOOLS STUDIED

From the analysis, it was discovered that 40% of the schools studied were basically made of hard landscape. While the schools with partial and inadequate soft landscape have 60% of the total studied buildings. Most of the buildings were not properly landscaped after construction in these areas.

Figure 1: Actual types of landscape found in the study areas.

THE CORRELATION BETWEEN THE NUMBERS OF PLANTS SPECIES AVAILABLE, AND USERS HAVING STRESS AFTER CLASSES.

Buildings that are not designed with the necessary species of plants that can help reduce pressure and fatigue can contribute to the amount of time spent by users; which can be a factor to their poor performance.

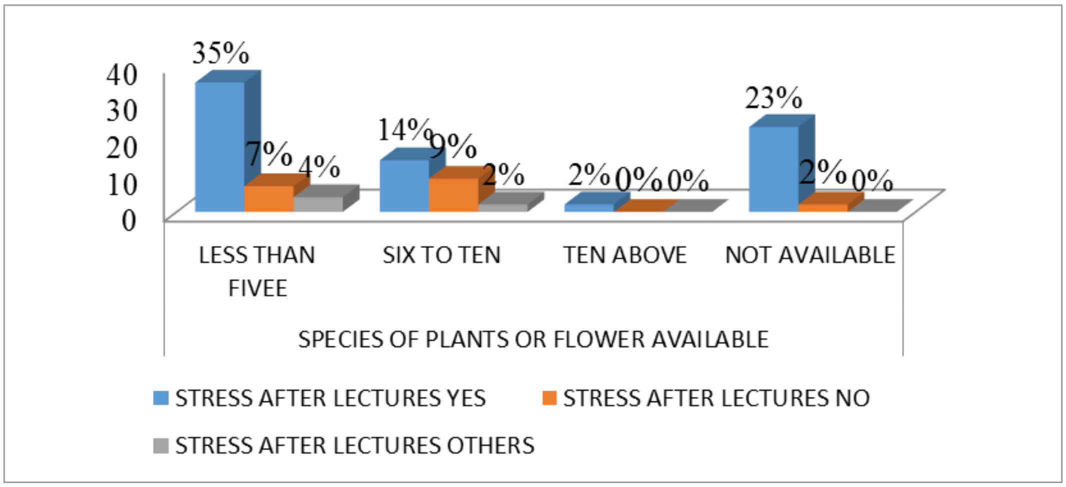


Figure 2: the correlation between the numbers of plants species available, and users having stress after classes.

THE CONDITION OF FOUNTAINS AND HOSE BIBS IN THE STUDY AREA.

From the research carried out, fountains and hose bib are completely not available. All the schools visited do not have this type of hard landscape in the school premises.

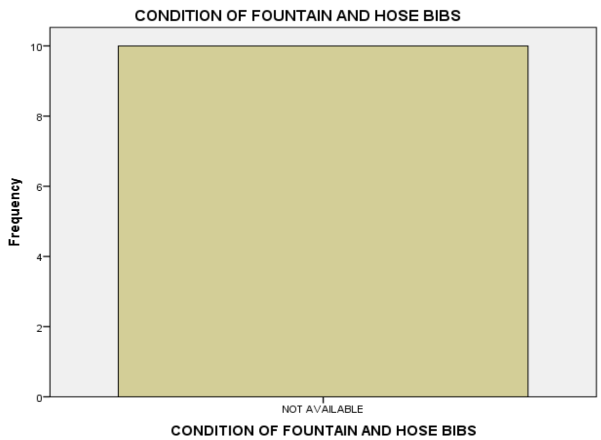


Figure 3: condition of fountains and hose bib.

THE CONDITION OF SHRUBS IN THE STUDY AREA.

From my findings, there were shrubs in some of the schools visited, however they were not well kept. 90% of the shrubs were in bad conditions while 10% was in good condition

THE SHRUBS FOUND IN THE STUDY AREA

Findings shows that shows 50% of the schools studied have shrubs as element of landscape and 50% do not have shrubs. However most of them are in bad conditions.

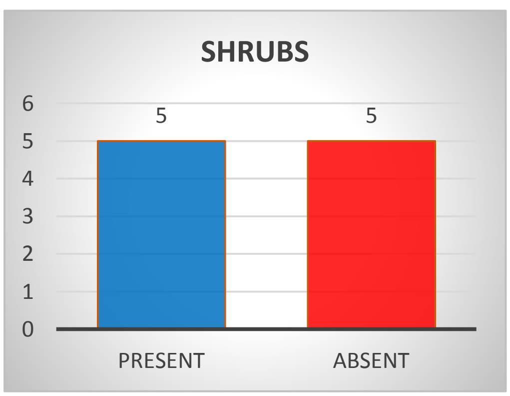


Figure 6; shows the level of shrubs

PLANTS AROUND BUILDINGS IN THE STUDY AREA.

From the field observation gathered, it that shows 60% of the schools studied has plants around classroom block as elements of landscape, and 40% of the schools do not have plants around the buildings

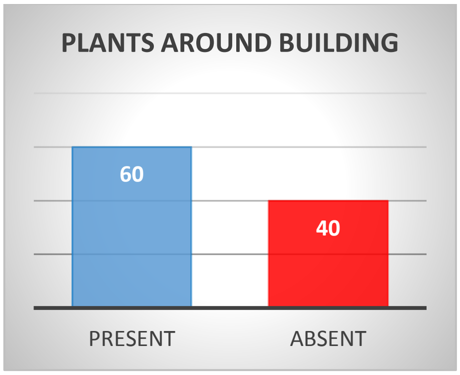


Figure 7; shows plants around buildings

INDOOR PLANTS IN THE STUDY AREA.

100% of the schools studied do not have indoor plants as element of landscape.

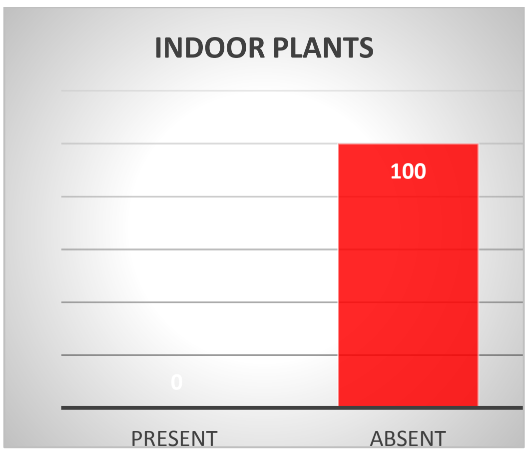


Figure 8; shows the level of indoor plant.

GARDENS.

100% of the schools studied do not have gardens as elements of landscape. All the government secondary schools visited do not have gardens.

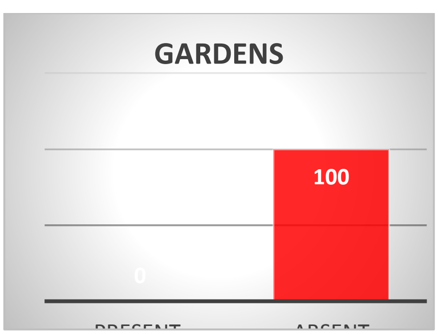


Figure 9; shows the level garden present.

PAVED WALKWAY.

All the schools studied do not have paved walkways in the school compound

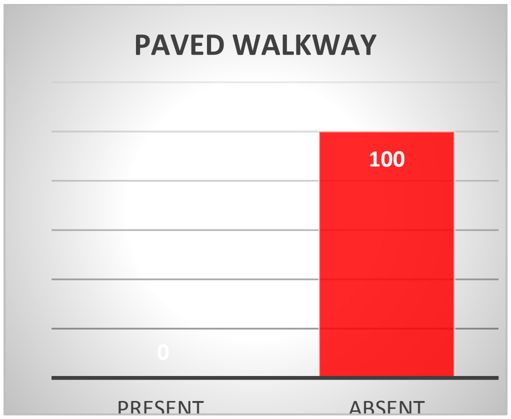
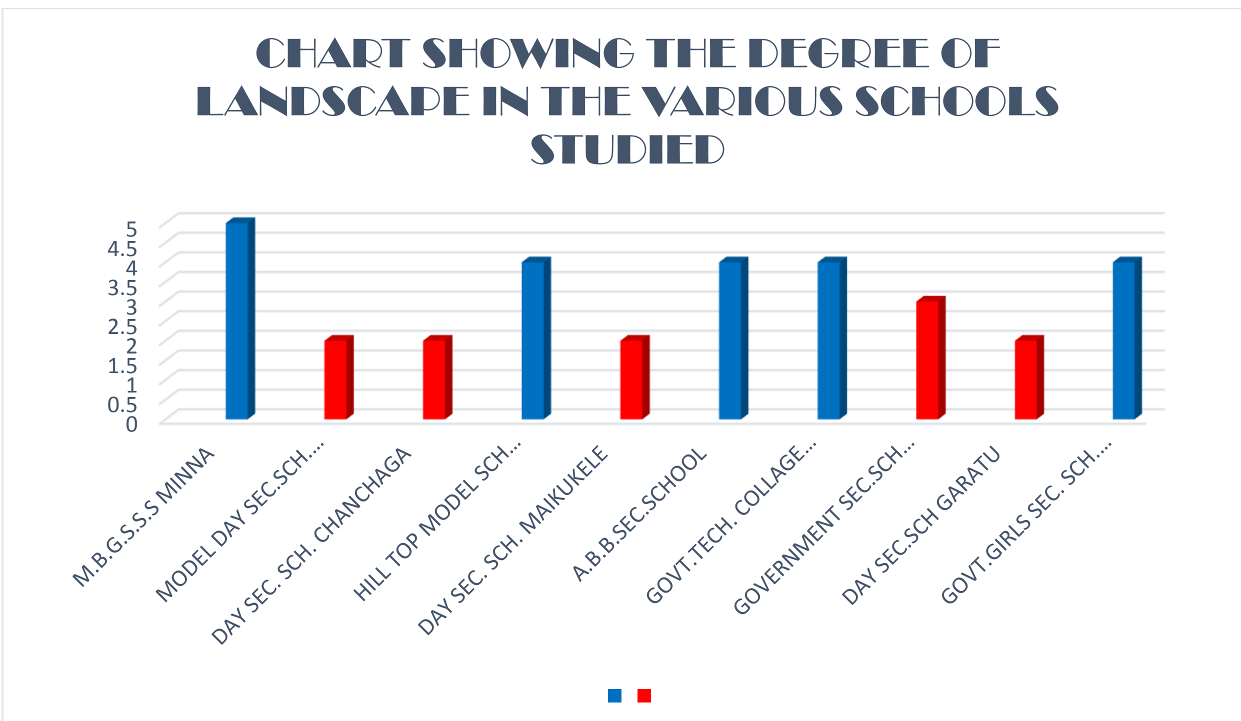


Figure 10; shows the degree of paved walkways.



From the chart above, we can deduce that Mariam babangida girls science secondary school have the highest number of landscape element, followed by hill top model school, then government technical collage, then A.B.B.secondary school, then government technical collage minna. The rest have little or no element of landscape in the school premises.

From the result of the research carried out it shows clearly that secondary schools in minna are not properly landscaped.

CONCLUSION

Studies carried out shows that government secondary school buildings in the study areas are either made of soft landscaping, or hard landscaping, But majority of the buildings and their environments have not properly adopted any type of the landscape mentionedabove; making it unattached for users. This contributes majorly to users' constant stress and fatigue in the study areas because there is a great relationship between the natural environments and man's well being. As a result of this, users' productivity will decrease over time due to the harsh learning environment. Only few of the school buildings had landscape elements adopted in their environments, and this is as a result of some natural landscape that were not discarded during their construction.

Analysis from the collected data shows that there is a great relationship between proper landscaping of the school buildings, and users comfort; because a greater percentage of the users felt uncomfortable and very uncomfortable. Only few users felt comfortable in their buildings, and these users are from schools that had their buildings landscaped to an acceptable degree. This indicates that improper landscaping of secondary school buildings affects the comfort of users per time in that environment.

RECOMMENDATION

In other to achieve a conducive learning environment, Secondary school buildings and their environments must be treated with great importance. Architects should take the lead in the design of how landscape can be adopted in the design of secondary school buildings and its environments.

- Garden designs and layout should be introduced in institutional environments; in respect to the type of plants needed in a particular layout and environment. The architect should design schools buildings to accommodate inbuilt plant systems that can harbour indoor plants, in order to increase the indoor air quality of the spaces.
- Atriums and courtyards should be designed with the right species of landscape to create a calm learning environment, and relaxation areas should be designed with plants that depict its function in respect to relaxation.
- Architects should also know the kind of soil and nature of the site given secondary school in order to determine what kind of landscape thatwill suit it in creating a conducive learning environment.
- Parking and walkways should be well defined and design with materials that will absorb less heat in order to reduce heat island effect; a situation that causes the emission of heat from paved and other none reflecting surfaces.
- Architects and designers should design a workable automated irrigation system that will cater for the watering of the plants to reduce manpower that may not be available to water the plants properly. Plant nurseries should be design to provided replacement of death plants in the future.
- Entrances of school buildings should be designed with plants that give a welcoming view.
- The ministry of education should make sure that contractors complete the design landscape layout and plan before commissioning of any school building projects.
- The ministry of education should make sure that funds are released to take care of the complete landscape design while the main structure is in progress; in order to

make sure some plants grow to maturity before completion of the secondary school buildings.

Maintenance of landscape school buildings and its environments should be totally considered with high priority by managements, and consultants should be employed to cater for the redesign of landscape layout, and replacements of plants per time.

REFERENCES

Adedeji, J. A., &Fadamiro, J. A. (2011). The DUO Building Setback and Landscape Quality: Lautech (Nigeria) Neighbourhood Examined. *Architecture and Built Environment, 38*(1), 23-30.

Adedeji, Y. M. D., Aluko, O. O., &Ogunsote, O. O. (2010). Sustainable Landscaping and Green

Adesina S (1977). Planning and educational development in Nigeria. Lagos, Nigeria: Educational Industries Limited.

Akingbohungbe, D. O. (2006). Site Planning and Design for Contemporary Housing in Nigeria. *International world journal Science and Technology, 3(2), 156-161*

American Institute of Architects. (2011). *The Architecture Student's Hand book of professional Practice* (14 ed.): John Wiley and Sons.

Ames, R. G. (1980). The Sociology of Urban Tree Planting.*Arboriculture, 6*(5), 120-123.

Archidude.(2012). Landscape Elements. Retrieved from www.archidude.com/.../Organic-and-inorganic-landscape-elements.pp.. Accessed on 26/11/2014.

Atolagbe, A. M. O., &Olorunfemi, J. F. (2012).An Evaluation of the Spatial Dimension of Landscape Consciousness among Residents in Ogbomoso, Nigeria.*Ethiopian Journal of Environmental Studies and Management 5*(2), 182 – 188.

Ball, K., Bauman, A., Leslie, E. and Owen, N. (2001) *Perceived environmental aesthetics and convenience and company are associated with walking for exercise among Australian adults.* Preventive Medicine, 33, 434-440.

Bartuska, T. J. (2011). The Built Environment: Definition and Scope. In W. R. McClure & T. J. Bartuska (Eds.), *The Built Environment: A Collaborative Enquiry into design and Planning*ssex: John Willey and Sons.

Beierkuhnlein, C. (2002). Landscape Elements. In O. Bastian & U. Steinhardt (Eds.), *Development and Perspectives of landscape Ecology.* Boston: Kluwer Academic Publisher.

Blake, B. J. (1999). *An Introduction to Landscape Design and Construction:* Grower publishing Ltd.

Brandon, P., &Lonbardi, P. (2011).*Evaluating Sustainable Developement*. West Sussex,UK: Blackwell Publishing Ltd.
buildings.org/attachments/contentmanagers/25/BenefitofPlants.pdf Accessed on 26/11/14.

Cimprich, B. E. (1990). *Attentional fatigue and restoration in individuals with cancer*.published doctoral dissertation, University of Michigan, Ann Arbor.

Chinelo OD (2011). Falling standard in Nigeria education: Traceable to Proper Skills Acquisition in Schools? Educ. Res. 2(1):803-808.

Dave's Garden.(2012). *Definition of Landscaping.*Retrieved from 25/11/14.

Fadamiro, J. A. (2000). Outdoor Spaces and their Landscape Qualities: A Comparative Analysis of three Neighbourhoods in Lagos Nigeria. *Urban and Environmental Research, 2, 55-67.*

Fadamiro, J. A., &Atolagbe, A. M. O. (2006). Urban Environmental Sustainability: A Challenge to Effective Landscaping in Nigeria. *DimensiTeknikArsitetur, 34*(1), 44-51.

Filloon, K. (2010). Project Ever Green Environmental Fact Sheets, Retrieved from www.projectevergreen.com Accessed on 28/11/2014.

Frank, M. S. (2003). The Benefits of Plants and Landscaping. Retrieved from http://greenplantsforgreen

Freeland, R. (2009). The Benefits of Landscaping for Outdoor Living Designing Outdoor Spaces, Installing Gardens,i Maintaining Landscapes. Retrieved from http://suite101.com/article/the- benefits-of-landscaping-for-outdoor-living-a160960.Accessed on 26/11/14.

Fafunwa AB (1974). History of education in Nigeria.U.K; George Allen &Urwin Limited.

Hartig T., Evans, G.W, Jamner, L.D., David, D.S. and Garling, T. (2003), Tracking restoration in and urban field settings. *Journal of Environmental Psychology, 23, 109-123.*

Forman, R.T.T. and M. Godron, M. (1981): Patches and structural components for a landscape ecology. BioScience 31(10):733–740; Forman, R.T.T. and M. Godron 1986:

Hartig, T., Mann, M.,&Evans, G.W. (1991). Restorative effects of natural environment experiences.*Environment &Behavior, 23,* 3-26.

Housing in Tropical Climates: a Case Study of Akure, Nigeria.

Ige AM (2011). Myths and realities of falling standard of education in Nigeria: The way forward. Niger. J. Prof. Teach. 2:36-48.

Kjeustorm, T., & Mercado, S. (2008).Towards Action on Social Determinants for Health Equity in Urban Setting.*Environment and Urbanization,* (20)2.551-574.

Kuo, F. E. (2001). Coping with poverty: Impacts of environment and attention in the inner city.*Environment &Behavior*, *33*, 5-34.

Milligan, C., Gatrell, A. and Bingley, A. (2003) *'Cultivating health': therapeutic landscapes and older people in northern England.*Social Science & Medicine, (in press).

Obong, L. B., Okey, S., Amniah, E. J., &Okaba, L. A. (2010). Strategies for School Environment Management in Nigeria Secondary Schools: a Case of Calabar, Nigeria. *International Education Studies, 196-205.*

Osho EO, Osho I (2000). The national policy on education and functionality: The case of Junior *Secondary* School (JSS). Knowl.Rev. 2(2):79-84.

Pearce, A. R., &Vanegas, J. A. (200).Defining Sustainability for Built Environment Systems.*International Journal of Environmental Technology and Management* , 2(1), 94-113.

Pohl, J. (2011). *Building Science: Concept and Application*: John Wiley and Sons.

Raff, M. (2006). Shrub Roses: Paradise in Blooming in Tropical Climates: a Case Study of Akure, Nigeria.

Riggins, F. (2012).Benefits of Good Landscape Design. Retrieved from http://blog.craftontull.com/integrated-architecture/2011/10/benefits- of-good-landscape-design/ Accessed on 26/11/2014.

Sustainable Landscape Designs (2010).*Sustainable Landscape design: Blending Artistry and Ecology*. Retrieved from http://www.sustainable-landscape.com/.

Tennessen, C. M.,&Cimprich, B. (1995).Views to nature: Effects on attention. *Journal of Environmental Psychology*, *15*, 77-85.

Turner, M.G. &Mladenoff, D.J. (2002) : Foundation papers in landscape ecology. New York, Columbia University Press:71–101 [First published as: Troll, C. 1950: Die geographischeLandschaft 3(4/5):163–181].

The free dictionary.com. (2012). Landscape retrieved from http://www.thefreedictionary.com/landscape Accessed on 25/11/14.

WordPress.(2011). Benefits of Landscaping.Retrieved from http://www.mrlawnmower.ca/10-benefits-of-landscaping/ Accessed on 28/11/2014.

BUILT ENVIRONMENTAL FACTORS ASSOCIATED WITH THE SPREAD OF VECTOR-BORNE DISEASE. THE CASE OF MALARIA IN URBAN AREAS OF NIGERIA.

Umaru E. T., Martins V. I., Shaibu S. I., Idowu, O.O.
Department of Urban and Regional Planning, Federal University of Technology Minna

Malaria disease is a pandemic that has affected many parts of the world especially the developing countries. Africa as a continent has suffered so much largely because of the built environmental and climatic factors associated with the disease. The effect of climate change which has affected all parts of the world is another contributory factor that aids in the spread of the disease. The study seeks to investigate the built environmental factors that aids in the spread of the disease. Reviews of various literatures that are related to the factors that influences the spread of malaria were searched through some of the literatures database. Over twenty related literatures were reviewed on the built environmental factors and malaria. The results revealed those inadequate infrastructures, poor building conditions, inefficient waste disposal system, poor sanitary system and ignoring the building byelaws during construction all aids in the spread of the malaria. The study recommends that adequate infrastructures should be provided to Nigerian urban centres, there should be efficient waste disposal system and building byelaws must not be ignore during construction.

Keywords: Built environment, climate, disposal, malaria, waste

eumaru@yahoo.com

Introduction

Almost a century now and especially from the 1950s to the present, have witnessed remakable international interest and efforts towards elimination of malaria (Stratton et al., 2008). Programs such as the Roll Back Malaria Initiative (RBM) and the Multilateral Initiative on Malaria (MIM) have seen international donor organizations (public and private) spend millions of dollars on malaria eradication programs (Williams and Jones 2003). Unfortunately, the results have not been completely positive. Today, despite decades of concerted global efforts, malaria related mortality is higher than half a century ago (WHO, 2010). Malaria has become the most important vector borne disease in Africa (especially south of the Sahara) parts of Asia and Latin America.

In spite of the various programs by the African governments to curb the spread of malaria disease, the sub- Saharan Africa still suffers greatly from the disease. According to World Health Organization (WHO) estimates, in 2010, of the 655,000 deaths attributed to malaria worldwide, 91% of these were in Africa (WHO, 2012). Malaria is caused by a parasite called Plasmodium, which is transmitted via the bites of infected mosquitoes. In the human body, the parasites multiply in the liver, and then infect red blood cells. Usually, people get malaria by being bitten by an infective female Anopheles mosquito. Only Anopheles mosquitoes can transmit malaria and they must have been infected through a previous blood meal taken on an infected person. When a mosquito bites an infected person, a small amount of blood is taken in which contains microscopicmalaria parasites. About 1 week later, when the mosquito takes its next blood meal, these parasites mix with the mosquito's saliva and are injected into the person being bitten. Because the malaria parasite is found in red blood cells of an infected person, malaria can also be transmitted through blood transfusion, organ transplant, or the shared use of needles or syringes contaminated with blood. Malaria may also be transmitted from a mother to her unborn infant before or during delivery (―congenital‖ malaria).

Symptoms of malaria include fever and flu-like illness, including shaking chills, headache, muscle aches, and tiredness. Nausea, vomiting, and diarrhea may also occur. Malaria may cause anemia and jaundice (yellow coloring of the skin and eyes) because of the loss of red blood cells. Symptoms usually appear between 10 and 15 days after the mosquito bite. If not treated, malaria can quickly become life-threatening by disrupting the blood supply to vital organs. Infection with one type of malaria, Plasmodium falciparum, if not promptly treated, may cause kidney failure, seizures, mental confusion, coma, and death. In many parts of the world, the parasites have developed resistance to a number of malaria medicines.

Anopheles gambiae sensu stricto (Diptera: Culicidae), the major African malaria vector is known to breed in temporary clean and clear water (WHO, 1971). But, the rapid unplanned urbanization observed in many parts of Africa is changing the context of human population and natural ecosystem interaction. Poverty, deteriorating infrastructure and overcrowding are some of the factors that contribute to the development of conditions that modify anopheline breeding sites.

At the moment, Africa’s demography is rapidly changing, with an increasing number of people moving to urban areas. In West Africa, the population growth rate for urban areas is estimated at 6.3%, which is more than double the total population growth rate (Donnelly et al 2005), and it is predicted that, by 2035, the urban population of sub-Saharan Africa will outnumber the rural one (Parnell &Walawege, 2011).With the continuous increase of urbanization in Africa, the factors that influences the spread of the disease will keep getting dominant.

The process of urbanization in Nigerian urban centres has not been accompanied with a corresponding supply of adequate housing, basic infrastructures and amenities. This has given birth to the development of shanty towns, informal settlements and slums as well as disorganized congestion and decline dilapidation of the environment. Another notable contributor to urban decay has always been the negligent urban housekeeping, and irresponsible civic management enhancing its spread. Continuous neglect will meant that physical decay of urban community will continue to stretch over the built environment with its attendant consequences of urban health problems. This study examines the built environmental factors that are associated with the spread of Malaria disease in Nigerian urban centres.

Methods

Literature Search. A systematic search on the built environmental factors associated with malaria transmission in Nigerian urban centres was carried out in January 2016 by the first named author on the following electronic databases: EMBASE, HMIC, Medline, Maternity and Infant Care, Psycinfo, and Transport. Key reports included World Health Organisation's Malaria reports, built environmental factors, urbanization, Policy documents from the National Population Commission and National Demographic reports from the Federal Ministry of Health. These were retrieved from the relevant websites.

Built Urban Environment and Health Hazards

In Nigeria, urbanization that is supposed to be the major force for modernization and rapid economic growth has rather resulted into massive unemployment, slum development, environmental degradation and high poverty levels (Gbadegesin and Aluko, 2010 & UN Habitat 2008b). A study by Ahiaba et al (2008) revealed that experience of many urban centres in Nigeira like Lagos, Ibadan, Port Harcourt, Aba and Benin is that they have urban planning and management crisis. There seems to be problems which are associated to uncontrolled urbanization in Nigeira which has overwhelmed the official capacity to handle them, thus; many urban areas in Nigeria are faced with serious environmental health problems because they are grossly deficient in housing and municipal services (Gbagedesin et al 2010). The problems of Nigeria urban built environment was analyzed by Ahianaba et al (2005 & 2008) which incudes inadequate basic amenities, substandard housing, overcrowding, poor ventilation, poor sanitation and non compliance with building regulations.

i) **Inadequate basic infrastructural amenities**: Most of our urban centres lack essential basic amenities such as pipe borne water, electricity, and road network. Where they are provided, these facilities are insufficient or do not function due to neglect by relevant authorities.
Waste disposal is also a major problem in our urban centres, especially in most slum areas and squatter settlements. There are no planned disposal sites for refuse with a resultant indiscriminate refuse disposal on any available sites.

ii) **Substandard housing**: Shelter which connotes housing has a fundamental purpose of protecting man, his activities and his possessions from humans, animals and other enemies and from the supernatural powers that plague man. Osuide (2004) suggests that: "Having a safe place to live in is one of the fundamental elements of human dignity and this enhances human development". Substandard housing in urban centres is a major problem of our cities. The problems resulted from the fact that they were never planned by experts but sprang from villages.

iii) **Overcrowding**: Another noticeable characteristic of our urban centres is overcrowding; arising from over population and insufficient accommodation. Over-crowding is a major problem of our built environment especially in slums and squalid environment

iv) **Poor ventilation in buildings**: In some Nigerian homes and offices, ventilation is not included while planning for such buildings but this is the most vital aspect of construction that makes for comfortable living. Izomoh (2005) cited that most residential buildings have been designed and constructed with little or no consideration for the thermal comfort through the process of cross-ventilation.

v) **Non-compliance with building Bye-laws and regulations**: The consequence of non-compliance with building bye-laws and regulations are already manifesting and are being felt in our urban centres.

Mortality from urban environmental health problems have been on the increase in Nigeira. Oyebanji (2013) pointed out that there is increase of death as a result of Malaria disease. It rose from 1,947 to 3,268. Diarrhea increased from 1,613 in 1991 to 2,056 in 1995 while reported deaths from pneumonia increased from 855 to 1,594 at the same period.

Owoeye and Omole (2012) conducted a study on the built environmental decay and the health situation in Akure. It was pointed out in the study that like most other traditional centers in Nigeria, the Akure city has continued to witness haphazard development without conscious effort to physical planning. In spite of its many years of existence, the city has no physical development plan (Master plan) as different land-uses juxtapose each other in a reflection of its traditional setting before and during colonial administration. This has contributed in no small measure to the rapid decaying of the built environment in the city. At the moment, the city is characterized by the proliferation of squalid and slum condition of environmental sanitation, overcrowded dwellings, poor waste disposal management, pollutions, inadequate water and unreliable power supply (Olanrewaju & Akinbamijo, 2002;

Owoeye, 2006; Adedeji & Owoeye, 2008; Omole & Owoeye, 2011). Thus, the sanitation coverage has not been able to keep pace with the urban population growth which has put the health of residents in greater risks. Consequently, the building characteristics which is made up of the kind of materials that was used for the construction, structural condition and age of the building have contributed greatly to the poor health condition which malaria is among and the most common disease in Akure.

In another study by Adefemi et al.,(2015), it was pointed out that the environment plays a defining role in the health outcomes of any society. But unfortunately, for most developing countries, the environment constitutes a particularly negative influence on health. This is especially true in Nigeria, where until very recently, the environment was one of the most de-emphasised health issues, nationally and locally (Orisakwe, 2011). According to Adefemi et al.,(2015 environmental factors that contribute to malaria risks include the large rural population, poor waste disposal, water and sanitation infrastructures and habits.

Apart from the built environmental factors, it is apparent that two major social determinants influence most of the malaria risks highlighted so far. These are low socio-economic (SES) status and low levels of literacy. From the ten social determinants of health identified by Wilkinson and Marmot (2003) at least seven are related to these two and thus shape children's exposure to malaria in Nigeria. These are Work, Social gradient, stress and anxiety, early life, social exclusion and food. At least 75% of children in Nigeria are born to parents in the low SES (NPC, 2009) who live in the lowest gradient of the society with limited access to well-paid job. WHO emphasised that poverty is the greatest single risk factor for malaria. Global malaria reports have shown that more than two-third malaria cases occur in the poorest fifth of the population (WHO, 2003). Poverty reduces opportunities for formal education, which then reduces chances for a good job which lead to more poverty. Social exclusion due to low SES creates and sustains anxiety while also limiting life's chances for children from the beginning of their life. And then the circle continues again.

Conclusion

The study was able to investigate the built environmental factors that are associated with the spread of malaria in Nigerian urban centres. From the reviews of the various literatures it is very obvious that inadequate basic amenities, substandard housing, overcrowding, poor ventilation, poor sanitation and non compliance with building regulations are the key factors that aid the spread of the disease. Another key factor is the poverty level and literacy level. To reduce the spread of Malaria in Nigerian urban areas adequate infrastructure must be provided, like the waste disposal system, steps must be taken to discourage the construction of substandard housing, and the building byelaws must be properly followed.

References

Adedeji, Y.M.D & Owoeye, J.O. (2008). Environmental sanitation and the health of Slum Dwellers in Akure: Knowledge Review (a multidisciplinary Journal); National Association for the Advancement of Knowledge, University of Benin, Benin-City, Nigeria; 17(2), 57-67.

Donnelly, M. J., McCall, P. J., Lengeler, C., et al., "Malaria and urbanization in sub-Saharan Africa," Malaria Journal, vol. 4, article e12, 2005.

National Population Commission. Nigeria Demographic and Health Survey: 2008. Abuja: National Population Commission; 2009.

Oaks SC, Violaine S, Mitchell GW, Carpenter CCJ. Malaria: Obstacles and Opportunities. In: Control CftSoMPa, editor. W

Olanrewaju, D.O. & Akinbamijo, O.B. (2002). Environmental health and target audience: A programmatic panacea for poverty alleviation in Nigerian cities: African Journal of Environmental Studies; Development Africa consortium; 3(2), 82-89.

Omole, F.K & Owoeye, J.O. (2011). Slum characteristics of deplorable residential district of Akure: FUTY Journal of the Environment, 6(2)

Orisakwe OE. Nigeria: Environmental Health Concerns. In: Editor-in-Chief: Jerome ON, editor. Encyclopaedia of Environmental Health. Burlington: Elsevier; 2011. p. 114-24.

Roll Back Malaria, Key Malaria Facts, 2012, http://www .rbm.who.int/keyfacts.html.

Parnell, S. and Walawege, R. (2011) "Sub-Saharan African urbanization and global environmental change," Global Environmental Change, vol. 21, no. 1, pp. 12–20, 2011.

Service MW. Studies on sampling larval population of Anopheles gambiae complex. Bull WHO 1971; 45:169–80.

Stratton L, O'Neill MS, Kruk ME, Bell ML. The persistent problem of malaria: Addressing the fundamental causes of a global killer. Social Science & Medicine. 2008;67(5):854-62. Doi: http://dx.doi.org/10.1016/j.socscimed.2008.05.013.

Wilkinson R, Marmot M. Social Determinants of Health: The Solid Facts. Geneva: World Health Organisation, 2003.

Williams HA, Jones COH. A critical review of behavioral issues related to malaria control in sub-Saharan Africa: what contributions have social scientists made? Social Science & Medicine. 2004;59(3):501-23. Doi: http://dx.doi.org/10.1016/j.socscimed.2003.11.010.

World Health Organisation. Africa Malaria Report 2003. Geneva: World Health Organisation, 2003.

World Health Organisation. World Malaria Report 2010. Geneva: World Health Organisation, 2010.

.

IMPACT OF A TERTIARY INSTITUTION ON THE INFRASTRUCTURE DEVELOPMENT OF THE HOST COMMUNITY

Olurotimi Kemiki[1], Adeyosoye Ayoola[1] & Olusegun Idowu[2]

[1]Department of Estate Management and Valuation, Federal University of Technology, Minna.
[2]Urban and Regional Planning, Federal University of Technology, Minna.

Federal university of Technology, Minna developed its main campus in Gidan-Kwano and started operation in 2005. This work examines the impact of university on the host community. Landsat imageries were used to monitor spatial growth in Gidan-Kwano between year 2005 and 2015. Ground survey data were collected from Federal university of Technology, Minna, Estate Agents, Property developers, Power Holding Company of Nigeria and Ministry of Lands and Housing. ILWIS was used to analyse the satellite imageries while Analyze-it was used for the analysis of the ground survey data. Findings revealed that residential land use which stood at 8.87% of the total land use in 2005 has now grown to 25.19% in 2015. There are other infrastructure attracted to the area during period under review. However, the growth has been marked with problems of uncoordinated development and inadequate infrastructure. The ever increasing population of the university will continue to attract physical development and if the growing development is not coordinated by enacting master plan, there will be chaotic and haphazard development. The study has revealed the spillover effects of locating university. It has also unfolded the pending danger of uncontrolled development. A comprehensive master plan should be developed for the community.

Keywords: Impact, University, Residential, Development

kemiki@futminna.edu.ng
ayosoye@yahoo.com
idowuolusegunowo@futminna.edu.ng

Kemiki, O.A. et. al. (2016). **IMPACT OF A TERTIARY INSTITUTION ON THE INFRASTRUCTURE DEVELOPMENT OF THE HOST COMMUNITY** Sustainable Built Environment and Climate change; The challenges of Post 2015 Development Agenda. School of Environmental Technology Conference, SETIC, 2016

1. Introduction

[1] Advanced that foreign direct investment has multiple effects on the economy of a host country. Relatedly, investment made in a particular local environment has impacts on the host community. Many researchers in the past and even till now have been focusing on the economic, social and cultural impact of tertiary education institutions to communities [2,3,4,5]. Meanwhile little or no attention has been given to the impact of university or tertiary education institutions on the physical development of host communities. It is within this analytical context that this research is conceived. Federal University of Technology Minna created in 1983 started operation in Bosso area of Minna. The growth of the Institution necessitated the development of a new permanent site in 2005 in Gidan-Kwano area of Minna. The main campus which is sited in Gidan-Kwano on 10,650 hectares of land houses majority of the faculties. Since the relocation in 2005, the once agrarian area has witnessed development of modern accommodations. Further to this, the host community has continued to enjoy other public and private physical developments.

In the report by [3] higher education is a major source of jobs in New York State. The number of jobs in higher education has been growing more rapidly than employment in the rest of the economy. During the 2001-2003 recession, higher education employment rose by 5.8 percent in New York while jobs in the rest of the State's economy declined by 2.6 percent. During the 2003-2007 economic expansion, higher education employment in New York grew by 4.8 percent, compared to job growth of 4 percent in the rest of the economy.More recently, higher education employment in New York grew by 2.7 percent between 2007 and 2009. The State's public and private colleges and universities provided 266,110 jobs in 2009 or 3.2 percent of all employment in the State and paid out $13.2 billion in wages.Higher education institutions contribute to the quality of life in their communities, providing services such as medical facilities, research centers, libraries, sports, arts, and cultural events. In many parts of the State, these schools account for a significant portion of local economic activity.

The aim of the research conducted by [6] was to determine the type of corporate social responsibilities schemes provided by tertiary institutions vis-a-vis the types of social responsibilities needed by the host communities with associated challenges. This study employed the survey design method. Management staff of the selected three (3) tertiary educational institutions numbering twenty-five (25) was selected via stratified random sampling method while fifty-five (55) prominent community leaders were randomly selected from the three host communities. The mean(x), Standard deviation (SD) and the t-test were the statistical tools used. Findings revealed that tertiary institutions in Delta State of Nigeria are socially responsible to their host communities by providing the following services in this ranked order: education needs; wealth and job creation; physical infrastructural development; creating and promoting cultural awareness and; health intervention. The challenges faced by tertiary educational institutions in discharging their corporate social responsibilities to host communities in Delta South include intercommunity agitations and strives; greedy community leadership, negative attitude of host communities; delay in release of funds by government to tertiary institutions and youth restiveness. The study recommended that tertiary educational institutions should develop more deliberate schemes to meet corporate social responsibility needs of their host communities as well as ensure that adequate enlightenment should be given to host communities on the objectives of corporate social responsibilities schemes.

One of the so many factors that influence the residential or commercial location choices of households or investors is educational institutions. Others may include access to employment, business, cultural or recreational opportunities; affordability; familiarity with one location or type of location, perhaps as a result of growing up there; or emotional attachment to a place or a lifestyle [7]. To what extent has the Federal University of Technology, an education institution influenced the location choices of households and investors in Gidan-Kwano, the host community?

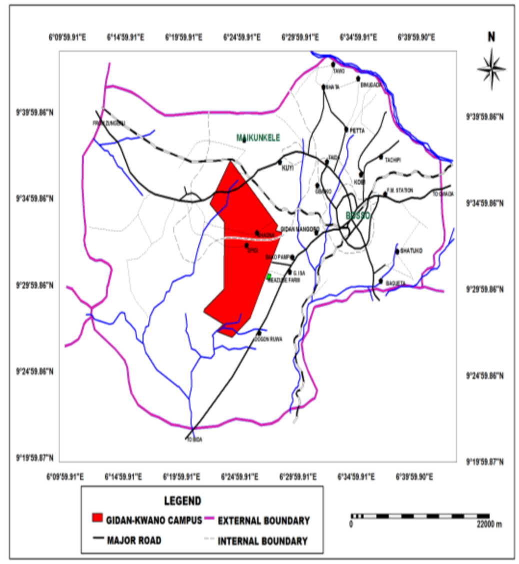
2. The Study Area

The Federal University of Technology, Minna was established on February 1st1983 [8]. This specialized university was established in Niger State of Nigeria to concretize the quest for technological development in Nigeria. In the beginning, the University took over the facilities of the former Government Teachers' College Bosso, for use on a permanent basis. This site now serves as the Bosso Campus of the University. The main campus which is sited in Gidan-Kwano 10,650 hectares of land is located along the Minna - Kataeregi - Bida Road started operation in 2005. As at today, the university has Eight (8) schools and four (4) centres.As part of its overall fitness program, the University hasamong others a floodlit sports arena on both campuses, athletics cinder tracks, badminton indoor courts, basketball courts, volley ball courts, football pitches, a fitness gymnasium and student-run radio station. The Federal University of Technology, Minna is one of the top ten (10) universities in Nigeria and one of the top hundred (100) universities in Africa.The location of Federal University of Technology, Minna is shown in figure 1.

Gidan-Kwano

Gidan-Kwano is the host community to the Federal University of Technology, Minna. The town is about 12km away from the main town of Minna which is situated along Minna- Bida Road. It lies between latitude $90^0 27^i$N to $60^0 27^i$E. Original settlers in Gidan-Kwano were farmers. Now, Gidan- kwano houses several students and staff of the Federal University of Technology, Minna. Gidan- Kwano area of Minna, Nigeria had been a predominantly village setting with mud houses and very scanty housing development with agrarian economy.Since the operation of the Federal University of Technology, Gidan-Kwano campus, the village has witnessed astronomical housing development as investors continue to develop off campus accommodation for students with attendant commercial activities. The location of Gidan-Kwano is shown in figure 1.

Figure. 1: Google Earth Map and Digitized Map of Federal University of Technology and GidanKwano



3. Methodology

Google earth maps, digitized maps and land use maps of 2005, 2012 and 2015 were obtained and analysed in a remote sensing environment using ILWIS 3.1 to analyse the land use variation over time experienced in the study area. Historic and present pictures were also used to explain the variations. Other sources of information include ministry of lands, National Population commission, PHCN and village heads. The data obtained were analysed descriptively.

4. Results and Discussions

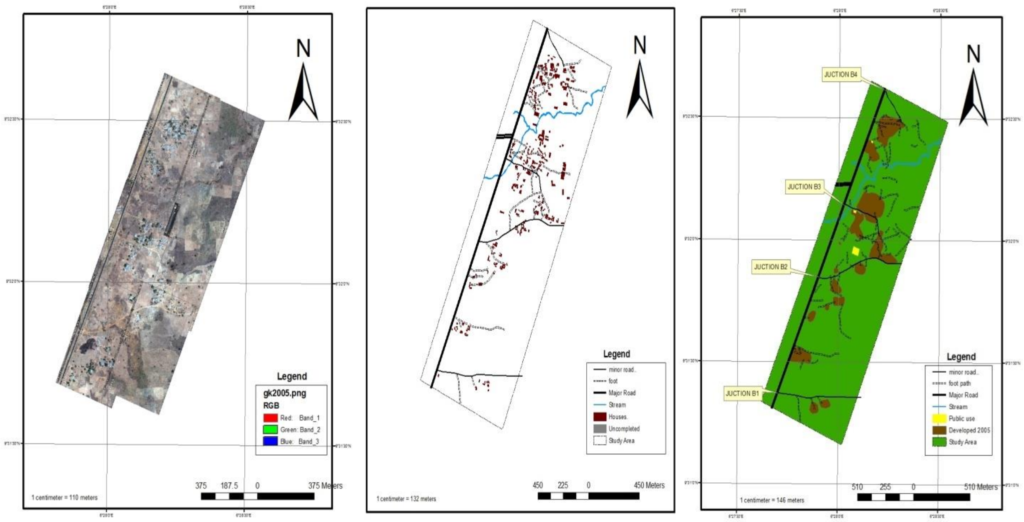
Gidan-Kwano(Host Community) prior 2005

Gidan-Kwano village prior to the sitting of the permanent site of the Federal University of Technology, Minna was observed to be inside the university site. Acquisition of the mass of land for educational purpose by the Federal government of Nigeria; was facilitated by the Land Use Act of 1978, that states that all land are entrusted into the hand of government. The move taken thereafter was to resettle the indigenous communities, farm stead and villages away from the university site to the present site of the village opposite the university main entrance retaining the same old name of the village known as Gidan-Kwano.

Assessment of Host Community in 2005

This revealed the existing situation of GidanKwano as at 2005 when the Federal University of Technology, Minna started its operation as shown in Figure 2, the Google earth image, digitized map and the land use map in 2005.

Figure 2: Google Earth Image, Digitized Map and Land Use Map of GidanKwano in 2005



Source: Urban and Regional Planning Department, FUT, Minna

Figure 2 reveals the level of development in 2005.The same year, Federal University of Technology, Minna moved to the permanent site at GidanKwano. The analysis of the digitized image of the land use of the area shows that 90.7% of the total land mass of the area are meant for agricultural purpose, while the area for residential and other uses was 9.3%. The activities of the host community were mainly agrarian, while the population stood at 485 persons with the total number of houses which was less than 100 housing units of habitable standard.

The characteristics of the housing in GidanKwano in GidanKwano in 2005 were mainly mud houses and traditional buildings.

Plate 1: The Mud houses of GidanKwano in 2005.

Taking into account the level of developments in Gidan-Kwano in 2005, the report confirmed that infrastructural development were not available as depicts in Table 1.

Table 1: Nature of Infrastructural development of Gidan-Kwano in 2005

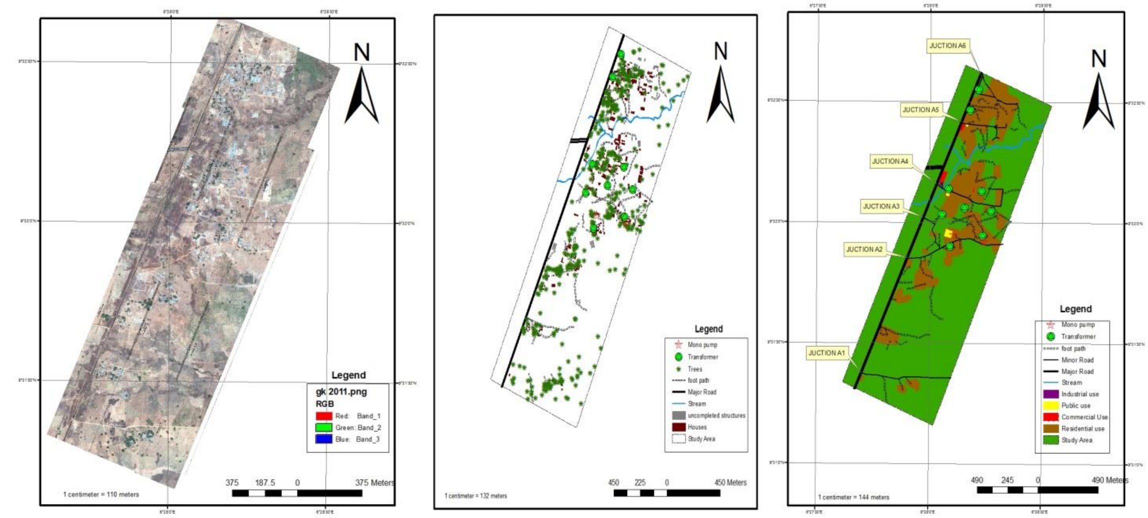
Facility	Remark
Water Supply	1 borehole
Electricity	No transformer and Electric poles
Accessibility	Earth road and narrow
Drainages	The main drainage has no culvert
Health	No health facility
Education	No primary school

Source: Department of Urban and Regional Planning, FUT, Minna

Assessment of Host Community in 2012 and 2015

As at 2012, Gidan-Kwano has witnessed astronomical housing development. Figure 3 shows the Google earth image, digitized map and the land use map in 2012.

Figure. 3: Google Earth Image, Digitized Map and Land Use Map of GidanKwano in 2012



Source: Urban and Regional Planning Department, FUT, Minna

Figure 3b: Land Use Map of Gidan-Kwano in 2015

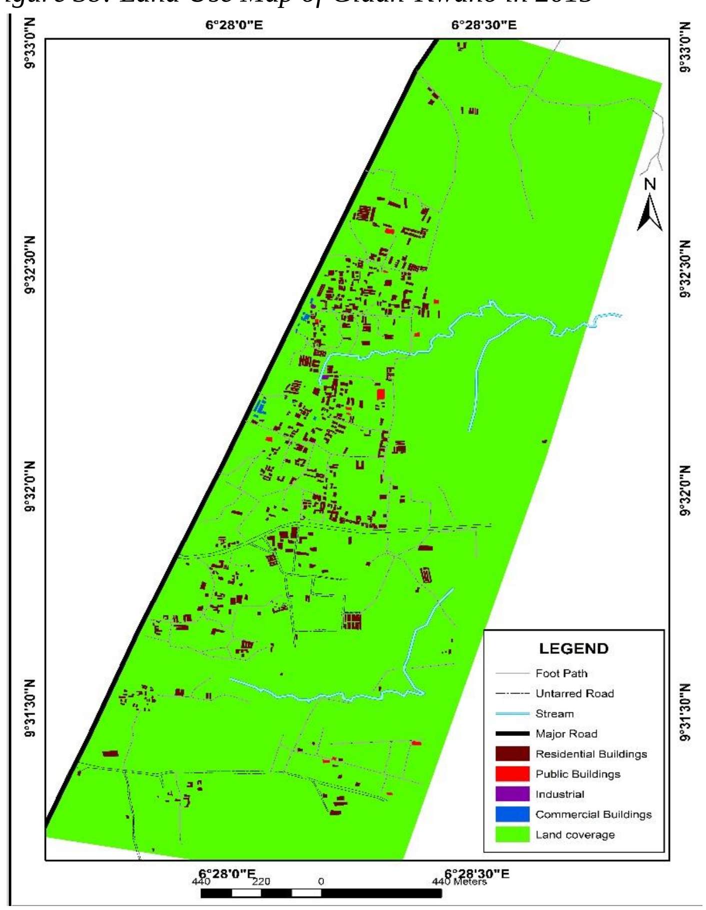


Figure 3 shows the changes that have occurred in the study area after 2005. The figure reveals that in 2012, impacts of the Federal University of Technology, Minna were more pronounced in the area in terms of expansion of residential buildings and infrastructural development. Considering the situation of the university host community in 2012, residential and other buildings increased beyond 22% while the agricultural land uses reduced to 77%. The habitable housing units in 2012 stood at 456 houses, which were characterised by block housing, modern flats including those that investors made available for students and other people in the area. The population of the people in Gidan Kwano in the year 2012 was 2,329 [9]. As at 2015, residential land use increased to 25.19% with a corresponding reduction in agricultural land use which stood at 74.07%. As at 2015, total number of houses stood at 644, representing 41.2% increase over 2012.

In terms of the Infrastructural development provision at the study area, Table 2 shows the changes and development now available in 2012.

Table 2: Physical development of GidanKwano in 2012/2015

Facility	Remark
Water Supply	3 Mono pump, 7 private borehole
Electricity	6 transformers
Accessiblity	Expansion of old roads and creation of new ones
Drainages	Construction of bridges and drainages
Health	1 primary health care center
Education	2 primary schools (private & public)
Commercial/Industrial	3 Sawmills/ departmental stores in the town and along the major road

Source: Department of Urban and Regional Planning, FUT, Minna

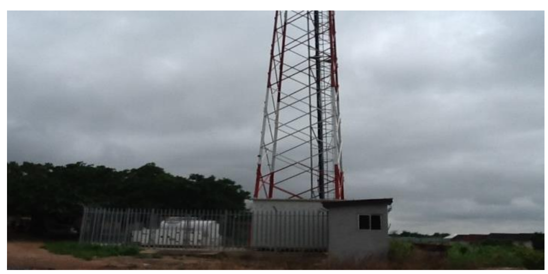
Plate 2: Modern houses and Infrastructure in GidanKwano in 2015.

Modern buildings

Transformer and road network

Health care centre and primary school

Sawmill and departmental stores



Overhead Water Tank and Telecommunication Mask

Level of Growth and Development in Gidan-Kwano; 2005 and 2015

This depicts the variation in growth and development of Gidan-Kwano within ten years interval (2005 – 2015).

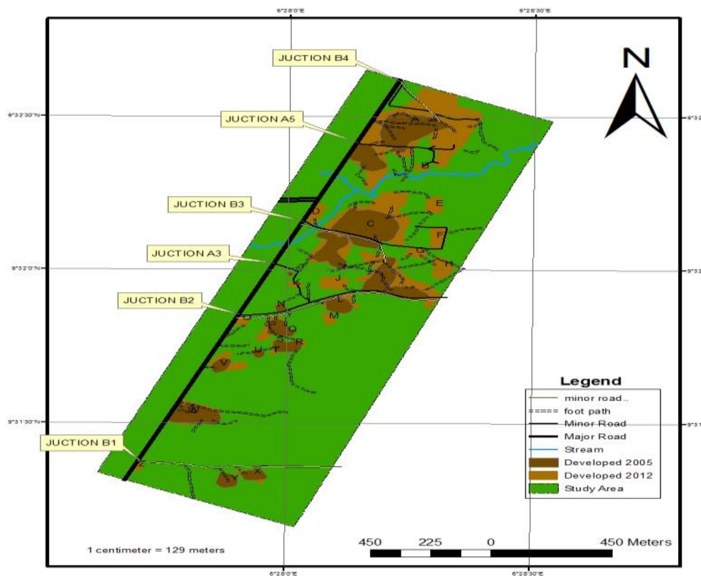
Table 3: Variation in Land Use of GidanKwano between 2005 and 2015

Land Use	Area coverage /percentage 2005		Area coverage /percentage 2012		Area coverage /percentage2015
Residential	182,256sqm	8.87%	461,608sqm	22.47% 25.19%	518,517sqm
Agricultural	1,868,839sqm	90.96%	1,582,455sqm	77.02% 74.07%	1,524,805sqm
Commercial	Nil	Nil	5,520sqm	0.27% 0.27%	5,538sqm
Public/Semi public	3,444sqm	0.17%	4,403sqm	0.17% 0.22%	4,590sqm
Circulatory	1,671sqm	0.08%	3,822sqm	0.19% 0.19%	3,957sqm
Industrial	Nil	Nil	553sqm	0.03% 0.047%	958sqm

Source: Jangado, 2013;fieldwork,2015

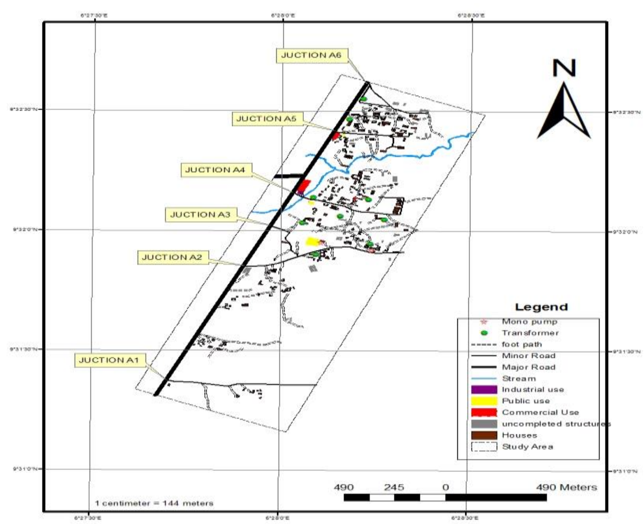
The variation of land uses as shown in Table 3reveals the changes experienced in the area, which is reflected in all the uses. Comparing the results of the analysis in 2005, 2012 and 2015, area coverage of residential land use increased from 8.87% to 22.47% in 2012 and to 25.19%in 2015. Agricultural land use reduced from 90.96% to 77.02% in 2012 and further reduced to 74.07% in 2015. Commercial land use increased from 0% to 0.27%, public/semi public increased to 0.22% in 2015. Circulatory use increased to 0.19% from 0.08% while industrial land use recorded an increase of 0.04%. By implication, residential land use has been greatly influenced by the movement of Federal University of Technology, Minna to the present location since 2005. Other land uses in the same like manner shared from the growth and development as a result of the movement of the university. Figure 4 shows the changes in land uses of the area between 2005 and 2012 respectively. Figure 5 shows the detailed digitized physical developments in the area as at 2012.

Figure 4: Variation in Land uses of the area between 2005 and 2012



Source: Urban and Regional Planning Department, FUT, Minna

Figure 5: Digitized physical developments in GidanKwano as at 2012



Source: Urban and Regional Planning Department, FUT, Minna

The Impacts of Federal University of Technology, Minna on the Physical Development of GidanKwano

The results of the analysis and findings show that developments have occurred as a result of the movement of the university to its permanent site since 2005 and these are enumerated below;

i. Physical expansion of the village.
ii. Increase in population of the residents.

iii. Construction of more residential and habitable housing units for students and staff.
iv. Provision of infrastructural facilities to support the growing population.
v. Increase in investments on landed properties.
vi. Corporate social responsibility of the university in the provision of bore hole and overhead water tank to the host community as well as employment of various categories of the indigenes (the skilled, semi-skilled and the unskilled).
vii. Opportunity for indigenous farmers to sell their farm produce to students and staff of Federal University of Technology, Minna there improving their economic development.
viii. Co-existence and social integration of the people despite differences in ethnicity and language. Despite the above positive impacts of the university on the host community, there are noticeable negative impacts which include;
ix. Ecological foot print on the host community - Gradual loss of green areas to man made improvements
x. Increase in urban heat
xi. Threat and insecurity as a result of lack of police post and security personnel.
xii. Non enforcement of planning laws and regulations resulting in haphazard development of the area.

5. Conclusion

The paper has revealed the impact of university on the physical developments of the host community. It is expected that as the university grows in terms of programmes and admission, it will exert influence on the host community in terms of Real Estate and infrastructural development. It is however recommended that there is need for a planning policy for the study area to prevent haphazard developments and slum formation.

6. References

1.Preeti Flora and Gaurav Agrawal[2014] Determinants of Direct Foreign Investment as a Means of International Market Entry: A Review. Indian Journal of Economics and Development. Vol 2 (4) pp.63-83

2.Falconer, J. (2006) "The impact of public four-year colleges and universities on community sustainability in non-metropolitan areas of the Great Plains" (January 1, 2006). *ETD collection for University of Nebraska – Lincoln.* Paper AAI3218892. http://digitalcommons.unl.edu/dissertations/AAI3218892

3.DiNapoli, T.P (2010). The Economic Impact of HigherEducation in New York State, Office of the New York State Comptroller, New York City publication office centre, vol., Report 7-2011

4. Ehinmowo, A.A. and Eludoyin O. M. (2010) International Journal of Sociology and Anthropology Vol. 2(7), pp. 149-154, August 2010 Available online http://www.academicjournals.org/ijsa ISSN 2006- 988x ©2010 Academic Journals

5. https://www.kent.ac.uk/about/impact/downloads/kent-viewforth-study-october-2014.pdf

6. Igbinedion, V.I andOvbiagele, A.O (2012). Corporate Social Responsibilities of Tertiary Educational Institutions to Host Communities in Delta South Senatorial District of Delta State of Nigeria, *International Review of Social Sciences and Humanities*, Vol. 4, No. 1 (2012), pp. 133-141, www.irssh.com, ISSN 2248-9010 (Online), ISSN 2250-0715 (Print).

7. Whitfield, J.B., Zhu, G., Heath, A.C., & Martin, N.G (2004). Choice Residential Location: Chance, Family Influence, or Genes. *Twin Research and Human Genetics*, November, 2004, vol. 8 no. 1 pp 22-26.

8.Federal University of Technology, Minna, Niger State, Nigeria. www.en.wikipedia.org/wiki/Federal_University_of_Technology_Minna. Retrieved 25 August, 2014.

9. Jangado,V.C (2014). A Study of Spatial Dynamics of GidanKwano, Bosso Local Government, Niger State. A dissertation submittedto the Department of Urban and Regional Planning, Federal University of Technology, Minna, Niger State, Pp. 36.

REINVENTING FEDERAL AND STATE INSTITUTIONS FOR EFFECTIVE AND SUSTAINABLE HOUSING DELIVERY IN NIGERIA

Mustapha Zubairu

Centre for Human Settlements and Urban Development, Federal University of Technology, Minna.

Nigeria which has an estimated population of 150 million faces a massive housing deficit also estimated at 17 million housing units. It was further deduced that an approximate value of 720,000 housing units per annum will be necessary to replenish the decaying housing stock and also meet the rising demands which if implemented will avert a further housing crisis by the year 2020. At N 3.5 million per unit, N 60 trillion will be required to provide the calculated 17 million housing units. This paper reiterates the importance of affordable housing delivery through the combined efforts of various government agencies and research institutions in making this a possibility. It also highlighted the various setbacks that contribute to the current challenges in this sector. The paper finally concluded on the importance of providing a stabilized institutional framework for effective housing delivery and urban management at all tiers of government which requires that all the three tiers of government develop a shared understanding, knowledge and skills to be able to perform the roles assigned to them in the National housing Policy.

Keywords: Decaying, delivery, framework, housing units, policy

mustapha.zubairu@futminna.edu.ng

Zubairu, M. (2016). **REINVENTING FEDERAL AND STATE INSTITUTIONS FOR EFFECTIVE AND SUSTAINABLE HOUSING DELIVERY IN NIGERIA** Sustainable Built Environment and Climate change; The challenges of Post 2015 Development Agenda. School of Environmental Technology Conference, SETIC, 2016

1. INTRODUCTION

It has long become part of the Nigerian psyche, especially at government level, to blame our collective failure to poor implementation. This is despite the distinction acquired by the country, in the international community, of producing very well thought out policies. The new National Housing and Urban Development Policies, promulgated in 2012, represent, yet, another attempt by the Federal Government to establish instruments aimed at ensuring the delivery of affordable housing to all Nigerians, irrespective of their economic conditions; and for creating more efficient and equitable urban areas.

There are many things unique about these Policies. Perhaps, it is in recognition of the size and rapidly increasing level of poverty in the country, that a chapter is created in the National Housing Policy dedicated to providing Social Housing i.e. housing for Nigerians with "No-income and Low-income group is here defined as all employees or persons whose monthly income does not exceed ₦70,000 per annum". Over one hundred million Nigerians, out of a population of about 168 million officially fall into this category. Another of their equally unique aspect has to do with the fact that both the National Vision 20: 2020 and the Transformation Agenda of the present administration are in agreement with the Policies in terms of the scale of the problems and strategies for addressing them. The report of the Vision 20:2020 National Technical Group in Housing states that "housing would be achieved through a private sector led housing delivery system anchored on mass construction of houses and strong mortgage finance". Its Implementation Plan states, among others, that "…10 million new houses to the national housing stock should be added by building an average of 1 million new homes every year; and ensure that at least 50 percent of the new homes are built in the urban centres and the remaining in the rural areas; and provide incentives to encourage Public Private Partnership (PPP) in mass housing development".

The Transformation Agenda of the present administration (2011-2015) stated that "….the Federal Ministry of Housing will provide Site and Services in all parts of the Country in collaboration with States and Local Governments. On their parts, States and Local Governments will provide Low Cost Housing units within the range of 100,000-200,000 housing units annually in major cities across the country. Local contents such as bricks will be encouraged in the construction of housing while all inputs used in delivering housing will be obtained from the locality to create jobs and add value". It further stated that "Housing is also part of the critical infrastructure to accelerate economic development and forms a substantial part of the Gross Domestic Product (GDP) of most developed countries. Nigeria with an estimated population of 150 million requires at least additional 720,000 housing units per annum (based on an estimate of 9 dwelling units a year per 1,000 of population) not only to replenish decaying housing stock, but also to meet rising demand and avert a further housing crisis by 2020. Consequently, at least ₦60 trillion is required to provide 17 million housing units at ₦ 3.5 million per unit".

The downside of the above is the sad reality that past efforts have not been successful. This is clearly stated in chapter two (the longest of all the chapters in the policy document) which reviews past Policies and Programmes and substantially admitted as much. The eminent danger the country faces is that, until and unless it does something drastically different this time around, the country will as usual dissipate so much energy and spend billions of Naira and at the end will have very little to show for it. The position of the paper is that the real operational structures of the federal institutions involved in the policy implementation of the

National Housing and Urban Development Policies have been the clog in the wheel of our effective and sustainable progress. The structures in most states are mere carbon copies of the federal structure.

2. OLD HABITS DIE HARD

The Federal Ministry of Lands, Housing and Urban Development (FMLHUD), now merged into the Federal Ministry of Power, Works and Housing (FMPWH) is the line Ministry in charge of formulation and implementation of National Housing and Urban Development Policies. It did an excellent job in assembling Nigerians with requisite knowledge and experience to produce drafts of the two Policies. The author was privileged to be part of the committee. The experience and commitment of the Honourable Minister saw to it that the Policies got approved by the Federal Executive Council with hardly any difficulty.

However, a close examination of the operation of the old FMLHUD, especially its Housing Department, shows that its structure has remained essentially that of the Public Works Department (PWD) of the colonial era. Its professional Departments are configured to plan, design projects (housing, public building) and implement projects directly or under their supervision by contractors. With such a structure and mindset, the Ministry does not appear to be equipped to perform the functions assigned to it in previous National Housing Policies and even the current one. Specifically, chapter nine of the 2012 Policy which deals with the Institutional Framework, states clearly that “Institutional framework forms the structure of the entire housing delivery system and the structure within which housing policy is implemented greatly influences the success of housing delivery”. Similarly the assertion in the Policy that “One of the greatest but avoidable problems facing effective housing delivery and efficient urban management in the country is the instability and capacity gaps caused and created at the Federal level due to the merging and de-merging of the Federal Ministry responsible for Lands, Housing and Urban Development issues”. This is perhaps part of the explanation but the reality is that the Ministry has a fundamental structural problem. Evidence of the deeply entrenched PWD structure is glaring in the operation of the Ministry. The introduction of the Prototype Housing project, in 1990, by late General Kontagora, the then Minister of Works and Housing, was ostensibly to demonstrate the feasibility, viability and affordability of low cost housing. To date, Prototype Housing has remained one of the major projects of the Ministry and perhaps a significant source of inter Departmental tension among its professionals. The Ministry is yet to demonstrate any innovation, cost effectiveness and replicability of the prototype project, more than 23 years after its commencement.

I recall that during my days as the Managing Director/Chief Executive of the Federal Housing Authority (FHA), next to the Gwarinpa Housing Project of FHA, the Ministry had its own version under its Prototype Project, in direct competition with FHA. Yet the Ministry had the mandate of supervising the activities of FHA. There was no level playing field.

As for the Federal Housing Authority, there is a seeming contradiction in its operation. On the one hand it’s enabling law-the Federal Housing Authority Act-Decree No. 40 of 1973 (CAP 136 of the Laws of the Federation 1990)-clearly mandates it to provide housing all categories of Nigerians especially to low income families. On the other hand the Performance Agreement between it, Federal Government of Nigeria and the Technical Committee on Privatisation and Commercialisation (TCPC), of 16th December 1992 (FGN,

1992) wants it to operate as the Commercialised and self-sustaining Real Estate Company. FHA itself seems to have adopted a massively bureaucratic and top heavy organizational structure while at the same time fighting, what seems to me, to be a losing battle of ensuring its self-sustainability. By focusing on the use of conventional building materials it has remained unable to provide leadership in the use of appropriate technology, local and environmentally friendly building materials that have been proven to drastically reduce the cost of construction, thereby, enhancing affordability by the poor and low income families. I recall that when I became its Managing Director, I inherited staff strength of 1720 even though there were only 200 tables for them to sit on at the Headquarters. FHA needed only 250 staff for its operation. We were to create semi-autonomous Subsidiaries out of the remaining staff, but could not implement the idea during my tenure. It is the position of the paper that so far FHA is only operating on the margin of the enormous powers it has to facilitate the construction of cheap and affordable housing for Nigerians of all income groups.

The activities of other private sector driven institutions established with the encouragement of the federal government, to facilitate the production of large scale affordable housing projects have been marginal. Members of the Real Estate Developers Association of Nigeria (REDAN) have focused on the narrow and profitable end of the market. There is a high degree of inevitability to this. As long as enough incentive is not put in place in terms of proven technology and alternative building materials and components, it is not likely that private Real Estate companies will venture into such new and potentially risky ventures.

It is common knowledge that national Research Institutions like National Roads and Building Research Institute (NBRRI) and many universities have been carrying out research on building materials, components and appropriate technology. The funding required to pilot test the research finding at a significant level has not been provided to them. The bulk of their findings have remained on the shelves gathering dust. Meanwhile the world has moved on with the production of local building materials that have facilitated the production of cheap, affordable and very functional housing that are at the same time safeguarding the environment and helping to secure the ecosystem.

3. THE WAY FORWARD

It is obvious that the fate of the 2012 National Housing Policy hangs in the balance. This is alluded to in the Policy that “the institutional framework for effective housing delivery and urban management at all tiers of government needs to be stabilised, empowered and strengthened to effectively discharge their respective functions as identified in the National Housing Policy”. We need to do more than just “stabilizing” the institutional framework, we must create an effective framework based on the apt recommendation of the Vision 20:2020 that “the setting up of a virile Ministry at the Federal level for the effective coordination of governance of the implementation of political and legislations that pertains to land use planning and housing development”.

The position of the paper is that we have to carry out a comprehensive restructuring of the Federal Ministry of Lands, Housing and Urban Development for it to be able to effectively perform the governance, political, legislative and technical support functions/roles assigned to it in section 9.3.3; and to coordinate the activities in section 9.3.2 of chapter nine of the National Housing Policy, dealing with Institutional Framework.

3.1 Restructuring required of the Housing Department of the Federal Ministry of Power, Works and Housing to enable it perform the Apex Functions Assigned to it in the Implementation of the National Housing and Urban Development Policies

The proposed restructuring should involve the creation of appropriate Departments; with requisite and fully trained staff to perform the under listed functions. It is only in the context of these that the Ministry can effectively perform the Apex role assigned to it in section 9.3.3 of the National Housing Policy in particular and that contained in section 21.4.1 of the National Urban Development Policy.

i. Become a national Planning, Research, Statistics and Capacity Developer to all the three tiers of government in the implementation of the National Housing and Urban Development Policies;
ii. Ensure the institutionalisation of an integrated housing and urban development processes within related ministries, Agencies and at inter-ministerial level as “two sides of the same coin”;
iii. Ensure the allocation and control of resources, through direct allocation and effective inter-ministerial coordination, for research into local building materials, components and appropriate technology by NBRRI, other related research institutions and universities; pilot testing new ideas using reasonably sized housing estates; and facilitating replication and commercialization of research findings;
iv. Promote the construction of Energy Efficient Building with Passive Energy and/or Zero Energy characteristics as a first step towards the creation of Eco cities in Nigeria;
v. Ensure that the Energy Efficiency is integrated into National Building Code, which should be fully understood and utilized by states and local governments and the Built Environment professionals;
vi. Make the Built Environment professionals the main Resource Persons to the Ministry through adequate incentive and legally mandated participation (carrot and stick approach);
vii. Ensure, through effective inter-ministerial coordination, that adequate water supply and sanitation systems are integrated into major housing projects (housing & urban development as two sides of the same coin);
viii. Rainwater harvesting and recycling of waste water (Grey water), to be promoted;
ix. Manufacture of WCs that use little or no water to flush should be promoted and/or the establishment of Biogas plants in housing estates should be promoted;
x. Renewable energy such as solar and wind energy should be integrated in to housing projects. The manufacture of solar water heaters, fridges, and Air conditioners should be promoted;
xi. Develop effective guidelines for the monitoring and evaluating the activities of such organisations as REDAN, Building Materials Producers Association of Nigeria (BUMPAN); and to provide incentive schemes to encourage investment in local building materials and appropriate technology;

xii. Incorporate environmental and energy issues at all levels of planning and decision-making on housing and urban development; and

xiii. Facilitate the restructuring of corresponding Ministries at state levels and build requisite capacity at local government level. The fact that housing is on the concurrent list in the Constitution will require a more constructive use of the National Council on Lands, Housing and Urban Development;

3.2 Restructuring of the Federal Housing Authority (FHA)

The position of the paper is that it makes very little sense for FHA to operate as Property Developer, seemingly in competition with members of REDAN and others. The effectiveness of FHA lies in its ability to be an effective Facilitator and a Bridge between a restructured FMPWH and all the stakeholders in the building industry. Accordingly, FHA should be structured, empowered, properly funded and its capacity developed to perform the following functions:

i. To work with the Built Environment professionals and research institutions to select, adapt and pilot test new construction technology, materials and components in parts of the country;

ii. Promote the commercialization of new technology and building materials through properly crafted and mutually beneficial partnerships;

iii. To ensure its self-sustainability FHA can establish subsidiaries to mass produce building materials such as Compressed Earth Blocks, Road Pavers, Roofing Sheets etc.; and

iv. Facilitate the restructuring of State Housing Corporations to be able to perform similar functions, at state level.

4. EXAMPLES OF WHAT A PROPERLY RESTRUCTURED FMPWH AND FHA CAN DELIVER TO NIGERIANS

Appropriate Technology for Mass Production of Compressed Earth Bricks

Compressed Earth Bricks

Bungalow Constructed With Compressed Earth Bricks

Interior of a Bungalow Constructed with Compressed Earth Bricks

Eco Housing, Bengal, India


Vertical Axis Wind Turbine (Adjudged To Be More Efficient and Less Noisy)


Portable Vertical Axis Wind Turbine (Mounted on a Roof)


A Typical 100mw Solar-Power-Plant on 650acres of Land
(Enough to Supply 30,000 Homes)

5. CONCLUSION

The challenge of addressing our massive housing deficit, estimated at 17 million units, requires that all the three tiers of government develop a shared understanding, knowledge and skills to be able to perform the roles assigned to the in the National housing Policy. This is despite the fact that housing is on the concurrent list in the Constitution. A fully restructured FMPWH will have a fulltime responsibility of creating enabling environment that will facilitate large scale production of cheap and affordable housing for all income levels; while the urban development components are fully integrated in the process.

FHA, as a Facilitator, should have the technical and professional capacity and adequate funding to effectively work with Built Environment professionals, NBRRI, other research institutions, universities and other stakeholders to select, adapt and pilot test new construction technology and techniques, building materials and component and facilitate their replication and commercialization in all parts of the country.

The instrumentalities of the National Council on Lands, Housing and Urban Development should be used to restructure the state Ministries of Lands and Housing and Housing Corporations to be able to contribute to achieving the purpose of the National Housing Policy of ensuring "that all Nigerians own or have access to decent, safe and sanitary housing in healthy environment with infrastructural services at affordable cost, with secure tenure".

6. REFERENCES

1. FHA, (1973) Federal Housing Authority Act (CAP 136)
2. FGN, (2012). National Housing Policy
3. FGN, (2012). National Urban Development Policy
4. FGN, (1992) Performance Agreement between the federal Government of Nigeria and Federal Housing Authority (FHA) and Technical Committee on Privatisation and Commercialisation (TCPC)
5. Zubairu M, (2011) Urbanisation and housing. The attendant Housing and Infrastructure Challenges in Urban Nigeria- A Paper presented to the Federal Government Committee on the Review of the Housing and Urban Development Policies, June 14th 2011
6. Zubairu (2001) Housing The Low-Income In Urban Nigeria: Re-Thinking The Role And Responsibilities Of The Federal Housing Authority

INDEX OF AUTHORS

Published by:
School of Environmental Technology
Federal University of Technology
Main Campus, Gidan Kwano, Minna, Niger State, Nigeria.
P. M. B. 65, Minna, Niger State, Nigeria.
setconference@futminna.edu.ng www.futminna.edu.ng