



**SCHOOL OF ENVIRONMENTAL TECHNOLOGY,
FEDERAL UNIVERSITY OF TECHNOLOGY**
MINNA, NIGER STATE, NIGERIA



4th

INTERNATIONAL CONFERENCE (SETIC2022)

BOOK OF PROCEEDINGS

MAIN THEME:

**SUSTAINABLE DEVELOPMENT AND RESILIENCE OF THE
BUILT ENVIRONMENT IN THE ERA OF PANDEMIC**

6th - 8th February, 2023

**VENUE: NITDA Centre,
Federal University of Technology,
Minna, Niger State, Nigeria**

Chief Host

Prof. Faruk Adamu Kuta

*Vice-Chancellor
Federal University of Technology Minna, Nigeria*

Host

Prof: R.E. Olagunju mnia

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

**EDITOR IN CHIEF
B.J. Olawuyi**





School of Environmental Technology International Conference (SETIC 2022)

6th – 8th February, 2023

**Federal University of Technology Minna, Niger
State, Nigeria**

BOOK OF PROCEEDINGS

**EDITOR IN CHIEF
B. J. Olawuyi**

ISBN 978-978-54580-8-4



**Proceedings of the 4th School of Environmental Technology International
Conference (SETIC 2022)**

Published by
School of Environmental Technology,
Federal University of Technology Minna.
PMB 65, Minna,
Niger State Nigeria.

© School of Environmental Technology, Federal University of Technology Minna 2023

ISBN 978-978-54580-8-4

Editor-in-chief:	Dr. Olawuyi, Babatunde James	Federal University of Technology Minna. Niger State, Nigeria
Editors:	Dr. Ogunbode, Ezekiel Babatunde	Federal University of Technology Minna. Niger State, Nigeria
	Surv. Adesina, Ekundayo A	Federal University of Technology Minna. Niger State, Nigeria
	Dr. Sule, Abass Iyanda	Federal University of Technology Minna. Niger State, Nigeria
	Dr. Ajayi Oluibukun Gbenga.	Namibia University of Science and Technology, Namibia
	Dr, Akande Olufemi K.	Department of Architecture, Federal University of Technology, Minna
	Mr. Morenikeji, Gbenga	Federal University of Technology Minna. Niger State, Nigeria
	Mr. Akande, Olaide S.	Department of Urban and Regional Planning, Federal University of Technology, Minna
	Mrs. Odine, Linda	Department of Quantity Surveying, Federal University of Technology, Minna
	Prof. James O.B. Rotimi	Massey University New Zealand
	Asst. Prof. Dodo Yakubu Aminu	Architectural Engineering Department, College of Engineering, Najran University, Najran, 66426, Kingdom of Saudi Arabia
	Dr. Renuka Thakore	Founder, Institute for Global Sustainable Futures, Progress through Partnership, UK

No responsibility is assumed by the Publisher for any injury and/or any damage to persons or properties as a matter of products liability, negligence or otherwise, or from any use or operation of any method, product, instruction, or idea contained in the material herein.

Copyright © 2023 by School of Environmental Technology, Federal University of Technology Minna, Nigeria. All rights reserved.

This publication is protected by Copyright and permission should be obtained from the publisher prior to any prohibited reproduction, storage in a retrieval system, or transmission in any form or by any means, electronic, mechanical, photocopying, recording, or likewise.



PREFACE

The 4th edition of School of Environmental Technology International Conference (SETIC2022) is organised by School of Environmental Technology, Federal University of Technology Minna, Nigeria. In collaboration with Massey University New Zealand, University of Namibia, Namibia, Department of Architectural Technology, Najran University, Saudi Arabia, Department of Civil Engineering, Stellenbosch University, Stellenbosch, South Africa and the Global Sustainable Futures, UK.

The main theme for this year conference is “**Sustainable Development and Resilience of the Built Environment in the Era of Pandemic**” and is of interest to everyone going by the fact that housing is a necessity following only after food and clothing while living in crowded places and poor sanitation is a concern and possible cause of spread of diseases and occurrence of epidemic/pandemic. This promotes and encourage innovative and novelty for emerging property management strategies in a pandemic era; modern geospatial tools for epidemiology; architecture, resilience and healthy buildings in pandemic era; planning for sustainable resilient neighbourhoods and cities in COVID-19 era; sustainable and resilient cities; sustainable cost management of built environment projects in the era of covid-19; wellbeing and resilience of the built environment.

The responses from participants for this conference are overwhelming, well attended, and successful. The operation mode was virtual for all participants with presentations in mode Our participants are from various Universities and other sector across the globe, from countries like United Kingdom, New Zealand, Saudi Arabia, South Africa, Namibia, Ethiopia and Nigeria just to mention a few. Hence, this conference provides a good platform for professionals, academicians and researchers to widen their knowledge and approach on latest advances in research and innovation. Papers presented in this conference cover a wide spectrum of science, engineering and social sciences.

Finally, a note of thanks must go to SETIC 2022 Local Organizing Committee (LOC) for their remarkable dedication in making this conference a success. We hope the event will prove to be an inspiring experience to all committee members and participants.



ACKNOWLEDGEMENTS

The effort put together in achieving the success of SETIC 2022 is predicated on the feat of the previous three edition of School of Environmental Technology International Conference held in 2016, 2018 and 2021, respectively. The support and goodwill from Vice-Chancellor of Federal University of Technology, Dean School of Environmental Technology, Dr. Renuka Thakore, Dr Dodo Y. A., Prof. James O.B. Rotimi and many other highly motivated people are highly appreciated.

It is also my privilege and honour to welcome you all, on behalf of the Local Organizing Committee (LOC) to the 4th edition of the Biennial School of Environmental International Conference (SETIC2022). This Conference which was earlier schedule for April, 2022 is holding now (6th to 8th February, 2023) due to the prolonged ASUU-FGN crisis which made our public Universities in Nigeria to be closed for over Eight Months. Our experience in the 3rd edition held in 2021 after the COVID-19 Pandemic has thought us on new ways of doing things with the Virtual Conferencing offering us a wider coverage, it is our hope that SETIC2022 will be an improvement on the Participants experience of opportunity available for global networking and interaction at Conferences via the Virtual mode of presentation.

The conference provides an international forum for researchers and professionals in the built environment and allied professions to address fundamental problems, challenges and prospects of **Sustainable Development and Resilience of the Built Environment in the Era of Pandemic**. The conference is a platform where recognized best practices, theories and concepts are shared and discussed amongst academics, practitioners and researchers. This 2022 edition of SETIC has listed in the program a Round Table Talk on on Housing Affordability Beyond COVID-19 with selected Speakers from across the globe available to do justice on the topic of discussion. Distinguished Conference participants, permit me to warmly welcome our Keynote:

- Dr. Ibrahim Idris, *Director Public health, State Ministry of Health, Niger State, Nigeria;*
- Dr. A.A. Bilau, *Lecturer and expert in Disaster Risk Management, Department of Building, Federal University of Technology, Minna, Nigeria and;*
- Dr. Yakubu Aminu Dodo, *Ass. Prof. Architecture Engineering Department, Faculty of Engineering, Najran University, Najran, Saudi Arabia;*

And the lead Discussants for the Round Table Talk:

- Prof. James O.B. Rotimi, *Professor of Construction Economics & Management, School of Built Environment, College of Sciences, Massey University of New Zealand;*
- Prof. O.A. Kemiki, *Professor of Estate Management and Valuation, Federal University of Technology, Minna, Nigeria;*
- Dr. Renuka Thakore, *Founder, Institute for Global Sustainable Futures, Progress through Partnership, UK;*
- Dr. Guillermo Delgado, *Senior Lecturer, Architecture and Acting Director, Institute of Land, Livelihoods and Housing (ILIH), Namibia University of Science and Technology, Namibia;*
- Prof. Adewumi John Babafemi, *Associate Professor and Head of Construction Materials and Unit; Stellenbosch University, Stellenbosch, South Africa;*
- Dr. Yakubu Aminu Dodo, *Ass. Prof. Architecture Engineering Department, Faculty of Engineering, Najran University, Najran, Saudi Arabia.*



for accepting to share from their knowledge, wealth of experience and be available to interact with participants on varied issues on “**Sustainable Development and Resilience of the Built Environment in the Era of Pandemic**”.

As reflected on the Conference program, the Conference activities will be Virtual for all presenters to run in four parallel sessions on the Zoon platform. With a total of Seventy (70) articles captured in the Conference Proceedings covering the six subthemes of the Conference, I have no doubt that we are all in for an impactful experience at SETIC2022 as we brainstorm, exchange ideas, share knowledge and participate in evolving more approach to sustainable housing and land management drives.

I implore us all to enjoy every moment of the deliberations and ensure we maximize the great opportunity offered by the Conference to network for better research and career development as we also make new friends.

I also on behalf of myself and the LOC express our appreciation to the Dean, School of Environmental Technology and the entire Staff of the School for giving us the opportunity to steer the ship for SETIC2022. To the Reviewers and various Committees that served with us, I say thank you for helping us through despite the pressure of work.

Thanks, and God bless you all.

Olawuyi, B.J. (PhD)
Chairman, LOC
SETIC2022



COPYRIGHT STATEMENT

© Copyright. School of Environment International Conference (SETIC2022). The copyright for papers published in the SETIC Conference Proceedings belongs to authors of the papers.

Authors are allowed to reproduce and distribute the exact format of papers published in the SETIC2022 Conference Proceedings for personal and educational purposes without written permission but with a citation to this source. No unauthorized reproduction or distribution, in whole or in part, of work published in the SETIC2022 Conference Proceedings by persons other than authors is allowed without the written permission of authors or organizers of the SETIC2022 Conference.

We have taken all necessary cautions to comply with copyright obligations. We make no warranties or representations that material contained in the papers written by authors do not infringe the intellectual property rights of any person anywhere in the world. We do not encourage, support or permit infringement of copyrights / intellectual property rights by authors. Should you consider any violation of your copyrights please do not hesitate to contact the conference secretariat at setic@futminna.edu.ng

SETIC2022 accepts no liability for copyright infringements or inappropriate use of material in any paper published. All authors developed their papers in line with the guiding principles of academic freedom and are responsible for good academic practice when conducting and reporting scientific research.

Correspondence relating to copyrights and requests for permission to use material from the SETIC2022 Conference Proceedings should be made to: Secretariat of SETIC Conference email: setic@futminna.edu.ng



DECLARATION

PEER REVIEW AND SCIENTIFIC PUBLISHING POLICY STATEMENT

6th February, 2023

TO WHOM IT MAY CONCERN

I wish to state that all the papers published in SETIC2022 Conference Proceedings have passed through the peer review process which involved an initial review of abstracts, 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 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

Babatunde James OLAWUYI
Chairman SETIC2022
Federal University of Technology, Minna, Nigeria

Papers in the SETIC2022 Conference Proceedings are published on www.futminna.edu.ng,
AND ALSO SELECTED PAPERS WILL BE PUBLISHED IN REPUTABLE JOURNALS





ORGANISING COMMITTEE

CHIEF HOST

Prof. Faruq Adamu Kuta
Vice-Chancellor,
Federal University of Technology Minna, Nigeria

HOST

Prof. Olagunju Remi Ebenezer
Dean
School of Environmental Technology,
Federal University of Technology Minna, Nigeria

CONFERENCE CHAIRS

Conference Chair	Parallel Sessions
Prof. Nuhu, M.B.	Emerging Property Management Strategies in a Pandemic Era
Prof. Junaid, A	Planning for Sustainable Resilient Neighbourhoods and Cities in Pandemic Era
Dr. Opaluwa, Y.D.	Modern Geospatial Tools for Epidemiology
Dr. Anifowose, M. O.	Sustainable Cost Management of the Built Environment Projects in the Era of Pandemic
Dr. Olatomiwa, Lanre	Wellbeing and Resilience of the Built Environment
Prof. Ayuba, P.	Architecture, Resilience and Healthy Buildings in Pandemic Era

CONFERENCE ADVISORY COMMITTEE

Dr. Isah, A. D	HOD, Department of Architecture
Dr., Apeh, J. A.	HOD, Department of Building
Dr. Popoola, N. I	HOD, Department of Estate Management and Valuation
Dr. Mohammed Y.	HOD, Department of Quantity Surveying
Prof. Musa A.	HOD, Department of Surveying and Geoinformatics
Dr. Bala Banki	HOD, Department of Urban and Regional planning



LOCAL ORGANIZING COMMITTEE

Dr. Olawuyi B. J.	Chairman	Department of Building, Federal University of Technology Minna, Nigeria
Surv. Adesina E. A.	Secretary	Department of Surveying and Geoinformatics, Federal University of Technology Minna, Nigeria
Dr. Muhammad I.B.	Member	Deputy Dean, School of Environmental Technology, Federal University of Technology, Minna
Dr. Ogunbode E. B.	Member	Department of Building, Federal University of Technology Minna, Nigeria
Dr. Sule A. I.	Member	Department of Estate Management and Valuation, Federal University of Technology Minna, Nigeria
Dr. Ajayi O. G.	Member	Namibia University of Science and Technology, Namibia
Mr. Morenikeji G.	Member	Department of Estate Management and Valuation, Federal University of Technology Minna, Nigeria
Mrs. Odine L.	Member	Department of Quantity Surveying, Federal University of Technology Minna, Nigeria
Mr. Akande O. S	Member	Urban and Regional planning, Federal University of Technology Minna, Nigeria
Dr. Akande O. K	Member	Department of Architecture, Federal University of Technology Minna, Nigeria
Dr. Saidu I.	Member	Department of Quantity Surveying, Federal University of Technology Minna, Nigeria

SCIENTIFIC COMMITTEE

Prof. Jimoh R.A..	Chairman	Department of Building, Federal University of Technology Minna, Nigeria
Dr Opaluwa Y.D.	Member	Department of Surveying and Geoinformatics, Federal University of Technology Minna, Nigeria
Dr. Musa D. Haruna	Member	Urban and Regional planning, Federal University of Technology Minna, Nigeria
Dr. Udoekanem N. B.	Member	Department of Estate Management and Valuation, Federal University of Technology Minna, Nigeria
Dr. Lawal L.A.	Member	Department of Architecture, Federal University of Technology
Miss Nmadu H.	Member	Department of Building, Federal University of Technology Minna, Nigeria
Miss. Hassan K.M.	Member	Department of Quantity Surveying, Federal University of Technology Minna, Nigeria
Mr. Kuma S. S.	Secretary	Department of Estate Management and Valuation, Federal University of Technology Minna, Nigeria



A	SUB-THEME 1: EMERGING PROPERTY MANAGEMENT STRATEGIES IN A PANDEMIC ERA	1
1	Property Management Strategies in the Post COVID 19 Pandemic Era in Nigeria: Moving Beyond the Myths and Misconceptions	Ankeli, I. A., Salihu, N., Nuhu, M. B., Sule, I. A., Tinufa, A. A. 2
2	Developers Compliance with Urban Residential Development Control Measures in Kaduna Metropolis, Nigeria	Salihu, N., Ankeli, I. A., Nuhu, M. B., Sanni, M. L., Sule, I. A., Aliyu, A. A. Gwamna S. E., & Hamza, U. Y. 10
3	Macro Economic Determinants of Rental Values of commercial Real Estate in Ilorin, Nigeria	Abdulmalik, F.B. & Udoekanem, N.B. 18
4	Real Property Management in the Era of COVID-19 Pandemic in Nigeria: Promoting Real Estate Investment Trust as an Investment Vehicle	Bokani, A.M., Ahmad, M. & Suleiman, B.Y. 27
5	Assessment of Property Management Practices During and After Covid-19 Pandemic in Lagos, Nigeria	Ogungbe, M.A., Akinwamide, D.O. & Jejelola, O.F. 39
6	An Assessment of Valuation Accuracy in the Residential Property Markets in Minna and Abuja	Dangana, U.S., Udoekanem, N.B. 50
7	Biosensor Re-design requirements for Operational Facility Management in the Post-COVID workplace	Ataguba, J.O. 60
8	An Assessment of the Effect of Coastal Externalities on Residential Housing Prices in Badore, Lagos-Nigeria	Ayoola, A.B. & Akande, S.O. 73
9	Commercial Property Market Performance and Macroeconomic Indicators Amid COVID-19 in Lagos: The Causal Linkage	Wahab, M.B., Alalade, O. & Hassan, O.A. 83
10	Factors Affecting Real Estate Project Delivery and Housing Affordability in Abuja	Emokpaire, E. & Mohammed, M. 94
B	SUB-THEME 2: MODERN GEOSPATIAL TOOLS FOR EPIDEMIOLOGY	100
11	GIS Based Land Suitability Analysis for Optimal Choice of Cereal Crops Production in Kaduna State	Abdulraheem, S. & Opaluwa, Y.D. 101
12	Review on Depth Determination Bathymetry Using Remote Sensing Technique- Theoretical Appraisal	Adeleke. A., Nwadiolor I. J., Odumosu, J., Baba.M. & Bako. M 107
13	Assessment of the Hydrological Characteristics of Shiroro Dam, Nigeria	Adesina E. A., Musa A., Onuigbo, I.C., & Adesiji, A. R. 115
14	Remote Sensing and GIS-Based Vulnerabilities Assessment Over Borno State	Attahiru, I.M. & Etim, E.E. 123
15	Drought Analysis in Jega Local Government, Kebbi State, Using Geospatial Tools to Analyse Vegetation Covers	Yahaya, I. A. & Etim E. E. 132
16	Flood Vulnerability Mapping of Communities Along River Kaduna in Lavun Local Government Area, Nigeria	Mohammed, A.B. Y. & Onuigbo, I.C. 139
17	Analysis of Urban Growth Monitoring and Indicator-Based Assessment Using Remote Sensing Technique in Abuja Nigeria	Umar, I.A. & Etim, E.E. 147
18	Estimation of Leaf Area Index using geospatial methods-A review	Oleh, T. C. & Ajayi, O.G. 155
19	Assessment of Climate Change Impact and Population Growth on Concrete Bridges in Minna, Niger State Using GNSS Technology	Ladan, M.D. & Etim, E. E. 168
20	Image Fusion for Improving Spatial Resolution of Multispectral Satellite Images	Gobir, M. O. & Etim, E. E. 177
21	Point and Spatial Evaluation of Some Selected Commercial Software Used in UAV Image Processing	Aliyu, K. A. & Nwadiolor, I. J. 178
C	SUB-THEME 3: ARCHITECTURE, RESILIENCE AND HEALTHY BUILDINGS IN PANDEMIC ERA	186
22	Nigerian Prisons Reformation! Panacea for Reduction of Recidivism - Case Study of Minna Medium Security Prison	Abdul, C. I., Ekule, A. A., Idachaba, M. K., Nuhu, A. A. 187
23	Incorporating Principles of Adaptability in Spatial Configuration to Enhance Spatial Requirement in the Design of General Hospital Suleja, Niger State	Isiaka, A.S., Maina, J.J., Salihu, M.M., Saliu, O.H. 194



24	Ascertaining Daylighting Wastage in the College of Engineering Complex, Najran University, Saudi Arabia	Bal-Harith, H.M., Abdul Karim, A.N., Alotaibi, B.S., Abuhussain, M.A., Qahtan, A.M. & Dodo, Y.A.	213
25	Evaluation of Daylighting Conditions in Public Libraries: A Case Study of Kaduna, Nigeria	Ojobo, H., Tachio, A., Boyle, G.M. & Chindo, M.	220
D	SUB-THEME 4: PLANNING FOR SUSTAINABLE RESILIENT NEIGHBOURHOODS AND CITIES IN COVID-19 ERA		228
26	GIS-Based Approach to Small Hydropower Potential Assessment Along River Ogun, Nigeria	Akande, S.O., Sanusi, Y.A., Sanni, L.M., Idris-Nda, A. & Santali, B.N.	229
27	Analysis of Women Benefits from Participation in Social Networks in Gulu Vatsa Area of Niger State	Martins V. I. & Tsado E. S.	240
28	Socio-Economic Characteristics of Slum and Informal Settlement in Akure, Ondo State, Nigeria	Adedeji A.A., Junaid, A.M. & Sanni L.M.	246
29	Impact of protest in Lagos state as an emerging mega city: A Review	Malik, A.A. & Bilau, A.A.	252
30	Performance Analysis of Railway Transportation Services on Abuja – Kaduna Route, Nigeria	O’odoh, B. A., Owoeye, I. O, Busari, A. O., Shehu, M., Haruna, A. M., Adamu, H. N.	262
31	An Investigation into the Satisfaction Level of Student Accommodation in Students’ Living Environment of Modibbo Adama University of Technology, Yola, Nigeria	Ekule, A. A., Abdul, C. I., Idachaba, M. K. & Nuhu, A. A.	268
32	Bus Stop Location Considering Passengers Waiting Time and Cost	Ojidoh, C., Mohammed S. & Hawawu, A.	275
33	Evaluation of the Impact of COVID-19 on Public Construction Project Delivery in Nigeria- a Review on Literature	Balogun, M. O. & Bilau, A. A.	284
34	Appraising Household’s Sewage Management Practices in Samaru-Zaria, Kaduna State, Nigeria	Habila, S.K.1a, Itopa, W.I., Ode, I., Akan, M. & Lawal, H.	291
35	The Effect of Oil Spillage and Gas Pollution on Safety Health and Agricultural Production in Delta State	Adigwe, M.U. & Okah, C.M.	300
36	Residential Location Choice: A Study of Household Preferences in Minna, Niger State, Nigeria	Santali, B.N.	308
37	Spatial Distribution Pattern of Public Water Access in Makurdi, Nigeria	Begha, M.C., Sanni, L.M.; Akande, S.O. & Aremu, R.	317
38	Assessment of Environmental Risks in Residential Housing Bosso Niger State.	Olakunle, D.O. & Junaid, S	327
39	Assessment of Environmental Implication of Final Municipal Solid Waste Dump Site in Ilorin, Kwara State, Nigeria	Yaqub, H. A. & Morenikeji, O.O.	332
40	Residents' Perceptions of Urban Green Spaces and Park Qualities in AMAC Abuja	Ugboh, R., Musa, H.D. & Ohadugha, C.B.	338
41	Environmental Impact of Automobile Workshop Activities on Soil Quality in Minna, Nigeria	Nagidi, B.O.; Morenikeji, O.O. & Abbas, Y.A.	346
E	SUB-THEME 5: SUSTAINABLE COST MANAGEMENT OF BUILT ENVIRONMENT PROJECTS IN THE ERA OF COVID-19		353
42	Impact of External Pressures on Adoption of BIM in Construction Organisations	Sani, S.N., Nasir, R.M., Abdullahi, A.M. & Jibril, U.S.	354
43	Assessment of Project Financing Options by Construction Micro, Small and Medium Enterprises in Nigerian Construction Industry	Yesufu, S.I., Musa-Haddary, Y.G., Gandu, J.Y., Abdullahi, I. & Momoh, N	364
44	Impact of Post-COVID Era on Contractors’ Managerial Capability towards Performance of Construction Projects in Abuja, Nigeria	Zubair, A	373
45	Performance of Housing Cooperatives Societies in Housing Finance in North Western Geo-Political Zone, Nigeria	Aliyu, A. & Ganiyu, B. O.	387
46	Influence of Risk Factors on Transnational Public Private Partnership Cost Performance	Waziri, A., Musa, M & Faruq, I.	395



47	Evaluating the Level of Adoption of Total Quality Management (TQM) Practices in Quantity Surveying Firms (QSFs) in Kaduna State, Nigeria	Kure, B. A., Alumbugu, P. O. & Mohammed, Y. D.	414
48	SUB-THEME 6: WELLBEING AND RESILIENCE OF THE BUILT ENVIRONMENT		427
49	Compressive Strength of Millet Husk Ash as Alternative to Silica Fume in Internally Cured High Performance Concrete	Onogwu, C.M., Apeh, J.A., Olawuyi, B.J. & Okoh, B. O.	429
50	Comparative Study on Rice Husk Ash and Silica Fume as Supplementary Cementitious Material in High Performance Concrete Production	Okoh, B.O., Olawuyi, B.O. & Onogwu, C.M.	436
51	Development of Scheffe’s Regression Model to Predict the Compressive Strength of Concrete Using Metakaolin as Partial Replacement of Cement	Jegede, A., Adejumo, T. W., Oritola, S. F., Shehu, M., Omojah, A., Mahmud, M. B.	443
52	Effect of Vibration on Static and Dynamic Response of Loaded Waffle Slab	Abanda, M. A., Sadiku, S. S., Mohammed, A. & Aguwa, J. I.	450
53	Optimum Particle Size of Calcium Carbide Residue Required for Effective Soil Stabilization Using Zeolite for Road Construction	Yahaya, A. U., Alhaji, M. M., Aguwa, J. I., Shehu, M., Kabiru, U. D., Mahmud, M.B.	457
54	Assessment of the Performance of Sandcrete Blocks Produced by Partially Replacing Sand with Coal Bottom Ash as a Fine Aggregate	Ojutiku, M. O., Sadiku, S., Oritola, S. F., Shehu, M., Oglekwu, F. O., Adamu, H. N.	464
55	Biogenic Possibilities of Improving Mortar Strength Using Effective Microorganisms	Olukotun, N., Abdul, C.I., Ekule, A. & Abdullahi, N.A.	469
56	Microstructure and Sorption Properties of Alkaline Surface Modified Coir Bio Fibre	Kure, M.A., Olawuyi, B.J., Ogunbode, E.O. & Apeh, J.A.	475
57	Nanotechnology Application in the Development of Fonio Husk Ash and Calcium Carbide Waste Based-Binder Mortar	Abeku, D. M., Olawuyi, B.J., Apeh, J. A., & Hassan I.O.	481
58	Investigating the Adoption Level of Building Information Modelling for Post-Construction Management in Nigeria	Bello, O.Y. and Ayegba, C	490
59	A Study of the Productivity of Permanent Staff and Contract Staff for POP Workers and Tilers in Abuja	Agada, D.I. & Ayegba, C	500
60	An Investigation of the Satisfaction Level of Student Accommodation and Resilience of Students’ Living Environment of Modibbo Adama University of Technology, Yola, Nigeria	Ekule, A. A., Abdul, C. I., Idachaba, M. K. & Nuhu, A. A.	506
61	Prediction of Water Loss in Hydraulic Distribution System in Minna, Nigeria Using Artificial Neural Network	Yaba, T., Jimoh, O.D., Adesiji, A. R.	513
62	Particulate Matter Exposure of Passengers at Bus Stops	Inufin, T., Kolo, S. S., Jimoh, O. D.	520
63	Assessment of Quality Control of Tiles Production in West Africa Ceramics Company, Ajaokuta, Kogi State	Abdullahi, D., Lawal S. S. & Abdul, C. I.	529
64	Production of Pavement Blocks Using Low Density Polyethylene Product Waste	Aboje, A. A.; Abbas, B. A.; Kolo, D. N.; Abubakar, M. & Abdulsalam A. M.	540
65	Effect of Partial Replacement of Cement with Cow Dung Ash Using Bida Natural Coarse Aggregate	Abbas, B. A., Yusuf, A., Kolo, D. N., Aboje, A. A., Mahmyd, M. B. & Ndaiji, A. U.	547
66	Performance Evaluation of Cement-Stabilized Soft Clay Admixed with Coal Bottom Ash	Zubbair, M. A., Adejumo, T. E. & Amadi, A. A.	556
67	Beneficiation and Characterisation of Kaolin Clay from Clay Deposit in Kutigi, Niger State, Nigeria	Ogundipe, F.O., Saidu, M., Abdulkareem, A.S., and Busari, A.O.	564
68	Factors Contributing to Stress Among Construction Practitioners in Kaduna	Yusuf, I. and Ola-awo, A. W.	573
69	Design Measures for Health and Safety in Pre-Construction Stage of Public Building Projects in Nigeria	Adekunle, E.O., Alumbugu, P.O., Mohammed, Y.D.	582
70	Assessment of Building Standard in Health Care Facilities in Minna, Niger State, Nigeria	Yakubu, R., Sulyman, S.O. & Ohadugha, C.B.	591
71	Factors Affecting Small and Medium Construction Firms Profitability	Aliyu, M & Aola-awo, A.W.	599



Investigating the Adoption Level of Building Information Modelling for Post-Construction Management in Nigeria

Bello, A. O.^{1a} & Ayegba, C.^{1b}

¹ Department of Building, School of Environmental Technology, Federal University of Technology, Minna

^aabdulkabiroyemi@gmail.com; ^bcalistus.ayegba@futminna.edu.ng

Corresponding author: abdulkabiroyemi@gmail.com

Abstract

The construction industry is often criticized for its reluctance to change and low productivity. However, Building Information Modelling (BIM) has been proposed as a solution to mitigate these challenges. While BIM has been widely adopted during the planning, design, and construction phases of projects, its adoption in the post-construction phase remains limited. This is a critical phase where up to 80% of the total life cycle cost of a facility is expended. This study aimed to investigate the adoption level of BIM for Post-Construction Management (PCM) in Nigeria, using a quantitative research method with 132 International Facility Management Association (IFMA) professionals as respondents. The study found that there is a high level of awareness of BIM for PCM among respondents, with 84% indicating a high and higher level of awareness. However, the usage of BIM-compliant software was very low, with limited proficiency in its use. This high level of awareness is a positive factor that could facilitate rapid adoption of BIM for PCM. Conversely, low awareness could result in slower adoption. Despite the high level of awareness, the adoption level of BIM for PCM remain very low. The study suggests that further efforts are needed to bridge the gap between awareness and adoption, including improving proficiency in BIM-compliant software and creating incentives for its use. Overall, the study highlights the importance of BIM for PCM and the need to increase its adoption in the construction industry.

Keywords: Keywords: Adoption, Awareness, BIM, Level, Post-Construction Management.

Introduction

According to World Economic Forum (2018) the construction industry contributes about 6% to the world Gross Domestic Product (GDP), similar the construction industry is expected to contribute about 15% to the world GDP by the year 2030 (Olanrewaju *et al.*, 2021). In the first quarter of 2021, the National Bureau of Statistics report, the industry accounts for 10.17% of the nominal GDP. Consequently, the construction industry is paramount to the development of nations globally. The construction industry is slow in adoption and transitioning from the conventional to a digitalized method of operation by application of technological tools which their application can increase productivity in the construction industry. According to Olorunfemi *et al.* (2021), an increase in new technological tools and applications has led to a paradigm shift in the method of operation from traditional to digitalized around the world.

Although the construction industry is regarded as a major contributor globally, the industry is faced with challenges relating to productivity due to the slow adoption and application of technologies such as BIM (Acre and Wyckmans, 2015), IoT (Ghosh *et al.*, 2021), Industry 4.0 (Newman *et al.*, 2020) and Blockchain (Parn and Edwards, 2019). Adoption of BIM software can ensure improvement in the facility life cycle and adequate data management (Olanrewaju *et al.*, 2021; Chioma *et al.*, 2020; Aka *et al.*, 2020). Despite BIM technology has been adequately adopted during the planning, design and construction phase of the project, it is still considered to be at the early stage of adoption for managing post-construction activities to ensure the facility performs optimally all through its life cycle after completion (Olanrewaju *et al.*, 2021).

According to Mohandes *et al.* (2014), PCM is the management of facility assets and maintenance after the design and construction phases have been completed. The American Institute of Architects considers the benefits of BIM lie in the post-construction phase of the project life cycle (AIA, 2015). Even though the major benefits of BIM lie more in the post-construction phase of the project, the level of awareness and adoption is still very low as indicated by various studies (Bello *et al.*, 2022; Durdyev *et al.*, 2021).



The post-construction activities have usually been managed manually which brings about a waste of time and resources. According to Anton and Diaz (2014) data are erroneously entered repeatedly up to seven times when entered manually, also resulting in poor quality documentation (Jylha and Suvanto, 2015) resulting in handing over delay (Wu and Issa, 2012). Real life can be traced to the United States, where almost \$11 billion is lost annually due to inefficient operation of facilities which is worth giving urgent attention to (Arayici *et al.* 2012). In a related study by Hu *et al.* (2018) annual costs through waste caused by operating issues from inaccurate information and interoperability were reported as \$10.6 billion in the United States. These cases among others bring about the need to carry out studies in the context of developing countries.

The awareness and level of adoption of BIM for PCM are reasonably high in the developed nations, however, in developing countries, the case is not the same as only south Africa is the only country that has fairly and leading in the adoption of BIM for PCM (Chioma *et al.*, 2020). Olanrewaju *et al.* (2021) indicated that sub-Saharan countries like Nigeria are lacking behind in the adoption of BIM for PCM, this basis was further supported by (Olapade and Ekemode, 2018)

This study investigates the adoption level of BIM for PCM in Nigeria using Abuja as the study area which is considered as one of the cities experiencing high rate of modern construction in Nigeria. The study set four distinct objectives to; determine the level of awareness of BIM for post-construction management; determine the usage level of BIM-compliant software among the professionals, determine the level of BIM-compliant software’s proficiency among the respondents and established the level of adoption of BIM for post construction management in Nigeria. The outcome of the study will adequately provide insight into the BIM-post-construction management adoption in Nigeria’s construction industry and provides the stakeholders with the requisite information about BIM-post-construction management to make informed decisions towards the adoption of BIM for post-construction management.

2.0 BIM Adoption in the Construction Industry

Although BIM adoption is expanding in most developed countries, it is stagnating in most developing countries, such as Nigeria (Chioma *et al.*, 2020). BIM is a cutting-edge technology that enables the parameterised expression and integrated management of various data kinds throughout a facility’s lifecycle (Eastman *et al.*, 2011). During the information management process in the facility lifecycle, BIM technology has transformed the conventional construction industry’s development mode, assisting in resolving difficulties such as work coordination and information integration (Hamma-Adama, 2020). As a result, BIM is regarded mainly as a transformative tool for the construction industry and enhancing project management efficiency (Cao, 2016; Ayegba and Root, 2018).

Using BIM technology in construction projects can save up to 40% on unnecessary budgetary modifications, reduce construction time by 7%, save 10% to 17% on operating costs, and reduce greenhouse gas emissions by 50%. (Boston Consulting Group, 2016; World Economic Forum, 2016). BIM can be adopted in the post-construction phase for restorations, space planning, and maintenance functions (Azhar, 2011). A study was conducted by Ikediashi and Uyanga (2016) to better understand the current state of BIM adoption for facilities management roles in Nigeria, with the goal of better understanding the current level of use and efficacy in facilities management service delivery established low usage level and lifecycle cost reduction and on-time service delivery were significantly impacted by the implementation of BIM for facilities management applications.

In a related study by Olapade and Ekemode (2018), just two (2) of the thirty-seven (37) facility management firms examined on their awareness and use of BIM for facility management practices are currently implementing BIM for their operations, indicating a low level of BIM for facility management adoption in Lagos. The findings of this study offered information on the level of understanding and use of BIM for facility management practice in Nigeria, allowing industry stakeholders to gain insight into the possible full integration with facility management practices in developing countries. The research



is a ground-breaking investigation of the use of BIM for facilities management awareness and implementation in a rapidly growing property market like Nigeria.

Traditional PCM is inefficient because of the wide time range, extended durations, multiple items, and sophisticated employees involved. In PCM, BIM technology can not only meet user's basic activity needs and increase investment income, but it can also enable information sharing between design, construction, and operations and maintenance, improve information accuracy, and provide a convenient management platform for all participants to enhance the efficiency of building facility management (Wang, 2015). In terms of BIM's application in PCM, Akcamete *et al.* (2010) discovered that maintenance costs account for more than 60% of total project costs. BIM can practically visualise many aspects of facility management in real time. Data can be stored in the BIM model indefinitely and studied from various angles to enhance PCM tasks.

Several researchers have demonstrated the potential of BIM in PCM, and they agree that the early application of BIM in the operation and maintenance phase included seven aspects of BIM: maintenance and repair, change management, space management, emergency management, security management, energy management, and asset management (Gao and Pishdad-Bozorgi, 2019). The literature reviewed argues for the embrace of innovation, particularly BIM innovation, for the sector to survive. In the construction industry, BIM has been innovative, and its adoption needs a streamlined approach. As this is a novel paradigm, investigation methods are continually emerging. There is limited study on BIM in the researched country significantly, outside of a single field and possibly cities (Hamma-Adama, 2020). More than three-quarters of the published literature on BIM studies in Nigeria such as (Abubakar *et al.*, 2014; Ugochukwu *et al.*, 2015) identified a fundamental barrier to BIM adoption as a lack of knowledgeable personnel in the technology. And more than half of them is due to a lack of knowledge and understanding of the technology's potential.

Methodology

This study adopts a quantitative method to carry out the research by collecting data from IFMA professionals in Abuja. A questionnaire was adopted as the method of data collection which was based on the five Likert scales. The research population are registered IFMA members in Abuja, and at the time of data collection for this study, the total number of registered IFMA members stands at 207. Since the total population is known, the study adopts a probability sampling technique using a simple random technique. The sample size is calculated below using the using Yamani's (2013) formula below and adopts a 95% level of confidence at 0.05.

$$n = \frac{N}{1+N(e)^2} \quad (1)$$

Where n = sample size

N = population size (207)

e = acceptable sampling error (0.05)

Adopting this formula, the sample size outcome is 135 which indicates the number is sufficient enough for this study.

A total number of 164 questionnaires were distributed among the 207 professionals, and 148 were retrieved during data collection. Two distinct criteria were set to select valid responses; any unanswered question and if more than one answer is provided for one question. Based on these criteria 16 responses were considered unfit for the study, hence the study considers 132 valid responses. The data were presented in table and charts for easy understanding.

Result And Discussion

Characteristics of the Respondents

A five-sectioned questionnaire was presented to the respondents based on five Likert scales. Among the 207 IFMA registered professionals in Abuja, the questionnaire was administered to 164, and 148 questionnaires were retrieved during collection. 132 questionnaire was properly filled and considered



for the study. The number of respondents considered in this study is found adequate compared to previous related studies (Olanrewaju *et al.*,2020; Chioma *et al.*, 2020). Table 1 presents the characteristics of respondents according to their academic qualification, profession, age group, gender, registration with IFMA, years of experience, client type and size of the firm. Academic qualification: The academic qualification of the respondents shows that 6.82% hold a Higher National Diploma, 4.55% hold a Post Graduate Diploma, 46.97% hold a bachelor’s degree, 36.36% hold a master’s degree and 5.30% hold a doctor of philosophy. Professional Background: Among the respondents, 6.06% were Architect, 25% were Builder, 12.88% were Engineer, 44.70% were Estate Surveyor, 0.76% were Project Managers and 10.61% were Quantity Surveyor.

The years of respondents have been a registered member of IFMA shows that 4.55% have been a registered member for less than 5 years, 43.18% have been a registered member for 5-10 years, 37.12% have been a registered member for 10-15 years, 9.85% have been registered for 15-20 years and 5.30% have been registered for 20 years above.

Table 1: Characteristics of the Respondents

Variable		Frequency	Percentage (%)
Academic Qualification	Bachelor Degree	62	46.97
	Doctorate Degree	7	5.30
	Higher National Diploma	9	6.82
	Master Degree	48	36.36
	Post Graduate Diploma	6	4.55
	Total		132
Profession	Architect	8	6.06
	Builder	33	25.00
	Engineer	17	12.88
	Estate Surveyor	59	44.70
	Project Manager	1	0.76
	Quantity Surveyor	14	10.61
Total		132	100.00
Registration with IFMA	Less than 5 years	6	4.55
	5-10 years	57	43.18
	10-15 years	49	37.12
	15-10 years	1	0.76
	15-20 years	12	9.09
	20 years Above	7	5.30
Total		132	100
Years of Experience	Less than 5 years	4	3.03
	5-10 years	49	37.12
	10-15 years	56	42.42
	15-10 years	1	0.76
	15-20 years	12	9.09
	20 years Above	10	7.58
Total		132	100.00
Client Type	Government	39	29.55
	Private	93	70.45
	Total	132	100.00
Size of Firm	Large (250 Above)	6	4.55
	Medium (50-249)	59	44.70
	Small (10-49)	67	50.76
	Total	132	100.00

The respondent working experience shows that 3.03% of the respondent has been working for less than 5 years, 37.12% have been working for 5-10 years, 42.42% has between 10-15 years of working experience, 9.85% has between 15-20 years working experience and 7.85% has 20 years above working experience. The result shows 29.55% of the respondents work in a government establishment while

70.45% work in a private establishment. The result shows that 4.55% of the respondent works in a large firm (250 above), 44.70% works in a medium firm (50-249) and 50.76% works in a small firm.

Awareness Level of BIM for Post-Construction Management

Figure 1 show the awareness level of respondents of BIM for PCM ranging from very high to very low. Respondents were asked to select based on their level of awareness on a scale of (5 = *Very High*, 4 = *High*, 3 = *Moderate*, 2=*Low*, 1 = *Very Low*). The result shows that the majority of the respondents are aware of the usage of BIM for PCM and none of them is unaware of BIM usage for PCM with 53.03% awareness level being very high, 31.06% high, 12.88% moderate and 3.03% low. According to Nicał and Wodyński (2016), the basis of appreciating a BIM-enabled process in the application of BIM for post-construction is to create awareness among the stakeholders. Studies in the context of developing nations like Nigeria (Babatunde *et al.*, 2020; Gamil and Rahman, 2019) and other developing nations Khoshfetrat *et al.* (2020) have all established lack of awareness of BIM as a major challenge.

A related study by Olapade and Ekemode (2018) using Lagos as a case study, established that awareness of BIM among facility management professionals is low. Also, (Bello *et al.*, 2022; Olanrewaju *et al.*, 2020) reported a low level of awareness of BIM at the operation stage in the Nigerian construction industry.

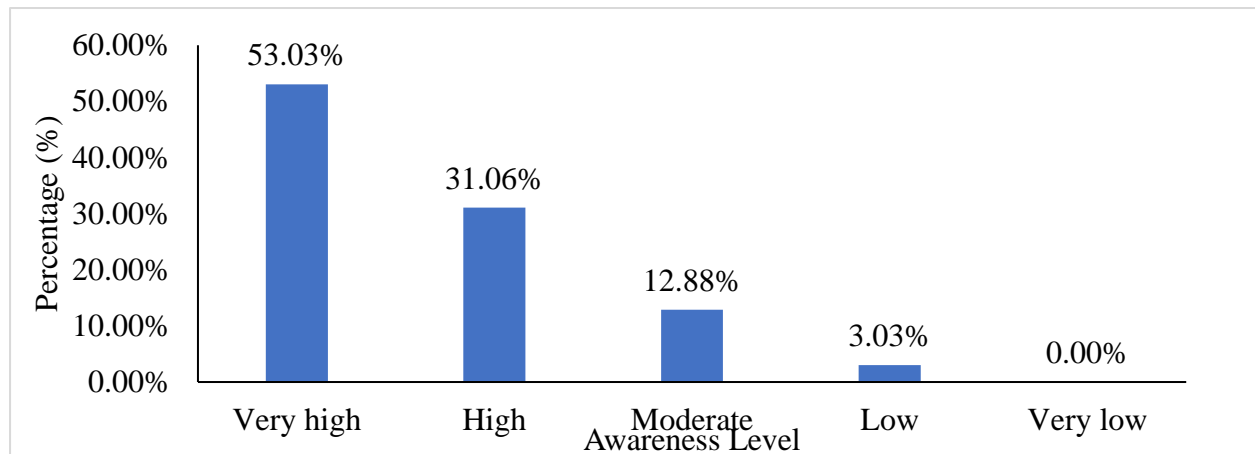


Figure 1 Awareness Level of BIM for Post-Construction Management

A similar study by Ogunmakinde and Umeh (2018) established that awareness of BIM has been rapidly growing in the Nigerian built environment industry but the understanding of the full concept is still found to be lacking among Nigerian built environment professionals. Hence, this study establishes there is now a high level of awareness of BIM for the PCM of the facility, which negates previous literature establishing a lack of awareness. However, despite the promising results on awareness of BIM for PCM in the Nigerian construction industry, there is a paramount need to transform the awareness into usage and implementation of BIM for PCM which is the most essential stage of the project lifecycle.

Usage Level of BIM-Compliant Software for Post-Construction Management

Table 2 shows the result on the usage level of some selected BIM-compliant software’s for PCM. The respondents were asked to select as appropriate on a scale of (5 = *Almost Always*, 4 = *Sometimes*, 3 = *Not sure*, 2 = *Rarely* and 1 = *Not at all*) based on their level of usage. Table 2 show the result for data reliability test, reliability test is necessary to determine if the collected data is reliable and suitable for analysis. According to rule of thumb of Maree and Pietersen (2016) on interpreting Cronbach’s alpha coefficient, value of 0.90 is considered strongly reliable, 0.80 is considered moderately reliable and 0.70 is considered low reliable. Based on the reliability value (0.806) show in Table 2 indicates the data for this study is reliable and suitable for analysis.



The result shows that the software’s are practically not in use in Abuja by the IFMA professionals. The mean score ranges between 1.136 to 1.000 as shown in Table 3. Similarly, Table 4 shows the scale measurement for the mean as relate to table 4.3. Only seven software’s have mean value higher than 1.000 which ranges from “BIM 360” (mean = 1.136; SD = 0.442; Var = 0.195) to “usBIM.facility“(mean = 1.008; SD = 0.087; Var = 0.008). Considering the scale measurement all the mean value in Table 3 fall under the scale of 0.00-1.49 which represent “not at all” level of usage. It can then be established that BIM compliant software’s are not in use by the professionals.

This study established that the conventional methods are practically still in use by the professionals in Abuja to provide guidance and operate the buildings during the post-construction stage of the facilities leaving numerous benefits of BIM untapped at the post-construction stage. It is advantageous to adopt tools such as BIM to foster the performance of facilities in the post-construction phase. As stated by Faltejsek and Chudikova (2019) lifecycle of facilities requires to be maintained to foster operation at the maximum level for end users throughout the lifecycle of the building.

Table 2: Test for Data Reliability

Reliability Statistics		
Cronbach’s Alpha	Cronbach’s Alpha Based on Standardized	
	Items	N of Items
0.806	0.858	7

Table3: Mean ranking of the identified BIM-software’s for PCM

BIM-Compliant Software	Mean	N	SD	Min	Max	Var
BIM 360	1.136	132	0.442	1.000	4.000	0.195
BIMCOLLAB	1.030	132	0.245	1.000	3.000	0.060
BIMOBJECTS	1.030	132	0.348	1.000	5.000	0.121
BIM TRACK	1.030	132	0.275	1.000	4.000	0.075
LOAD PLANNER	1.023	132	0.261	1.000	4.000	0.068
REVIZTO	1.015	132	0.123	1.000	2.000	0.015
usBIM.facility	1.008	132	0.087	1.000	2.000	0.008
ECODOMUS	1.000	132	0.000	1.000	1.000	0.000
ONUMA	1.000	132	0.000	1.000	1.000	0.000
ARCHIBUS	1.000	132	0.000	1.000	1.000	0.000
YOUBIM	1.000	132	0.000	1.000	1.000	0.000
VUEOPS	1.000	132	0.000	1.000	1.000	0.000
AVAIL	1.000	132	0.000	1.000	1.000	0.000
BIMandCO	1.000	132	0.000	1.000	1.000	0.000
SEFAIRA	1.000	132	0.000	1.000	1.000	0.000
GREEN BUILDING STUDIO	1.000	132	0.000	1.000	1.000	0.000
LADYBUG	1.000	132	0.000	1.000	1.000	0.000
TRIMBLE CONNECT	1.000	132	0.000	1.000	1.000	0.000
ALLPLAN BIMPLUS	1.000	132	0.000	1.000	1.000	0.000
DROFUS	1.000	132	0.000	1.000	1.000	0.000

Note: SD = Standard Deviation: Var = Variance

Table 4: Scale Measurement for Mean

Scale	Mean	Decision
5	4.50 to 5.00	Almost Always
4	3.50 to 4.49	Sometimes
3	2.50 to 3.49	Not sure
2	1.50 to 2.49	Rarely
1	0.00 to 1.49	Not at all

This study further establishes a low level of BIM adoption for post-construction management concerning previous studies (Durdyev *et al.*, 2021; Chioma *et al.*, 2020; Olanrewaju *et al.*, 2020; Ademci and Gundes, 2018; Olapade and Ekemode, 2018; Ikediashi and Uyanga, 2016; Akcamete *et al.*, 2010).

Level of BIM Adoption for Post-Construction Management

Figure 2 shows the result when the respondent was asked to indicate the adoption level of BIM for PCM. Respondents were asked to select based on their level of agreement on a scale of (5 = *Very High*, 4 = *High*, 3 = *Moderate*, 2 = *Low*, 1 = *Very Low*). The majority of the respondents are of opinion that the adoption level of BIM for post-construction management in Abuja is on the low side, as none of the respondents considered the adoption to be very high or high, 2.27% considered it as moderately adopted, 72.73% considered the adoption is low and 25.00% considered the adoption level to be very low.

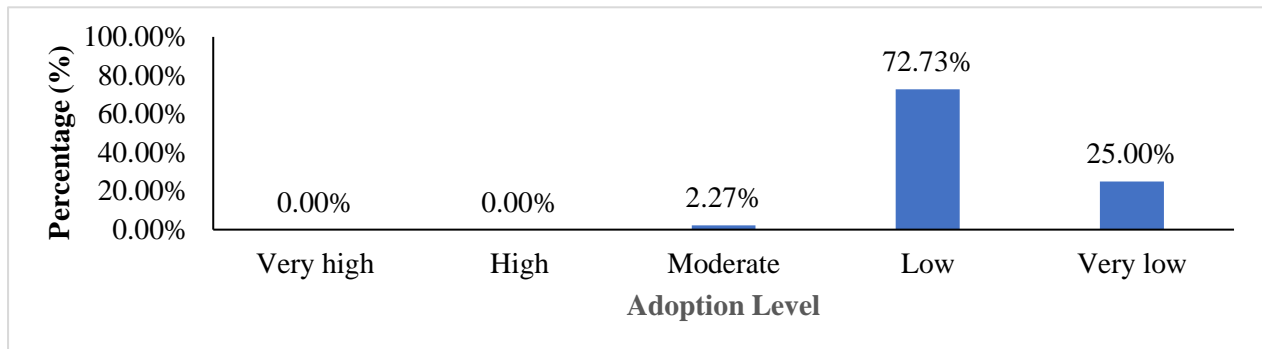


Figure 2: Level of BIM Adoption for PCM

This result further corresponds with table 4.3 investigating the usage level of BIM-compliant software’s for PCM. This study establishes that there is low adoption of BIM for PCM in Abuja which is in line with and backed by the previous related studies (Bello *et al.*, 2022; Durdyev *et al.*, 2021; Chioma *et al.*, 2020; Olanrewaju *et al.*, 2020; Ademci and Gundes, 2018; Olapade and Ekemode, 2018; Ikediashi and Uyanga, 2016; Akcamete *et al.*, 2010). Further, since BIM compliant software’s are not in use, it explains the reason why the proficiency level is lacking among the professionals.

Conclusion And Recommendation

Conclusion

Generally, the adoption of BIM is low in developing countries, especially African nations which are considered the only continent that has not maximized the benefits of BIM. However, its adoption at PCM of the facility is lacking and almost not appearing. In the context of Nigeria where previous studies have established a low level of awareness for PCM in the construction industry, this study established that currently there is a high awareness level of BIM for PCM among professionals. Despite the high level of awareness of BIM for PCM, its adoption and implementation are low among the industry professionals as they are all still operating traditionally (manually). As indicated in the findings of the study, usage of BIM-compliant software’s is insignificant which then interprets low adoption and implementation. Consequently, this study contributes to the literature indicating a low awareness level of BIM for PCM. This study set out four objectives which were adequately discussed based on the valid responses considered for the study which contribute to the body of literature and will be of benefit to both industry and academia.

Recommendation

This study recommends the construction industry stakeholders should encourage flexibility towards the adoption of new technologies to ease operations which will in turn bring about mitigating productivity challenges which have been ravaging the industry. Various organizations should encourage and provide training on BIM for PCM for their employees to increase the adoption, usage and proficiency of the BIM software’s. Higher institutions offering construction-related courses should include BIM courses in their respective curriculum, this will create more awareness from the grassroots and rapid rate of experts in the handling of BIM software’s. Governments have been a major driving force towards



ensuring BIM is adequately adopted and implemented in developed countries, this approach is recommended to be emulated in developing countries to foster the adoption of BIM software's.

REFERENCES

- Abubakar, M., Ibrahim, Y. M., Kado, D., and Bala, K. (2014). Contractors' perception of the factors affecting Building Information Modelling (BIM) adoption in the Nigerian Construction Industry. *International Conference Computing in civil and building engineering*, 167-178.
- Acre, F., and Wyckmans, A. J. S. (2015). The impact of dwelling renovation on spatial quality: The case of the Arlequin neighbourhood in Grenoble, France, *Smart Sustain. Built Environment*, 4(3), 268-309.
- Ademci, E., and Gundes, S. (2018). Review of studies on BIM adoption in AEC industry. *5th International Project and Construction Management Conference (IPCMC) Proceedings*, 1046-1055.
- AIA Trust (2015). New Processes, Tools, and Technologies: BIM to IPD, (available online <http://www.theaiatrust.com/whitepapers/sustainable/processes.htm> (accessed February 12, 2022).
- Aka, A., Iji, J., Isa, R. B., and Bamgbade, A. A. (2021). Assessing the relationships between underlying strategies for effective building information modeling (BIM) implementation in Nigeria construction industry. *Architectural Engineering and Design Management*, 17(5–6), 434–446.
- Akcamete A, Akinci B, and Garrett H. J. (2010). Potential utilization of building information models for planning maintenance activities. *Computing Civil and Building Engineering Proceedings of the International Conference*, 1(6), 151-165.
- Akerele, A. and Etiene, M. (2016). Assessment of the level of awareness and limitations on the use of building information modeling in Lagos state, *International Journal of Scientific and Research Publications*, 6(2), 229-234.
- Anton, L. Á., and Díaz, J. (2014). Integration of life cycle assessment in a BIM environment. *Procedia Engineering*, 85, 26-32.
- Arayici, Y., Onyenobi, T. and Egbu, C. (2012). Building information modelling (BIM) for facilities management (FM): the media city case study approach, *International Journal of 3-D*, 2(4), 28-42
- Ayegba, C. and Root, D., (2018). “Procurement Tactics for Selecting Suitable Contractors for Collaboration and Long-Term Relationships” A Productive Relationship: Balancing Fragmentation and Integration. *Presented at the Proceedings of the 34th Annual ARCOM Conference*, Belfast, UK, ARCOM, London, UK, 72-81
- Azhar, S., Khalfan, M., and Maqsood, T. (2011). Building information modelling (BIM): Now and beyond, Australasian. *Journal of Construction Economics and Building*, 7, 15–28.
- Babatunde, S. O., Ekundayo, D., Adekunle, A. O. and Bello, W. (2020). Comparative analysis of drivers to BIM adoption among AEC firms in developing countries: a case of Nigeria, *Journal of Engineering, Design and Technology*, 18(6), doi: 10.1108/JEDT-08-2019-0217.
- Bello, A. O., Ayegba, C., Olanrewaju, I. O., Afolabi, O., and Ihedigbo, K. S. (2022). A Review on the Awareness and Challenges of Building Information Modelling for Post Construction Management in the Nigerian Construction Industry. *5th International African Conference on Current Studies*, 137–142.
- Boston Consulting Group (2016). *Digital in Engineering and Construction: The Transformative Power of Building Information Modeling*, Boston Consulting Group, Boston, MA, USA.
- Cao, D., Li, H., Wang, G., Huang, T. (2016). Identifying and contextualising the motivations for BIM implementation in construction projects: *An empirical study in China*, *International Journal of Project Management*, <http://dx.doi.org/10.1016/j.ijproman.2016.02.002>.
- Chioma, O., Innocent, M., and Andre, K. (2020). Identifying motivators and challenges to BIM implementation among facilities managers in Johannesburg, South Africa. *September*, 104–110. <https://doi.org/10.3311/cc2020-028>
- Durdyev, S., Ashour, M., Connelly, S., Mahdiyar, A. (2021). Barriers to the implementation of Building Information Modelling (BIM) for facility management, *Journal of Building Engineering* (2021), doi: <https://doi.org/10.1016/j.jobe.2021.103736>. 84, 195–206.
- Eastman, C., Teicholz, P., Sacks, R. and Liston, K. (2011). *BIM Handbook: A Guide to building information modeling for owners, managers, Designers, Engineers, and Contractors*, John Wiley and Sons Inc, New Jersey, USA.
- Faltejsek, M. and Chudikova, B. (2019). Facility management and building information modelling during operation and maintenance, *MATEC Web of Conferences*, 277, 2022.
- Gamil, Y. and Rahman, I.A.R. (2019). Awareness and challenges of building information modelling (BIM) implementation in the Yemen construction industry, *Journal of Engineering, Design and Technology*, 17(5), 1077-1084.



- Gao, X., and Pishdad-Bozorgi, P. (2019). BIM-enabled facilities operation and maintenance: A review. *Advanced engineering informatics*, 39, 227-247.
- Ghosh, A., Edwards, D.J. and Hosseini, M.R. (2021), Patterns and trends in Internet of Things (IoT) research: future applications in the construction industry, *Engineering, Construction and Architectural Management*, 28(2), 457-481.
- Hamma-Adama, M. (2020). Framework for macro building information modelling (BIM) adoption in Nigeria. Robert Gordon University, PhD thesis. Hosted on OpenAIR [online]. Available from: <https://openair.rgu.ac.uk>.
- Hu, P. Tian, S. Li, J. Zhang. (2018). BIM-based integrated delivery technologies for intelligent MEP management in the operation and maintenance phase. *Advances in Engineering Software*, 115 (2018) 1–16.
- Ikediashi, D., and Uyanga, J. (2016). Adoption of BIM technologies for facilities management roles in Nigeria: An Empirical Investigation. *ICCREM 2016: BIM Application and Offsite Construction - Proceedings of the 2016 International Conference on Construction and Real Estate Management*. <https://doi.org/10.1061/9780784480274.001>.
- Jylha, T. and Suvanto, M.E. (2015), "Impacts of poor quality of information in the facility management field", *Facilities*, 33 (5), 302-319. <https://doi.org/10.1108/F-07-2013-0057>
- Khoshfetrat, R., Sarvari, H., Chan, D. W. M. and Rakhshanifar, M. (2020). Critical risk factors for implementing building information modelling (BIM): a delphi-based survey, *International Journal of Construction Management*, doi: 10.1080/15623599.2020.1788759.
- Li, X., Wu, P., Shen, G. Q., Wang, X., and Teng, Y. (2017). Mapping the knowledge domains of Building Information Modeling (BIM): A bibliometric approach. *Automation in Construction*, 84, 195-206.
- Maree, K., and Pietersen, J. (2016). The quantitative research process, in Maree, K. (Ed.), *First Steps in Research*, 2nd ed., Paarl Media, South Africa, 161-172
- Mohandes, S. R., Preece, C., and Hedayati, A. (2014). Exploiting the effectiveness of building information modeling during the stage of post construction. *Journal of Basic and Applied Scientific Research*, 4(10), 5-16.
- Newman, C., Edwards, D., Martek, I., Lai, J., Thwala, W. D., Rillie, I. (2020). Industry deployment in the construction industry: A bibliometric literature review and UK-based case study, *Smart Sustainable. Built Environment Journal*, 1(2), 25-38.
- Nicał, A. K., and Wodyński, W. (2016). Enhancing Facility Management through BIM 6D. *Procedia Engineering*, 164, 299–306. <https://doi.org/10.1016/J.PROENG.2016.11.623>
- Ogunmakinde, O. E. and Umeh, S. (2018). Adoption of BIM in the Nigerian architecture engineering and construction (AEC) industry, *Paper presented at the 42nd Australasian Universities Building Education Association (AUBEA)*.
- Olanrewaju, O. I., Chileshe, N., Babarinde, S. A., and Sandanayake, M. (2020). Investigating the barriers to building information modeling (BIM) implementation within the Nigerian construction industry. *Engineering, Construction and Architectural Management*, 27(10), 2931–2958. <https://doi.org/10.1108/ECAM-01-2020-0042>
- Olanrewaju, O. I., Kineber, A. F., Chileshe, N., Edwards, D. J. (2021). Modelling the impact of building information modelling (BIM) implementation drivers and awareness on project lifecycle. *Sustainability and Engineering Journal*, 13, 88-87. <https://doi.org/10.3390/su13168887>.
- Olapade, D. T., and Ekemode, B. G. (2018). Awareness and utilisation of building information modelling (BIM) for facility management (FM) in a developing economy: Experience from Lagos, Nigeria. *Journal of Facilities Management*, 16(4), 387–395. <https://doi.org/10.1108/JFM-09-2017-0046>.
- Olorunfemi, E., Olanrewaju, O., Oyewobi, L., and Olorunfemi, R. (2021). Competencies and the penetration status of building information modelling among built environment professionals in Nigeria. <https://www.researchgate.net/publication/352787164>
- Parn, E.A. and Edwards, D. (2019), "Cyber threats confronting the digital built environment: Common data environment vulnerabilities and block chain deterrence", *Engineering, Construction and Architectural Management*, 26(2), 245- 266. <https://doi.org/10.1108/ECAM-03-2018-0101>
- Ugochukwu, S.C., Akabogu, S.C., and Okolie, K.C. (2015). Status and perceptions of the application of building information modelling for improved building projects delivery in Nigeria. *American Journal of Engineering Research*, 4(11), 176-182.
- Wang, C. (2015). Assessment of BIM implementation among MEP firms in Nigeria. *International Journal of Advances in Applied Sciences*, 4(3), 73-81.



- World Economic Forum (2016). Shaping the future of construction: *A Breakthrough in Mindset and Technology*, World Economic Forum, Geneva, Switzerland.
- World Economic Forum (2018). Shaping the future of construction - Future Scenarios and Implications for the Industry, World Economic Forum, Geneva, Switzerland, available at: http://www3.weforum.org/docs/Future_Scenarios_Implications_Industry_report_2018.pdf (accessed 8 January, 2022).
- Wu, W. and Issa, R. R. (2012). BIM-enabled building commissioning and handover.
- Yamani, N. A. (2013). *Housing and quality of life implications of the three qualities of housing in Amman*, Jordan. Unpublished PhD Thesis submitted to Cardiff University, School of Planning and Geography