Built Environment Journal

Faculty of Architecture, Planning and Surveying

Volume 12 No. 2 July 2015 ISSN 1675-5022

Built Environment Journal is jointly published by Faculty of Architecture, Planning and Surveying and UiTM Press, Universiti Teknologi MARA, 40450 Shah Alam, Selangor, Malaysia.

Built Environment Journal

Faculty of Architecture, Planning and Surveying
Volume 12 No. 2 July 2015 ISSN 1675-5022

DEVELOPING CRITERIA AND VARIABLES FOR EVALUATING THE EFFECTS OF VEGETATION ON SINGLE-FAMILY HOUSES

Alamah Misni
Faculty of Architecture, Planning and Surveying, Universiti Teknologi MARA, Shah Alam, MALAYSIA
alamahmisni@gmail.com

ABSTRACT

This paper describes the methodology used to measure the effects of surrounding vegetation, building construction and human factors on a small number of individual houses and a large number of single-family houses. The primary data were obtained from fieldwork and site measurements during a two-stage process. All supporting data for this study was sourced from various Malaysian government departments. Fieldwork in the first stage focused on five individual single-family houses. Quantitative measurements were taken to record the construction of the buildings, their surrounding vegetation, human factors, and weather data during the daytime. In this report only five houses of different ages and types of landscaping were chosen to compare the effect of landscaping on the thermal performance of the house. These five houses had used different styles and designs of tropical landscaping, which could produce different conditions of micro-climates. The air temperature, relative humidity and wind speed data were obtained from the exterior and interior of houses during similar weather conditions to ensure they could be accurately compared. This data was automatically recorded at half hour intervals by static and mobile sensors of the data loggers. The albedo data for every type of building were also measured during the day time. In the second stage, the fieldwork measurements were divided into four categories: building construction, landscaping, human factors, and weather data. The annual energy consumption for every house was also evaluated by analysing electricity consumption for different single-family houses ranging in age from 3 to 40 years. The target number of respondents was 50 houses. Statistical calculation and analysis was used to measure and evaluate the energy saving.

Keywords: *Building construction, human factors, single-family houses, vegetation*

INTRODUCTION

This study describes the methodology used to measure the effects of surrounding vegetation, building construction and human factors on a small number of individual houses and a large number of single-family houses. The primary data were obtained from fieldwork and site measurements during a two-stage process. All supporting data for this study was sourced from various Malaysian government departments. Fieldwork in the first stage focused on 10 individual single-family houses. Quantitative measurements were taken to record the construction of the buildings, their surrounding vegetation, human factors, and weather data during the daytime. In this report only five houses of different ages and types of landscaping were chosen to compare the effect of landscaping on the thermal performance of the house. These five houses had used different styles and designs of tropical landscaping, which could produce different conditions of micro-climates.

The air temperature, relative humidity and wind speed data were obtained from the exterior and interior of houses during similar weather conditions to ensure they could be accurately compared. This data was automatically recorded at half hour intervals by static and mobile sensors of the data loggers. The albedo data for every type of building were also measured during the day time. In the second stage, the fieldwork measurements were divided into four categories: building construction, landscaping, human factors, and weather data. The annual energy consumption for every house was also evaluated by analysing electricity consumption for different single-family houses ranging in age from 3 to 40 years. The target number of respondents was 50 houses. Statistical calculation and analysis was used to measure and evaluate the energy saving.

LITERATURE REVIEW

The research methodology was divided into the two fieldwork stages using a process called triangulation. This is where more than one research method or type of data is used to answer the research questions (Evans & Gruba, 2002). In this study, two stages of methodology were used to answer two research questions. According to Yin (2003), at least three principles for collecting data must be used from the six possible sources of documented evidence. The three main sources chosen for collecting data in this study were interviewed, direct observation, and physical artefacts evidence.

To measure the effect of surrounding landscaping on the thermal performance of a house, site measurements were made of the physical features that surrounded the building, and equipment was used to record weather data inside and outside of the houses (Wong & Yu, 2005). The outdoor weather data included temperature, relative humidity and wind speeds while the indoor data focused on temperature and relative humidity (Koch-Nielsen, 2002). Finally, in assessing the influence of landscaping on reducing the amount of energy used for air-conditioning was to calculate the average proportion of electricity used for cooling (Akbari, 2002). Data on landscaping, building construction and energy use of air-conditioning systems, and the number of occupants in each house was obtained through observation and interviews with the homeowners.

METHODOLOGY

Study location

Figure 1: Putrajaya and Shah Alam located at approximately 101ºE and 3ºN
Source: (Malaysia, 1993)

The single-family houses sampled, were randomly chosen from two well planned Malaysian cities: Putrajaya and Shah Alam (Samad, Zain, Maarof, Hashim, & Adnan, 2011). The city of Putrajaya is situated at latitude 2°N and longitude 101°E, at an elevation of between 75 and 94m, 25km south of Kuala Lumpur. While Shah Alam is located at latitude 3°N and longitude101°E, at an elevation of between 24 and 48m, about 25km west of Kuala Lumpur. The distance between Putrajaya and Shah Alam is approximately 23.7km. Five locations of low-density housing development were selected to be the case study areas. The specific locations used were in Precinct 14, in the Federal Territory of Putrajaya, and Sections 3, 6, 9 and 11 in Shah Alam, Selangor. Putrajaya is a well planned city, and is known as an "intelligent city" because of its extensive information and communication technologies (Malek, 2011). It was also planned as a garden city, with 38% of the city reserved for green space areas that emphasise and enhance the natural landscape. Shah Alam is the capital of Selangor State, and is also one of the most well planned cities in Malaysia (Aziz & Hadi, 2007). It has around 10% of its area dedicated to green space areas.

The Study House

In Putrajaya and Shah Alam, the most common type of house is the two-storey single-family house that is surrounded by a garden. Generally, these types of house represent around 10 to 30% of all houses in a housing development.

Figure 2: Examples of modern tropical houses in the study areas ranging in age from 3 to 40 years with surrounding landscaping
Source: (Misni, 2010)

In this study the houses looked at were medium sized, single-family houses (around 300–600m^2). The garden area includes the entire space around the building and is private to the owner. This

research was undertaken looking at single-family houses ranging in age from 3 to 40 years. The different ages were chosen because they provided differences in the maturity of the surrounding landscape, which affects the amount of energy used and thermal comfort and performance of the house.

Weather Data

In the first stage of fieldwork, which included site measurements for 10 individual houses, weather data from the Malaysian Meteorology Department was gained for the same days as when the climate data was recorded in the houses. This weather data was required to compare it with the study location. The dates this data was gathered were the 16th and 17th of January, 2010 in Putrajaya, and the 23rd, 24th and 28th of February, 2010 for the Shah Alam study areas. The data included air temperature, relative humidity, rainfall, daily global radiation, cloud cover and wind. In the second stage of fieldwork, which included site measurements of 50 houses, weather data was obtained from the Malaysian Meteorology Department in 2008 and 2009. Weather data were recorded at two stations: Sepang Weather Station for the Putrajaya study area and Subang Weather Station for Shah Alam. Averages of this data were used to determine the exact tropical weather conditions in the study areas.

Local Authority Records

Putrajaya Cooperation and Shah Alam City Council were the two local authorities involved in this study. They provided the master plans, construction details and landscaping information for the sample houses. In the Putrajaya study area, the whole housing development was designed and constructed by a developer. The sizes of the houses are slightly different, but are similar in design and are typical of tropical architecture. In Shah Alam, every homeowner is free to build their own house. Developers only provide the infrastructure and land for sale. Detailed plans for houses in Shah Alam are done privately. In this study, the architects, landscape architects and planners who managed the areas of study were interviewed to gather information about the general construction, basic building design, landscaping, and the exact date and age of construction for every development. This primary data was validated with on-site interviews, data collection, and observation of each of the sample houses.

Electricity Uses Data

Domestic electricity tariff information was obtained from the Malaysian Electric Utility Company (National Energy Limited–TNB). Data for the monthly amount of electricity used by the 50 residential houses was collected as the cost of electricity in Malaysian Ringgit (MYR). These costs were converted into energy used in kWh based on current local tariff. Annual domestic electricity use in the city of Shah Alam was analysed to validate the amount of energy used in relation to the increase in air temperature and humidity levels in the two main seasons: rainy and dry. The increase in cooling energy use was closely related to air temperature changes in the hot-humid tropical environment.

Satellite Images

Satellite images for the study areas were obtained from Remote Sensing Data Services, Malaysian Remote Sensing Agency, Kuala Lumpur. These satellite images were formatted in high resolution, ‘Quickbird’ data series (0.6m resolution), and were taken in 2007. The images show the natural condition of the housing estates and their surrounding landscapes. Vegetation information was observed by the author during the fieldwork stages, and was compared with the digital satellite images. The satellite images came from geographic information system (Archview@GIS). This data was compared with the master plans from each house’s local authority to confirm their location,

orientation and surrounding landscape; and to record the overall condition of the houses and landscaping in each location.

The Variables

Building Orientation

The configuration of the house should be designed to ensure the comfort of its occupants and for energy efficiency. In a hot-humid tropical climate, proper house orientation in relation to the sun and its devices will enable energy savings and more comfortable conditions. In this study four main categories of wall orientation/direction are North, East, South and West and also the in between of the main directions include the Northeast, Southeast, Southeast and Northwest.

Building Envelopes

Building envelopes include the walls, roof, glazing and floor foundation. Walls are the major part of the building envelope and in these houses faced in all directions, while the roof is the top covering and is exposed to the direct solar radiation throughout the day. In the tropics, heat gain through glass windows and doors is often the major source of solar heat gain. Hence, if such glazing located facing the direct solar radiation orientation, it should be minimized and shading maximized. Hence, not only were the materials of the building noted, but the direction of the glazing was also assessed. The measurements taken in the study areas were the areas of building envelopes include walls, roof, glazing and floors.

Surrounding Vegetation

Strategically placed shade trees around the building can potentially modify micro-climate and building energy use through shading. This shading can minimize the amount of radiant heat absorbed and stored by buildings and other built surfaces. Shading in outdoor areas will be provided by all types of vegetation to the building envelopes and surrounding garden earth surfaces. The plants shading areas and their angles were recorded during morning, afternoon, and the peak time of the day. The measurement of evaporation and transpiration in the study areas refers to the amount of water vapor in the atmosphere. The evapotranspiration is gained as a result of evaporation from exposed water surfaces, moist ground and plant transpiration. The measurements in the study areas were relative humidity or absolute humidity reading. In a hot-humid tropical climate, wind is generally of moderate speeds and is not steady all the time. Strategic outdoor designs to promote wind are required. The strategic location of vegetation can capture and directing the flow of air and provide effective ventilation and convective cooling of surrounding gardens and building surfaces. The measurements taken in the study areas were wind speeds.

Human Factors

Human factors in this study are the number of occupants who need cooling and their daily living habits of using air-conditioning system. The cooling energy use will be calculated based on the horsepower of the air-conditioning system, temperature setting and the duration of daily use.

RESULTS AND DISCUSSIONS

Stage 1

In this first stage, the measurements focused on individual houses. Research methods have been divided into three parts: selection of houses with suitable surrounding landscape; observation of

building construction and landscape design; and field measurements of building construction, landscaping and day time weather data.

Case study one involved looking at the construction and surrounding landscape of three single-family houses aged 5, 10 and 30 years old in Shah Alam, Selangor, Malaysia. While their construction was similar, the design and size of each house varied because they were built in different eras of construction methods, and styles of architecture and landscaping. As mentioned before, the design and construction of single-family houses in Shah Alam are up to each homeowner to decide on. The 30 year old house was located in Section 6, Shah Alam, and was surrounded with mature tropical landscaping, while the 10 year old house was located in Section 11, Shah Alam, and was surrounded by tropical landscaping of intermediate age. The 5 year old house was located in Section 9, Shah Alam, and was surrounded by immature tropical landscaping. The houses were labelled as mature, ordinary, and new landscaped houses. The three housing estates were close in location, as they were around 3km apart. The three ages of construction were chosen because they provided different vegetation maturity and landscaping styles, which would have different effects on the thermal performance of the houses by shading, evapotranspiration and channeling wind.

In case study two, two similar house constructions and locations were chosen, but the landscape of each house was totally different. This was to help demonstrate the effects of the surrounding landscape on a house's thermal performance. These houses were located in Precinct 14, Putrajaya, Malaysia, and were labelled as a heavily landscaped house and a sparsely landscaped house. The heavily landscaped house had strategic landscaping, while the sparsely landscaped house had a minimum of landscaping in the garden. A heavily landscaped house will usually produce cooler ambient air than a sparsely landscaped house. This is because large quantities of vegetation located in strategic areas of a property could lower the ambient air temperature by providing shade, channeling wind and through evapotranspiration. A well designed tropical house will also reflect heat from solar radiation from the building envelope, while providing shade for every opening and by being orientated to allow wind to blow through the building's interior spaces.

Local weather recording

In case study one, which was conducted in Shah Alam, weather recordings were carried out during daytime on the 23rd, 24th, and 28th of February, 2010. These dates were chosen because they had similar weather conditions each day, with six to eight hours of sunshine during the day and drizzle at night. In case study 2, which was conducted in Putrajaya, the weather recordings were carried out during daytime on the 16th and 17th of January, 2010. The weather on these two days was similar, with sunshine for the whole day, and the soft rain starting at 19.30 hours. Cloud is very typical of this tropical region, measuring approximately 6.9–7 okta. The study measured climatic parameters and the physical characteristic of the four azimuths of the houses. Each measurement point represents an area of 90m², and an approximate radius of 3m to 10m around the fixed/mobile weather station. The measurements were taken at 30-minute intervals in all locations a meter above the ground and in the shade. The albedo data for every type of building envelope was also measured during the daytime.

Exterior space

The weather measurements taken for both studies were not influenced by shadows or reflected solar radiation. The basic measuring equipment that was used to do the field measurements included:

- *Two sets of mobile TSI VelociCalc Plus Meters, model 8386, data loggers and sensors.*
- *Two sets of portable Model Babuc A code BSA014, multi-data loggers and sensors.*
- *Two sets of Lux meters PCE-172.*
- *Two sets of compasses and measuring tapes.*
- *A set of digital cameras and drawing equipment.*

Interior space

Four sets of Electronic Mini Thermo hygrograph, model Testo 175-T2 were used to measure air temperature and air humidity data inside the buildings. This equipment was set automatically, and placed at a metre above the floor near the windows that faced the four azimuths on the ground floor of the houses. The purpose of these measurements was to compare with outside weather data.

Energy use measurements

This experiment used quantitative measurements to document the energy used for air conditioning, while considering the influence of surrounding vegetation, including trees, shrubs, vines, groundcover and lawn. Data about the internal temperature of each house was obtained during days with similar climate conditions. This was to ensure the data for houses with different designs and landscaping was comparable. Interviews with home owners and observations revealed that air conditioning units were used in every room of the houses looked at. The type of air-conditioning units used and their horse power were recorded, and energy consumption for these units was given by the owner of the house. The cost for air conditioner use has been determined by National Electricity Limited (TNB). This, along with an analysis of the reduction of ambient temperature and air conditioning consumption during the day and on the hottest afternoons, would reveal the potential savings associated with the corresponding landscape.

Landscape element measurements

The study of all landscape elements was conducted through observation and interviews with the owner of each house. Landscape elements and house plans were drawn in detail and to scale. Landscape elements included soft landscape and hard landscape. The location of every type of vegetation was recorded at five meter intervals extending out from the building from each of four azimuths, as shown in Figure 3. Tree azimuth classes were defined with reference to building wall orientation. According to Simpson (2002), a wall is cardinally oriented if the normal distance to the wall is within ±45°E of a cardinal direction (North, East, South or West), otherwise, it is inter-cardinal (NE, SE, SW or NW). A detailed landscape plan was recorded for every type of vegetation because shading, evapotranspiration and wind flow are all affected by different types of landscaping.

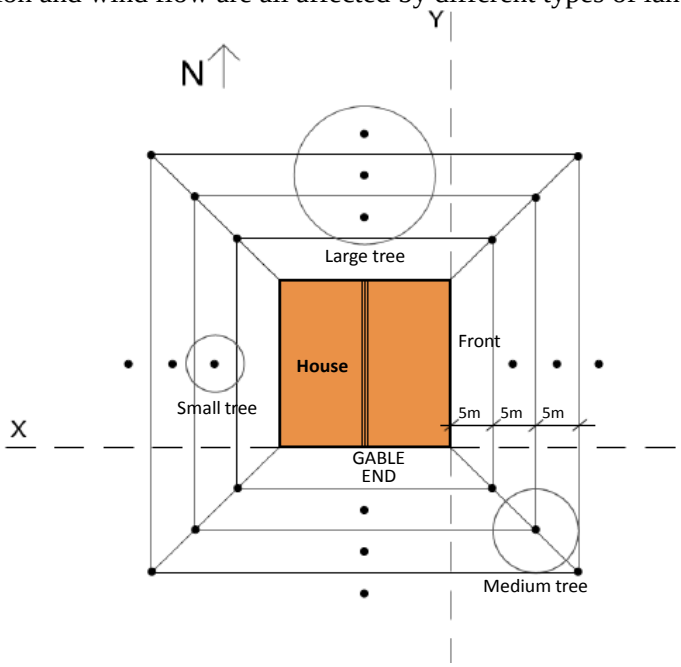

Figure 3: House configuration and the five metre intervals of vegetation measurements and other landscape elements around the house
Source: (Simpson, 2002)

Data Analysis

Once all of the data were collected, master spreadsheets were developed using Microsoft Excel 12.0 and Origin 8.0. All vegetation data gathered from the four azimuths of each house and was recorded numerically in this spreadsheet as percentages or figures. This data was analysed based on a few variables, including vegetation structure and typology or biomass, which was representative of the real conditions of vegetation on the site. The actual amount and biomass of every type of vegetation could appear as an average or mean to represent the surrounding landscape and design for every sample house. The types of equipment used for cooling, and resident's living habits were given different codes and numerical values in the spreadsheets to convert the actual values to energy consumption. Energy consumption for cooling was represented as a total value for the study period of kWh in Malaysian Ringgit (MYR). All drawings used as supporting documents were generated by Autodesk Revit Architecture 2011 and AutoCAD 2011.

All exterior and interior weather data gathered using devices such as the Babuc A, mobile TSI VelociCalc data loggers, and the Mini Thermo hygrograph were transferred and formatted for Microsoft Excel 12.0. The daily to yearly weather data obtained from the Malaysian Meteorology Department and monthly electricity costs data from National Energy Limited (TNB) were also put into this format. The best weather data from five individual houses was chosen for case studies 1 and 2, and the results of these studies were presented in various types of tables and figures using Microsoft Excel 12.0 and Origin 8.0 software.

Stage 2

Survey data were divided into two categories: data was collected by interviewing the owners of the houses, and from measurements and observation of the properties.

Homeowner interviews

Homeowner interviews were conducted to find information on human factors such as the amount of occupants, and lifestyle habits, including the time and numbers of air-conditioning units used every day. This provided information on the exact amount of cooling energy used in the house on a daily and monthly basis. These took approximately 10 to 15 minutes to complete, and asked three main questions. The first question asked about the number of residents in the house. The second question focused on a set number of electricity bills during the two main seasons in the tropics to evaluate the monthly and annual energy consumption for every house. Details about the type of air-conditioning systems used were also gathered, including each system's capacity, the total time it is used, the times it is turned on during the day and night, and the average temperature setting of the system. From this data the total amount of cooling energy used was calculated. Approximately 50 data collection sheets were filled in, and interviews completed from throughout the metropolitan Shah Alam and Putrajaya areas from January through March of 2010. Overall, only one-fifth of the number of householders approached cooperated and answered the interviews.

Data collection

To obtain accurate data about each house in the study, the fieldwork information was collected through observation and by taking measurements. The aim of the fieldwork was to collect all the possible data about the physical characteristics of the house, including the structure and construction method, and the surrounding landscape. These were filled out after consent was gained from the participants. Primary data from homeowners through interviews, along with direct observations of each house's environment were essential. The main goal was to observe the physical characteristics of the properties, including building construction and the surrounding landscape, and the lifestyle habits

of the occupants that could not be obtained without going to each property and contacting them directly.

Building structure and construction

The first data collected was general information about the building structure and construction of each house in the study. This data can be validated against construction records from local authorities, but the on-site data collected is the most up to date information about the houses, as some houses in the sample have had extensions built, such as enlarged car porches and additional kitchen spaces. The year of construction and house sizes were the main data variables used to classify the houses to ensure there was a range of ages and that they were medium sized. Information about the main structure and materials used was gathered to ensure the houses had similar construction and materials.

Data on the building envelope of every house was also gathered. This included information on windows and doors, wall and roof area and colour, and insulation. This information is significant because the building envelope influences the amount of heat absorbed by a house, which indirectly influences the cooling system. Data collected about windows, sliding doors and common external doors included actual size, materials and locations. For wall and roof areas, the biggest building envelope surfaces of every building, the areas were calculated in square meters. Their colour was also noted, because colour provides different abilities to reflect sunlight, as well as an albedo value for every house sample. Every house in the study areas used a layer of aluminium foil as an insulation layer for roofing. Ceiling type and the material used were also noted, as these provide another insulation layer for the roof. Data about the type of ceiling was collected for every room in each house; include heights, ceiling types, materials, and colours.

Landscaping

Data about the surrounding landscaping was divided into two types: soft landscape and hard landscape. Soft landscape included any type of vegetation that was planted around the houses, and is divided into five categories of vegetation: trees, shrubs, vines, groundcover and turf. Trees were divided into six types: roadside tree, roadside palm, garden tree, edible fruit tree, garden palm and bamboo. The explanation for every species of tree includes location, tree to building distance, trunk height and overall height, canopy size, shape, and the amount and size of the leaves. Shrubs, vines and groundcover were also categorized, as well as trees with slight differences in size. Turf species were stated and calculated in areas. The botanical name and common name for vegetation types were updated later using photographs. Hard landscaping in the study areas included paved surfaces, swimming pools, fish ponds, fountains, and shelters such as pergolas or gazebos. These are located among the soft landscaping, and are intended to complement and beautify garden design and provide space for outdoor activities. The data collected included recording the type of landscaping feature, its location and distance from the house, and construction material, size and colour and total area.

Table 1: Canopy Size, Shape, and Amount and Size of Leaves of Trees

Canopy size (diameter) (m)		**Shape**	**Amount of leaves (density) (%)**		**Size of leaves (mm^2)**	
Small	Below 3	Spreading	Few	Below 40	Small	Below 150
Small moderate	3–7	Round	Medium	40–70	Medium	150–1000
Medium	8–11	Columnar	Dense	Above 70	Large	Above 1000
Large moderate	12–15	Pyramidal				
Large	Above 15	Fountain				

Source: (Misni, 2012)

The final portion of the data collection sheet contained a space to sketch the house plan and surrounding landscaping elements to provide a detailed reference about their exact location and sizes. The plan of the house was also based on satellite images, master plans and detail drawings found from government departments. A scale of 1:200 was used as can be seen in Figure 3. This data collection took approximately three to four hours to complete per house, depending on the size of the house and surrounding landscape.

Data Analysis

Quantitative methods were used to evaluate the result of the effect of vegetation, building construction and human factors on cooling energy used in a hot-humid environment. All of the data gathered from 50 houses and their surrounding landscapes, from five housing estates in two cities, was analysed using the Statistical Package for the Social Sciences (SPSS 19.0). Origin 8.0 software was used to generate figures and tables from SPSS data. The effects of the surrounding landscape, together with building construction and human factors data, were calculated and evaluated by these statistical analysis systems. The cooling energy used in an individual single-family house was revealed in parallel with the neighbourhood trends of energy used for cooling.

CONCLUSIONS

The direct and indirect thermal impact of the vegetation surrounding single-family houses and their neighbourhoods in tropical climates was investigated using three research methods to collect data: interview, direct observation, and physical artefacts evidence. The primary data on the effects of vegetation on the thermal performance of buildings and their micro-climates on site were gathered to predict the effects of shade, evapotranspiration, and channeling wind on temperature and energy use. The secondary data was obtained from government agencies. These were used to validate that all of the primary data was accurate. In the first stage of fieldwork and measurements, the physical condition of five houses and their surrounding landscaping and weather data was recorded. The outdoor and indoor weather data were recorded for approximately 12 hours during the daytime in each of the four azimuths of the houses at 30 minute intervals using scientific equipment. In the second stage, 50 homeowners were interviewed to gain information about the human factors aspect of this study. On-site observations, data collection and information about building construction and the surrounding landscaping of each house were made manually and recorded by photographs. Statistical analysis was used to quantify and analyse the cooling-energy savings potential. This was based on the comparison between the surrounding landscaping, building construction and cooling energy use.

REFERENCES

Akbari, H. (2002). Shade trees reduce building energy use and CO2 emissions from power plants. *Environmental Pollution, 116* (Supplement 1), S119-S126.

Aziz, N. A., & Hadi, A. S. (2007). Linking urban form to a liveable city. *Malaysian Journal of Environmental Management, 8*, 87-107.

Evans, D., & Gruba, P. (2002). *How to Write a Better Thesis*. Victoria Melbourne University Press

Koch-Nielsen, H. (2002). *Stay Cool a Design Guide for the Built environment in Hot climates*. London James & James (Science Publishers) Ltd.

Malaysia. (1993). Gambar Peta Malaysia Retrieved 5 March, 2011, from http://gambar-peta.blogspot.com/2010/09/gambar-peta-malaysia.html.

Malek, J. A. (2011, July 14-16). *Informative Global Community Development Index of Informative Smart City.* Paper presented at the 8th WSEAS International Conference on EDUCATION and EDUCATIONAL TECHNOLOGY, Corfu Island, Greece.

Samad, A. M., Zain, M. A. M., Maarof, I., Hashim, K. A., & Adnan, R. (2011, 4-6 March). *Utilization of Artificial Neural Network and GIS for property market valuation.* Paper presented at the 2011 IEEE 7th International Colloquium on Signal Processing and its Applications, Penang, Malaysia.

Simpson, J. R. (2002). Improved estimates of tree-shade effects on residential energy use. *Energy and Buildings*, *34* (10), 1067-1076.

Wong, N. H., & Yu, C. (2005). Study of green areas and urban heat island in a tropical city. *Habitat International*, *29* (3), 547-558.

Yin, R. K. (2003). *Applications of Case Study Research* (Second edition). London SAGE Publications.

Arising Issues in the Execution of Heritage Conservation Projects: Collective Reflections from Case Studies in Ireland

Muhammad Firzan[1], Nila Keumala[1], Rodiah Zawawi[1], and A Ghafar Ahmad[2]
[1]Faculty of Built Environment, University of Malaya, 50603 Kuala Lumpur, MALAYSIA
[2]School of Housing, Building and Planning, Universiti Sains Malaysia, 11800 USM, Pulau Pinang, MALAYSIA
nazrif87@gmail.com

ABSTRACT

Apparently, conservation agenda around the globe is getting more significant nowadays. In the quest to safeguard and sustain invaluable heritage assets remaining today, it is evident that more new: guidelines being regulated, approaches being introduced, courses being offered, and, growing interests being projected. Architecture discipline which melds together different areas such as: history, humanity, science, art, and technology, has emerged a new branch of specialization known as built heritage conservation. Realising the importance of Western's experience as precedence for the relatively new Malaysian conservation industry, this paper collectively highlights on the execution of built heritage conservation projects across Ireland. Through a series of reflection sessions shared by practitioners based on their involvements on respective case studies, this paper summarises four arising issues of: an enquiry on praxis and compliance of conservation doctrines, essentiality of engaging the public in decision-making process and volunteerism, obsolescence and dereliction of historical buildings and sites as the diseases to heritage tourism, and, achieving environmental sustainability demand through energy efficiency and building retrofitting. Prior insights and recommendations based on these arising issues are presented for the attention of heritage stakeholders and conservation actors of Malaysia.

***Keywords**: Heritage, conservation, Ireland, Malaysia, reflective practice.*

INTRODUCTION

Ireland is a country renowned for its richness in tradition, culture, and history. Despite merely having two of its cultural heritage assets being prescribed into the UNESCO World Heritage namely, the Archaeological Ensemble of the Bend of the Boyne (Irish: *Brú na Bóinne*) in 1993, and, the Skellig Michael Island (Irish: *Sceilg Mhichíl*) in 1996 (UNESCO, 1999-2014), there are great abundance of heritage assets can be observed across the country ranging from cultural and natural properties. Evidently, Ireland has a respectable historical protection schemes and systematic heritage management structure in their conservation agenda as can be observed in their two primary concern of conservation as stipulated in Ireland's Planning and Development Act 2000 namely: the Protected Structures and the Architectural Conservation Area (Oireachtas, 2000; Department of Arts, Heritage and the Gaeltacht, 2011). Hence, in the quest to shift the relatively new Malaysian conservation industry to a better standard (Syed Mustapa, Kamal, Zaidi and Abd Wahab, 2007; Sulaiman, Kamaruzzaman, Rao and Pitt, 2011; Syed Mohamad, Akasah and Abdul Rahman, 2014), precedent from Ireland's conservation experience is of the essence. To such a great degree, global conservation agenda for both developed and developing countries, should legitimately be emphasised, uplifted and celebrated in order to savour our finite and precious assets of cultural heritage that are still remaining today.

HERITAGE CONSERVATION IN IRELAND

According to Ireland's main conservation doctrine, the Architectural Heritage Protection Guidelines for Planning Authorities (Department of Arts, Heritage and the Gaeltacht, 2011): "*a 'Protected Structure' is a structure that a planning authority considers to be of special interest from an architectural, historical, archaeological, artistic, cultural, scientific, social, or technical point of view and is included in its Record of Protected Structures (RPS) which may be a building or part of a building which is of significance because of its architectural or artistic quality, or its setting, or because of its association with commercial, cultural, economic, industrial, military, political, social or religious history*". Meanwhile, "*an Architectural Conservation Area (ACA) is a place, area, group of structures or townscape which is either of special architectural, historical, archaeological, artistic, cultural, scientific, social or technical interest in its own right, or which contributes to the appreciation of protected structures which could include, for example, a terrace of houses, buildings surrounding a square, or any group of buildings which together give a special character to an area inclusive of a group of structures associated with a mill or with a country house estate providing that they are located in a rural setting"*.

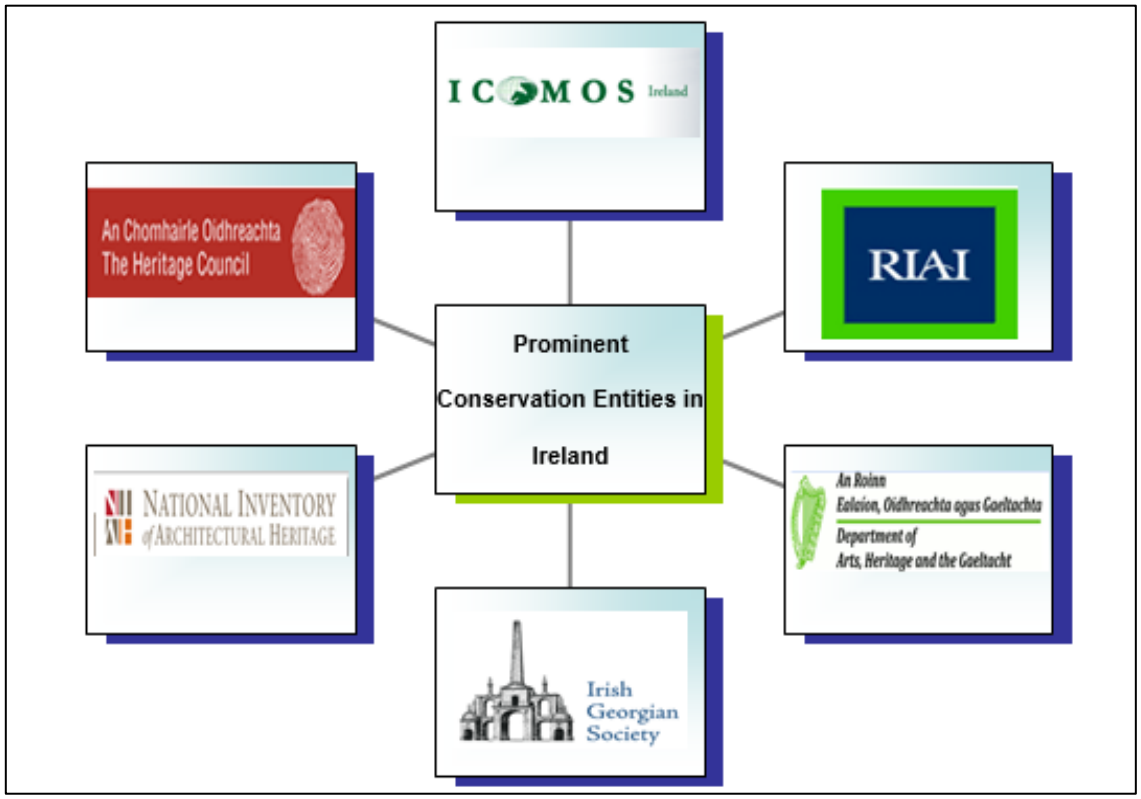

Figure 1: The Prominent Conservation Entities in Ireland
Source: Google Images (n.d.)

Moreover, the aforementioned doctrine also stated that ACA may as well include protected structures. Correspondingly, in case of any Planning Authority in Ireland considers that any 'place, area, group of structures or townscape' requires preservation, declaration of such as an ACA then must be made and defined in the Development Plan.

Ashworth and Larkham (2013) further elaborated on the criteria of whose and which heritage in Ireland to be conserved:

- *"It must reflect the identification of the specific fusion of all the exogenous and indigenous influences which created Ireland's history".*
- *"The particularity of that past and its relevance to the present must be placed within the context of a recognizable generality of the European process".*
- *"Heritage definition must underscore the maturation of Irish identity into a plurality, central to which is the rejection of the Gaelic origin-myth and the removal of Catholicism as a defining element of nationality".*

REFLECTIVE PRACTICE: LEARNING FROM CASE STUDIES

Reflective practice as defined by Schon (1983) is: "*the capacity to reflect on action so as to engage in a process of continuous learning".* Based on one's intuition or gut feeling, reflective practice may enhance in approaching and deriving problems and solutions respectively. To prove such claim, Schon (1983) further explained that practitioner will be able to identify both the ends to be sought (solutions) and the means to be employed (methods) through reflecting in and on practice by the process of: framing the problem, determining the features to attend, attempting the order to impose and trying to change the directions of a situation. It is imperative to note that reflective practice enable novice students lacking in practical knowledge and technical skills, to learn critically through project reviews and case studies as shared by professional consultants within the industry.

Apart from aiding professional and personal development, reflective practice enable skills pertinent to the tasks being shared to be polished and improved. A typical reflection session basically provides the 'mentor-protégé' learning experience on pragmatic conservation approaches between conservation practitioners and learners. Contextually, information acquired within this paper are based on a series of reflection sessions by involved practitioners ranging from Ireland's architects, conservationists and archaelogists, whom shared their experiences in executing built heritage conservation projects. Discussion made is based on Surgenor (2011)'s explanation regarding reflective writing that involve: looking back at the case studies, analysing the conservation interventions from own perspective and theoretical background, and then, rethinking the meaning of learned experiences from the practicing professionals.

SUMMARY ON ARISING ISSUES IN THE EXECUTION OF BUILT HERITAGE CONSERVATION PROJECTS IN IRELAND

Conservation Doctrines: An Enquiry on its Praxis and Compliance

Commonly, the uniqueness of built heritage physical attributes and its dissimilarities with one another in terms of design, construction and materials influence the rationale regarding selection of conservation approach and philosophy. In that sense, it is apparent that there are plethora of international standards, regulations, charters, formal recommendations and conventions, affecting the conservation procedures around the world. Most of the do's and don'ts in conservation nowadays basically are contributory to earlier experts in the field, as derived from renowned former theoreticians and practitioners such as the names of William Morris, John Ruskin, Paul Philippot and Jukka Jokilehto. Although the existence and formulation of these epistemological doctrines are basically intended to ward off unnecessary damage to cultural heritage and to assist decision makers and conservators in carrying out conservation, it is still unclear on how conservators do really approached, embedded and abided so, to the best possible level.

In fact, the abundance of conservation doctrines has indirectly provided a sense of freedom pertain to the uses of conservation language among conservators. With that, due to the utilisation of rhetorical statements from conservation doctrines, it has become difficult for others to delineate and differentiate

the uprightness and especially, the erroneous of any particular conservation project. It is indeed questionable whether the guidelines prior conservation doctrines were choice out of personal preferences of conservators or not, since the tendency of meeting conservation best practice can be perceptively met according to one's very own understanding. On the other facet, the ambiguity in the extent of adherence and compliance of conservation projects to conservation doctrines also remains a question mark as there is no any specific measurement to determine so.

Corresponding to that, Argyris and Schön (1974) stated that people have mental maps regarding the way they act in situations, which involves the way they plan, implement and review their actions. As a consequence, these maps that actually guide their actions rather than the theories people explicitly espouse. In real scenario, discrepancy do exists between what is recommended in conservation doctrines and what has actually taken place on heritage site. Taking the conservation case of Skellig Michael Island for an exemplar, a criticism on the reconstruction work at this particular site has been made by a group of archaeologists lead by Michael Gibbons. As an independent archaeologist during that time, Gibbons claimed that the shape of the Oratory Terrace has been done based on conjectural study.

Referring to a pertinent doctrine, this case has therefore violated the main doctrine adopted by UNESCO namely the Venice Charter (ICOMOS, 1964) in terms of "the aesthetic and historic value" of a monument that must be preserved. According to outline in its Article 5, "*The conservation of monuments is always facilitated by making use of them for some socially useful purpose. Such use is therefore desirable but it must not change the lay-out or decoration of the building. It is within these limits only that modifications demanded by a change of function should be envisaged and may be permitted*." In addition, Article 6 of the same charter stated, "*The conservation of a monument implies preserving a setting which is not out of scale. Wherever the traditional setting exists, it must be kept. No new construction, demolition or modification which would alter the relations of mass and colour must be allowed*."

Figure 2: The Large (Top) and Small (Below) Oratory Terrace at Skellig Michael Island
Source: Bourke, Hayden, & Lynch (2011)

Despite the criticism, Grellan Rourke, the senior conservation architect of Irish Heritage Service who was also the main archaeologist of Office of Public Works in charge for the conservation of Skellig Michael Island has denied the claim. He posited that merely preservation of existing fabrics has been undertaken without intruding the originality and authenticity of the monastic structures of this hermitage site (The Tara Foundation, 2014). Rourke further summarised the rationale behind the decisions taken regarding his conservation works and the resultant of archaeological excavations in a report titled, "Skellig Michael, Co. Kerry: The Monastery and South Peak Archaeological Stratigraphic Report: Excavations 1986–2010" (Bourke, Hayden and Lynch, 2011).

Apart from the compliance issue, it is unfathomable on which standards or guidelines out from the multifariousness should be adopted by conservators in dealing with their specific case. The abundance availability of conservation doctrines demands conservators to fully understand and digest each document which may adversely, resulting in confusion and overlapping ideas. Nevertheless, in a global context, more conservation documents and guidelines pertaining region-specific or particular treatment of building components are being published. Yet looking on the positive side, those materials potentially offer more detailed and more comprehensive sources of reference to enrich conservators with the know-how as well as the do's and don'ts's knowledge.

Presumably, one of the ways to omit scepticism on work done by conservators is through acknowledgment by any means of award, accolade or honour acquisition. The recognition received from relevant or prestigious organisation will give a sense of confidence to a conservator besides helping to deter cynical feedback from both peers and laymen. Among the prestigious conservation awards in Ireland are the Irish Georgian Society's Architectural Conservation Award and the Royal Institute of the Architects of Ireland (RIAI)'s Irish Architecture Awards in the Best Conservation/ Restoration Project category.

Learning from this sub-issue, Malaysia may enhance its conservation industry through revisiting the currently in-use doctrines in particular, the National Heritage Act 2005 (Act 645) and also the *Garis Panduan Pemuliharaan Bangunan Warisan 2012* by conforming the existing measures adopted from international doctrines to be more contextualised locally, through in-depth research by experts and full stakeholders engagement and consultation. Moreover, the main conservation governance of Malaysia namely, the Department of National Heritage may actively initiate more conservation awarding programmes to reward the conservation practitioners, of consultants and contractors, whom have exercised and demonstrated a plausible good model of conservation projects. With that, improved benchmarking standards in conservation can be set up thus better contributions to the protection of local cultural heritage resources can be triggered and anticipated.

Essentiality of Engaging the Public in Decision-Making Process and Volunteerism

Decision-making process certainly is a very crucial planning agenda in harvesting the feasibility and sustainability of any intervention. As we all know, a successful conservation programme or development project outcome is always conflict-free after its execution. In order to achieve such, empowerment of the local community and involvement of the public in any decisive process is therefore an indispensable matter and should no longer be considered merely as an option. After all, relying on conservation laws alone is insufficient in meeting the best practice prior safeguarding built heritage properties.

By taking the case study of Granby 'Pop-Up' Park for instance, it is proven that creation of a cheap, sustainable and enjoyable space is possible and achievable due to the beauty of community engagement and great volunteerism. This 'pop-up' park with the iconic pallet theatre reflects the success of multi-collaboration, public outreach, team effort and local creativity. It is obvious that great things can be accomplished when the community acts as an active unit and take responsibility to make harmonious decisions together. In addition, this sort of project in pro-bono collaboration by Sean Harrington Architects firm also nurtures the sense of ownership, place and pride within the locals. Adding to that, social problem affecting the environment such as vandalism will not be an issue as people will protect and appreciate their shared possession and effort.

The aforementioned scenario is also in line with the Charter of Built Vernacular Heritage (ICOMOS, 1999) statement of, *"The built vernacular heritage occupies a central place in the affection and pride of all peoples. It has been accepted as a characteristic and attractive product of society. It appears informal, but nevertheless orderly. It is utilitarian and at the same time possesses interest and beauty. It is a focus of contemporary life and at the same time a record of the history of*

society. Although it is the work of man it is also the creation of time. It would be unworthy of the heritage of man if care were not taken to conserve these traditional harmonies which constitute the core of man's own existence".

Figure 3: The Pallet Theatre at Granby 'Pop-Up' Park, Dublin
Source: Sean Harrington Architects (2014)

It is claimed that the more participation, the happier a community will be (Wallace & Pichler, 2008). Local community is a basically group of people within a shared locality whom shares social interactions and want the most productive, effective and rewarding way of working together, besides the freedom of making choices. They also look forward to meet their personal needs and growth opportunity as the mileage for their commitment and contribution into the community. The beauty of community-building concept is it encompasses a wide range of activities, goals, actors and processes in diverse range of community, social, economic, environmental and urban change issues (Woodend, 2013). This is also practiced in Japan, another Asean country where community-based agenda is a major concern which has been long-rooted in their planning tradition termed as '*Machizukuri'*.

By having public outreach and hearing session, decision-makers can conduct the need assessment to gain information on local people's requirements, hopes and desires which can assist in achieving social equity. The consideration of enabling access, egress and use of facilities to accommodate the disabled and elderly people in an area is one good example of better considerations and sensitivity to the public. Referring to Ireland's architectural conservation, accessibility and universal design is much concerned yet also much challenging, due to the factor that most old buildings were generally designed without fulfilling barrier-free features. This scenario has commit issuance to official publications such as Code of Practice on Accessible Heritage Sites and Advice Series on Improving the Accessibility of Historic Buildings and Places by the National Disability Authority (NDA). It is imperative to note that by not consulting the local community, provision of such documents will tend to have the propensity to overlook on their problems mitigation.

However, the critical issue of engaging community members is, on its real influence in implementing decision. De Filippi (2005) addressed on manipulation issues in participatory process by asserting that: "*community members can make valuable contributions in all steps of communication, not just as targets of messages and materials developed by communication specialists*". In other words, people voices are being moulded and patterned by the desired outcome of certain stakeholders with their own interests. As the proverb says 'truth is stranger than fiction', this issue does exist and is common in nowadays planning and management scenario in which community participation is merely

treated as a requirement rather than solution. Such flaw should totally be avoided as for its backfiring aftermath in resulting ineffectiveness of any programme results pertinent to conservation.

Positive values such as respect, understanding, volunteerism, trust and honesty are crucial to improve public engagement in Malaysian physical infrastructure's planning, development and conservation activities. These values are vital in transforming the local people in becoming the 'changing agents' by making decisions and taking actions for themselves in tune with the famous Abraham Lincoln's slogan "*of the people, for the people and by the people*". Furthermore, it is observable that cultural heritage conservation in Melaka and George Town, as the UNESCO World Heritage Sites of Malaysia, are having essential need to increase the liveability of the city while maintaining the status of a living museum. Yet, both cities are heavily demanding on the role of each city's state government and local authority despite the potential strength of local people to employ the 'Heritagization' buzzword. 'Heritagization' is a process of using heritage resources to achieve certain social goals and aim to establish solidarity among members of national, religious or social group by highlighting their differences thus legitimizing a certain social order (Poria and Ashworth, 2009).

Obsolescence and Dereliction of Historical Buildings and Sites as the Diseases to Heritage Tourism

Apparently, heritage assets are facing strong competition to coexist with contemporary and sophisticated world of today, besides suffering constant pressure in blending with modern development. Even though possessing bankable demand via heritage tourism, a threat to both heritage significance and tourism industry is vivid in the form of negligence of old buildings and historical sites, to the point of dilapidation and obsolescence pose. These problems can be related with a number of factors such as underuse, care-free, aesthetical impairment and lack of financial funding. Obsolescence and negligence of historical building is definitely inappropriate either economically or ethically as conservation should be continuous and not meant to be focused during a specific period of time.

Such predicament can be strongly linked with the lack of awareness and ill perception on maintenance activities which carry paramount benefits in conservation, both philosophically and practically (Dann and Cantell, 2008). The tendency to leave old building deteriorating and dilapidating before being conserved is such an unethical manner as conservation should not only be perceived as a heroic major restoration work yet also minor actions such as repairing, cleaning and replacing. Harun (2011) acknowledged that the absence of proper maintenance may adversely leads to a more severe defects and deterioration to the building fabrics. Meanwhile, Sodangi, Khamidi and Idrus (2013) emphasised the benefits in maintaining heritage buildings such as: enhancing the quality of life for everyone in the community, fostering investment through tourism products which will economically benefit the community, contributing to regeneration and providing a source of local pride and sense of place. Dann and Cantell (2008) further asserted that the longer maintenance is being ignored, rejected or postponed, the more advantages of maintenance are lost to building owners and managers.

This notion is supported by Yahya and Ibrahim (2012) saying that achievement from maintenance investment in buildings will define their value. A good building is always precedential by optimal care besides having fewer occurrences of defects on the building elements, which calls upon necessary actions to be taken at the UNESCO World Heritage Sites of Melaka and George Town, inflicted with core problem of poorly executed maintenance and restoration as based on the Draft of Special Area Plan (AJM Planning and Urban Design Group, 2011). This has consequently resulted in the strong presence of dilapidated buildings and premises within both historical cities which may potentially lead to more adverse impacts such as damaging the Outstanding Universal Values (OUV), disqualifying the World Heritage status and impairing the tourism industry.

Looking into a larger scope, dereliction of an urban area especially historical site requires urgent effective resolution to prevent further loss in terms of society, physical and economical aspects.

Aungier Street, a neighbourhood in Dublin is one of the examples of historical sites which has been regarded as underused and currently is undergoing revitalisation process to make it more marketable as a heritage tourism product, under the responsibility of Dublin City Council. The rebranding process of its Valentine District has adopted the 'place-making' planning strategy for the benefits of residents, businesses and visitors which sets out to capitalise on the tourism potential of the area. Place-making as defined by Schneekloth and Shibley (1995) is the way in which all human beings transform the places they find themselves into the places where they live.

Figure 4: The Aungier Street Area Map (right) and
Postcard View from the Early 20th Century (left)
Source: Dublin City Council (2013) and Dublin City Council (n.d.) respectively

Urban spatial and design features such as increased footpath width, incidental space, surface change, shared space and traffic calming are being incorporated in the physical revitalisation scheme besides improving the traffic connection by making cities 'lighter, flow and smiles' in the area. By taking such initiatives, the problem of vacant buildings can be tackled as more residential and commercial opportunities will be created thus making the area thrive economically and functionally (Dublin City Council, 2013). Other potentials of the Aungier Street Area as shared by Dublin City Council are: the existence of 17th Century houses and listed buildings, development of social housing for precinct improvement, Dublin City Council Energy Pilot Project, public realm improvements and greening projects.

The Charter for the Conservation of Historic Towns and Urban Areas also known as the Washington Charter 1987 (ICOMOS, 1987) summarised, *"…'the conservation of historic towns and urban areas' is understood to mean those steps necessary for the protection, conservation and restoration of such towns and areas as well as their development and harmonious adaptation to contemporary life*". Furthermore, the Nara Document on Authenticity (ICOMOS, 1994) in its Appendix 2 defines conservation as, *"…all efforts designed to understand cultural heritage, know its history and meaning, ensure its material safeguard and, as required, its presentation, restoration and enhancement (Cultural heritage is understood to include monuments, groups of buildings and sites of cultural value as defined in article one of the World Heritage Convention).*"

In a nutshell, it is utmost appropriate to treat cultural heritage tourism as a mechanism to upkeep heritage significance while not sacrificing the site authenticity to compromise and satisfy visitors' expectations at any cost (Fullerton, McGettigan and Simon, 2010). This assertion is much applicable in the context of conservation realm in Malaysia, currently managed to get four of its heritage sites officially registered in the prestigious UNESCO's World Heritage List and potentially will became major attractions and icons of national identity besides holding international accountability via tourism

industry (Shackley, 2006; Freya and Steiner, 2011; Maghsoodi Tilaki, Abdullah, Bahauddin and Marzbali, 2014).

Achieving Environmental Sustainability Demand through Energy Efficiency and Building Retrofitting

Green building, sustainable design and eco-architecture are among the keywords of post-modernism architectural movements that share a similar idea on environmental-friendliness. In current conservation practice, integrating environmental sustainability measures in upgrading heritage buildings to meet the contemporary expectations is a noble endeavour. Moreover, the demands of sustainable conservation itself are wide-ranging that include economic, social, physical, ethical and environmental spectrums. Focusing on conservation endeavour, the environmental sustainability can be achieved through energy efficiency and building retrofitting.

In Ireland, new building standards which urge minimal consumption of energy and fuel have influenced the expectations of older buildings users. The European Directive on the Energy Performance of Buildings (2002/91/EC) adopted into Irish law in 2006, specifically targeted energy requirements of buildings whether new or existing residential or non-residential, due to the fact that buildings contribute significantly to this country's energy consumption. Building Energy Rating (BER) and Dwellings Energy Assessment Procedure (DEAP) are two prominent rating and assessment tools for such procedure. Yet, it is vital to have realistic expectations of older buildings and to bear in mind that environmental sustainability should not forsake heritage interest.

In the quest to meet the balance of environmental and authenticity demands, it is imperative to fully recognise: architectural characters of a building, repair and maintenance issues, past construction techniques and unique characteristics of traditional building materials. Detrimental impacts on historic fabrics may result in absence of such understanding and misapplication of modern technologies (The Department of the Environment, Heritage and Local Government, 2010).

Perceivably, there is a distinction in the process of man-made environment between new developments and readily-available resources, in terms of the needs to pre-planned sustainable design features for the former and to reintegrate those for the latter. However, the greenest buildings are the ones that we already have (Jacobs, 1993) as existing buildings possess 'embodied energy' which means efforts, materials and systems that can be saved by avoiding demolition and reconstruction of a new building which will generate the carbon footprint of logistics and transportations. This notion champions the beneficial act of reusing heritage buildings through adaptive reuse by minimising waste and avoiding toxic emission to the environment as demolition of building and its materials does not took place (Langston, 2010).

Basically, environmental sustainable features in a building deal with the performance of quantifiable measurements such as: lighting, acoustics, temperature, humidity, durability of materials, amount and distribution of spaces and also end-user satisfaction (Mahgoub, 1999). There are various stakeholders and parties in Ireland which possess expertise in this matter such as the Irish Green Building Council (IGBC), the Sustainable Energy Authority of Ireland (SEAI) and of course, the Royal Institute of the Architects of Ireland (RIAI) in case of reference and consultation needed. As a summary, these are the basic critical sustainable design issues and sciences of architecture to be scrutinised by heritage stakeholders and conservation actors in Malaysia as highlighted by architects, Sean Harrington (personal communication, 22 April 2014) and Paul Jennings (personal communication, 01 April 2014):

- *Energy: Reducing thermal demand by south-facing site strategy of building to make full use of sun orientation, high level of insulations to walls and roofs as well as avoidance of cold bridges and lowering airtightness.*
- *Biodiversity and wildlife: Provision of habitats for insects besides enabling residents to grow plants and trees through gardens, plant boxes, courtyards and communal spaces as well as green roofing.*

- *Building materials: Avoid the use of environmental-hazardous materials and substances such as cement, PVC products and Medium-density fibreboard (MDF) and high Volatile Organic Compounds (VOC).*
- *Water: Utilise and save water through; water absorption via green roofs and soft landscaping, rain-water harvesting for irrigation and car wash and smart water usage by having dual flushes toilet and powerless shower.*
- *Waste: Having good waste composting machine and recycling pavilions such as the Swedish vacuum waste disposal system.*

CONCLUSION

Learning through case studies and reflective practice manifest change, solidify understanding and foster confidence in oneself prior to embark through professional journey. Well-equipped future practitioners with up to the standard knowledge and skills pertinent to heritage conservation and management are in ever greater demand. As built heritage that we enjoyed today have survived years of generation, it is supremely a shared-responsibility to ensure those treasures are inheritable by upcoming generations without any hiatus or lacklustre. As time proceeds, construction industry of new development may get saturated as a result of land scarcity nevertheless conservation industry presumably will perpetuate, through the activities of maintenance and adaptive reuse.

Therefore, apart from lessons learned through contemplating on foreign case studies arising issues, conservation performance in Malaysia can be further fine-tuned by reflecting continuously on local conservation endeavours. This is achievable by incorporating evaluation paradigm in the current conservation programme. Despite of various benefits in having programme evaluation, evaluation is still rare and uncommon especially in the context of heritage conservation in Malaysia. Lastly, this paper serves as a part of an on-going doctoral research focusing on developing a conceptual framework (Post Conservation Evaluation) catering for Malaysian heritage building.

ACKNOWLEDGEMENT

The content of this paper is mostly based on the precedent study conducted during the researcher involvement in the Erasmus Mundus Europe Asia (EMEA) Exchange Programme at University College Dublin, Dublin, Ireland. This research is funded by University of Malaya's Postgraduate Research (PPP) Grant with the Grant I.D. No.: PG192-2014B.

REFERENCES

AJM Planning and Urban Design Group. (2011). George Town Historic Cities of the Straits of Malacca. *Draft Special Area Plan*. George Town World Heritage Incorporated.

Argyris, C., & Schön, D. A. (1974). *Theory in practice: increasing professional effectiveness.* Jossey-Bass Publishers.

Ashworth, G., & Larkham, P. (2013). *Building A New Heritage (RLE Tourism).* Routledge.

Bourke, E., Hayden, A. R., & Lynch, A. (2011). *Skellig Michael, Co. Kerry: The Monastery and South Peak Archaeological Stratigraphic Report: Excavations 1986–2010.* Ireland: Government of Ireland.

Cavanagh, S., Masson , J., & McDowell, K. (2011). Reflective practice groups in learning disability services. *The Cumbria Partnership Journal of Research, Practice and Learning*.

Dann , N., & Cantell, T. (2008). Maintenance in Conservation. In M. Forsyth, *Understanding Historic Building Conservation.* Oxford, UK: Blackwell Publishing Ltd.

De Filippi, F. (2005). Sustainable "Living" Heritage Conservation Through Community-Based Approaches. *Forum UNESCO University and Heritage 10th International Seminar*, (p. 6). Newcastle Upon Tyne.

Department of Arts, Heritage and the Gaeltacht. (2011). Architectural Heritage Protection: Guidelines for Planning Authorities. dublin, Ireland: The Stationary Office, Government of Ireland.

Dublin City Council. (2013). *Aungier Street: Revitalising an Historic Neighbourhood.* Dublin, Ireland: Dublin City Council.

Dublin City Council. (2013). *Public Realm Strategy: Your City Your Space Annual Report* . Dublin, Ireland: Comhairle Cathrach, Bhaile Atha Cliath.

Dublin City Council. (n.d.). *AUNGIER STREET: Revitalising an Historic Neighbourhood*. Retrieved April 26, 2014, from http://www.dublincity.ie/yourcouncil/localareaservices/southeastarea/southeastarea/aungierstreet/Pages/default.aspx

Freya, B., & Steiner, L. (2011, November). World Heritage List: Does it Make Sense? *International Journal of Cultural Policy, 17*(05), 555–573.

Fullerton , L., McGettigan , K., & Simon, S. (2010). Integrating Management and Marketing. *International Journal of Culture, Tourism and Hospitality Research*, 108.

Google Images, (n.d.) Retrieved from Google: http://images.google.com/

Harun, S. (2011). Heritage Building Conservation in Malaysia: Experience and Challenges. *Procedia Engineering*.

ICOMOS. (1964). Venice Charter 1964. *The International Charter for the Conservation and Restoration of Monuments and Sites*. International Council on Monuments and Sites.

ICOMOS. (1987). Washington Charter 1987. *Charter for the Conservation of Historic Towns and Urban Areas*. Washington DC: International Council on Monuments and Sites.

ICOMOS. (1994). *Nara Document on Authenticity*. Japan: International Council on Monuments and Sites.

ICOMOS. (1999). *Charter on the Built Vernacular Heritage*. Mexico: International Council on Monuments and Sites.

Jacobs, J. (1993). *The Death and Life of Great American Cities.* New York: Random House.

Langston, C. (2010). Green Adaptive Reuse: Issues and Strategies for the Built Environment. *1st International Conference on Sustainable Construction & Risk Managment (ICSCRM 2010).* Chongqing Municipality, China.

Maghsoodi Tilaki, M., Abdullah, A., Bahauddin, A., & Marzbali, M. (2014). The Necessity of Increasing Livability for George Town World Heritage Site: An Analytical Review. *Modern Applied Science, 08*(01), 123-133.

Mahgoub, Y. (1999). Building Performance Evaluation. *An Integrative Framework for Architectural and Urban Design Projects Evaluation*. Lectured on 1st Arab Architecture/ Design Convention & Exposition, 24-27 October.

Oireachtas (2000). Planning and Development Act 2000 (Amended 2010). Ireland.

Poria, Y., & Ashworth, G. (2009). Heritage Tourism—Current Resource for Conflict. *Annals of Tourism Research, Vol. 36*(No. 3), pp. 522–525. Shackley, M. (2006). *Visitor management: Case Studies from World Heritage Sites.* Oxford: Butterworth-Heinemann.

Shackley, M. (2006). *Visitor management: Case Studies from World Heritage Sites.* Oxford: Butterworth-Heinemann.

Schneekloth, L. H., & Shibley, R. G. (1995). *Placemaking: The Art and Practice of Building Communities.* New York: Wiley.

Schon, D. (1983). *The reflective practitioner.* San Francisco: Jossey Bass.

Sean Harrington Architects. (2014). *Pallete Theatre*. Retrieved April 25, 2014, from Sean Harrington Architects: http://www.sha.ie/portfolio/pallet-theatre/

Sodangi, M., Khamidi, M., & Idrus, A. (2013). Towards Sustainable Heritage Building Conservation in Malaysia Mahmoud. *Journal of Applied Sciences & Environmental Sustainability*, 54-61.

Sulaiman, R., Kamaruzzaman, S. N., Rao, S. P., & Pitt, M. (2011). The Environmental Performance of Air Conditioning Systems in Heritage Buildings in Tropical Climates. *Journal of Surveying, Construction & Property, 02*(01), 93-106.

Surgenor, P. (2011, May). Reflective Practice. *Tutor, Demonstrator & Coordinator Development at UCD*. UCD Teaching and Learning/ Resources. Retrieved from UCD Teaching and Learning/ Resources: www.ucd.ie/teaching

Syed Mohamad, S., Akasah, Z., & Abdul Rahman, M. (2014). Factors Contributing to Building Maintenance Performance of Heritage Buildings. *InCIEC 2013* (pp. 851-860). Singapore: Springer Science+Business Media.

Syed Mustapa , S., Kamal, K., Zaidi, M., & Abd Wahab, L. (2007). Maintenance Approach of Historic Buildings in Malaysian Context. *Building Engineer*.

The Department of the Environment, Heritage and Local Government. (2010). Advice Series. *Energy Efficiency in Traditional Buildings*. Dublin, Ireland: The Stationary Office, Government of Ireland .

The Tara Foundation. (n.d.). *The Tara Foundation: Campaigning for Ireland's heritage, resources and human rights*. Retrieved April 07, 2014, from Grellan Rourke denies damage to Skellig Michael: http://thetarafoundation.wordpress.com/2008/07/06/grellan-rourke-denies-damage-to-skellig-michael/

UNESCO. (1999-2014). *Ireland - UNESCO World Heritage Centre*. (UNESCO World Heritage Centre) Retrieved 04 27, 2014, from http://whc.unesco.org/en/statesparties/IE/

Wallace , C., & Pichler, F. (2008). More Participation, Happier Society? A Comparative Study of Civil Society and the Quality of Life. *Social Indicators Research*.

Woodend, L. (2013). A Study into the Practice of Machizukuri (Community Building) in Japan.

Yahya , M., & Ibrahim, M. (2012). Building Maintenance Achievement in High Rise Commercial Building: A Study in Klang Valley, Malaysia. *OIDA International Journal of Sustainable Development*.

The Importance of Healthy and Sustainable Built Environments for Vulnerable Groups of Population

Bhzad Sidawi
Mohamed Taha Al-Hariri

ABSTRACT

Researchers worldwide have demonstrated the adverse impact of unsustainable and unhealthy built environment on citizens. In the case of diabetes, studies have concentrated on the environmental impact and accessibility issues of a place i.e. the home and neighbourhood, whereas very few studies have addressed the spatial arrangement of places and linked it with the prevalence of diabetes. Also, little research has tackled the place's impact on diabetic patients and their views concerning their neighbourhoods. This paper illustrates the outcomes of survey that was carried out on diabetic individuals in the eastern province, Kingdom of Saudi Arabia (KSA). The present researchers found significant links between patients' diabetes symptoms with the unsustainable and unhealthy conditions of their homes and neighbourhoods. The paper makes recommendations on how to improve the built environment in the KSA to be sustainable and healthier for all citizens including the diabetic patients.

Keywords: *Perception of place, unhealthy built environment, healthy principals, sustainable programs*

INTRODUCTION

The provision of a healthy built environment became increasingly under focus nowadays as profound links are found between a healthy built environment and healthy lifestyles. Several programs such as LEED (i.e. Leadership in Energy & Environmental Design, is a green building certification program), BREEAM (i.e. Building Research Establishment Environmental Assessment Methodology), and HIA (i.e. Health Impact Assessment) (LEED, 2009, BREEAM 2009, and WHO, 2013) have attempted to measure the effect of physical environment on environment and health and minimize the adverse impact of the built environment on people health. Consequently, the World Health Organization (WHO) set a number of healthy principals for planning of cities and towns and these are: healthy lifestyle, social cohesion, housing quality, access to employment and education opportunities, accessibility, local low-input food production, safety, equity, air quality and aesthetics, water sanitation and quality, quality of land and mineral resources, and climate stability (Barton and Tsourou, 2000).

The design of a sustainable and healthy built environment became increasingly important as it would provide healthy environment for citizens, support their sustainable activities and healthy lifestyles, promote healthy lifestyles and facilitate the social cohesion and offer smooth access to educational, cultural, leisure and retail facilities capable of sustaining urban development (Barton, Grant, and Guise, 2010; Barton and Grant, 2011, Sidawi and Al-Harriri, 2012, Sidawi, Deakin and Al-Harriri, 2014, Sidawi, Al-Harriri and Albaker, 2014). However, vulnerable individuals such these with chronic diseases are more sensitive to the built environment's conditions than normal and healthy individuals thus they have more chance to be affected by bad environment conditions.

Diabetes, for instance, is caused by a complex interaction between patient's genetics and environment factors. Barton, Grant, and Guise (2010) pointed out to the direct and indirect impact of the built environment on health. Among the indirect effects are the place i.e. Home and neighbourhood characteristics and the people's perception of their neighbourhoods. In the case of Kingdom of Saudi

Arabia (KSA), certain cultural, environmental, and urban constraints would affect health. The consideration of such factors, would not only tackle the catastrophic spread of "unhealthy lifestyles", and enable the built environment to contribute to the healthy lifestyles of diabetic patients in the KSA but also sustain the sustainable and healthy urban development of towns and cities in the KSA. The present researchers investigated the possible indirect built environment and spatial arrangement impacts on the health of diabetic individuals in the KSA. A survey has been carried out on a sample that consists of seventy six patients who usually visit the King Fahd teaching hospital of the University of Dammam, Al-Khober. The patients were surveyed and physically examined. The field study's results are discussed and linked with previous research studies.

THE DIABETES SYMPTOMS AND ITS' PREVALENCE IN THE KSA

Diabetes mellitus is the most common non-communicable disease worldwide and the fourth to fifth leading cause of death in developed countries. There are – in general- two types of diabetes. In Diabetes type I (T1DM), the person's own body has destroyed the insulin-producing beta cells in the pancreas. Although type II diabetes mellitus (T2DM) can be caused by genetic factors, an unhealthy lifestyle happens to be the main cause (Sidawi and Al-Hariri, 2012). A person with T2DM has one of two problems, and occasionally both: a) not enough insulin is being produced; and b) the insulin is not working properly. The direct symptoms of diabetes, such as thirst, frequent tingling sensation, frequent urination and fatigue, can be mild and may cause little interruption to activities of daily living, it is the complications of the disease, including blindness in adults (Jeppesen & Bek, 2004) non-traumatic lower-limb amputation (Chaturvedi, Stevens, Fuller, Lee, & Lu, 2001) and kidney failure that result in transplantation and dialysis (Atkins, 2005). Furthermore, the risk of coronary heart disease is two to four times higher in diabetic patients. The risk of stroke or peripheral vascular disease also increases strongly.

The Kingdom of Saudi Arabia has one of the highest percentages of diabetes in the world, with an estimated number of 3,414,510 people diagnosed with the disease in 2012, which is 23.38% of the population (International Diabetes Federation, 2012). Little research though was conducted in the KSA with regard to the effect of the unhealthy built environment on diabetic patients whereas it is evident that urbanism and poor built environment conditions in the KSA (Khodeir et al. 2012) have promoted unhealthy lifestyles and aggravated diabetes (Sidawi and Al-Hariri, 2012, Sidawi, Al-Harriri and Albaker, 2014, Sidawi, Deakin and Al-Harriri, 2014).

THE IMPACT OF BUILT ENVIRONMENT ON HEALTH

Barton, Grant, and Guise (2010) have classified the impact of the built environment on health into two categories: direct and indirect. Direct impacts include those traditionally associated with: a) planning and b) environmental health, e.g. air quality (indoor and outdoor), climate, water quantity and quality, noise and traffic-related injuries (Sustainable Development Commission, 2008). Indirect impacts include how the characteristics and design of the built environment influence the determinants of health, in particular perceptions of the local area, social connections and physical activity, which in turn are associated with physical and mental health and well-being (Barton, Grant, &, Guise 2010).

THE INDIRECT IMPACTS OF BUILT ENVIRONMENT

Home and neighbourhood characteristics

This section discusses the characteristics of a home and neighbourhood, and how it promotes social connections, accessibility, physical activity, and whether it creates positive perception for the residents in their neighbourhood. It is well known that the influences of interactions between the level of activity and psychosocial wellbeing and stress in the pathogenesis of T2DM.1 (Sridhar, Venkata, and Lakshmi, 2010). Additionally, genome-wide association studies have identified the complex interplay between genes and the environmental factors that may change in genes expression making the genes

potentially important pathogenic mechanisms in Diabetes and its consequences (Jirtle and Skinner, 2007).

At home level, a US study has looked at many risk factors for diabetes including physical characteristics and personal habits (e.g. weight, smoking, exercise, and alcohol use), marital status, education and housing conditions. The study rated the houses on the following basis: cleanliness inside of the building, the physical condition of the building's interior and exterior, and the condition of the furnishings in the building. The researchers tested the impact of housing conditions and used physical attributes and habits as mediators and they found that housing conditions still influence diabetes risk and contribute to the development of diabetes (Schootman, Andresen, Wolinsky, 2006). For instance, dampness in buildings would critically affect health and a study found that damp housing is often associated with poor maintenance of the dwelling and socio-economic disadvantage of the occupants (Environmental Epidemiology Unit, 1999). There is a growing body of literature suggest that the progression of the Diabetes and its complications resulting in part from poor lifestyle habits such as lack of physical activity, which are in turn affected by built environment factors (Sudhir, Appa and Sridhar, 2010). Poorer health status in socioeconomically deprived and rural environments may reflect, in part, the inaccessibility of built environmental features such as public pools, recreation centres, physical fitness utilities, parks, sidewalks, and streetlights (Goldberg et al., 2000).

Allanah, Ashley and Farley (2010) stated that an ill designed urban setting would enforce people to adopt an unhealthy lifestyle thus contribute to the development of T2DM. Eckel et al. (2004) have linked passive entertainment and a lack of physical activity with the increasing incidence of the diabetes. Physical activity has been found to reduce the symptoms of coronary heart disease and strokes associated with T2DM (Frumkin, Frank and Jackson, 2004). The decline in local facilities, the reduction in pedestrian movement and neighbourly street life all reduce opportunities for the supportive social contact so vital for mental well-being (Barton, Grant, &, Guise, 2006). The absence of facilities, barriers to facilities (such as steep hills, busy roads to cross) or the perception that facilities are inadequate have negative associations with physical activity (Humpel, Owen, Leslie, 2002). So, neighbourhood design that promote social networks are those which have mixed use and pedestrian oriented, with public spaces, such as parks, that can act as places for socializing (Greenspace Scotland, 2008). Those living in more "walkable" neighbourhoods, characterized by high population density, mixed land use and high levels of connectivity (e.g. good pedestrian and cycling facilities) have been found to be more physically active (Pikora, Giles-Corti, Knuiman et al. 2005, Duncan, Spence, and Mummery, 2005).

The neighbourhood characteristics in Saudi Arabia

There are a number of housing arrangements in KSA such as: gated compounds; terraced housing, villas, blocks of flats, or mixed development. The gated compounds are usually well fenced and guarded and have facilities that are different in number and quality according to the compound class i.e. middle, upper, rich and very rich. Facilities in gated compounds can be only used by the compound's residents and their guests. Some of the compounds have a lack in facilities such as: café shops, restaurants, laundries, bank branches, gardens etc., so the residents have to travel by car to get their daily/ weekly needs from the district's centres or shopping malls. Each of the above mentioned spatial arrangements would have a unique effect on the occupant's health and well-being. Residential districts in KSA can be also classified in accordance to the social class. The facilities, finishing quality, level of furnishing and cleanliness varies from one district to another. These suffer from irregular location of the amenities such as; gardens, parks, leisure and recreation within the neighbourhoods, quarters, and districts (Choguill, 2008).

In Jeddah, problems of poor quality public spaces within modern residential areas seem to beset the public realm (Manadeli, 2010). Alshuwaikhat and Aina (2006) conducted a study in AL Dhahran, KSA and found that there is low level of access to open spaces by people (i.e. percentage of population) comparing with the standards. Also, there is lower percentage of total land dedicated to open space than standard (ibid). Aleid and Alseef (2010) revealed a lack of recreational

places/facilities and public parks, particularly kids' playgrounds. Citizens in Alkhober are also not satisfied about the public facilities. They highlighted the absence of green areas, lack of safety, lack of entertainment facilities for children, the absence of shaded public spaces and recreational facilities, and lack of hygiene and cleanness (Alshuaibi, 2012). With respect to the built environment and individuals' habits in KSA, the following issues are noticed:

- *rapid growth of Saudi cities and the absences of healthy and sustainable planning code*
- *the extreme hot, dry inland and humid weather in coastal cities create environmental conditions that affect the type and timing of people's activities. Thus, Saudis tend to engage in unhealthy activities: such as irregular sleeping patterns (e.g. afternoon nap, sleeping late), evening or late night trips to local malls and shopping arcades or sitting in coffee shops, late night's heavy meals. These activities replace outdoor activities, such as children's playgrounds and walking children to school (Choguill, 2008);*
- *in major cities across the KSA, it was found that the majority of Saudi adolescents spent more than 2 hours watching TV, and around half of them do not meet the daily physical activity requirements (Al-Hazzaa et al., 2011)*
- *poor living conditions add to these problems and adversely affect the health of all citizens, particularly those with diabetes (Allanah, 2012, Sidawi and Al-Hariri, 2012, Sidawi, Deakin and Al-Harriri, 2014). Such living conditions make it difficult for diabetics to enjoy walking around their neighbourhoods due to the extreme hot, dry and humid weather conditions and high level of air pollution within cities (Sidawi et al. 2011 and Sidawi, 2012);*
- *certain cultural issues should also be taken into consideration when exploring the relationship between diabetics and living conditions such as the segregation between men and women and restricted rules regarding women clothing and their mobility, social relationships within the Saudi families and tribes and socio-economic disadvantage for poor (Sidawi, 2013& 2014).*

Perceptions of Place and Health

Perception of place problems refers to aspects people say they dislike about their local area when interviewed in general health surveys (NICE, 2007). Such problems have been considered in relationship to health (Parkes & Kearns, 2005, Stafford & Marmot, 2003). Some problems can be labelled as physical or environmental when they relate to the presence of noise, dense traffic, dirt, odours, fumes or various signs of deterioration in the built environment such as abandoned buildings, trash, litter, graffiti and vacant housing (NICE, 2007). Other problems refer to the absence of basic infrastructure, facilities and amenities in the neighbourhood (ibid). Studies have consistently found evidence of a relationship between neighbourhood environment (both perceptions and more objective measures) and self-reported health (Curtice, Ellaway and Robertson et al. 2005, Wilson, Elliot and Law et al. 2006). For example, people who perceive their neighbourhoods to be hostile, dirty, poorly maintained, and lacking in safe places to play, are more likely to experience anxiety, depression, and poor health (Curtice, Ellaway and Robertson et al., 2005). On the other hand, high self-efficacy, perceptions of good quality facilities in the area and high levels of neighbourliness were independently associated with good self-rated health and physical functioning. Perceptions of problems in the area were also predictive of poorer health (NICE, 2007). The perception of problems in the neighbourhood is negatively associated with several health outcomes such and health behaviours (NICE, 2007). Such perceptions might influence people's health through various pathways (Kawachi & Berkman, 2003). Perceived environmental problems, such as air or water pollution would affect physiological pathways, whereas perceived problems and social cohesion may influence health through psychosocial and physiological pathways (Latkin & Curry, 2003). So, perceived problems in the neighbourhood, such as noise and dense traffic are considered as chronic stressors heightening the level of anxiety, insecurity and fear among residents. Perceived local environments might influence health through behavioural pathways such as smoking, diet and physical activities.

HEALTHY BUILT ENVIRONMENT AND HEALTHY LIFESTYLE

WHO has emphasized on the importance of planning healthy built environments (Barton and Tsourou, 2000). The built environment should be designed to be sustainable and promote healthy lifestyles, facilitate social cohesion and offer access to educational, cultural, leisure and retail facilities capable of sustaining urban development (Curwell and Deakin 2002, Barton, Grant, and Guise, 2010, Barton and Grant, 2011). Jackson and Kochtitzky (2001) advocated providing neighbourhood opportunities for walking to accomplish routine activities such as shopping, going to work and exercise. Green areas should be carefully located, designed and integrated with the neighbourhood in order to be pleasant in appearance, encourage walking and improve health. Landscape architecture appears to be the primary key at the finest scale to sound mind and body, and simply viewing nature reduces the stress of daily urban life (Jackson, 2011). In addition, urban green space does more than offer opportunities for physical activity; it offers opportunities for engagement with, and observation of, nature, as well as opportunities for social interaction, thus enhancing individuals' sense of well-being (Greenspace Scotland, 2008). Accessibility for all types of users to all facilities and services is a must. Visual landmarks and logical transit pathways assist people, particularly the elderly, in reaching their destinations. Psychologically, the above-mentioned elements provide a sense of ease and comfort. On a neighbourhood, urban or city level, urban planning should promote walking, the use of public transport, minimizing the number of vehicles on roads, providing well (cross) ventilated and shaded urban areas in hot climate countries. It also reduces the pollution and noise levels and would provide thermally comfortable urban areas.

THE RESEARCH OBJECTIVES AND METHODOLOGY

The research aim is to examine the effect of the built environment on diabetic individuals within the context of The Eastern province, Kingdom of Saudi Arabia. Therefore, the researchers have set a number of objectives and these are:

- *To find out the relation between the disease's symptoms and resulted medical investigations of patients with the characteristics of their residence;*
- *To find out possible links between the disease's symptoms and medical investigations of patients with their perception of the neighbourhoods*

Consent to carry out the study was first obtained from the University of Dammam's ethics committee. The fieldwork began in January 2013. The study's sample constituted of diabetic patients who usually visit the diabetic clinic at the King Fahd teaching hospital of the University of Dammam, Al-Khobar. This list of patients includes T1 and 2DM male and female adults, age 15-70 years and resident in the Eastern province, KSA. Seventy six patients have participated in the study. These patients were handed a questionnaire form to fill in, and physical exams of patients' health statuses were carried out. The questionnaire includes questions on the characteristics of their home and neighbourhood, the patients' lifestyles and activities since the onset of the disease, their perception of the environmental conditions of the home, work and neighbourhood, and self-reported health conditions since the onset of the disease. All patients have filled in the questionnaire and returned it. The patients were physically examined. The exams include; a blood pressure test and Body Mass Index (BMI). The medical test results such as the fasting blood glucose, HBA1C, urine albumin, and lipid profile, were extracted from the patients' medical files.

DISCUSSION OF THE RESULTS

Many previous researchers have pointed out to the pathways through which the unsustainable and unhealthy built environment would impact health. This is true for diabetic patients who suffer from indoor and outdoor conditions (see for instance Schootman, Andresen and Wolinsky, 2006). Such conditions would force people to adopt unhealthy lifestyles, and contribute not only to the development of diabetes T2DM but to the deterioration of the health status of T1DM patients (see also

Allanah, Ashley and Farley, 2010, Eckel et al., 2004, Jirtle and Skinner, 2007, Sidawi, Deakin and Al-Harriri, 2014).

In this paper the present researchers examined the adverse impact of the built environment on health of specific population that is the diabetic individuals in the KSA. The study showed that the progress of the disease is caused by unhealthy built environment in the KSA (see also Khodeir et al. 2012, Sidawi and Hariri, 2012, and Sidawi, Deakin and Al-Harriri, 2014). This is represented by high pollution levels, and irregularity of spatial configuration/ arrangement of public facilities and the lack of the public facilities as well. The irregular settings of urban services would promote unhealthy lifestyles as around half of the respondents never or rarely do any recreational activities, morning sport exercises or participate in social activities (see also Barton, Grant, and Guise, 2006, and Humpel, Owen, Leslie, 2002). In regards to the dietary habits, around half of the respondents admitted bad habits related to drinking fizzy drinks or eating junk food meals, watching TV or working in the office for long hours.

In regards to the environmental conditions, the patients suffered from various home or neighbourhood's environmental conditions such as unpleasant outside views, noise from neighbours, traffic noise etc. Also, patients said they suffer mostly from extreme fatigue/ tiredness, tension/ stress, blurred vision, and an inability to control their nerves. The study found significant links between the environmental conditions at home and in the neighbourhoods with the frequency of disease symptoms whereas bad environmental conditions are associated with higher frequency of self-reported symptoms (see also Schootman, Andresen and Wolinsky 2006). The home conditions have links with the medical investigations results whereas uncomfortable home conditions from environmental, social and psychological perspectives have a bad effect on diabetic individuals and causes higher levels of LDL, TG and poorer HDL. Respondents who live in poor areas suffer more from the poor environmental conditions at home and in their neighbourhoods and subsequently they suffer more from a number of diabetes manifestations such as: Paraesthesia, Blurred vision, and stress (also see Barton, Grant, and Guise, 2010 for health& poor environment correlations).

CONCLUSION AND RECOMMENDATIONS

With regards to this research findings and previous research, the present researchers would suggest that fundamental changes should be carried out in the Saudi built environment to promote physical activity, improve psychological and physiological conditions not only of normal citizens but also for vulnerable groups of population such as diabetic individuals. However, a number of issues should be considered in any future planning of cities. Amongst of these, is the Islamic lifestyle and practices; and the Saudi culture. Also, one should consider the have unique social, cultural, environmental and economic characteristics of Saudi cities. The fabric of these cities is rapidly changing due to the urban sprawl on macro level, neighbourhoods' level, and micro level (i.e. homes level). There are also on-going and rapid negative environmental changes due to the increased levels of pollution and desertification in the KSA and the global warming at national, regional and global level. Therefore, the present sustainability programs and Health Assessment tools should be developed further into a robust assessment framework that addresses and measures the relationship between people's activities and the built environment (i.e. indoor, outdoor, and interlink relationship between them). Such framework should be incorporated into the planning and decision making process so it would help improving the existing neighbourhoods and designing new healthy neighbourhoods and cities.

ACKNOWLEDGEMENT

The researchers would like to thank the University of Dammam (UoD), deanship of scientific research for funding this research study under the research project number 2012107.

REFERENCES

Allanah, Li; Ashley, K., and Farley, E. (2012). Diabetes and the built environment: Contributions from an emerging interdisciplinary research programme, *UWOMJ*, 79:1, pages 20-22

Aleid, I and Alseef, S. (2010). The application of GIS in planning public services in Alriyadh. *The 10th National GIS Symposium in Saudi Arabia*, Dammam, 2014.

Alshuaibi. M. M. (2012). Retrieving of the city centres: A case study of the Prince Bander Bin Abdullazziz street, Alkhober (Alsuwaikit). Msc thesis.

Alshuwaikhat Habib M. & Aina Yusuf A. 2006. GIS-based urban sustainability assessment: The case of Dammam city, Saudi Arabia, *King Fahd University of Petroleum & Minerals Journal*, Dhahran, Saudi Arabia.

Al-Hazzaa, H. M., Abahussain, N. A., Al-Sobayel, H. I., Qahwaji, D. M., & Musaiger, A. O. (2011). Physical activity, sedentary behaviors and dietary habits among Saudi adolescents relative to age, gender and region. International Journal of Behavioral Nutrition and Physical Activity, 8, 140. http://dx.doi.org/10.1186/1479-5868-8-140

Atkins R. (2005). The epidemiology of chronic kidney disease. *Review, Kidney Int. Suppl.* 94 (Apr), S14–S18.

Barton, H., Grant, M. and Guise, R. (2006), *Shaping neighbourhoods a guide for health, sustainability and vitality*. Taylor & Francis, USA.

Barton, H., Grant, M. and Guise, R. (2010). *Shaping Neighbourhoods for local health and global sustainability*, Routledge, London.

Barton, H. and Grant, M. (2011). Urban planning for healthy cities: A review of the progress of the European Healthy Cities Programme, *Journal of Urban Health, Bulletin of the New York Academy of Medicine,*
http://dx.doi.org/10.1007/s11524-011-9649-3

Barton, H. and Tsourou, C. (2000). *Healthy urban planning,* Spon Press on behalf of WHO Regional Office for Europe, London, 2000.

BREEAM. (2009). BREEAM for Communities: Stage 2. SD5065 Technical Guidance Manual: Version 1, BREEAM for Communities Assessor Manual: Development Planning Application Stage.

Chaturvedi, N., Stevens, L. K., Fuller J. H., Lee, E. T., Lu M. (2001). Risk factors, ethnic differences and mortality associated with lower-extremity gangrene and amputation in diabetes: The WHO Multinational Study of Vascular Disease in Diabetes, *Diabetologia*, 44, 65–71.

Choguill, C. L. (2008). Developing sustainable neighbourhoods. *Habitat International*, 32, 41–48.

Curtice, J., Ellaway, A., Robertson, C, *et al*. (2005). *Public Attitudes and Environmental Justice in Scotland.* Scottish Executive Social Research,

Curwell, S. and Deakin, M. (2002). Sustainable urban development and BEQUEST, *Building Information and Research*, Vol. 30, No. 2.

Duncan, M., Spence, J., Mummery, W. (2005). Perceived environment and physical activity: a meta-analysis of selected environmental characteristics, *International Journal of Behavioural Nutrition and Physical Activity*, 2005, 2 (11): DOI: 1186/1479-5868-2-11

Eckel, R. H. , York, D. A. , Rössner, S., et al. (2004). Obesity, a Worldwide Epidemic Related to Heart Disease and Stroke: Executive Summary: AHA Conference Proceedings Prevention Conference VII, *Circulation*, 110:2968-2975

Environmental Epidemiology Unit. (1999). *Rapid Reviews of Public Health for London: Housing and the Built Environment*. London: London School of Hygiene and Tropical Medicine.

Frumkin, H., Frank, L., and Jackson, R.(2004). *Urban Sprawl and Public Health: Designing, Planning and Building for Healthy Communities,* Island Press, Washington.

Greenspace Scotland.(2008). *HIA of Green space: A Guide*. Greenspace Scotland, Stirling.

Goldberg, M. S., Bailar, III J. C., Burnett, R. T., Brook. J. R., Tamblyn. R., & Bonvalot, Y. (2000). Identifying subgroups of the general population that may be susceptible to short-term increases in particulate air pollution: A time series study in Montreal, Quebec. *Res. Rep. Health Effects Inst.*, 97, 7-113.

Humpel, N., Owen, N., Leslie, E. (2002). Environmental factors associated with adults' participation in physical activity: a review. *American Journal of Preventative Medicine*, 22(3):188-199.

International Diabetes federation. *IDF DIABETES ATLAS*, (2012) http://www.idf.org/sites/default/files/5E_IDFAtlasPoster_2012_EN.pdf

Jackson, R.J., Kochtitzky, C. Creating a Healthy Environment: The Impact of the Built Environment on Public Health. Sprawl Watch Clearinghouse, Washington, DC, 2001.

Jackson, R. J. 2011. What Olmstead [sic] Knew. Western City. [http://www.westerncity.com/Mar01Olmstead.htm]

Jeppesen, P., and Bek, T. (2004). The occurrence and causes of registered blindness in diabetes patients in Arhus County, Denmark , *Acta Ophthalmol. Scand.*, 82 (5), 526–530.

Jirtle RL, Skinner MK. (2007). Environmental epigenomics and disease susceptibility. *Nat Rev Genet*, 8: 253–262

Kawachi, I., & Berkman, L. Introduction. In I. Kawachi, & L. F. Berkman (Eds.). (2003). *Neighborhoods and health* (pp. 1–19). New York: Oxford University Press

Khodeir, M., Magdy, S., Mansour, A., Mianhua, Z. ,Hong, S., Max, C., Lung-Chi C., Polina M. (2012). Source apportionment and elemental composition of PM2.5 and PM10 in Jeddah City, Saudi Arabia, *Atmospheric Pollution Research*, 3 331-340

Latkin, C. A., & Curry, A. D. Stressful neighborhoods and depression: A prospective study of the impact of neighborhood disorder. *Journal of Health and Social Behavior*, 2003, 44, 34–44.

LEED. (2009). LEED 2009 for Neighborhood Development Rating System. U.S. Green building council.

NICE. (2007). *Assessing people's perceptions of their neighborhood and community involvement* (Part 1), 2007, http://www.nice.org.uk/nicemedia/documents/peoplesperceptions.pdf

Parkes, A., & Kearns, A. (2001). The multi-dimensional neighbourhood and health: A cross-sectional analysis of the Scottish Household Survey, *Health & Place*, 12 (1). pp. 1-18

Pikora, T., Giles-Corti, B., Knuiman, M. *et al*. (2005). Neighbourhood environmental factors correlated with walking near home: using SPACES , *Medicine and Science in Sports and Exercise*, 38(4): 708-14.

Schootman, M., Andresen, E.M., Wolinsky, F.D., Malmstrom, T.K., Miller, J.P., & Miller, D.K. (2006). Neighborhood conditions and risk of incident lower-body functional limitations among middle-aged African Americans. *American Journal of Epidemiology*, 163(5), 450-8.

Sidawi B. and Meeran S. (2011). A framework for providing lifelong finance to the owners of affordable dwellings in the Kingdom of Saudi Arabia , *Cities*, Volume 28, Pages 138-146.

Sidawi, B., Al-Hariri M. T. A. (2012). The Impact of Built Environment on Diabetic Patients: The Case of Eastern Province, Kingdom of Saudi Arabia , *Global Journal of Health Science*, 2012, Vol 4, No 4, pp 126-138.

Sidawi, B. (2012). The clients' satisfaction with property-related financing by banks and Real Estate Development Fund (REDF) , *IAHS XXXVIII World Congress on Housing, Visions for the Future of Housing Mega Cities*, edited by Ural, O., Şahin M., and Ural, D., April 16-19, 2012, Istanbul, Turkey, Pages 1207-1213.

Sidawi, B. (2013). The financial support of ongoing socio-economic needs of citizens: the case of Kingdom of Saudi Arabia. *International Journal of the Built Environment and Asset Management (IJBEAM), 2013*, Vol. 1, No.2, pp. 106 - 120

Sidawi, B., Al-Harriri, M. T., Albaker, W. I. (2014). Creating a healthy built environment for diabetic patients: the case study of the Eastern province of the Kingdom of Saudi Arabia. *Global Journal of Health Science*; Vol. 6, No. 4; pp 136-147.

Sidawi, B., Deakin, M. and Al-Harriri M. (2014). The place-based impact of built environments: Diabetes, living conditions, homes and neighbourhoods. *Indoor and Built Environment*. October 29, 2014.

Sidawi, B. (2014). An Evaluation of the performance of the housing finance system in the Kingdom of Saudi Arabia – from the perspective of low and middle income consumers. *International Journal of Housing Markets and Analysis*, Emerald, UK, V7, issue 2, pp.156 - 174

Sridhar GR, Venkata P, Lakshmi G. (2010). Time trends in the prevalence of diabetes mellitus: ten year analysis from Southern India (1994–2004) on 19,072 subjects with diabetes. *J Assoc Physicians India.*, 58:290–4.

Stafford, M., & Marmot, M. (2003). Neighbourhood deprivation and health: Does it affect us equally? International *Journal of Epidemiology*, 32, 357–366.

Sudhir Kumar, P., Appa Rao, A., & Sridhar, G. R. (2010). Built environment and diabetes. Intl J Diab. Dev.

Countries, 30, 63-8.Sustainable Development Commission. (2008). *Health, place and nature: How outdoor environments influence health and well-being: a knowledge base*. London,

Wilson, K., Elliot, S., Law, M., *et al*. (2006). Linking perceptions of neighbourhoods to health in Hamiton, Canada. *Journal of Epidemiology and Community Health, 58: 192-198.*

WHO. (2013). Health Impact Assessment (HIA). http://www.who.int/hia/about/en/

Implementing The Last Planner™ System in a Road Construction Project in Nigeria

Ograbe Ahiakwo[1]; David Oloke[2]; Subashini Suresh[3] and Jamal Khatib[4]
[1]BTech, MSc, PhD Student in Built Environment, School of Technology, University of Wolverhampton, Wulfruna Str. Wolverhampton WV1 1LY United Kingdom
[2]BEng, MSc, PhD, Snr. Consultant-Built Environment, School of Technology, University of Wolverhampton, Wulfruna Str. Wolverhampton WV1 1LY, United Kingdom
[3]BEng, MEng, PhD, Principal Lecturer, School of Technology, University of Wolverhampton, Wulfruna Str. Wolverhampton WV1 1LY, United Kingdom
[4]BEng, MEng, PhD, Professor in Civil Engineering Material, Built Environment, University of Wolverhampton, School of Technology, Wulfruna Street, WV1 1LY, United Kingdom
ograbe.ahiakwo@wlv.ac.uk; d.a.oloke@wlv.ac.uk; s.subashini@wlv.ac.uk; j.m.khatib@wlv.ac.uk

ABSTRACT

This paper describes a research investigation into the implementation of the Last Planner System (LPS) in a road construction project. LPS is known to be the most developed practical use of Lean Construction. It focuses on minimising the negative impacts of variability, uncertainties, buffers, making projects more predictable, creating reliable work plans and convalescing collaborative planning. LPS is unpopular in highway and road construction projects, as a lot of case studies have been recorded of its application on infrastructure and building projects as against highway and road projects. However in the road project. In order to achieve this aim, an Action Research strategy is adopted using different data collection methods such as interviews, observation and survey questionnaire. The initial state of production plan reliability within this case project was observed to be highly unreliable with a high degree of variability. However as the implementation commenced, production plans were stabilized with an improved reliability in the schedules. The results from this study demonstrate that although a road construction process is a linear process, a number of benefits were still recorded in terms of improving construction planning and control processes, during the implementation.

Keywords: *Action research, Last Planner System, Lean construction, Planning, Road construction.*

INTRODUCTION

Nigeria ranks tops compared with other countries in Sub-Saharan Africa in terms of road network infrastructure with an estimated road network of 200,000 km connecting different villages to cities (FME 2013). However, the highway industry in Nigeria suffers from many problems and most of these problems can be practically linked to the construction culture within the industry.

This construction culture at the project level is often associated with such attributes as fragmentation, antagonism, mistrust, poor communication, short-term mentality and blame culture (Odeh and Battaineh, 2002; Oke and Ogunsemi, 2011). As a result, the entire construction industry is

overwhelmed by poor quality work, cost and time overruns resulting from poor project definitions during planning; inadequate planning; inadequate funds; inflation; bankruptcy of contractor; variation of project scope; political factors; death of client; incompetent project manager; wrong estimate; inadequate cost control unethical behaviours in the form of fraudulent practices and kickbacks (Mansfield *et al.,* 1994; Olomolaiye *et al.,* 1987; Oyewobi *et al.,* 2011; Olusegun and Michael 2011, Oke and Ogunsemi, 2011).

These attributes all affect the quality work of work produced, the final cost of executing the project and the time spent in carrying out the project (Aibinu and Jagboro, 2002; Odeh and Battaineh, 2002). Furthermore, Ankara (2007) looked at different cultural orientations in relation to project performances. It was revealed that dimensions of culture were found to be significantly associated with project performance outcomes.

Conversely, Mossman (2012) proposed that Lean Construction using the Last Planner System influences construction culture by encouraging collaboration, transparency, trust, reliability of scheduling and delivery of value while, consuming the fewest resources. Henceforth, overcoming natural cultural issues of poor quality work and overruns in time and cost.

THE LAST PLANNER SYSTEM

The Last Planner System (LPS) has been argued to be the most developed practical use of lean construction (Thomas *et al.,* 2003), and it is a trademark of the Lean Construction Institute (Kalsaas, 2012). Lean Construction on the other hand is a construction production management, philosophy that arose from the recognition of the limitations of the traditional project management philosophies while applying Lean Production to the construction industry (Howell, 1999). It focuses on improving production flow with a goal of better meeting customer needs while using fewer resources and maximizing value (Gonzalez *et al.,* 2010, Ballard 1999, Howell 1999, Koskela 1992).

The general idea behind the Last Planner™ System (LPS) of Production Control originates from the need to collaboratively manage program co-ordination, so as to increase work flow and work plan predictability (Ballard, 1993; Ballard, 1997; Ballard, 2000; Ballard and Howell, 2003). It operates with buffers in the form of 'workable backlogs' that level the workflow by buffering against unpredicted plan variation. The basic function of LPS thus is to make projects more predictable, minimising buffers, learning from plan failures, reducing uncertainties, creating reliable work plans, decreasing workflow variability and improving collaborative planning, (Ballard, 2000; Ballard *et al.,* 2009, Gonzalez *et al.,* 2010, Mossman, 2013).

The Last Planner allows planners to produce a record of "what *can* be done", from which workers choose tasks – "what *will* be done", while a procedure of system appraisal allows a review of "what *was* done", whereas all the time steps are taken to shield tasks from the effects of dependences with other tasks (Ballard, 2000; Ballard *et al.,* 2007, Ballard *et al.,* 2009). In a nutshell it develops a work plan using 'should-can-will' analysis (Ballard, 2000). The 'should' shows all the work to be carried out, but in most cases restrains arise which limit the work that 'can' be done. Then LPS works in such a way that it makes a commitment to the work that 'will' be done. The PPC calculates the ratio of tasks 'did' to the task that 'will' be done. A low PPC shows poor planning and the reasons for poor results are investigated to promote better planning (Ballard 2000; Ballard and Howell 2003; Salem *et al.,* 2005)

Generally LPS involves five levels of planning: (1) The Master Schedule, (2) Phase Schedule, (3) Look-ahead planning, (4) Weekly work plans and (5) Percentage Plans Completed (PPC). Details of these are explained as sighted in Koskela *et al*., (2010) Tommelein and Ballard, (1997); Ballard and Howell, (2004); Ballard, (1997); Hamzeh *et al.,* (2008), however a summary of their description is shown below.

The Master Schedule

This is generally referred to as the master plan, and it is the first phase of the production planning system (Hamzeh *et al*., 2008). Here the objective is to provide an overall view of the project, and to analyse feasibility of project completion (Tommelein and Ballard, 1997). The aim is to bring all the major actors together early in the process, so that critical interdependencies can be discussed, assumptions tested, with a collaborative creation of an agreement to the production sequence and best practice for the entire project (Alsehaimi, 2011).

Phase Schedule

This entails phase planning i.e. breaking the entire master plans into phases and planning based on those phases. This is achieved by using reverse-phase scheduling – i.e. working backwards from the desired delivery dates; tasks are scheduled in reverse order, allowing them to be performed at the last responsible moment, thus minimising unnecessary accumulation of work in progress (Ahiakwo *et al.*, 2014). Phase scheduling involves developing more detailed work plans and providing goals that can be considered targets to the project team. It basically entails a face to face conversation that establishes context, define the milestone deliverable, develops an execution strategy, identifies tasks and organises them in a pull plan working from the end of the phase back (Patel, 2011).

Look-ahead planning

Look-ahead planning breaks activities down into the level of processes/operations, identifies constraints, assigns responsibilities, and makes tasks ready by removing constraints (Hamzeh and Bergstrom, 2010). They also make tasks ready so that they can be done when the right time comes. Look-ahead planning states the preconditions that must be evaluated by breaking down activities into the level of processes/operations, so that possible constraints are identified, responsibilities are assigned, and assignments are made, while frantic efforts are made to remove the constraints (Hamzeh, 2011). Any tasks whose constraints have been removed are put on a list called the 'workable backlog'. They are usually the outcomes of mid-term planning by showing activities at the level of processes and operations (Ballard, 1997).

Weekly work plans

Weekly work planning develops the look-ahead plan into a weekly work plan by presenting activities in the most detailed level required to drive the production process (Hamzeh and Bergstrom, 2010). Consequently, they contain only tasks that are ready to be performed after thel constraints associated with performing the planned task has been removed (Patel, 2011).

Percentage Plans Completed (PPC)

PPC is a measure of the proportion of promises made that are delivered on time and it is calculated in percentage as the number of completed planned activities divided by the total number of planned activities (Ballard, 1997). The aim of PPC is to learn about planning failures and to measures whether the planning system is able to reliably anticipate what will actually be done (Patel, 2011)

The Last Planner System has been predominantly implemented in building and infrastructure projects, with only few case studies recorded for road and highway construction. This is because the planning and management of road construction generally involved the use of Linear Scheduling Method (LSM) (Trofin 2004). LSM was developed mainly for scheduling repetitive linear construction projects, such as roadways, pipelines and rail construction (Song *et al*, 2008). These activities are usually positioned in a time and space format, along with the production rates for the

activities and it integrates the schedule in the form of the slope of the lines that represent them (Javkhedkar 2006).

LSM in comparison with LPS involves an accurate representation of the inherent space time relationships of the activities (Javkhedkar 2006). In LSM, repetitive activities are represented as the same line segments (Trofin 2004). Furthermore, LSM provides a basis for superintendents and foremen to either schedule their work using computers or using pencil and paper as it assists in analysing the overall impacts of the detail assignments on a weekly schedule (Javkhedkar 2006). In addition, Yamin and Harmelink (2001) stated that LSM offers an intuitive visual representation of the sequence in which the activities will perform, as well as the location they will occupy at specific times.

However, Javkhedkar (2006) and Song *et al*, (2008) integrated LSM and LPS in linear construction projects as shown Table 1.0.

Table 1: Integration of LPS and LSM (Javkhedkar 2006; Song et al, 2008)

Last Planner System	Linear Scheduling Method
Should/can analysis	LSM time/space buffer
Work continuity	Activity continuity
Pull driven scheduling	Easily represent pulling of activities
Involvement of many levels of participants in developing schedules	Easy to add/delete assignments by different users

Nevertheless, this research entails the implementation of LPS on a road construction project in Nigeria. Road infrastructure has been identified to form a major factor for economic growth and development in Nigeria (Onolememen, 2012). Willoughby (2004) identified the relationship between transport and economic development. Here Willoughby (2004) advocates that socioeconomic development of any nation can be catalyzed by the presence of infrastructure especially roads transportation.

In Nigeria, the estimated at 200,000km within the country represents the principal means for freight and passenger movements across the entire country. The Road transport accounts for nearly 95% of all modes of transport and is estimated at N200 Billion (Approx £800 Million), growing at 10% per annum compared with other developed economies such as South Africa, UK and US (FMW, 2013)

THE CASE PROJECT

The project entailed constructing a 4-Kilometer standard single carriageway road with sidewalks on both sides of the road and an 80 meters span bridge over river Ebeku to link up with an existing road. The pavement was proposed to have a total thickness of 450mm consisting of 150mm lateritic sub base; 150mm crushed stone base and 100mm asphaltic concrete and 50mm wearing course. The project involved both the construction of an access road and a bridge (as already pointed out). The road segment entailed pre-fill surveys, clearing, fillings, compaction and scarification, priming and asphalting. While the bridge section entailed retaining walls, abutments, erosion control works and pilings.

The project was a unique one, and this was as a result of the existing terrain of the area. The terrain was gently sloping or near flat and it was typical of the Niger Delta environment. The vegetation along and around the project was the coastal type of thick evergreen tropical rain forest, comprising of palm trees, coastal grasses, cassava farmlands etc. Geologically, the entire road alignment lies within the 'Back Swamp' of the coastal plain sand of the Benin geological formation. Benin formation is the most recent of the three lithostratigraphic units (i.e. Benin, Agada and Akata formations) of the Niger delta (Amajor, 1991).

RESEARCH METHOD

The research method used in carrying out this research is a prescriptive kind of research and is termed Design Science Research (DSR). DSR is a research method used in solving problems faced in the real world by producing an innovative construction that can make contribution to theory in the area where it is applied (Lukka, 2003). The basic idea in DSR is that the entire research process is not linear but generally involves fundamental activities; 'build' and 'evaluate' (March and Smith, 1995). 'Build' here refers to creating things that serve human purposes. While 'evaluate' entails evaluating the performance of what was built.

Similarly, Vaishnavi and Kuechler (2007) indicated that in DSR, knowledge is produced during the research process and this knowledge strengthens the relevance of an academic research. Consequently, DSR is a research approach for conducting research in Lean Construction (Formoso *et al.*, 2012). This is because, Koskela (2008) revealed that to help solve the problem of relevance affecting construction management as a discipline, other than carrying out explanatory studies in the form of explanatory science, such studies should be positioned as a design science research. Similarly, Alshehamni *et al.*, (2009) and Simeon (1996) points out that in order to connect research and practice while producing theoretical knowledge, research should be positioned as design science. In view of these, this research is positioned under the umbrella of DSR.

The research strategy adopted to provide a structure for a plan of actions, which would guide and govern this research process, is an Action Research strategy. An Action Research (AR) is an established qualitative research method used for scholarly enquiry by building and testing theories with a perspective of solving practical problems in a real setting (Azhar 2007). It is usually carried out within a five phase cyclical process of: diagnosing, action planning, action taking, evaluating and specifying learning.

Step 1: Diagnosing: This entails analysing the current situation to identify all the problems that can be derived. It also involves holistically interpreting complex research problems that lead to the development of theoretical assumptions (Baskerville, 1999; Jang *et al.*, 2011). Within this research however, diagnosing involved analysing the current state of Nigerian highway construction process. It was identified that road construction projects and other construction projects are faced with a lot of challenges.

Step 2: Action planning: This involves setting up plans based on the theoretical assumptions identified. In this phase, the researcher and practitioners collaborate, specifying the actions that would improve the problems identified (Azah *et al.*, 2010). The Last Planner System is identified as the tool to tackle the basic management challenges that usually occur within highway projects.

Step 3: Action taking: For Action taking, the planned action is implemented with a collaboration of the research and practitioners. These actions result in changes within the organisation (in which the intervention is carried out) (Baskerville, 1999; Azah *et al*, 2010). Here the LPS is implemented within the road construction process. It comprised of five levels of planning processes of: The Master Schedule, Phase Schedule, Look-ahead planning, Weekly work plans and Percentage Plans Completed (PPC).

The master plan was the first phase of the production planning system. The objective was to provide an overall view of the project, and to analyse feasibility of project completion and to display the execution strategies, demonstrate the feasibility of completing the work within the available time and identify the important milestones and these milestone schedules are used to divide the project into logical phases. The duration within these schedules are established in a manner so that those responsible for the project are confident that the work can be completed as planned

The phase plan involved developing a more detailed work plan and providing the goals that served as targets to the project team. It basically entailed working backwards from the desired delivery dates,

scheduling tasks in the reverse order, allowing them to be performed at the last responsible moment, so as to minimise unnecessary accumulation of work in progress.

Look-ahead planning broke down activities down into the level of processes/operations, so that possible constraints were identified, responsibilities were assigned, and assignments were made ready by removing possible constraints.

The Preparation of the weekly work plan was in consultation with the last planner (the researcher served as the last planner) and it involved negotiating with all project team managers in a meeting to achieve a plan for each week that contains only tasks that are ready to be performed.

Step 4: Evaluating: The researcher and practitioner critically assess the outcome of implementing the plan. This includes examining the theoretical effects of executing the plan (Azah *et al*, 2010). Percentage Plans Completed (PPC) checks were also used to evaluate the implementation process on a weekly basis. The aim of the PPC was to measures whether the planning system was able to reliably anticipate what will actually be done.

Step 5: Specifying learning: This is usually an ongoing process. The accumulated knowledge gained from the action research is directed to the organisation where the research was carried out and the scientific community as well. Consequently, where the results are negative and the planned change is unsuccessful and it also provides a foundation for further research.

RESEARCH ACTIVITIES AT THE SITE

The research plan was to implement Last Planner System in three phases of the project comprising of 8 weeks of implementation and PPC calculations. These phases are:

Phase 1- clearing and preliminary earthworks; Phase 2- comprehensive earth works and grading; Phase 3- Priming and asphalting.

At the end of each phase (8 weeks) a comparison and review of the implementation was carried out. Conversely, during the implementation, the look-ahead schedule and the constraint analysis chart were used to allow for the anticipation of future needs for materials, equipment and labour. They ensured tasks were ready to start when required with a certainty of labour, equipment and material requirements. The constraints identified during the constraint analysis were grouped under eight categories; contract, designs, submittals and documentation, operations, equipment, labour, weather and materials. This classification helped facilitate an enhanced co-ordination with the responsible persons resolving particular constraints identified.

The PPC charts and reasons for non-completion forms on the other hand were used throughout the implementation process. These reasons for non-completion were also subdivided into eight categories; contract, designs, submittals and documentation, operations, equipment, labour, weather and materials. A weekly PPC's of 8 weeks was measured and is shown in Table 2 to Table 5.

Figures 1 and 2 show the PPC analysis for the first phase, i.e. 8 weeks within the project. At the end of the phase, a meeting was held to evaluate the implementation process, discussing the lessons learnt from the implementation.

Table 2: Comparison of 8 weeks of PPC (19/11/12 – 21/01/13)

Start date for week	No. of completed tasks	No. of uncompleted tasks	Total activities/tasks	PPC
19/11/2012	5	6	11	45%
26/11/2012	8	6	14	57%
03/12/2012	10	4	14	71%

Start date for week	No. of completed tasks	No. of uncompleted tasks	Total activities/tasks	PPC
10/12/2012	9	6	15	60%
17/12/2012	8	3	11	72%
07/01/2013	8	2	10	80%
14/01/2013	6	1	7	86%
21/01/2013	6	2	8	75%
TOTAL	***60***	***57***	***90***	***67%***

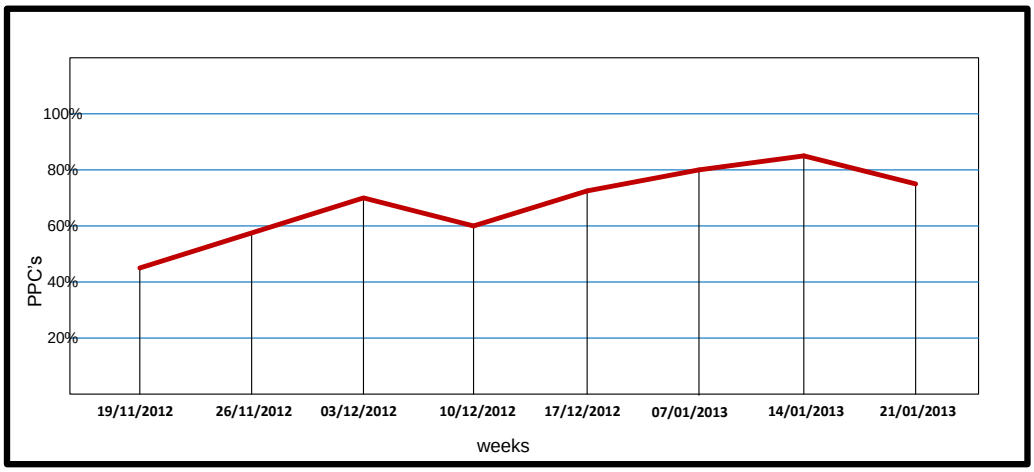

Figure 1: Weekly PPC's for 8 weeks (19/11/12 – 21/01/13)

From the review of the implementation process, it was observed that the involvement of all parties in the project was crucial for the success of the implementation process. Similarly, the reasons for incomplete assignments were analysed and documented for corrective actions to be taken during the next weekly meeting.

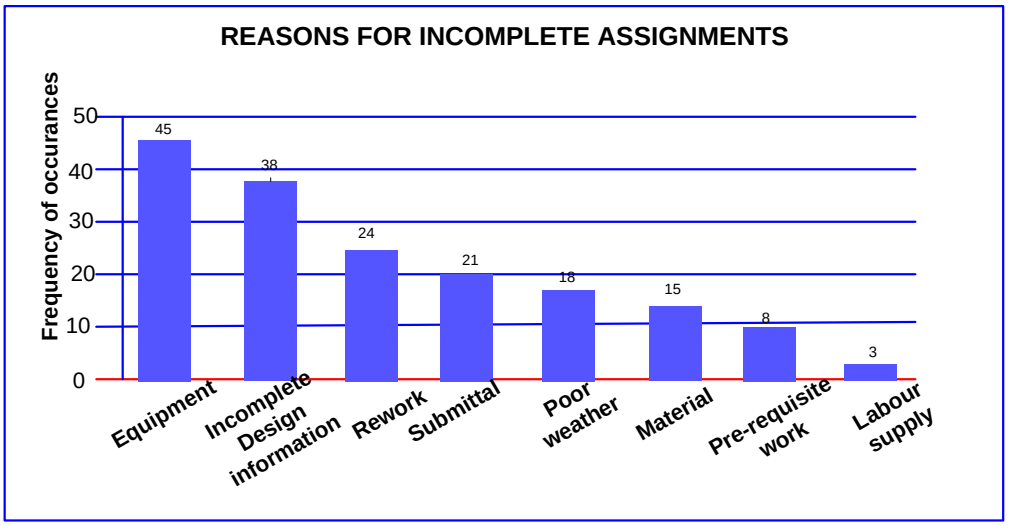

Figure 2: Reasons for incomplete assignments (19/11/12 – 21/01/13)

The reasons for the incomplete assignments within the first phase of 8-weeks are shown in Figure 2. The figure demonstrated that equipment break down was the most frequent reason for incomplete assignments. This was followed by incomplete design information; a lot of details were not included in the vertical and horizontal alignments designs. This made it difficult setting-out the project and calculating the levels for the cut and fill. In the same vein, this led to a lot of rework; which had the third highest frequency of 24. Other reasons for incomplete assignments included; submittals (late

request), poor weather and materials unavailability, pre-requite work and labour supply. Although this analysis for incomplete assignments was limited to the category presented.

Furthermore, weekly PPC's were calculated for next 16 weeks with an evaluation process carried out after 8 weeks for the 16th week of the project. The evaluation process basically evaluated the implementation process with the project team also discussed the lessons learnt from the implementation. Tables 3 and figure 3 shows the PPC measure for the second phase which commenced on the 28th of January 2013 till 18th March 2013. Similarly, Figures 4 showed the reasons for incomplete assignments within this phase.

Table 3: Comparison of 8 weeks of PPC (28/01/13 – 18/03/13)

Start date for week	No. of completed tasks	No. of uncompleted tasks	Total activities/tasks	PPC
28/01/2013	8	3	11	73%
04/02/2013	7	2	9	78%
11/02/2013	9	4	13	69%
18/02/2013	9	3	12	75%
25/02/2013	8	3	11	73%
04/03/2013	10	2	12	83%
11/03/2013	11	4	15	73%
18/03/2013	9	3	12	75%
TOTAL	***71***	***22***	***93***	***76%***

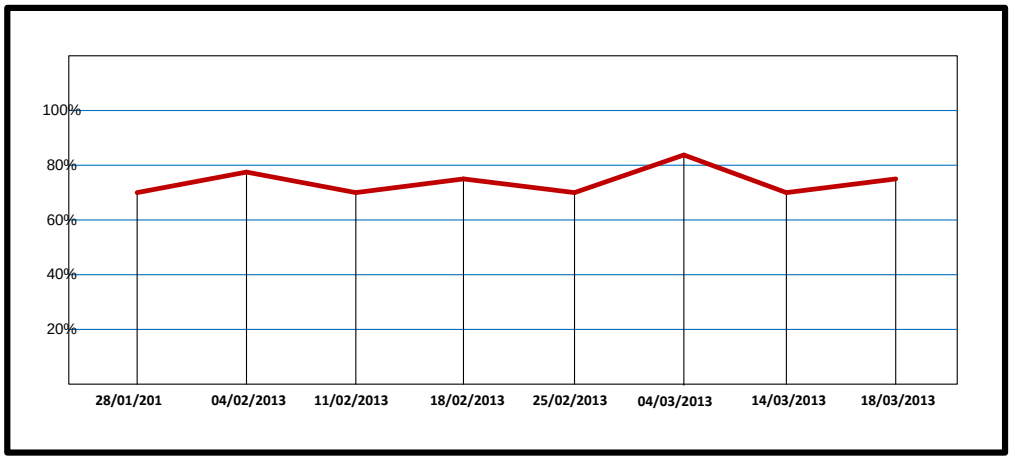

Figure 3: Weekly PPC's for 8 weeks (28/01/13 – 18/03/13)

From Tables 3 and Figures 3 it is observed that the average PPC within this period was 76% which was a remarkable improvement from the previous evaluation whose PPC was averaged at 67%. In addition, the highest PPC value of 83% was recorded on the week commencing from the 4th of March 2013, while the lowest PPC value of 69% was recorded on the week of 11th February 2013.

Furthermore, the reasons for the incomplete assignments within these 8-weeks are shown in Figure 4. It was identified that pre-requisite work was the most frequent reason for incomplete assignments and delays as a result of waiting for a task to be completed before another starts. This was basically because of the nature of the stage that the project had reached; i.e. this was the stage where most of the activities were dependent on the earth works. Particularly the compaction of the graded laterite in layers of 150mm by vibrating rollers; the compactor had to wait for the stock-piled materials to be spread along the road. However the site engineer had to stockpile the laterite materials to avoid setbacks experienced from community disturbances being experienced during haulage of the laterite materials.

In the same vein, the compacted surfaces had to be scarified and compacted over and over again and this rework was affecting the completion of assignments planed. This rework was also recorded in Figure 4 as the second highest percentage of uncompleted assignments. The third reason given was the

un-availability of materials. This was because of community disturbances from the youths around a neighbouring community; this community was the only access to the project site and suppliers delivering materials to the site were delayed until government officials had to step in to resolve the situation.

The fourth major reason for incomplete assignments was equipment break down. This was followed by incomplete design information; especially during the construction of the side drains which was carried out within this phase. Similarly, details of the fill levels were not indicated hence the surveyors had to establish one. Other reasons for incomplete assignments included; poor weather, submittals (late request) and labour supply.

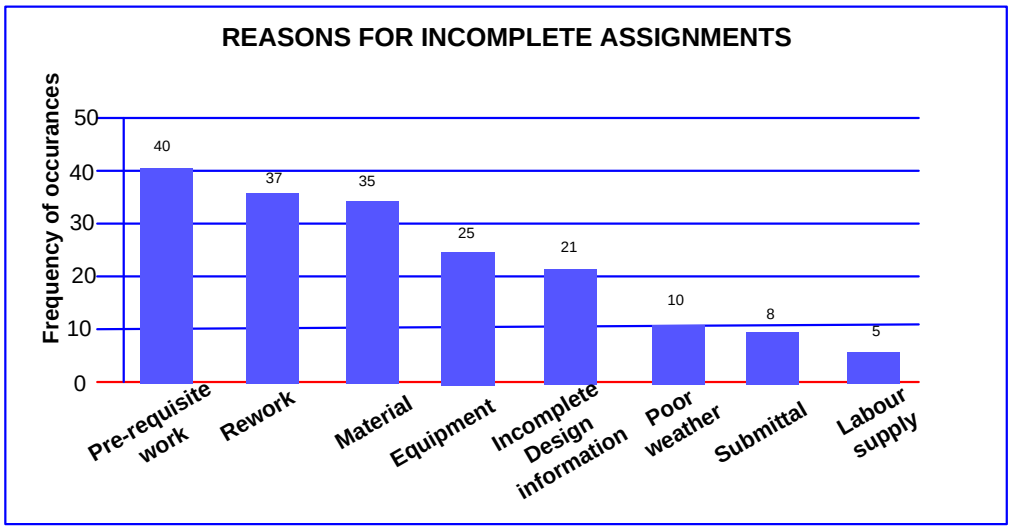

Figure 4: Reasons for incomplete assignments (28/01/13 – 18/03/13)

Finally, for the remaining 8 weeks to make up 24 weeks of the LPS implementation weekly PPC's were calculated and an evaluation carried out at the end of the 8 weeks. The project team discussed the lessons learnt from the implementation and evaluated the entire implementation process. Tables 5 and Figure 5 shows the PPC measure for week commencing on 25th March 2013 to week commencing 13th May 2013 while Figure 6 shows the reasons for incomplete assignments.

Table 4: Comparison of 8 weeks of PPC (25/03/13 – 13/05/13)

Start date for week	No. of completed tasks	No. of uncompleted tasks	Total activities/tasks	PPC
25/03/2013	9	3	12	75%
01/04/2013	8	2	10	80%
08/04/2013	7	2	9	78%
15/04/2013	6	3	9	67%
22/04/2013	5	1	6	83%
29/04/2013	5	2	7	71%
06/05/2013	6	2	8	75%
13/05/2013	7	1	8	88%
TOTAL	***53***	***16***	***69***	***77%***

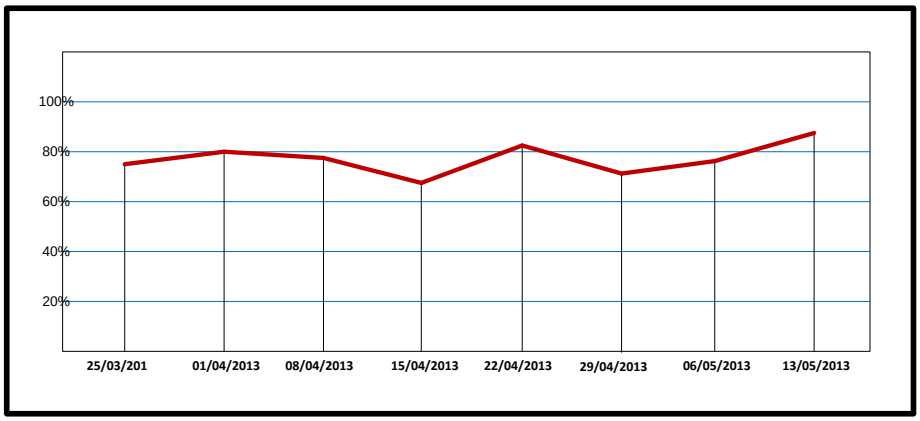

Figure 5: Weekly PPC's for 8 weeks (25/03/13 – 13/05/13)

From comparison of the 8 weeks PPC in Tables 5 and the chart of the weekly PPC's in figures 5 it is observed that the average PPC within this period is 77%. This stage of the project had just rounded up earth works while priming and asphalting commenced. It was recorded that the highest PPC value of 88% was recorded on the week commencing from the 13th May 2013. Major activities carried out within that week were the pavement works consisting of lateritic sub base, crushed stone base and asphaltic concrete. However, the lowest PPC value of 67% was recorded on the week of 15th April 2013; the major setback on the project within that week was poor weather. The reasons for the incomplete assignments within these 8-weeks are shown in Figure 6.

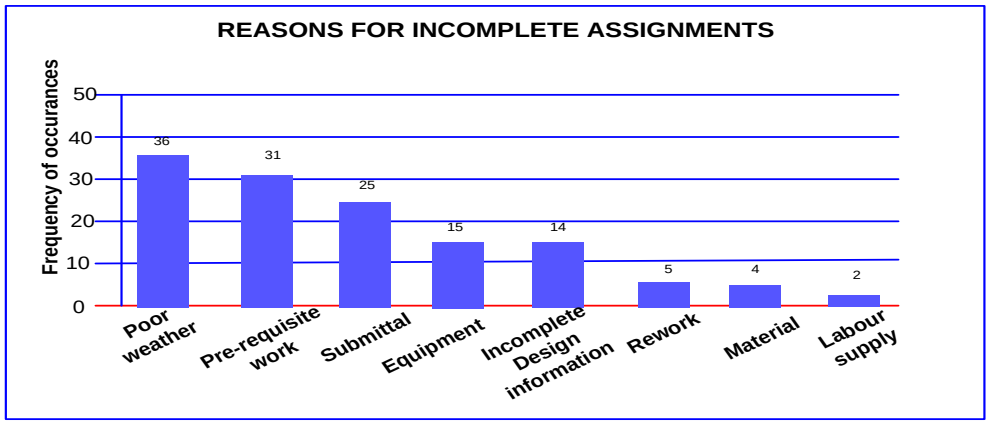

Figure 6: Reason for incomplete assignments (25/03/13 – 13/05/13)

The reasons for the incomplete assignments were captured in Figure 6. It was observed that poor weather was the major reason for incomplete assignments within this phase and it had a chain effect of affecting pre-requisite work. The rains poured out heavily and caused most of the tasks to be suspended and this resulted in workers waiting for task to be completed before another starts. Similarly, submittal (late request) was the third highest reasons for incomplete assignments; and it resulted in delays as requests were submitted too late for decisions to be made that would enable particular activities to start on time.

The fourth major reason for incomplete assignments was equipment break down. This was followed by incomplete design information; especially while constructing the pavements. Other reasons for incomplete assignments included; defects requiring rework, material unavailability and labour supply.

FINDINGS

Observation: It was revealed from the initial observations that there was no set out procedure for managing site activities. The site engineer gathered the project team every morning to assign work packages on a day to day basis. The back drop to this arrangement was that operators, subcontractors and suppliers did not know ahead of time what was planned out. This caused series of delays in the start-up process of the project. Nevertheless, it was observed that team-working was very evident at the site and responsibilities were well shared among the project team.

Interviews: From the interviews carried out, it was noticed that there was no planning technique in place. The answers to the interviews provided a comprehensive account of the organisation's project management practice and it was revealed that the project manager and the management team were motivated. They were made up of professionals who had good experience on road construction and a little knowledge of project management concepts with no awareness of Lean construction. Furthermore, it was also identified that there was no special communication tool such Walkie Talkies or ICT tools (such emails and intranet or internet communication) was available for the project. The project team relied on mainly on verbal communication. Finally, meetings were held daily before start of work at site to brief the operators of their tasks and management meetings were held if any issues went wrong within the site.

Implementation: During the implementation of the last planner system, a lot of data was gathered and different forms were completed on site by the project team, and these forms include the look-ahead schedule, constraints analysis charts, PPC chart and the reason for non-completion forms. The implementation occurred in three phases of 8 weeks per phase.

The average PPC's for the entire implementation period was 73%, with the highest PPC at 88% and the lowest at 45%.

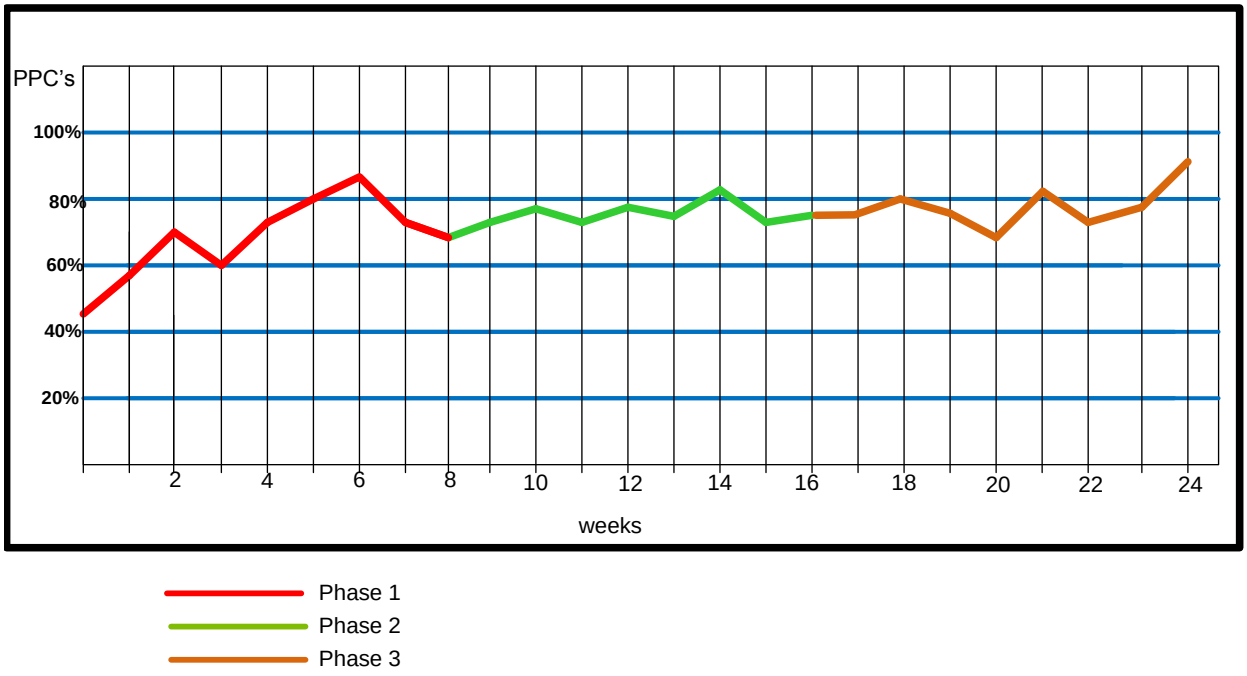

Figure 7: Comparison of Weekly PPC's for the three phases

From the assessment as depicted in Figure 7, after the PPC's stabilised for Phase 2 and Phase 3, the project participants became familiar with the implementation process. They showed great enthusiasm to learn and improve the project hence improvements recorded in phase 2 and 3. Similarly in phase 1, it was observed that after 2 weeks of PPC calculations, the project team was ready to keep their commitments and improve the project performance.

Similarly, a comparison of the reasons for incomplete weekly assignments were analysed for each phase and further compared for the entire project duration. This is depicted in Figure 6.16. From the analysis, it is observed that equipment breakdown was the major reason for incomplete assignment for the 3 phases of 24-weeks recorded. It had a total frequency of 85 occurrences. This is because during any road construction project in Nigeria, plants and equipment are the main items used in carrying out the project. Hence, when equipment and plants breakdown or are unavailable, there is a chain effect on the project program and outcome.

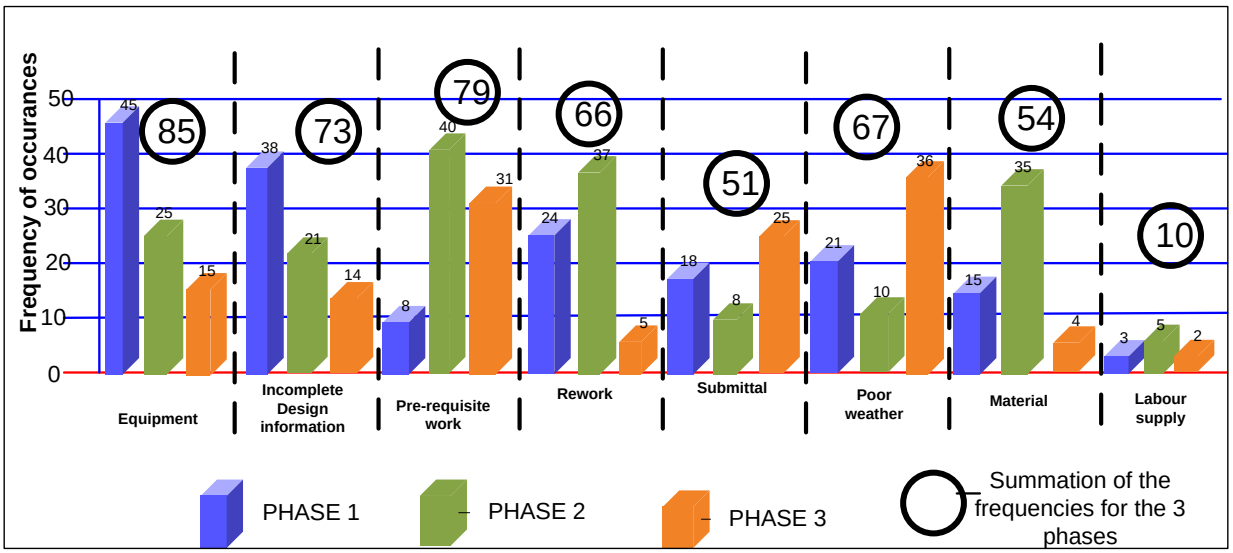

Figure 8: Reasons for incomplete assignment for the three phases

In the same vein, a road construction project is linear in nature; hence it is mandatory that some tasks have to be completed before others start. For examples, asphalting will only commence after the road section to be asphalted has been primed, and priming will only take place and all earthworks has been completed. Similarly, the earthwork depends on clearing and setting out of the road. All of these indicate the importance of pre-requisite work and pre-requisite work was observed to be the second most recurrent reason for incomplete assignments throughout the entire project implementation period, with a total frequency of 79.

Furthermore, incomplete design information was the third most frequent reason, with a frequency of 73. It was observed that three weeks into commencement of the project, the working drawings and specifications were not ready. The contractor had to wait for the consultants to furnish them with the specifications of the vertical and horizontal alignments. This however caused most of the planned assignments not to be completed.

The fourth was poor weather. This was a major reason for incomplete assignments during the third phase of the implementation. The poor weather was mainly excessive rainfalls resulting in flooding of the road sections, caused most of the planned work to be suspended. Most graded sections were scarified and re-graded which was counted as rework. Hence rework was recorded as the fifth most frequent reason for incomplete assignment throughout the entire implementation period.

Additionally, community disturbances caused material unavailability within the second phase of the 24 weeks of the full implementation period. This material unavailability reoccurred 54 times as reasons for incomplete assignments. While, submittals i.e. sending in late requests for materials and equipment resulted in the sixth most frequent reason for incomplete assignments and labour supply was the lowest reason for incomplete assignment; because equipment's were mainly relied upon to carry out majority of the tasks.

Questionnaires: The survey questionnaires were administered to the entire project participants to evaluate the LPS implementation process. The respondents to the question included the main

contractor team, the consultants, the subcontractors and suppliers. Each questionnaire was divided into four sections (A-D) with section A focusing on the overview of the implementation. Section B dwelt on the barriers of the implementation, while the section C focused on the critical success factors of the LPS and the finally section D concentrated on the benefits gained from the LPS process. Tables 5.1 to Table 5.4 illustrate the results from the questionnaire surveys.

Tables 5.1: Overview of the LPS implementation

	Reasons	**weighting frequency (f)**									
		1	2	3	4	5	Σf	χ	RII	Rank	% Rating
1	*LPS was effective*	0	0	0	13	6	19	4.31	0.86	3rd	100%
2	*Results obtained were satisfactory*	0	0	0	4	15	19	4.79	0.95	2nd	100%
3	*WWP & PPC was useful*	0	0	0	2	17	19	4.89	0.98	1st	100%
4	*difficulty in carrying out the implementation*	5	10	3	1	0	19	2.00	0.40	4th	5%

Tables 5.2: Barriers of the LPS implementation

	Barriers	**weighting frequency (f)**									
		1	2	3	4	5	Σf	χ	RII	Rank	% Rating
1	*Poor supervision & quality control*	0	2	4	12	1	19	3.63	0.73	5th	68%
2	*Fluctuations & variation*	0	4	8	6	1	19	3.21	0.64	6th	37%
3	*Subcontractors involvement*	0	2	5	9	3	19	3.68	0.74	4th	63%
4	*Resistance to change*	0	0	6	10	3	19	3.84	0.77	3rd	68%
5	*Cultural issues*	0	0	1	13	5	19	4.21	0.86	1st	95%
6	*Lengthy approval*	0	0	2	9	8	19	4.31	0.84	2nd	89%

Tables 5.3: Critical Success factors of the LPS implementation

	Barriers	**weighting frequency (f)**									
		1	2	3	4	5	Σf	χ	RII	Rank	% Rating
1	*Training & empowering last planners*	0	0	0	15	4	19	4.21	0.84	3rd	100%
2	*Team work*	0	0	3	15	1	19	3.89	0.78	6th	84%
3	*Motivating people to make changes*	0	0	0	9	10	19	4.52	0.90	2nd	100%
4	*Appropriate human capital*	0	2	5	8	4	19	3.74	0.75	7th	63%
5	*Top management support*	0	0	0	8	11	19	4.58	0.92	1st	100%
6	*Managing resistance to change*	0	2	3	8	6	19	3.95	0.79	5th	74%
7	*Close relationship with suppliers*	0	0	1	16	2	19	4.05	0.81	4th	95%

Tables 5.4: Benefits of the LPS implementation

	Barriers	weighting frequency (f)									
		1	2	3	4	5	Σf	χ	RII	Rank	% Rating
1	*Solve problems on time*	0	1	7	4	7	19	3.89	0.78	7th	57%
2	*Reduces bad news*	0	0	0	10	9	19	4.47	0.89	1st	100%
3	*Reducing load on management*	0	0	1	8	7	16	3.68	0.74	9th	95%
4	*Predictable & reliable work plan*	1	1	3	7	7	19	3.95	0.79	6th	74%
5	*Projects are safer, faster and within cost*	0	0	2	11	6	19	4.21	0.84	4th	90%
6	*Stabilises projects*	0	0	1	9	9	19	4.42	0.88	3rd	95%
7	*Improves logisitics*	1	1	3	9	5	19	3.84	0.77	8th	74%
8	*Improves predictions of labour*	1	2	3	9	4	19	3.68	0.74	9th	68%
9	Reduces risks	0	3	0	10	6	19	4.00	0.80	5th	84%
10	completes project on schedule	0	0	0	10	9	19	4.47	0.89	1st	100%

The findings from the questionnaire on the overview of the implementation revealed that the respondents were in agreement that the LPS implementation was Useful, Satisfactory and Effective, with only few respondents indicating that they experienced difficulty in carried out the implementation. For the questionnaire response on the barriers during the implementation, lengthy approval ranked first as the main barrier, this was followed by cultural issues, then resistance to change and subcontractors. While poor supervision and quality control ranked fifth. The sixth barrier was fluctuation and variation.

The findings from the Critical Success factors (CSF) indicates that most identified important CSFs are Top management support, Motivating people to make changes and Training and empowering Last planners. While the respondents indicated that the main benefits recorded from the implementation are: Reduces bad news, Completes projects on schedule, Stabilises projects, Projects are safer, faster and within cost.

CONCLUSION

This LPS implementation has shown that LPS, which is rarely implemented in a linear process like a road construction process, could enhance construction management practice in an environment which differs from places where it has been previously implemented and characterised predominantly by poor quality, cost and time overruns.

On the whole LPS had a significant and positive impact on the project management process of the road project by enhancing planning practice, improving site logistics, removing constraints before they became obstacles and improving the entire site management.

Nevertheless, during the LPS implementation obstacles were encountered and these prevented the achievement of the full potential of the LPS implementation. Some of the obstacles include: cultural issues, lengthy approvals, resistance to change, sub-contractors involvement, supervision and quality control, fluctuation and variations. Besides its contribution in improving the project management practice within the study organisation, it has contributed to construction management by illustrating that irrespective of the nature of the construction project or the environment within which the project is occurring, the LPS can still be successfully implemented to record improvements.

Furthermore, the results from this case project can be used as a reference for organisations in Nigeria which look forward to improving their managerial practice. The study also suggest that

implementing LPS in a road project in Nigeria can improve the process by encouraging collaboration among the project participants, transparency, trust and the reliability of the schedule.

REFERENCES

Ahiakwo, O., Oloke, D., Suresh, S and Khatib, J (2012) A Critical Review of The Potential For The Implementation of Lean In The Nigerian Building Industry. *Proceedings for the 20th Annual Conference of the International Group for Lean Construction*

Aibinu, A. and Jagboro, G. (2002) The effects of construction delays on project delivery in Nigerian construction industry. *International Journal of Project Management*, **20**(8), pp. 593-599

Aina, O.O. And Wahab, A.B. (2011) An Assessment of Build ability Problems In The Nigerian. *Construction Industry Global Journal of Research Engineering* Volume 11 Issue 2 Version 1.0 March 2011

Alsehaimi, A., (2011) Improving Construction Planning Practice In Saudi Arabia by means of Lean Construction Principles and Techniques, PhD Thesis, University of Salford, UK.

Alsehaimi, A., Tzortzopoulos, P. and Koskela, L. (2009) Last planner system: Experiences from pilot implementation in the Middle East *Proceedings of the 17th Annual Conference of the International Group for Lean Construction.* pp.53-65.

Amajor, L. C (1991) Aquifers in the benin formation (miocene—recent), eastern Niger delta, Nigeria: Lithostratigraphy, hydraulics, and water quality. Environmental Geology and Water Sciences March/April 1991, Volume 17, Issue 2, pp 85-10

Ankrah N.A (2007) An investigation into the impact of Culture on construction project performance, PhD Thesis, University of Wolverhampton, UK

Aslesen, S and Bertelsen, S (2008) Last Planner in a Social Perspective – A Shipbuilding Case. Proceedings for the 16th Annual Conference of the International Group for Lean Construction

Azhar, S., Ahmad, I. and Sein, M. (2010) Action research as a proactive research method for construction engineering and management, Journal of Construction Engineering and Management 136(1): 87-98

Azhar,S. (2007) Improving collaboration between researchers and practitioners in construction research projects using action research technique *Proceedings of the 43rd ASC National Annual Conference.*. pp.12-14.

Ballard, G. (1993) 'Lean construction and EPC performance improvement', proceedings of the I" IGLC workshop, Espoo.

Ballard, G. (1997). "Lookahead Planning: The Missing Link in Production Control", *Proc. 5th Annual Conf. Int'l. Group for Lean Constr., IGLC 5*, July, Gold Coast, Australia, 13-26.

Ballard, G. (1999) ''Improving work flow reliability.'' *Proc., IGLC-7, 7th Conf. of Int. Group for Lean Construction*, Univ. California, Berkeley, Calif., 275–286

Ballard, G. (2000) The Last Planner System of Production Control, PhD Thesis, University of Birmingham, Birmingham, UK.

Ballard, G. and Howell, G.A. (2003) Competing construction management paradigms. *Lean Construction Journal***, 1**(1), pp. 38-45

Ballard, G., Hammond, J. and Nickerson,R. (2009) Production control principles *Proceedings of International Group for Lean Construction (IGLC) International conference.*

Ballard, G., Kim, Y.W., Jang, J.W., and Liu, M. (2007). *Road Map for Lean Implementation at the Project Level, Research Report 234-11*, Construction Industry Institute, The University of Texas at Austin, Texas, USA, 426.

Baskerville, R. (1999) Investigating information systems with action research, Communications of the Association of Information Systems 2(19): 7-17

Dlakwa, M. and F Culpin, M. (1990) Reasons for overrun in public sector construction projects in Nigeria. *International Journal of Project Management*, 8(4), pp. 237-241

Federal Ministry of Works (2013) Compendium Report on Road Infrastructure & Related Development In Nigeria - An Investor's Manual Copyright 2013 by Pison Housing Company

Fiallo, C. M., and Revelo, P. V. H. (2002). "Applying the Last Planner System to a construction project- Case study in Quito Ecuador." *Proc., 10th Annual Conf. of the Int. Group for Lean Construction (IGLC-10)*, International Group of Lean Construction, Granmado, Brazil

Formoso, C.T., da Rocha, C.G., Tzortzopoulos-Fazenda, P., Koskela, L., and Tezel, A., (2012) Design Science Research in Lean Construction: An analysis of Process and Outcomes. *Proceedings for the 20th Annual Conference of the International Group for Lean Construction*

González, V., Alarcón, L.F., Maturana, S., Mundaca, F. and Bustamante, J. (2010) Improving planning reliability and project performance using the reliable commitment model. *Journal of Construction Engineering and Management*, 136pp. 1129

Hamzeh, F.R. (2009). *Improving Construction Workflow – The Role of Production Planning and Control*, PhD Dissertation, University of California at Berkeley, Berkeley, CA, 273.

Hamzeh, F.R. (2011). "The Lean Journey: Implementing the Last Planner System in Construction", Proceedings of the 19th Annual Conference of the International Group for Lean Construction, IGLC 19, 13-15 July, Lima, Peru, pp. 379- 390

Hamzeh, F.R., and Bergstrom, E. (2010). "The Lean Transformation: A Framework for Successful Implementation of the Last PlannerTM System in Construction", Proc. 46th Ann. Int'l Conf. of the Associated Schools of Construction, ASC 46. 07-10 April, Boston, Massachusetts

Hamzeh, F.R., Ballard, G., and Tommelein, I.D. (2008). Improving construction Workflow- The Connective Role of Lookahead Planning, Proceedings of the 16th Annual Conference of the International Group for Lean Construction, IGLC 16, 16-18 July, Manchester, UK, 635-646.

Howell, G. A. (1999) What is lean construction-1999 *Proceedings IGLC.*pp.1.

Javkhedkar, A (2006) Applying Lean Construction To Concrete Construction Projects. Msc Construction Management, Faculty of Engineering Technology, College of Technology University of Houston.

Kalsaas, Bo T (2012) The Last Planner System Style of Planning: Its Basis in Learning Theory. Journal of Engineering, Project, and Production Management 2012, 2(2), 88-100

Koskela, L. (1992). "Application of the New Production Philosophy to Construction". Tech. Report No. 72, CIFE, Stanford Univ., CA.

Koskela, L. (2008) Which kind of science is construction management? Proceedings of the 16`" IGLC Conference, July 2008, Manchester, UK.

Koskela, L., Stratton, R. and Koskenvesa, A. (2010) Last planner and critical chain in construction management: comparative analysis. Haifa, Israel: National Building Research Institute, Technion-Israel Institute of Technology, pp. 538-547.

Koskenvesa, A. and Koskela, L. (2005). "Introducing Last Planner-Finnish experience." Proc., CIB Conference, Helsinki,

Lindhard, S and Wandahl, S. (2013) Improving Onsite Scheduling: Looking Into the Limits of the Last Planner System *The Built & Human Environment Review, Volume 6, 2013*

Lukka, K. (2003). The constructive research approach. In: Case Study Research in Logistics, ed. By L. Ojala and O.-P. Hilmola, Publications of the Turku School of Economics and Business Administration, Series B 1:2003, pp. 83-101.

Mansfield, N., Ugwu, O. and Doran, T. (1994) Causes of delay and cost overruns in Nigerian construction projects. *International Journal of Project Management*, 12(4), pp. 254-260

March, S.T. & Smith, G.F. (1995). Design and natural science research on information technology. Decision Support Systems Vol. 15, Nr. 4, pp. 251 – 266.

Mossman, Alan (2013) *Last Planner®: 5 + 1 crucial & collaborative conversations for predictable design & construction delivery*. http://bit.ly/LPS-5cc (22-Apr-13)

Nielsen, A. S., and Thomassen, M. A. (2004). "How to reduce batch size." Proc., 12th Annual Conf. of the Int. Group for Lean Construction (IGLC-12), International Group for Lean Construction, Salford, U.K.

Odeh, A.M., & Battaineh, H.T. (2002) Causes of construction delay: traditional contracts. *International Journal of Project Management*, **20**(1), pp. 67-73

Oke, A.E. and Ogunsemi, D.R. (2011) Value Management in the Nigerian Construction Industry: Militating Factors and the Perceived Benefits.

Olano, R. M, Alarcón, L. F., and Razuri, C. (2009). "Understanding the relationship between planning reliability and schedule performance—A case study." Proc., 17th Annual Conf. of the Int. Group for LeanConstruction (IGLC-17), International Group for Lean Construction, Salford, U.K.

Olomolaiye, P., Wahab, K. and Price, A. (1987) Problems influencing craftsmen's productivity in Nigeria. *Building and Environment* 22(4), pp. 317-323.

Olusegun, A.E. and Michael, A.O. (2011) Abandonment of Construction Projects in Nigeria: Causes and Effects. *Journal of Emerging Trends in Economics and Management Sciences (JETEMS*2 (2), pp. 142-145

Onolememen, M (2012) Investment Opportunities in Nigeria's Transportation Sector: Road Infrastructure, Business and Investment Summit, *Dorchester Hotel, London* 31st July, 2012

Oyewobi, L; O Ganiyu, B; A Oke, A; W Ola-awo, A. and Shittu, A. (2011) Determinants of Unethical Performance in Nigerian Construction Industry. *Journal of Sustainable Development* [online]**, 4**(4), pp. p175

Patel,A (2011) The Last Planner System for reliable project delivery. M.sc Thesis at the University of Texas at Arlington,

Simeon 1996 Simon, Herbert A. 1969. The sciences of the artificial. The M.I.T. Press, Cambridge (MA)

Simonsson, P., and Emborg, M. (2007). "Industrialization in Swedish bridge engineering: A case study of lean construction." *Proc., 15th Annual Conf. of the*

Song, L., Liang, D., and Javkhedkar, A. (2008). "A case study on applying lean *Group for Lean Construction (IGLC-15)*, International Group of Lean Construction, East Lansing, MI.

Thomas, H.R.; M.J. Horman; Minchin Jr, R.E. and D Cheng (2003) Improving labor flow reliability for better productivity as lean construction principle. *Journal of Construction Engineering and Management*, 129pp. 251

Tommelein, I.D. and Ballard, G. (1997). "Look-ahead Planning: Screening and Pulling." Technical Report No. 97-9, Construction Engineering and Management Program, Civil and Environmental Engineering Department, University of California, Berkeley, CA, USA.

Trofin, I (2004) Impact of Uncertainty On Construction Project Performance Using Linear Scheduling. Msc Thesis Building Construction University Of Florida

Vaishnavi and Kuechler 2007 Vaishnavi, V. & Kuechler, B. 2007. Design Research in Information Systems. Available at http://www.isworld.org/Researchdesign/drisISworld.htm

Willoughby, C. (2004) Infrastructure and the Millennium Development Goals: *Complementarity of Infrastructure for Achieving the Millennium Development Goals.* Berlin: United Nations, 2004. 1-33.

Windapo, A. and Martins, O. (2010) An investigation into Nigerian property construction companies' perception of critical risk. Insurance Markets and Companies: Analyses and Actuarial Computations, Volume 1, Issue 1, 2010

Yamin, R.A. and Harmelink, D.J (2001). Comparison of linear scheduling method (LSM) and critical path method (CPM), Journal of Construction Engineering and Management, ASCE, 127 (5), 374-381.

Impact of Procurement Methods and Project Types on Construction Projects Performance

Jimoh Richard[1], Oyewobi Luqman[2] and Aliu Nurayn[3]*
[1,3]Building Department, Federal University of Technology, Minna-Nigeria
[2]Quantity Surveying Department, Federal University of Technology, Minna-Nigeria
rosney@futminna.edu.ng

ABSTRACT

Procurement systems provide the general framework and organisation of line of responsibilities for stakeholders within the construction process. It is a major contributor to client satisfaction in achieving successful completion of projects. This paper focused on examining the impact of different procurement methods and project types on performance of construction projects. The research employed a quantitative approach using structured questionnaires to elicit information from 420 stakeholders in the Nigerian construction industry. The relationship between project types and procurement systems was established as well as their influence on project delivery. The data were analysed and discussed. The results showed that there is correlation between procurement methods and factors used in assessing project success, while no relationship exists between procurement methods and project type. The implication is that cost, time and quality are factors affecting the selection of procurement methods.

Keywords: *Construction project; procurement methods; project performance; project types; Nigeria*

INTRODUCTION

The construction industry globally is highly fragmented; therefore the coming together of participants in the building process on an *ad hoc* basis has significant effect on project delivery and performance. Hence, the obvious separation of clients, main or general contractors and subcontractors requires an arrangement to procure the projects and establish authorities between the stakeholders for construction work to commence (Gruneberg and Hughes, 2006). Since Emerson's (1962) and Latham's (1994) reports have been published, the need to implement procurement methods in building process has heightened. However, evidence from the literature indicates that though there are many distinct methods available for realising construction projects, but in practice only a relatively few procurement methods are employed (Love *et al*., 1998; Masterman, 1992; Ng, Luu and Chen, 2002).

Broadly, construction procurement systems are classified as traditional and non-traditional procurement systems (Harris & McCaffer, 2005). For a very long time in the UK, traditional construction procurement system has been the major route for procuring constructed facilities after the industrial revolution, and to date, it remains the foremost procurement system in the UK (Saad, Jones and James, 2002; Royal Institution of Chartered Surveyors (RICS), 2007). This option appears as the most preferred system of procuring construction project by client who is involved in the construction process. The continued increase in the complexity of buildings, the need to manage project finance, the need to reduce design coupled with the need to have constructed facilities realised faster without compromising the client objectives has resulted in the decline in the use of the traditional procurement system to procure building works across the globe (Love *et al*., 1998; Maizon, 1996). Xue, Wang, Shen and Yu (2007) and Eriksson, Nilsson and Atkin (2008) advanced the reasons for this decline to include acrimonious relationship which often leads to conflicts and disputes; poor collaboration among parties, poor focus on customers' needs, and incessant failure to meet clients' requirements which have become prevalent in the construction industry.

Literature on research that examined procurement systems in the Nigerian construction industry established that both traditional and non-traditional procurement options are being practised in the industry (Babatunde *et al*., 2010; Ibrahim, Daniel and Ahmad, 2014). However, traditional procurement method is more popular in the Nigerian construction industry than the non-traditional, while the use of traditional construction procurement option in the industry accounts for most of the projects underperformance in terms of cost and time (Ojo *et al.,* 2006; Ibrahim *et al*., 2014). As a result of this and the demand for suitable procurement method to be employed in achieving successful projects to reduce the impact of time overruns, poor quality and cost overruns of construction projects on the growth and performance of the construction industry, other procurement systems have been explored.

Considering the plurality of research in the industry that investigates procurement systems being used in the Nigerian construction industry, none of them examines the influence of procurement methods and project types on performance (time, quality and cost) in Nigeria. To achieve this aim, the research presented in this paper addresses the following hypotheses:

- *There is statistical significant relationship between the different types of procurement methods available for procuring building projects and the various project types.*
- *There is statistical significant relationship between the different types of procurement methods available for procuring building projects and project success criteria.*
- *There is significant relationship between project performance measures (cost and time overruns) and different procurement methods.*

OBJECTIVE PERFORMANCE OF THE VARIOUS PROCUREMENT METHODS

The construction industry professionals will be able to produce any project with any procurement method, if given unlimited time and cost resources and the client not being too enthusiastic about quality requirement. However, because of cost of finance and advantages in putting the building into early use, particularly by the private developers, clients have to impose limits on cost and time, and must be satisfied with the quality of the building (Naoum and Langford, 1987). Hence construction industry professionals have resorted to using the 'appropriate' procurement method to achieve the constraints imposed by the client. Naoum and Langford (1987) opined that the use of appropriate procurement method can define the project's success on cost, time and quality objectives. Construction project may be considered as being successful if the constructed facility is delivered on time, within the estimated cost and quality standards, and meets the client high level of satisfaction (e.g. Cookie-Davies, 2002; Naoum and Langford, 1987). Construction projects performance is a function of meeting client's need and satisfaction with regards to the roles and responsibilities of participants engaged in the construction process (Gruneberg and Hughes, 2006). This is the desire of many construction clients, but the project performance considered in this paper is measured against the widespread and traditional measures of performance based on the iron-triangle of cost, time and quality (Cookie-Davies, 2002).

However, Masterman (1992) argued that the approach being used by many construction project clients and their professional advisors in selecting the procurement methods can be haphazard, ill-timed and illogical. Therefore, wrong choice or inappropriate usage of suitable procurement options has been established to be one of the main problems of project performance and successful completion. Although, each procurement method exhibits different characteristics, have distinctive benefit and inherent disadvantages, but 'one-cap-fits-all' does not exist as there is no single best system that could suit all kinds of clients and projects (Ng *et al*., 2002). This research thus investigates which procurement method is more appropriate for different project types and what is their performance effect in meeting client's objectives in terms of cost, time and quality.

METHODS

This research employs quantitative research approach using structured questionnaires to elicit information as it has been successfully employed in previous similar studies (e.g. OJo & Ikpo, 2013). However, a number of researchers have acknowledged that survey questionnaire as a method of obtaining information often suffers from poor response rate, but it permits views from a wide range of credible participants to be elicited (e.g. Bryman, 2008). The list of active professionals and contractors on the register of relevant professional bodies in Abuja (Federal Capital Territory) were obtained amounting to 551 using formula technique to determine the minimum sample size (see Table 1). Thus, 551 questionnaires were self-administered using simple random sampling among main contractors, consultants, and clients (construction professionals working in client organisations), and of these, 420 were returned and used for the analyses. In an effort to obtain and ensure the credibility of the results, the questionnaires were administered to the participants with over five years' experience and who are actively involved in construction procurements in their respective organisations. This criterion was unambiguously stated in the request for information notice provided in the survey questionnaire. Nonetheless, the authors were unable to determine if this requirement in any way influence the response rate obtained, but the desire to get experienced participants that have requisite knowledge and to ensure that credible responses prevailed. This high response rate of 76.2% was possible because of the self-administration of the questionnaires and the series of follow-ups on phone and mails. A period of six (6) months was used in the administration of the questionnaires. The data obtained were analysed using correlation and regression methods of analyses to establish relationship and at the same time test the hypotheses.

Table 1: Sample size derivation table

S/No	Description Of Population	Population	Source Of Population	Sample Size At 95% Confidence Level
	CONSULTANTS			
1	Architects	64	Nigeria Institute of Architects, Abuja Chapter	56
2	Structural Engineers	58	Council for the regulation of engineering in Nigeria	51
3	Quantity Surveyors	76	Nigeria Institute of Quantity Surveyors, Abuja Chapter	64
4	Electrical & Mechanical Engineers	51	Council for the regulation of engineering in Nigeria	46
	CONTRACTOR			
5	Contractors	200	Federal Ministry of Works Registration Board	134
	CLIENTS			
6	Federal Ministries	57	Federal Ministry of Information	50
7	FCT local councils/ Municipal Authority	16	Federal Capital Authority	16
8	Corporate/ financial Institutions	127	Corporate affairs commission	97
9	Private individuals/ private developers	48	Corporate affairs commission and Federal inland revenue service	43
Total Questionnaires distributed				**557**

RESULTS AND DISCUSSION

Table 2 provides the breakdown of the 551 administered and 420 returned questionnaires. Of 134, 206 and 211 questionnaires that were self-administered to contractors, clients and consultants in building

projects in Abuja, 132, 180 and 108 questionnaires were returned from contractors, clients and consultants respectively, giving a total of 420 questionnaires returned.

Table 2 also reveals the length of time or the period the respondents have been operating in the Nigerian construction industry. The respondents that have spent 20-25 years have the highest percentage of 42.8% with a response count of 180 followed by those that have spent 15-20 years with a response count of 84 representing 17.9%. The newest staff members that have been there for 5-10 years have the least response count of just 24 with 5.1%. On the other hand, the respondents that are oldest in the industry, spending 31 years and above have a response count of 60 accounting for 12.8% of the total respondents. In general, most of the respondents have at least five years working experience in the construction industry. Based on the number of years spent in the construction industry, majority of the respondents are well informed about the activities in the industry.

Table 2: Background information of respondents'

	Categorisation of the groups		
Group	Number of questionnaires sent	Number returned	Response rate
Contractors	134	132	98.51%
Clients	206	180	87.38%
Consultants	211	108	51.19%
Total	551	420	76.23%
Year of experience in the construction industry			
Year of experience	Frequency	Percent	
5-10 years	24	5.1	
10-15 years	72	15.4	
20-25 years	84	17.9	
25 - 30 years	180	42.8	
31years and above	60	12.8	
Total	420	100.0	
Respondent profession in the organisation			
Professional role in the organisation	Frequency	Percent	
Architect	83	19.8	
Builder	85	20.2	
Quantity Surveyor	42	10.0	
Engineer (Civil, Structural, Mechanical and Electrical)	48	11.4	
Project Manager	162	38.6	
Total	420	100.0	

Project Type and Procurement Methods

Using the quantitative survey approach to elicit information, a number of projects and constructed facility types as well as procurement methods were identified. Table 3 presents the project types and the respective procurement systems employed in delivering the projects obtained from the questionnaire survey. Table 3 indicates that traditional lump sum methods were majorly the procurement route used in the Nigerian construction industry to procure new projects 33.3% (amounting to 140). Design and build route was the closest indicating 26.2% of the total responses. Construction management methods account for 22.9% of the total survey, Contract Management and PPP have the lowest with counts of 56 and 18 representing 13.3% and 4.3% respectively. In all, most of the respondent's organisations execute combination of traditional, design & build, construction management, management contracting and PPP. This result shows that the organisations are well acquainted with the various procurement methods, hence their capabilities to give accurate answers to the questions asked. Also, the result confirms the study carried out by Babatunde *et al*. (2012), they ranked traditional method as the highest and most frequently used procurement method for procuring building projects in Nigeria. This finding is also in line with Saad, Jones and James (2002) study who argued that traditional construction procurement system has been the major route for procuring

constructed facilities for a very long time in the UK. This is not surprising as Nigeria still tows the UK construction industry ways of doing things.

Table 3 shows that respondents were involved in the procurement of a variety of project types, the most prominent project types were commercial and administrative offices (27.3%), followed by residential buildings (22.7%). This result affirms the nature of the study area which is the Federal Capital of Nigeria with many office buildings both for administrative and commercial purposes.

Table 3: Project types and procurement methods

Types of Project Awarded	**Frequency**	**Percent**
Offices	36	27.3
Industrial (Factories, Shopping Complexes and warehouses)	11	8.3
Health (Hospital)	18	13.6
Residential Houses	30	22.7
Commercial (Hotels, Banks, Markets, Shopping Mall)	23	17.4
Educational (Schools and Universities)	14	10.6
Total	132	100.0
Procurement methods	**Frequency**	**Percent**
Traditional Contract Method (Lump Sum)	140	33.3
Design and Build	110	26.2
Construction Management	96	22.9
Management Contracting	56	13.3
Public Private Partnership (PPP)	18	4.3
Total	420	100.0

Relationship between project type and procurement system

The previous research that focused on the Nigerian construction sector asserted that both the traditional and non-traditional procurement systems are in use in the industry. However, a major problem identified with traditional procurement system is the non-integration of design and construction (Ojo *et al*., 2006). To mitigate this shortcoming that is associated with the use of traditional procurement method, non-traditional systems such as design and build, management contracting and construction management have been encouraged (Dada, 2013; Oladinrin *et al*., 2013). Hence, the following hypothesis was formulated and tested:

H1: There is a statistical significant relationship between the different types of procurement methods available for procuring building projects and the various project types

Table 4 shows the correlation coefficient, level of significance between procurement methods and project types. The decision taken is based on the categorisation by Field (2013), a correlation of ±0.1 denotes small effect, ±0.3 represents medium effect and ±0.5 is a large effect. The results show that offices have a correlation coefficient of 0.217, a value that is weak but positive. It is statistically significant ($p = 0.007$). The same applies to Health (Hospital) with a value of 0.326. All other Project Types give values that are statistically insignificant. Conclusively, with 2 "reject" and 4 "accept", the correlation results show that most of the project types are statistically insignificant and hence, the hypothesis that stated that there is correlation between procurement methods and project types is partially supported. Hence, the procurement methods available are not dependent on the types of project available.

Table 4: Correlation analysis of procurement methods and project type

Project Type	**Correlation Coefficient**	**P-value**	**Significance of Correlation**	**Decision**
Offices	0.217**	0.007	Significant	Reject
Industrial (Factories, Shopping	0.054	0.506	Not Significant	Accept

Project Type	Correlation Coefficient	P-value	Significance of Correlation	Decision
Complexes and warehouses)				
Health (Hospital)	0.326**	0.000	Significant	Reject
Residential Houses	0.067	0.405	Not Significant	Accept
Commercial (Hotels, Banks, Markets, Shopping Mall)	0.151	0.059	Not Significant	Accept
Educational (Schools and Universities)	-0.007	0.931	Not Significant	Accept

Procurement methods and project success criteria

In order to determine the relationship between the various procurement methods studied and the identified project success criteria, the following hypothesis was tested:

H2: There is statistical significant relationship between the different types of procurement methods available for procuring building projects and project success criteria.

Table 5 shows weak correlation coefficient between procurement method and project success criteria except health and safety measures (i.e. when no causalities recorded to complete a project) that indicate medium effect on construction projects. However, the procurement methods used have significant effects on all the measures of project success criteria except "When no conflicts recorded to complete a project" that is statistically insignificant. The correlation results show that most of the factors are statistically significant and hence, the hypothesis that states that there is statistical significant relationship between the different types of procurement methods available for procuring building projects and project success criteria is accepted. That is, there is correlation between procurement methods and project success criteria. The implication is that cost, time and quality are factors affecting the selection of procurement methods. Hence, the procurement methods available are dependent on the project success criteria. These results are in line with the findings of Eyitope *et al.* (2012), who inferred that completing a project within its budgeted cost is more relieving and satisfying to the client. The findings are also in consonance with assertion of Peter *et al*. (2008) who argued that causalities constitute hindrances to the progress of work and consequently impede the success of the project. Nonetheless, conflict within a project also constitute a great hindrance to the progress of work as this could amount to disruption of work, which could lead to time overrun as posited by Maizon *et al. (*2006) but the study shows its effect is insignificant.

Table 5: Correlation analysis of procurement methods and project success criteria

Factor	Correlation Coefficient	P-value	Significance of Correlation	Decision
Completing a project within budgeted cost	0.210**	0.008	Significant	Reject
Completing a project within the estimated construction time	0.225**	0.005	Significant	Reject
Satisfying with the quality of a project	-0.170**	0.033	Significant	Reject
When no conflicts recorded to complete a project	-0.068	0.402	Not Significant	Accept
When no causalities recorded to complete a project	-0.435**	0.000	Significant	Reject

The effect of the different procurement systems on project performance (cost and time overruns)

Construction projects performance is measured using the most commonly used parameters of cost, time and quality. This is due to the fact that construction clients want their project completed on time, within the budgeted cost without compromising the quality and safety. The performance of project with respect to the procurement method used is measured using cost and time. Therefore, to establish whether the various procurement systems have any effect on project performance, the hypothesis stated below was tested.

H3: There is significant relationship between project performance measures (cost and time) and different procurement methods.

Table 6 shows the results of the regression analysis of different procurement types on cost performance of construction projects. The coefficient of determination R^2 ranges from 0.52, 0.88 for the entire projects considered. The significant level shows that there is a significant effect of cost overrun on contract sum for traditional method, which implies that other procurement routes should be considered for procurement as it relates to reliability of estimated cost. These findings are in tune with the findings of Jaafar and Nuruddin (2012) and Eyitope *et al.* (2012), who confirmed that the increasing awareness of construction stakeholders to the benefits of other procurement methods as opposed to the traditional procurement method. However, this is contrary to the submission of Adesanya (1992) and Enekwechi (1993) which identified traditional procurement as the best method in Nigeria to achieve estimated time target and cost budget. The reason for this may not be farfetched in that these studies were conducted more than 20 years when designs and construction were simpler than what we have presently. The findings also supported the result of Rose and Manley (2011) who reported their research work based on forty-two case studies that 78% of management contracting projects were completed within or less than their budgeted cost compared with only 30% traditional contracts. The results of similar research work by Mathonsi and Thwala (2012) in Southern Africa confirmed the above result.

Table 6: Summary of regression analysis of cost overrun for different procurement methods

Regression Analysis of Cost Overrun (Co) on Contract Sum (Cs)				
	Traditional Method			
Project Size	R2 (Adjusted)	Regression Equation	P.value	Remarks
1-10 million	0.64	Cs = 0.633+3.725Co	0.0001	Significant
11-100 million	0.73	Cs = 0.368+2.7776Co	0.0000	Significant
Above 100 million	0.58	Cs = 0.356+1.655Co	0.0000	Significant
Design and Build Method				
1-10 million	0.69	Cs = 0.452+3.895Co	0.1000	Not Significant
11-100 million	0.62	Cs = 0.321+2.651Co	0.2000	Not Significant
Above 100 million	0.88	Cs = 0.821+1.612Co	0.2000	Not Significant
Project Management Method				
1-10 million	0.76	Cs = 0.410+3.521Co	0.2000	Not Significant
11-100 million	0.79	Cs = 0.201+2.416Co	0.1000	Not Significant
Above100 million	0.59	Cs = 0.301+1.430Co	0.5000	Not Significant
Management Contracting Method				
1-10 million	0.81	Cs = 0.391+3.310Co	0.0000	Significant
11-100 million	0.73	Cs = 0.290+2.201Co	0.1000	Not Significant
Above 100 million	0.64	Cs = 0.910+1.343Co	0.2000	Not Significant
PPP Method				
1-10 million	0.64	Cs = 0.150+3.267Co	0.2100	Not Significant
11-100 million	0.52	Cs = 0.482+2.722Co	0.0700	Not Significant
Above 100 million	0.58	Cs = 0.290+1.327Co	0.1000	Not Significant

Table 7 presents the results of the regression analysis of different procurement routes and its effects on time performance of construction projects in terms of time overrun. The coefficient of determination R^2 ranges from 0.24 to 0.71 for whole projects considered. The results showed that insignificant effects exist between other procurement methods and project duration except traditional methods. This result is supported by earlier researchers (e.g. Maizon et al., 2006; Peter *et al*., 2008) that asserted that other procurement methods other than traditional route allow for more efficient and effective coordination of works, materials, manpower and plants, thus making construction time shorter compared to other procurement systems.

Although in the construction industry, it is only in few instances that the same contractor can be involved in identical buildings with different procurement methods. This therefore, makes the research work of Oztas and Okmen (2004) to be of particular interest. Oztas and Okmen (2004) evaluated the time performance of ten design and build projects against seven traditional industrial projects. These projects were executed by the same contractor who built all the seventeen industrial projects for various owners and consultants in the United Kingdom. They reported that design and build projects were constructed within an average of eighteen months while the traditional projects took an average of twenty-seven months. Oztas and Okmen (2004) by focusing on one type of building and one potential contractor eliminate certain variable concerned with the technology of the building and variance in pricing procedure. This suggests that differences in results are more likely to be the different procurement methods employed upon the projects.

Table 7: Summary of regression analysis of time overrun for different procurement methods

Regression Analysis of Time Overrun (To) on Contract Sum (Cs)				
	Traditional Method			
Project Size	R2 (Adjusted)	Regression Equation	P_ value	Remarks
1-10 million	0.24	Cp = 0.421+3.920 To	0.0000	Significant
11-100 million	0.53	Cp = 0.388+2.329 To	0.0002	Significant
Above 100 million	0.58	Cp = 0.856+1.545 To	0.0001	Significant
Design and Build Method				
1-10 million	0.43	Cp = 0.353+3.655 To	0.1000	Not Significant
11-100 million	0.61	Cp = 0.368+2.457 To	0.1000	Not Significant
Above 100 million	0.38	Cp = 0.956+1.855 To	0.1000	Not Significant
Project Management Method				
1-10 million	0.54	Cp = 0.733+3.765 To	0.7500	Not Significant
11-100 million	0.48	Cp = 0.568+2.7876 To	0.1000	Not Significant
Above 100 million	0.51	Cp = 0.456+1.455 To	0.7000	Not Significant
Management Contracting Method				
1-10 million	0.70	Cp = 0.561+3.671 To	0.3000	Not Significant
11-100 million	0.71	Cp = 0.356+2.810 To	0.6000	Not Significant
Above100million	0.62	Cp = 0.626+1.510 To	0.2000	Not Significant
PPP Method				
1-10 million	0.60	Cp = 0.562+3.720 To	0.1500	Not Significant
11-100 million	0.47	Cp = 0.389+2.682 To	0.7000	Not Significant
Above 100 million	0.39	Cp = 0.630+1.673 To	0.3000	Not Significant

CONCLUSION

Selection of appropriate procurement method is a herculean task for all the stakeholders especially the client due to various factors regulating the execution and realisation of construction projects. Individual client has different needs and requirements and as such measure project success differently as no two construction projects are entirely the same in every respect, thus, no single method of procurement can be appropriate for every project. The research presented in this paper examined the impact of different procurement methods and project types on performance of construction projects. Mostly, project performance or success is measured using the iron triangle of cost, time and quality which are considered as the three essential parameters of project performance,

but health and safety has found its way into these performance criteria as shown in the study. The research showed that construction clients in Nigeria are becoming more informed due to the quest to have their project completed on time, within budget and with the right quality; the adoption of different procurement methods show that the construction industry is now trying to meet the clients' needs. The study indicated that different procurement method have different effect on the cost and time performance of construction projects. The results established that there is a relationship between procurement methods and factors used in assessing project success, while no relationship exists between procurement methods and project types. The implication is that cost, time, quality and health and safety are factors affecting the selection of procurement methods.

REFERENCES

Adesanya, O.M. (1992). Management Contracting Concepts and Nigeria's Construction Industry. Paper Presented At the Joint Seminar on Management Contract of Quantity Surveyors Registration Board of Nigeria and Nigerian Institute of Quantity (18thSeptember 1992, Lagos)

Babatunde, S.O., Opawole, A. & Ujaddughe, I.C. (2010). An Appraisal of Procurement Methods in the Nigerian Construction Industry. *Civil Engineering Dimension*, 12, 56-58. Retrieved from www.puslit.petra.ac.id/../c1v10120010.pdf/ (Accessed 14 December 2012).

Bryman, A. (2008). *Social Research Methods*, 3rd edition. New York: Oxford University Press

Cooke-Davies, T.J. (2002). The 'real' success factors on projects. *International Journal of Project Management*, 20, 185–190.

Dada, M.O. (2013). Conflicts in construction projects procured under traditional and integrated systems: A correlation analysis. *International Journal of Construction Supply Chain Management.* 3(1), 1-15

Emerson, H. (1962). *Report for Ministry of Works: Survey of Problems before the Construction Industries*. London: HMSO

Enekwechi, C.O. (1993). Construction Management as a Contract Procurement System', *Builders Magazine*, VII (6), 17-18

Eriksson, P. E., Nilsson, T. & Atkin, B. (2008). Client perceptions of barriers to partnering. *Engineering, Construction and Architectural Management*, 15(6), 527–539

Eyitope, A., Ajibola, M., Ajibola, O. & Gbadebo, F. (2012**)** Critical Selection Criteria for Appropriate Procurement Strategy for Project Delivery in Nigeria. Retrieved from http://jetems.sholarlinkresearch.org/article (Accessed 31 January 2013)

Field, A. (2013). *Discovery statistics using IBM SPSS statistics*, 4th edition. Los Angeles: Sage Publication Limited.

Gruneberg, S. and Hughes, W. (2006), ''Understanding construction consortia: theory, practice and opinions'', Royal Institution of Chartered Surveyors (RICS) Research Papers, 6(1), 1-53.

Ibrahim, I. I., Daniel, S. and Ahmad, A. (2014). Investigating Nigerian Indigenous Contractors Project Planning In Construction Procurement: An Explanatory Approach. *International Journal of Civil & Environmental Engineering IJCEE-IJENS*, 14(04), 16-25

Jaafar, M & Nuruddin, A.R. (2012). The development of Public and Private construction procurement system in the Malaysian construction industry. *Journal of Design and Built Environment*, 11, 1-11. Retrieved from http://e-journal.um.edu.my/filebank/publis (Accessed 12 February 2013)

Latham, M. (1994). *Constructing the team: Joint Review of Procurement and Contractual Arrangements in the United Kingdom Construction Industry: Final Report*. London: Department of Environment. Retrieved from http://hdl.handle.net/10068/491035 (Accessed 21 September 2011)

Love, P.E.D., Skitmore, R.M. & Earl, G. (1998). Selecting an appropriate procurement method for a building project. *Construction Management and Economics*, 16, 221-223

Maizon, H., Melissa, C.Y., Ng Chu, Y., Ng Sock, H., Shim Mong, H. & Tay Lee, Y. (2006). Factors Influencing the Selection of Procurement Systems by Clients. *Proceeding of International Conference on Construction Industry 2006*, Padang, Indonesia, 21st – 25th June, 1-10

Maizon, H. (1996). The Effects of Procurement Systems on performance of construction projects in Malaysia**.** *Proceedings of CIB W92*: *North Meets South: Developing Ideas, The University of Natal, Durban, South Africa*

Masterman, J.W.E. (1992). *An Introduction to Building Procurement Systems*. London: E and FN Spon

Masterman, J.W.E. & Gameson, R. (1994). Client characteristics and needs in relation to their selection of procurement systems. In: Rowlinson, S. (ed.) *Proceedings of East Meets West Procurement Systems Symposium,* CIB Publication 175, 4–7 December, Hong Kong, 79–87

Mathonsi, M.O & Thwala, W.D. (2012), Factors influencing the selection of procurement systems in the south-african construction industry. *African journal of business management*, 6, 3583-3594. Retrieved from http://www.academicjournals.org.AJBM (Accessed 12 February 2012)

Naoum, S.G., & Langford, D.A. (1987). *Management Contracting in managing Construction Worldwide*. London: Chartered Institute of Building

Ng, T. S., Luu, D. C. & Chen, S. E. (2002). Decision criteria and their subjectivity in construction procurement selection. *The Australian Journal of Construction Economics and Building,* 2(1), 70-80

Ojo, S. O. & Ikpo, I. J. (2013). Determining the Performance of Procurement Methods against Selection Criteria using Outranking – Satisfying Methodology. *Journal of Engineering, Project, and Production Management*, 3(2), 74-84

Ojo, S.O., Adeyemi, Y.A. & Fagbenle, I.O. (2006). The Performance of Traditional Contract Procurement on Housing Projects in Nigeria. *Civil Engineering Dimension Journal,* 8(2), 81-86.

Oladinrin, O.T., Olatunji, S.O. & Hamza, B.T. (2013). Effect of selected procurement systems on building project performance in Nigeria. *International Journal of Sustainable Construction Engineering & Technology,* 4(1) 48-62

Oztas, A., & Okmen, O.(2004). Risk Analysis in Fixed-Price Design-Build Construction Projects. *Building and Environment Journal,* 39, 229-237.

Peter, D., Peter, L., & David, B. (2008). Building Procurement Methods (Report). Construction Innovation. Retrieved from www.construction-innovation.info/im (Accessed 14 January 2013)

Royal Institution of Chartered Surveyors (RICS) (2007). *Survey of Building Contracts in Use During 2007*. London: The Royal Institution of Chartered Surveyors

Saad, M., Jones, M. & James, P. (2002). A review of the progress towards the adoption of supply chain management (SCM) relationships in construction. *European Journal of Purchasing and Supply Management*, 8(3), 173–183

Xue, X., Wang, Y., Shen, Q. & Yu, X. (2007). Coordination mechanisms for construction supply chain management in the Internet environment. *International Journal of Project Management*, 25(2), 150–157

NOTES FOR CONTRIBUTORS

SUBMISSION

All materials submitted for publication must be original, unpublished work and are not under consideration for publication elsewhere.

Papers may be submitted by e-mail to **bej.fspu@gmail.com**. Alternatively, 2 copies of the manuscript together with a full version on CD may be submitted to the Editorial Board.

Address:

Assoc. Prof. Datin Dr. Hamimah Adnan
Managing Editor
Built Environment Journal (BEJ)
Faculty of Architecture, Planning and Surveying
Universiti Teknologi MARA
40450 Shah Alam
Selangor, Malaysia.

Editors reserve the right to edit/comment on the content of the manuscript. If major or substantial amendments are recommended by the editors the authors will be given the option to accept or reject the recommendations (and withdraw participation).

MANUSCRIPT PREPARATION

Language

The manuscript must be submitted in British English.

Length

The manuscript should be within the range of 5000 – 7500 words in Times New Roman font, 12 point type. Authors are requested to state how many words their paper contains. The manuscripts should be typed and single spaced on one side of A4 paper only, with 4 cm margins on the sides, the top and the bottom. All text should be set aligned justified throughout. The pages should be numbered in order.

Title Page

The first page of the manuscripts must contain the full title, name of author(s), designation(s) of affiliation(s), highest academic qualification and the present address(es) with the telephone/fax/e-mail contact information listed.

Abstract and Keywords

The abstract must not exceed 250 words and should summarise the paper including the main conclusions. There shall be not more than 5 keywords.

Text

The order when typing manuscripts: Title, author(s), highest academic qualification, Affiliations, Abstract, Keywords, Main Text (Aim, Problem Statement/Issues, Methodology and Analysis),Conclusion and Recommendations, References, Acknowledgment and Appendix (if any). Simple language, short sentences and a good use of headings are encouraged. Headings should be numbered and the use of more than three levels of heading should be avoided. Headings and paragraphs should be separated by two carriage returns. Text following a heading should not be indented.

Illustration

Photographs, diagrams and charts should be referred to as "Figure(s)" and numbered in the order in which they are referred to in the text. Maps and diagrams should be submitted in a form ready for reproduction, all in legible digital format. Please note that illustrations in the journal shall be printed in black-and-white or grey-scale.

Units

All measurements and data should be given in metric units or, if other units are used, then the metric equivalent should be given in parentheses.

Reference

The Harvard system is used. The reference is referred to in the text by the following manner:

Onojaefe D, Ukpere WI (2009). *Partnership and the e-commerce initiative of small businesses. African Journal Business Management, 3(12): 855-861*.

Shahimi, N. (2006). *A Study on The Achievement of Class F Contractors. Shah Alam: Department of Quantity Surveying, Faculty of Architecture, Planning and Surveying, Universiti Teknologi MARA Malaysia.*

Swan W, Khalfan MMA (2007). *Mutual Objective Setting For Partnering Projects in the Public Sector. Engineering, Construction and Architectural Management, 14(2): 119-130*.

Stevens, R. (2004). "*Partnering, Environmental & Risk Management",. International Construction Conference 2004. CIOB Malaysia.*

CIDB (2011*), Construction Industry Development Board, Malaysia, www.cidb.gov.my*.

COPYRIGHT

Once published in the Built Environment Journal, the copyright including electronic copyrights of the article is automatically invested with UiTM. The copyright covers the exclusive use of rights to reproduce and distribute the article, including reprints, photography reproductions, microfilm, electronic publication or any reproduction of a similar nature and translations. Permission to publish illustrations must be obtained by the author before submission. Any acknowledgements should be included in the figure captions.