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EDITORIAL

Anthony O. Ujene
Editor-in-Chief

On behalf of the editorial crew of Journal of Contemporary Research in the Built Environment (JOCREBE) I wish to welcome our numerous readers to Volume 3, Number 1, March, 2019 edition of the Journal. I sincerely congratulate all the contributors for choosing JOCREBE as a medium for disseminating their well investigated and articulated researches. This edition has tried to provide reasonable insight and solution to several problems in the Built Environment in line with the aim of the Journal. The highlight of the Twelve papers in this edition are hereby presented to stimulate your curiosity, as you are encouraged to read the main articles for proof of worth.

The first paper titled "Effects of overhead cost of civil engineering projects in Nigeria" by Ogbu and Imafidon, focuses on overhead costs in civil engineering projects, by assessing the factors affecting overhead cost, determining the relationship between the factors and the overhead costs and determining the frequency of use of overhead cost items in civil engineering projects. Respondents were conveniently selected from civil/structural engineers and quantity surveyors who have participated in civil engineering projects in Nigeria. The results from data analyzed using percentages, relative importance index, multiple regression and factor analysis, show that the most important factor affecting the overhead cost of civil engineering projects is delayed payment. The factors significantly affecting overhead costs of civil engineering projects are either project or contractor-related. Provisions for water supply, setting out and handover were found to be the predominant general items allowed in civil engineering projects. The paper recommended that payment delays should be assessed while estimating the cost of general items, and only applicable general items should be priced.

The second paper by Mu'azu, Batagarawa, Hauwa and Giwa, investigated the thermal performance of building envelopes for buildings in Abuja, Nigeria. The paper aimed at determining the thermal performance of building envelope types, mainly walls, that are commonly used locally and other prescribed/recommended typologies. This was carried out using computer-based simulation, with the aid of Integrated Environmental Solutions – Virtual Environment (IES-VE) software, in which thermal comfort temperature ranges was used as an indicator of performance. This helped to determine the durations in which thermally comfortable internal spaces can be obtained without reliance on non-natural means [heating, ventilation and air conditioning (HVAC) mechanisms]. The paper found that thermal comfort is obtainable for more than 50% of the occupancy periods in Abuja for all wall types, while the most commonly used wall types showed improved thermal performance of up to 70% during the hot season. The result can enable architects to make informed design decisions in creating thermally comfortable buildings, with attendant low energy implications.

The third paper by Gambo, Ibrahim, Lawan and Albert investigated the impact of small and medium construction companies' human resources management practices on

workers' performance. The paper examined human resources management touchstones such as training and development, selection criteria in construction firms and employee`s participation, using questionnaire survey of 40 small and medium-sized construction companies in Kano state, Nigeria. The finding revealed that human resources management practices such as: training and development, selection criteria in construction firms and employee's participation have an impact on worker`s performance in small and medium construction companies. The knowledge of this impact by stakeholders will help to increase worker`s performance and enhance productivity in the construction industry.

The next paper by Adu, Sanni and Asuquo, investigated stakeholders' perception of the causes and effects of variation orders in public construction projects in south-south zone of Nigeria. The study adopted the exploratory survey design approach, using 241 valid questionnaires distributed to professionals in the building construction industry. Data obtained were analysed using mean score method, and Kruskal Wallis tests. The findings of the paper revealed that change of work scope, errors and omissions in design, change in specifications by client, client`s financial difficulties and inadequate project objectives were the dominant causes of variation orders, while, the major effects include the increase in overall project duration, increase in project cost, disputes, schedule delays, and rework. The paper concluded that, there is similarity in the perception of the stakeholders, recommending that Construction Professionals should adopt the results for effective project delivery.

The fifth paper by Ujene and Udoudoh evaluated home qualities and sustainability concerns, with a view to providing an insight into the importance of sustainability concerns on quality of homes occupied by federal income earners in Akwa Ibom state. This study adopted a cross-sectional survey design using structured questionnaire purposively administered on 208 households. Data were analysed using descriptive, relative importance index and Kruskal Wallis test. The paper concluded that there were 45.5%, 50.0% and 72.7% significant home quality attributes among low, medium and high-income earners respectively. There were 76.2%, 71.4% and 66.7% significant housing sustainability concerns among low, medium and high-income earners respectively, with minimal concerns attaining high level consideration. The study concluded that there is significant variation in the home qualities of the various income groups, but there is no significant difference in their sustainability concerns. It was recommended that the low and medium income earners should put more consideration on economic sustainability concerns so as to enhance their home quality, while the high-income earners should include social concerns together with improved concerns of environmental sustainability for enhanced housing development and maintenance.

The next paper by Lashinde and Ekung investigated the application of BIM in construction projects delivery in Niger-Delta, Nigeria. The paper employed the qualitative and quantitative approaches in generating data from One hundred and twenty participants in the six states of nine states of the Niger-delta with notable volume of construction projects and awareness of BIM tools. Data analyzed using mean score and criticality index, revealed that there are three main categories of the barriers in BIM based on the three main types of the stake holders in construction projects. The study unravelled the probability of occurrence and impact of the 14 barriers in construction project delivery, and also established that seven barriers were most critical. The study concluded that appropriate BIM development will enable construction industry to make expected contributions to the economic and development growth of Niger-Delta region. It was recommended that Government should support the adoption and implementation of BIM in all capital projects at the three tiers of government, while the professional bodies in the

construction industry should mandate training and retraining of their members on the application of BIM.

The seventh paper by Ujene aimed at providing insight into the level of application of different decision techniques, as well as the prioritization the factors militating against their adoption in Akwa Ibom state. The paper used a cross-sectional survey of 150 professionals who practice as construction project managers in the study area. Data were collected using questionnaire and analysed using mean score and Kruskal Wallis test. The result showed that there is inadequate utilization of quantitative techniques in decision making among construction managers, while the adoption of quantitative techniques is seriously plagued by many factors. The significance attached to, poor awareness by the supervisory managers was attributed to their lower educational level and experience. The significance attached to inadequate skills and knowledge by middle managers was attributable to inadequate training and experience. The importance attached to data unavailability and inadequate training curriculum by top and middle managers was attributable to poor data management by many companies, as well as inadequate course content in institutions. It is recommended that construction managers should be encouraged through organisational polices which support the development of data bank, adequate training and skills, while Government agencies should ensure that quantitative method curricula adequately cover the required knowledge areas.

The next paper by Edike and Odusami carried out a review of the performance characterization of waste polyethylene terephthalate modified mortar and concrete. The aim of the paper is to present a state-of-the-art review of recent studies on performance properties of concrete and mortar production using waste plastic with a view to identifying areas of further improvement. The study found that waste plastics have been successfully incorporated into concrete and mortar production at various modes and levels of applications as aggregates, fibres, binding agent and as an encapsulate in eco-bricks production. Also, strength performance of plastic modified concrete and mortar are considerably reported in contemporary literature but studies on determination of life span of building components produced with waste plastics are currently not available. The paper recommended that the application of waste plastics as an alternative material for the production of concrete and mortar with special mix design would help reduce and partly prevent the environmental nuisance caused by plastic waste.

The ninth paper by Adeagbo aimed at evaluating the efficacy of public-private partnership arrangements for affordable housing delivery in Nigeria by investigating obstacles to PPP's efficacy, and examining variables that could enhance PPP's efficiency in affordable housing delivery in the research region. Survey research design was used for the study with population of the study drawn from Architects, Quantity Surveyors, Civil Engineers, Contractors and Project Managers. A structured questionnaire was used to collect data from 51 valid responses. The results revealed that the main variables influencing housing delivery through Public Private Partnership (PPP) were the issues of inaccessibility to land in good place and insufficient financing by the mortgage scheme. The factors that challenge PPP's efficiency in housing delivery were absence of political will to reduce housing construction costs, lack of anti-corruption measures, absence of powerful legislative structure, and absence of adequate mortgage scheme. The paper recommended that government should prioritise the provision of land in attractive location and subsidise construction costs for affordable housing projects.

The next paper by Effiong and Nissi is aimed at strengthening Town Planning Laws and property management as a measure of reducing the incidences of building collapse in Nigeria. The research relied on secondary source of data. Findings revealed that the lack of proper implementation of town planning laws has contributed to the incidence of

building collapse. Corruption seems to be a "canker worm" that has eaten deep into the fabric of professionals in the built environment. Non-involvement of Estate Surveyors and Valuers in the management of private and public properties has to some extent contributed to the menace. The paper recommended that all states of the federation should domesticate and implement Urban and Regional Planning Law; and all contractors, building developers, state government and the general public should be more proactive at addressing this scourge, while professional bodies saddled with the duty of regulating building development should find ways of raising the standard of practice and develop sustainable approach to tackle the emerging development challenges.

The eleventh paper by Adeagbo made an attempt to investigate factors responsible for poor cost performance of construction projects in Abuja, Nigeria. The paper adopted purposive sampling method to collect data using structured questionnaire administered on 80 professionals handling public construction building projects in Abuja. The findings show that delayed payments to contractors, inflation, fraudulent practices, and inadequate financial planning are top critical factors contributing to poor cost performance. In addition, mobilisation of financial resources in advance, proper and realistic planning, efficient estimation process, training on value management, change management and procurement management are also crucial to minimise poor cost performance in construction industry. The study recommended that payments should be made to contractors without delay, decision making on projects should always be fast tracked, establishment of preventive measures against unethical practices should be in place. Management should focus more on human resource related issues and adequate planning using modern technology, as mitigating measures for minimising poor cost performance in construction projects.

The last paper by Umo aimed at educating Architects and other key players in the building industry on the concept and principles of wayfinding as it relates to architectural practice. The paper adopted a survey method, using structured questionnaire to obtain information from 40 architects each in Rivers and Akwa Ibom States. Data were collated, grouped and results represented in percentages using pie charts. The results generally showed that respondents do not have adequate knowledge of the concept and principle of architectural wayfinding. The poor knowledge was attributed to; lack of what wayfinding was in general, little or no familiarity of what the principles of wayfinding was and what they had to do with architecture, poor consideration of wayfinding as an integral design element and as such, little or no thought into its importance and effects. The study recommended that for buildings to be easily navigable, architects must understand the concept of architectural wayfinding and incorporate the various principles of wayfinding into their designs.

In conclusion, there is no doubt that these papers have advanced knowledge on theoretical and practical aspects of the built environment and have provided opportunity for increasing the stock of data and information on problems of the built environment and possible ways of providing solution to them. We look forward to more novel research papers for the next issues which will be out not too long.

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EFFECTS OF OVERHEAD COST OF CIVIL ENGINEERING PROJECTS IN NIGERIA

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ABSTRACT

Purpose: "General items" is an important cost center in civil engineering projects given the complexities of facilitative works and support services that are normally required in such projects. However, extant literature makes little or no difference between preliminaries in building projects and general items in civil engineering projects. This study, which focuses on overhead costs in civil engineering projects, was carried out to: (1) assess the factors affecting overhead cost of civil engineering projects, (2) determine the relationship between the factors and the overhead costs of civil engineering projects and; (3) determine the frequency of use of overhead cost items in civil engineering projects.
Design/methodology/approach: Respondents were conveniently selected from civil/structural engineers and quantity surveyors who have participated in civil engineering projects (n=73) in Nigeria. The data were analyzed using percentages, relative importance index, multiple regression and factor analysis.
Findings: It was found that the most important factor affecting the overhead cost of civil engineering projects is delayed payment. Based on factor analysis, it was concluded that the factors affecting overhead costs of civil engineering projects are either project or contractor-related. These two groups of factors were found to have significant effects on the overhead cost of civil engineering projects. Provisions for water supply, setting out and handover were found to be the predominant general items allowed in civil engineering projects. The possibility of payment delays should be assessed while estimating the cost of general items, and only applicable general items should be priced.
Research limitations/implications: Many types of civil engineering projects were considered in this study. Future studies may look at how overhead costs differ for different types of civil engineering projects.
Social implication: Delayed payment avoidance by the government will have a positive effect on the overhead and, ultimately, the overall costs of civil engineering projects.
Originality/value: This study ascertained the frequency of use of general items in civil engineering projects. It also determined the domains of the variables that affect the overhead cost of civil engineering projects. Most previous studies on construction project overhead costs were based on building projects.

Keywords: Civil engineering projects; general items; overhead cost; preliminaries.

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1. INTRODUCTION

Nowadays, the competitiveness of the construction industry forces contractors to tender for projects with low margins – profit, incidental expenses, project overhead costs and company's overhead (Plebankiewicz & Leśniak, 2013). Lowering a contractor's overhead costs could be a veritable way of increasing his profit on a project. Nevertheless, contractors' overhead costs will not go down on their own without conscious efforts by the contractors. The construction industry is an extremely competitive market largely controlled by prices. To maintain competitiveness, construction firms have to continuously seek to reduce their project cost while concurrently providing quality products and service to their clients (Patil & Bhangale, 2014). Experience shows that direct cost items are estimated with higher accuracy than overhead costs (Chan & Pasquire, 2004). This reflects a lack of understanding of the factors affecting project overhead costs. With the increasing complexity of construction projects, overhead cost estimates have become complicated and require expertise from contractors' planners and estimators. Although overhead costs may not be regarded as the most significant cost center, they constitute an important cost center for winning and executing projects at a profit (Hesami, & Lavasani, 2014). A contractor should understand his overhead costs to be able to make appropriate allowances for them in his bids (Siskina *et al*., 2009). Assaf *et al*. (2001) stated that the unbalanced construction market makes it problematic for contractors to decide on the optimal level of overhead costs that allow the contractors to win open tenders and to manage huge projects without financial losses.

Civil engineering projects are frequently complex. Usually, the projects require the deployment of heavy construction equipment with attendant logistical planning and estimating. Additionally, the complexities of such projects often necessitate more expensive preliminary (general) items than those normally used for building projects. Beside the general items expressly required by clients, the Civil Engineering Standard Method of Measurement Fourth Edition (CESMM4) provides for contractors to state the methods they intend to use in the execution of projects and to price same under method related charges. This provision, which does not apply to building projects, is necessary to compensate contractors for the huge expenditure on overheads in civil engineering projects. Irrespective of this, extant literature on factors affecting project overhead costs make no distinction between overhead costs of civil engineering and building projects.

Existing studies have attempted to identify the factors affecting overhead costs of construction projects (Enshassi *et al*., 2008; Ujene, Idoro & Odesola, 2013), but they have poorly shown the extent to which the factors affect the costs. Such a perspective is necessary in order to adequately inform contractors on the relatedness between the factors and the overhead costs themselves. Furthermore, the frequently used overhead cost items in construction sites should be identified to aid contractors' estimators to know which preliminary cost items are likely to be necessary in a typical civil engineering project. Juszczyk and Leśniak (2019) noted that it is difficult to unambiguously determine which preliminary cost item is of highest importance in construction projects. Contractors' estimators will benefit greatly if they are able to prioritize the attention given to the factors affecting civil engineering overhead costs, which will lead to overhead cost optimisation in the long run. Consequently, this paper: (1) assesses the factors affecting overhead cost of civil engineering projects, (2) determines the relationship between the factors and the overhead costs of civil

engineering projects and; (3) determines the frequency of use of overhead cost items in civil engineering projects.

2. FACTORS AFFECTING PROJECT OVERHEAD COSTS IN CIVIL ENGINEERING PROJECTS

Civil engineering projects are diverse and require high construction expertise for execution. Such projects as roads, railways, tunnels, dams, ports and harbors are examples of civil engineering projects. While they present opportunities for contractors to shore up their turnovers due to the large sums of money involved, they also present huge risks of losses should things go contrary to plans. Overhead cost items often provide the framework for managing and controlling cost-risk events due to their facilitative and supportive nature.

Construction project overhead cost is defined as the cost that cannot be classified with or charged to a unit of construction production (Plebankiewicz & Leśniak, 2013). Cilensek (1991) viewed overhead cost items as supportive works that do not form part of the intended permanent works. Project overhead costs include items that can be identified with a particular job, but are not materials, labor, or production equipment. They are expenses that cannot be charged directly to a particular branch of work, but are required to construct the project (Dagostino, 2002). In general, a building contractor's overhead costs are divided into two categories: project (field) overhead costs and home office overhead costs (Peurifoy & Oberlander 2002; Nabil & El-Riyati, 2015; Ronald & Lumbantoruan, 2019). Home office overhead costs are also called general or administrative overhead costs. Overhead costs represent fixed operational costs which must be expended by the contractor in order to do business (Leśniak & Juszczyk, 2018). Home office overhead costs include all those expenses made by the home office that cannot be tied directly to a given project such as home-office building rental, clerical staff and utility bills. These costs are distributed over all company projects by some basis. The overhead cost referred in this study includes both home office and project (field) overhead costs given that both types of overhead costs are included in the general items of civil engineering projects.

It is a commonly held opinion that the more complex a project is, the more its overhead cost. Also, there are misconceptions about the factors affecting overhead costs in the construction industry in Nigeria. Related past studies (El-sawy *et al.*, 2011; Hesami & Lavasani, 2014; Ujene *et al*., 2013; Chan, 2012; Chao, 2008) show that project duration is an important factor affecting project overhead cost. The authors further viewed some overhead cost elements like telephone tariff, electricity bill, staff salaries, plant rental as time-related. Project type, project location and contract type are among other variables affecting construction project overhead costs (El-sawy *et al.*, 2011; Hesami & Lavasani 2014; Ujene *et al*., 2013). Hesami and Lavasani (2014), Ujene *et al*. (2013) and Chan (2012) identified project complexity as also affecting overhead cost. Presently, there exists numerous unorganized suggestions on the factors affecting overhead cost of projects. It is necessary to statistically group these variables in order to ascertain their categories for effective management of project overheads. Secondly, most of the studies shown in Table 1 were based on building projects. Hence, given the often significant difference between overhead costs in civil engineering and building projects, it is important to ascertain the prevalent factors affecting overhead costs in civil engineering projects.

Table 1: Factors affecting overhead cost of construction projects

S/N	FACTORS AFFECTING OVERHEAD	El-Sawalhi and El-Riyati (2015)	El-sawy *et al.* (2011)	Patil and Bhangale (2014)	Hesami, and Lavasani (2014)	Ujene *et al.*, (2013)	Chan (2012)	Chao (2008)
1	Difficulties in obtaining materials	√						
2	Financial liquidity of the company/contractor's cash availability	√			√	√		
3	Schedule/Mechanism of contract payments	√			√	√		
4	The experience in implementing similar projects	√			√			
5	Construction Firm Category		√					
6	Project Size		√		√			√
7	Project Duration		√		√	√	√	√
8	Project Type		√		√	√		√
9	Project Location		√		√	√		√
10	Type-Nature of Client		√			√		
11	Type of Contract		√		√	√		
12	Contractor-Joint Venture		√					
13	Site Terrain and Preparation Requirements		√					
14	Project need for Extra-Man Power		√					
15	Delay payment			√				
16	Lack of new project			√				
17	Cost inflation			√	√			√
18	Government regulation			√				
19	Firm’s growth			√				
20	Similar Project Availability				√			
21	Site layout (Shape of site)				√		√	√
22	Contractor’s designing necessities				√		√	
23	Extent of bond/warranty requirement				√		√	
24	Stakeholders’ Profit				√		√	
25	Familiarity and Influence in Area				√			
26	Work Scope				√			√
27	Required quality level of projects				√			√
28	Country in performing the project,				√			
29	Company classification				√			
30	Assigning work to subcontractors				√	√		
31	Number of competitors				√	√		
32	Method of performing the project				√			
33	Project Management method				√			
34	Tendering method				√		√	
35	Contractor's need for work				√	√		
36	Regional Economic condition				√		√	
37	The client' s strictness in supervision				√			
38	Project complexity				√	√	√	
39	The type, size and policy of construction firm					√		
40	Contractor’s experience with client					√		
41	Type of consultants					√		
42	Level of available information					√		
43	Fraudulent practices and kickbacks					√		

3. RESEARCH METHODOLOGY

This study examines the relationship between overhead cost factors and overhead cost of civil engineering projects. The population of interest to the study was on-going or recently completed civil engineering projects. A sample frame could not be obtained for such projects in Nigeria. Consequently, engineers and quantity surveyors who normally manage the cost of such projects were contacted by emails and personal contacts, and requested to fill the questionnaire, or forward them to other colleagues who are better suited to provide the responses. Seventy-three (73) suitably filled copies of the questionnaire were returned and used in the analysis. For each project, the study obtained the importance of the factors affecting its overhead costs on a Likert scale (5- very important, 4- important, 3- moderately important, 2- less important, 1-not important), identified the overhead cost items used for the project as well as the percentage of overhead cost to the contract sum of the project.

The overhead cost items included in the questionnaire were obtained from the list of preliminary items (n=61) in the Building and Engineering Standard Method of Measurement Fourth Edition (BESMM4) (Nigerian Institute of Quantity Surveyors, 2015). Some adjustments were, however, made on the list. For example, the employer's requirements section of the list was expunged since the items there were equally captured in the Main Contractor's Cost Item section. Similarly, in the Mechanical Plants section, roadwork and earthwork plants were included because this study primarily focuses on civil engineering projects. These and similar adjustments brought the total number of items to 50. The frequencies of occurrence of the preliminary items on site were grouped into always (>80%), often (>60≤80%), average (>40≤60%), sometimes (>20≤40%), and seldom (≤20%). The respondents were asked to select the project overhead cost items applicable to their projects, and to rank the factors affecting overhead costs identified from literature based on their experience on their respective projects.

3.1. Data analysis

Based on the argument that mean and standard deviation are poor indicators of ranking since they do not reflect the relationship between the variables being ranked, this study used relative importance index to rank the variables affecting overhead cost in civil engineering projects (Doloi, et al., 2012).

$$RII\ (Relative\ Importance\ Index) = \frac{\sum w}{AN}$$

W - Weight given to each attribute by respondent
A - Highest weight
N - Total number of respondents

Using factor analysis, the factors affecting overhead costs were reduced to a more parsimonious set of variables. The factor analysis was carried out using the Statistical Package for Social Sciences (SPSS) version 22 and varimax rotation. In factor analysis, the minimum allowable value for the Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy test is 0.6, and Bartlett's test of sample sphericity should be significant (i.e. $p<0.05$) (Fellows & Liu 1997; Field 2005). Variables with loading ≥0.50 were considered to have loading significantly following the recommendations of Kaiser (1974). The factors

were saved as variables for use in multiple regression analysis. Using multiple regression analysis, the factors were related to the percentage of overhead cost to contract sum of the projects.

4. PRESENTATION OF RESULTS

4.1. Demography of the respondents

Table 2 shows the characteristics of the respondents and types of projects covered by the study. Most of the respondents were civil/structural engineers (n=46, 63.01%), while road construction projects dominated in the type of projects (n=34, 46.58%). Majority (n=25, 34.25%) of the respondents have had 6 – 10years construction industry work experience. Overhead cost to contract sum percentage of the projects was grouped in ranges of 1-5%, 6-10%, 11-15%, 16-20% and above 20%. Table 2 shows that for most (n=26, 35.62%) of the projects, the overhead cost was 6-10% of the contract sum. This is partly within the range of 8-15% reported in literature by Enshassi *et al*. (2008). These results support the use of the data gotten from the study for the analyses that follow.

Table 2: Demography of the respondents

Criteria	Categories	Frequency	Percentage (%)
Profession	Civil/Structural Engineering	46	63.01
	Quantity Surveying	27	36.99
Project Type	Road construction	34	46.58
	Drain construction	14	19.18
	Power infrastructure	8	10.96
	Oil and gas related	4	5.48
	Erosion control	7	9.59
	Others	6	8.22
Construction industry work experience	1 – 5year	17	23.29
	6 – 10years	25	34.25
	11 – 15years	14	19.18
	16 – 20years	12	16.44
	Above 20 years	5	6.85
Overhead cost to Contract sum in percentage	1-5%	6	8.22
	6-10%	26	35.62
	11-15%	18	24.66
	16-20%	19	26.03
	Above 20%	4	5.48

4.2. Analysis of factors affecting overhead cost of civil engineering projects

Table 3 shows the RII ranking of the factors affecting overhead cost of civil engineering projects based on the respondents' opinions. Delayed payment (RII=0.882) is the overall most important factor affecting the overhead cost of civil engineering projects. Normally, when payments are delayed, the contractor may stop work altogether, while retaining personnel and heavy construction equipment on site. Overhead cost losses due to interruptions in the progress of construction owing to delayed payment are normally

contested by the client, making it difficult for the contractor to be adequately compensated in this regard. The 2nd ranking variable is site layout (RII=0.852). An uneconomical site layout will impede project progress and therefore affect the contractor's overhead cost. In the same vain, it can affect the length of access road required, the extent of materials storage on site, and the general work flow. Table 3 shows that all the factors obtained from literature affect civil engineering project overhead cost to some degree since all the variables have RIIs of ≥0.5, except project need for extra man power (RII=0.447). The engagement of extra manpower in a project does not necessarily increase the project overhead cost since site labour is more production related than time-related.

Table 3: Ranking of factors affecting overhead costs of civil engineering projects

Code	Factors affecting overhead cost	RII	RANK
x15	Delay payment	0.882	1
x21	Site layout (Shape of site)	0.852	2
x6	Project Size	0.844	3
x43	Fraudulent practices and kickbacks	0.819	4
x4	Experience in implementing similar projects	0.803	5
x40	Contractor's experience with client	0.803	6
x30	Assigning work to subcontractors	0.797	7
x32	Method of performing the project	0.797	8
x7	Project Duration	0.795	9
x9	Project Location	0.792	10
x38	Project complexity	0.792	11
x25	Familiarity and Influence in Area	0.778	12
x13	Site Terrain and Preparation Requirements	0.775	13
x27	Required quality level of projects	0.764	14
x10	Type/Nature of Client	0.753	15
x26	Work Scope	0.753	16
x39	The type, size and policy of construction firm	0.753	17
x33	Project Management method	0.742	18
x29	Company classification	0.74	19
x16	Lack of new project	0.737	20
x23	Extent of bond/warranty requirement	0.734	21
x36	Regional Economic condition	0.734	22
x42	Level of available project information	0.732	23
x19	Firm's growth	0.726	24
x28	Country of performing the project	0.726	25
x3	Schedule/Mechanism of contract payments	0.723	26
x34	Tendering method	0.723	27
x24	Stakeholders' Profit	0.718	28
x8	Project Type	0.712	29
x37	The client' s strictness in supervision	0.71	30
x17	Cost inflation	0.704	31
x5	Construction Firm Category	0.693	32
x22	Contractor's designing necessities	0.688	33
x35	Contractor's need for work	0.679	34
x2	Financial liquidity of the company/contractor's cash availability	0.66	35
x20	Similar Project Availability	0.655	36
x31	Number of competitors	0.655	37
x41	Type of consultants	0.655	38
x11	Type of Contract	0.638	39
x18	Government regulation	0.586	40
x1	Difficulties in obtaining materials	0.581	41
12	Contractor-Joint Venture	0.51	42
x14	Project need for Extra-Man Power	0.447	43

4.3. Factor analysis

The factor analysis was conducted using Varimax rotation, and the results are displayed in Table 4.

Table 4: Factor analysis result

		FACTOR	
CODE		1	2
x6	Project Size	0.889	
x7	Project Duration	0.852	
x43	Fraudulent practices and kickbacks	0.844	
x27	Required quality level of projects	0.837	0.501
x32	Method of performing the project	0.835	
x4	The experience in implementing similar projects	0.831	
x39	The type, size and policy of construction firm	0.826	0.517
x38	Project complexity	0.823	0.526
x13	Site Terrain and Preparation Requirements	0.822	0.525
x21	Site layout (Shape of site)	0.818	
x9	Project Location	0.807	0.519
x42	Level of available information	0.775	0.601
x40	Contractor's experience with client	0.769	0.58
x28	Country of performing the project	0.767	0.61
x10	Type/Nature of Client	0.755	0.607
x30	Assigning work to subcontractors	0.755	0.597
x26	Work Scope	0.754	0.618
x3	Schedule/Mechanism of contract payments	0.75	0.63
x15	Delay payment	0.745	0.56
x36	Regional Economic condition	0.74	0.642
x8	Project Type	0.736	0.646
x33	Project Management method	0.726	0.653
x22	Contractor's designing necessities	0.724	0.622
x35	Contractor's need for work	0.714	0.648
x25	Familiarity and Influence in Area	0.703	0.652
x17	Cost inflation	0.701	0.684
x11	Type of Contract	0.676	0.672
x16	Lack of new project	0.67	0.665
x14	Project need for Extra-Man Power		0.918
x12	Contractor-Joint Venture		0.874
x18	Government regulation		0.861
x1	Difficulties in obtaining materials	0.541	0.811
x19	Firm's growth	0.532	0.776
x24	Stakeholders' Profit	0.603	0.748
x5	Construction Firm Category	0.62	0.744
x31	Number of competitors	0.605	0.741
x41	Type of consultants	0.638	0.735
x37	The client' s strictness in supervision	0.603	0.729
x2	Financial liquidity of the company/contractor's cash availability	0.653	0.726
x20	Similar Project Availability	0.67	0.698
x29	Company classification	0.652	0.698
x23	Extent of bond/warranty requirement	0.644	0.697
x34	Tendering method	0.673	0.694
	Eigenvalue	39.032	1.147
	Percentage of variance explained	51.101	42.338
	Cumulative percentage of variance explained	51.101	93.439

The KMO measure of sampling adequacy was appropriate at 0.910, while the Bartlett's Test of Sphericity was suitable at 9181.560 (df = 903. Sig.= 0.000). Loadings ≤0.50 were suppressed. A two-factor solution was obtained based on the point of deflection on the Scree plot (Figure 1).

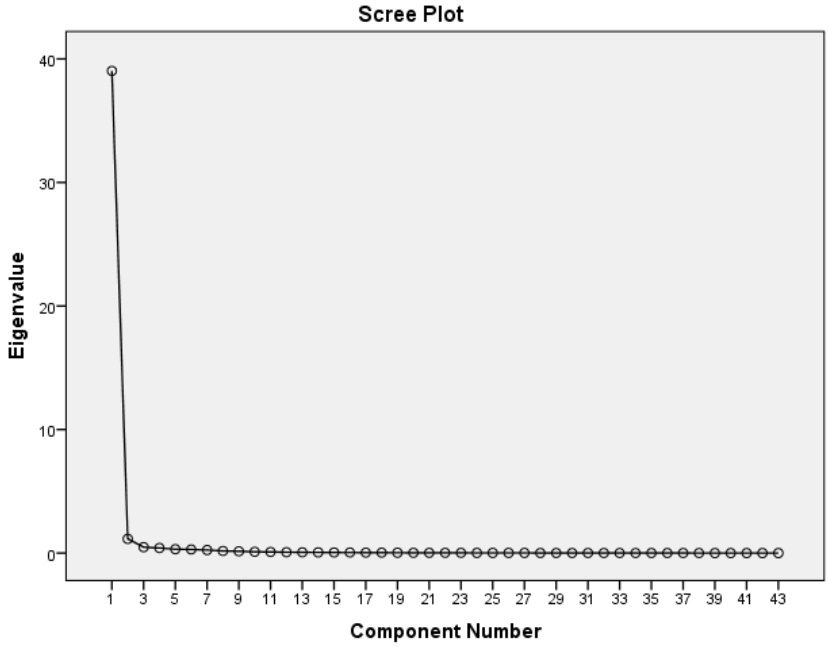

Figure1: Scree plot

5. DISCUSSION OF FINDINGS

5.1. Factor 1: Project-related factors

Project-related factors form the first domain of factors affecting the overhead cost of civil engineering projects. The first factor was named "project-related factor" on account of the high loading on variables such as project size (0.889), project duration (0.852) fraudulent practices and kickbacks (0.844) and required quality level of projects (0.837). These overhead cost factors vary relative to projects. For instance, project sizes differ. Whether measured in terms of cost of construction or complexity, overhead cost will tend to increase with increasing project size. A number of other authors have identified project-related factors such as project complexity, location and size as affecting the overhead cost of projects (Hesami & Lavasani, 2014; Ujene *et al*., 2013), which aligns with the findings of this study. Assaf *et al*. (2001) ranked delayed payment and lack of new project as 1st and 2nd reasons for increase in company overhead cost of contractors. Enshassi *et al*. (2008) ranked the variables as 4th and 2nd respectively. ElSawy *et al*. (2011) equally concluded that project type, size, location and site conditions are important determinants of project overhead cost. Consistent with the results of this study, these previous findings point to the issues surrounding the project as the major determinant of its overhead cost. Project related factors explain 51.101% of the variance in the data, which means that they are better predictors of overhead cost in civil engineering projects than contractor-related variables. This agrees with Kumaraswamy and Chan (1998), where the respondents ranked project-

related factors as more important than contractor-related factors in terms of effects on project delay.

5.2. Factor 2: Contractor related factors

Factor 2 is related to variables that point towards issues within the contractor's control. Essentially, the contractor's role is site assemblage or construction of a designed project. Ultimately, how much he spends on facilitative resources and works will depend on his managerial abilities at the project site level. The major variables underpinning factor 2 include project need for extra-man power (0.918), contractor joint venture (0.874), government regulation (0.861), difficulties in obtaining materials (0.811) and firm's growth (0.776). In the event of supervisory personal or technical man power becoming necessary at the site level, the project overhead cost is bound to increase, although such an event could arise from poor planning on the part of the contractor. The high loading of government regulation reflects the effects of government's policies on the contractor's overhead cost budget in civil engineering projects. For instance, policies requiring registration with certain public bodies before a contractor could tender for public projects, or local taxes and permits demanded by state and local governments have influences on contractors' overall cost of project overheads. Previous studies by Kumaraswamy and Chan (1998) and Lo, et al. (2006) identified contractor-related factors among the factors responsible for delays in construction projects. The present result suggests that such delays eventually lead to higher overhead costs.

5.3. Influence of factors on the overhead cost of civil engineering projects

The data obtained showed that, generally, the overhead costs of the projects ranged from 3% to 25% of the total project cost, with a mean of 11.9315% and a standard deviation of 5.508%. Table 5 shows the summary of the regression analysis between the factors affecting overhead cost of civil engineering projects and the overhead costs of the projects.

Table 5: Regression Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.441[a]	.194	.171	5.01439

a. Predictors: (Constant), Project related factors, Contractor related factors

Table 6: Relationship between factors and overhead costs of civil engineering projects

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	11.932	.587		20.330	.000
	Project Related Factors	2.013	.591	.365	3.406	.001
	Contractor Related Factors	1.358	.591	.247	2.298	.025

a. Dependent Variable: overhead cost

The predictive power of the model though considerably low, (adjusted R^2=17.1%), Table 6 shows that the independent variables are significant since $p<0.05$ for both project-related and contractor-related factors. This result confirms that the project overhead variables indeed affect the overhead cost of civil engineering projects in line with

expectations in previous studies. However, it gives room for researchers to investigate other factors which may contribute to overhead costs in such projects given that the adjusted r^2 is 17.1%.

Table 7: The frequency of use of general items in civil engineering projects

CODE	COMPONENT	TICK	%	FREQUENCY
C13	Temporary Water Supply	73	100.0%	
C24	Setting Out	73	100.0%	
C39	Handover	73	100.0%	
C12	Sundries	72	98.6%	
C18	Security Staff	72	98.6%	
C31	Concrete Plant	70	95.9%	ALWAYS
C2	Project Specific Management and Staff	68	93.2%	
C1	Management and Staff	66	90.4%	
C11	Consumable and Services	66	90.4%	
C48	Performance/advance payment/bid bonds	66	90.4%	
C25	Protection of Work	64	87.7%	
C6	Staff Establishment	58	79.5%	
C37	Site Records	58	79.5%	
C33	Earthwork plant	56	76.7%	
C35	Access Scaffolding	51	69.9%	
C36	Temporary Works	51	69.9%	OFTEN
C43	Professional fees	51	69.9%	
C41	Site Tidy	45	61.6%	
C8	Temporary Works in Connection with Site Establishment	44	60.3%	
C15	Temporary Electric Supply	44	60.3%	
C20	Hoarding Fence and Gates	44	60.3%	
C44	Charges	44	60.3%	
C7	Site Accommodation	40	54.8%	
C26	Test Samples	40	54.8%	
C3	Visiting Management and Staff	37	50.7%	
C34	Other Plant	37	50.7%	
C38	Testing and Commissioning Plan	37	50.7%	
C32	Road work plant	34	46.6%	AVERAGE
C9	Furniture and Equipment	33	45.2%	
C10	IT Systems	33	45.2%	
C5	Staff Travel	29	39.7%	
C17	Temporary Drainage	26	35.6%	
C23	Environmental Protection Measures	23	31.5%	SOMETIMES
C40	Post-completion Services	18	24.7%	
C42	Maintenance of Work Paths and Paving	15	20.5%	
C30	Access Plant	12	16.4%	
C4	Extraordinary Support Costs	11	15.1%	
C16	Project dedicated temporary telecommunication systems	10	13.7%	
C22	Barriers and Safety Scaffolding	9	12.3%	
C19	Security Equipment	7	9.6%	
C49	Guaranties	7	9.6%	
C28	Mobile Crane	5	6.8%	
C21	Safety Programs	4	5.5%	SELDOM
C27	Tower Crane	4	5.5%	
C46	Public Liability Insurance	4	5.5%	
C47	Employer's (Main Contractor's) Liability Insurance	4	5.5%	
C29	Hoists	3	4.1%	
C14	Temporary Gas Supply	0	0.0%	
C45	Works Issuance	0	0.0%	
C50	Warranties	0	0.0%	

5.4. Frequency of use of overhead cost items in civil engineering construction sites

Table 7 shows the frequency of use of overhead (preliminary) cost items in the civil engineering sites covered by the study. Foremost overhead cost items reported to be applicable in most of the sites are temporary water supply, setting out and handover costs. Other cost headings like personnel, consumables, security provisions and protection of the work are within this category. These overhead cost items were in 80 – 100% of the projects, which means that they are always applicable in civil engineering construction sites in Nigeria. Ujene *et al*. (2013) identified personnel, consumables and temporary works costs as affecting the cost performance of educational and administrative building projects. The present study builds on that result by isolating the preliminary items that are always found on civil engineering projects sites in Nigeria. Further, it shows that preliminary items such as gas supply, warranties and insurance of works are hardly used in civil engineering projects in Nigeria, which means that contractors should carefully justify the pricing of any general item to be included in their bids by avoiding unnecessary overhead cost items. Use of percentages in the pricing of general items as noted by Jimoh and Adama (2011) should, therefore, be discontinued.

6. CONCLUSION

This study examined the factors affecting overhead costs and how they influence the overhead cost of civil engineering projects, as well as identified the frequency of use of overhead cost items in civil engineering projects. Firstly, it was discovered that the most important factors affecting the overhead cost of civil engineering projects are delayed payment, site layout and project size in decreasing order of magnitude. A factor analysis of the variables revealed that the factors affecting overhead costs of civil engineering projects can be summarized as either project-related or contractor-related although the former is more important than the latter. These two domains of overhead costs were found to have significant influences on the overhead cost of civil engineering projects. Eleven general items were found to be used always in civil engineering projects covered by the study. They include items such as temporary water supply, setting out and handover.

Based on the findings of this study, civil engineering project cost estimators should carefully examine the possibility of delayed payment occurring in the course of a project and factor this risk into their estimates for general items in their bids. Government should work harder to prevent payment delays in civil engineering projects due to its impacts on the overhead cost of the projects. Ultimately, this will lead to a significant drop in the overhead cost of infrastructural projects in Nigeria.

For project supervisors, careless site layout will be expensive in civil engineering projects. It is recommended that civil engineering project supervisors should carefully plan and optimize the layout out of their sites prior to commencement of site operations. This study has provided contractors will a checklist of the frequency of use of general items in civil engineering projects to which they can make reference in the course of bid preparation to avoid omission of important cost items. Furthermore, civil engineering estimators should ensure that only relevant general items are priced in their bids, instead of reducing their chances of winning the project by putting a price against every general item some of which may not be used in the project. This result further implies that the use of percentages in the computation of cost of general items should not be practiced in civil engineering projects.

This study confirms that the overhead cost influencers in civil engineering projects are project and contractor-related. Future studies should, however, investigate how overhead costs differ for different types of civil engineering projects.

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THERMAL PERFORMANCE OF BUILDING ENVELOPES FOR BUILDINGS IN ABUJA, NIGERIA

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ABSTRACT

Purpose: This research aims to determine the thermal performance of building envelope types, mainly walls, that are commonly used locally and other prescribed/recommended typologies.
Design/methodology/approach: This was carried out using computer-based simulation, with the aid of Integrated Environmental Solutions – Virtual Environment (IES-VE) software as the simulation tool, in which thermal comfort temperature ranges was used as an indicator of performance. As such durations in which thermally comfortable internal spaces can be obtainable without the reliance on non-natural means [heating, ventilation and air conditioning (HVAC) mechanisms] was determined.
Findings: The result showed that thermal comfort can be obtainable for more than 50% of the occupancy periods in Abuja for all wall types. Meanwhile the most commonly used wall types also showed improved thermal performance of up to 70% during the hot season.
Originality/value: Thus, the research was able to demonstrate in very clear terms, the comparative thermal performance of wall types used as building envelopes in Abuja-Nigeria. This approach also shows the importance of computer-based simulation in evaluating building design options. Thus, enabling architects to make informed design decisions in creating thermally comfortable buildings, with attendant low energy implications (for cooling) as well as the achievement of sustainable built environment. The research was also able to determine/demonstrate actual thermal performances of wall types prescribed in local building codes, which hitherto, have remained largely prescriptive.

Keywords: Building envelope; computer simulation; Nigeria; sustainable buildings; thermal performance.

1. INTRODUCTION

It has been established that buildings are responsible for about 40% energy consumption and responsible for up to a third of greenhouse gas emissions globally. Hence, it comes as no surprise that the push for more energy efficient and sustainable building design has been on the rise. This move is more evident amongst the developed

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countries where policies, regulations and benchmarks abound stipulating one form of compliance or the other. Examples include code for sustainable homes in the United Kingdom (UK), the leadership in energy and environmental design (LEED) building rating system in the United States of America (USA) and the German Sustainable Building Council (DGNB) system in Germany just to mention a few.

Energy Efficiency in Buildings standards is also making inroads within developing countries as exemplified by the emergence of numerous Green Building Councils in Africa, the Excellence in Design for Greater Efficiencies (EDGE) rating system in South Africa and Ghana, as well as the Buildings Energy Efficiency Guide (BEEG) in Nigeria amongst others.

Incidentally, building development in Nigeria, particularly within office typologies, and commercial and high-end housing markets are towing the line of various systems and standards for sustainable design. These emerging practices has more or less been attuned to global business practices and signification rather than compliance to any green or sustainable building targets. Despite the recent development of the building code as well as BEEG, there is limited evidence to suggest compliance within the industry.

Within this purview therefore, it is evident that there is a significant demand for improvement in building envelope performance, largely due to the role which building envelopes play in the control and demand for energy within buildings – such as through its impact on thermal comfort and ultimately cost of energy, amongst others.

Hence this research intends to evaluate the performances of recommended building envelopes specifications obtainable within local regulatory frameworks as well as other locally applicable building envelope typologies.

2. REGULATIONS FOR BUILDING ENVELOPES IN NIGERIA

In architecture, building envelope is a design variable which consists of structural materials and finishes that enclose space, separating inside from outside; balances requirements for ventilation and daylight while providing thermal and moisture protection appropriate to the climatic conditions of the site (Reffat, 2004) The building envelope is often described as a function of its permissible heat flow or heat resistance (overall heat transfer co efficient) which is described as its U-value (Papadopoulos & Giama, 2007); (Yang, Yan, & Lam, 2014). U-values have been established for a variety of materials and are available in building standards.

This information allows designers/architects to evaluate material response to climate in relation to their design requirements. For example, Cheng, Ng, and Givoni (2005) examined the effectiveness of a building's envelope in free flow building using three different levels of mass (low, medium and high) with the same heat loss coefficients for three buildings in the hot humid climate of Sala, San Diego. On the hottest summer day of the research, the high- mass building obtained an indoor temperature of 24.5˚C when outdoor maximum was 34˚C. (Shaviv, Yezioro, and Capeluto (2001)) and Ogoli (2003) reported similar results where indoor temperatures of up to 4˚C and 7˚C lower than outdoor maximum were obtained using a variety of materials for the building envelope in hot humid and equatorial climates of Israel and Kenya respectively.

Also, in Givoni's (2005) analyses, the relationship between the indoor maxima and various parameters of the outdoor climate demonstrated that the best correlation exists between the outdoor average and the indoor maximum temperatures. However, "it is also

widely believed that in a hot humid climate, like Florida, it is not recommended to use thermal mass with night ventilation as a passive cooling design strategy" (Shaviv *et al*., 2001). This suggests that ventilation strategy other than natural ventilation may have to be employed, because in this case the diurnal temperature swing between day and night is not enough to dissipate heat gains. Collectively, the examples given above demonstrate that the building envelope is an important factor which influences the amount of energy a building will consume during its occupancy phase as a result of cooling, heating or lighting demand. It also demonstrates that a solution for a particular climate may not necessarily be applicable to another. Therefore, a set of particular specifications may be required for every design and location. As a result, countries have developed policy/regulations that are peculiar to their situations.

In Nigeria, the National Building Code (NBC) was the first regulatory document developed (in 2006) at national level for the regulation of the built environment development and used complimentarily with local regulations such as the Development Control Manual (DCM) for Abuja. Though the NBC contained specific guidelines that were more detailed compared to the DCM, it did not contain any clear/specific regulations towards the development of energy efficient and sustainable built environment components (Dahiru, Abdulazeez & Abubakar, 2012). Additionally, guidelines related to design issues were sometimes loosely defined. For example, the regulation on ventilation for office buildings was simply to provide natural and/or mechanical ventilation. Again, this is an open-ended regulation where the architect/developer has the discretion to design either a low energy or energy intensive building. Other regulations, again rather open-ended and perhaps vague, include that of the external wall and roof construction. For instance, the regulation for roof construction simply stipulates that roof design is done in conventional manner with minimum pitch of 30^{o}. Generally, the enactment of the NBC has been widely applauded, however, researchers have uncovered its shortfalls and in its review recommended that issues such as energy efficiency in buildings, sustainability and performance thresholds/indicators are incorporated (Dahiru *et al*., 2012; Mu'azu, 2011).

More recently, there has been increasing demand for a robust road map for energy efficiency in buildings which critically takes into account local and global considerations towards obtaining sustainable built environments (Ochedi *et al.*, 2016; Amasumou *et al*., 2017). Consequently, the Buildings Energy Efficiency Guidelines was developed by the Federal Ministry of Power, Works and Housing in conjunction with the Energy Commission of Nigeria (ECN) and in collaboration with German Corporation for International Cooperation (GIZ) as part of the National Energy Support Programme (NESP). This document provided finer details compared to what is obtainable in the NBC. Notwithstanding, the recommendations emphasised the need to incorporate an integrated design process in the development of building designs taking numerous lessons from bioclimatic design disposition as well as vernacular architecture of the sub regions. As such, the recommendations were more performance based and less of technical specifications in nature in which computer-based simulations have become widespread due to its reliability, cost effectiveness and have also been applied in developing world contexts (Musa *et al.*, 2018; Jimoh & Onazi 2019).

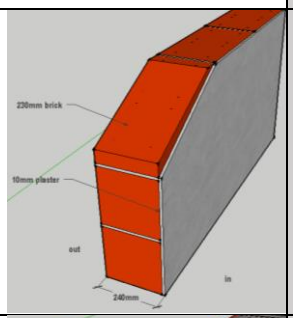
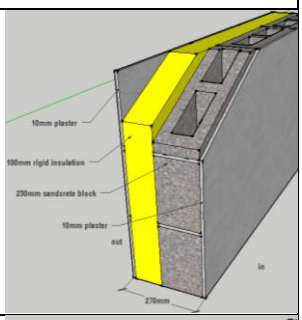
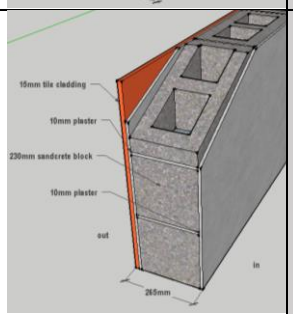
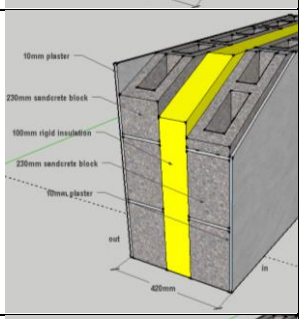
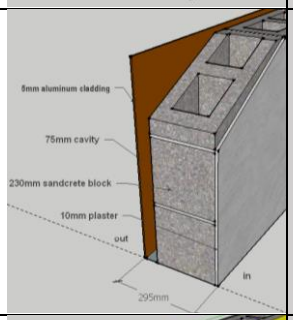
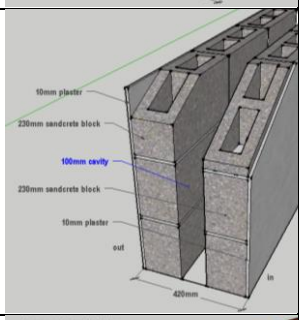
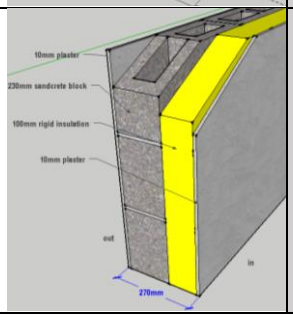
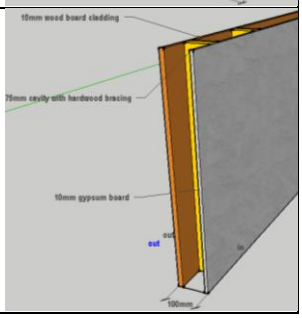
3. EVALUATING PERFORMANCES OF BUILDING ENVELOPES

3.1. Building envelope typologies

Eight building envelope types were selected for evaluation. Nine-inch cement based (*Sandcrete*) blocks is the most popular type of block used for buildings in Nigeria and it is

one major recommendation contained in the NBC for building envelopes. Bricks are seldom used. Notwithstanding, the typology is also included for evaluation. Furthermore, the sandcrete blocks are often clad with tiling or aluminium particularly in recent developments. Other wall types often recommended but with limited local application include insulated walls, cavity walls and wooden walls. Table 1 shows the wall types whose performance were evaluated.

Table 1: Wall types used as building envelopes in Abuja, Nigeria

	General description	**Sectional diagram**		**General description**	**Sectional diagram**
Wall 01	Brick wall, with plastered internal face		Wall 05	block wall with insulation to the external and plastered on both faces	
Wall 02	Block wall with plastered internal face, and tile clad external face		Wall 06	Double wall with insulation in between and plastered on both faces	
Wall 03	block wall with plastered internal face, and aluminium clad external face		Wall 07	Double wall with cavity in between and plastered on both faces	
Wall 04	block wall with insulation to the internal and plastered bon both faces		Wall 08	Lightweight wall made of wood board to the external and gypsum board to the internal.	

3.2. Thermal performance evaluation

Studies have shown that cooling load demands account for up to 50% of energy consumed in buildings. This suggest that a reduction in the demand for cooling has a

significant potential in reducing building energy consumption. Therefore, the longer the duration in buildings where comfortable temperature ranges are obtainable, the lower the potential energy demands. The objective of the simulation in this section is therefore to identify the wall type with the best thermal performance.

With the adoption of the attainment of satisfactory thermal requirement as a performance indicator, a design degree day method was adopted as for thermal comfort evaluation. In this method, base-case temperature is identified and the total duration with cooling or heating requirement (to achieve comfort) is calculated (Day, Knight, Dunn, & Gaddas, 2003). Due to climatic disposition of Abuja, only cooling degree days CDD are examined because of the prevalent high temperature which negates the demand for heating throughout the day time or working hours.

Also, the Humphery's adaptive thermal comfort model was chosen because it suits buildings designed based on natural ventilation strategy (Yang *et al*., 2014). Though there exists a few variations in the adaptive thermal comfort model, Humphrey's formula was adopted in this research because result from fieldwork aimed at developing thermal comfort indices for various locations in Nigeria corroborate the adaptive model (Adunola, 2014) (Ogbonna & Harris, 2008). It is also considered that when mean external temperature range between 10^{o}C and 30^{o}C, then adaptive thermal comfort is applicable in the design of naturally ventilated building (Humphreys, Rijal, & Nicol, 2013).

Nicol, Humphreys, and Roaf (2012) showed that the adaptive thermal comfort temperature can range from +/-2^{o}C to as high as +/-7^{o}C depending on the adaptive options available to the occupants. However, in this research the more conservative median temperature range of +/-3^{o}C is applied to enable gradual acclimatisation for the occupants already accustomed to air-conditioned spaces.

According to this model, adaptive thermal temperature range for Abuja is between 24.0^{o}C and 28.5^{o}C while mean annual comfort temperature is 26.1^{o}C. Therefore, impact of design iterations (output) will be aimed at achieving maximum duration of temperature ranges between 22^{o}C and 29^{o}C.

Table 2: Summary of properties of selected wall types

Wall type	Thickness (mm)	U-value (W/m^{2}K)	R-value (m^{2}K/W)	Mass (kg/m^2)
Wall 01	240	2.4189	0.2363	307.80
Wall 02	265	2.0814	0.2982	607.75
Wall 03	320	1.5992	0.4482	554.10
Wall 04	270	0.0807	12.2154	393.00
Wall 05	270	0.0807	12.2154	393.00
Wall 06	420	0.0787	12.5364	1106.00
Wall 07	420	1.1192	0.7164	1097.00
Wall 08	100	1.6071	0.4452	29.20

4. PERFORMANCE EVALUATION USING COMPUTER-BASED SIMULATION

Computer based simulation have become increasingly popular in the last few decades for the purposes of performance evaluation. Among the numerous software available, Integrated Environmental Solutions Virtual Environment (IES-VE) is the simulation software chosen for this research while and the validation exercise for the software has been provided elsewhere (Mu'azu, 2015). One of the considerations for its selection is the

capability of the software to conduct energy load deductions due to numerous factors including heat gains, design alterations etc.

Furthermore, the simulation tool contained a module known as Macroflo which deals with bulk air flow movement. The module adopts zonal airflow calculations to estimate bulk air flow movement in and within the building, driven by wind and buoyancy induced pressure. As such air movements and associated temperature responses can be deduced. This was sufficient from an architectural perspective, to analyse infiltration and natural ventilation gains in buildings.

Otherwise, a detailed numerical simulation of fluid flow and heat transfer process used in computational fluid dynamics would have been required. This level of understanding in building physics and engineering is beyond the scope of this research.

4.1. Simulation constants

Abuja was selected as the site location and its attendant simulation weather files input was made constant throughout the simulation using a one sample model building. Occupancy profile, which is the duration investigated was also made constant. This reflected mainly official working hours of 0800-1700hrs daily from Monday to Friday throughout the year culminating to a total of 2340hrs. This represents daytime hours which also encapsulate durations when high temperatures are mostly obtainable.

5. Results and Discussion of Findings

5.1. Results

Fig 1 shows the thermal performance of all the walls types with the thermal comfort durations expressed in percentages of occupied hours. The chart also shows performances during hot months which spans from January – June months and throughout the year. A detail of monthly performance analyses of each wall type is provided in Appendix A.

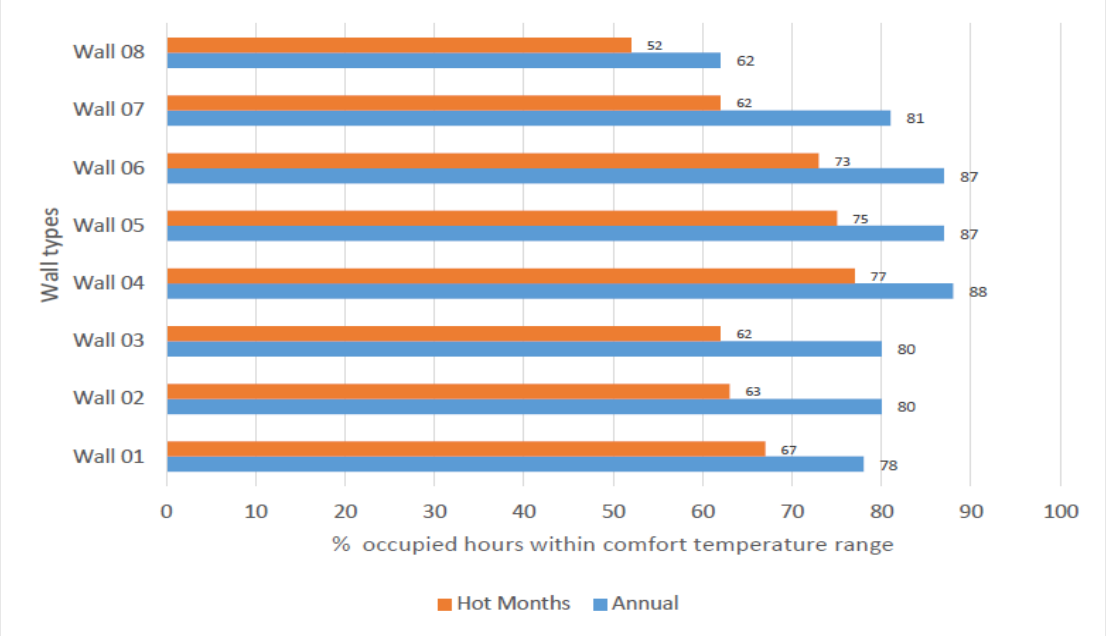


Figure 1: Thermal performances of wall types from simulation

5.2. Discussion of findings

The wall types, wall 01, wall 02 and wall 03 prescribed in local building codes and commonly obtainable within the local built environment are all capable of providing thermally comfortable internal spaces for a minimum of 50% of the occupancy periods. Though the literature review suggested poor/non-robust energy efficient content in the local building regulations, in which case structural integrity enjoyed more concern as against any environmental/thermal performance requirements (Dahiru *et al.*, 2012; Geiseller *et al.* 2018).

However, the results showed that the existing regulation for walls is indeed energy efficient. Whether this is by mere coincidence or well calculated is another matter entirely. It also showed that the trending material used for cladding has limited/insignificant implication on the building's thermal performance. In fact, wall 02 and 03 showed a lower performance during hot season compared to the widely used wall 01.

Meanwhile, for the much-advocated insulated wall types, all the types evaluated (wall 04, 05 and 06) showed the high thermal performances, providing thermally comfortable internal spaces for longer than 70% of the occupancy periods both in the hot season and all year-round scenarios. Furthermore, providing insulation towards the external leaf showed improved performance compared to all other iterations (even though marginally). Notwithstanding, the difference of 1% performance has the potential of translating to a more significant implication particularly when considering a life cycle analyses.

In addition, even though it is obvious that the cost implication of constructing the insulated walls will be higher than the common uninsulated wall (wall 01), this cost component may be viewed as a hindrance against the adaptation of this type of wall construction for higher performance building envelopes. However, detailed energy analyses over the building's life cycle with focus on the attendant cost of energy consumed versus cost of construction can reveal the trade-offs or return on investment for choosing the insulated wall type. Moreover, it has been argued that green/energy efficient buildings can come with a price particularly at the initial stage (Dalibi *et al*. 2017).

Conversely, the result showed that the cavity wall (wall 07) had a poorer performance compared to that of insulated walls though generally higher than the widely used common wall (wall 01). In fact, through the hot months, wall 01 showed better performance compared to wall 07. With this outcome, and coupled with the cost of constructing the cavity wall, it can be said that wall 07 is not recommended as a good thermal performance building envelope.

Lastly, wall 08, which is the wooden wall type showed the lowest thermal performance even though thermally comfortable internal space can be achieved for 50% of occupancy period. As this wall type is mostly associated with temporary structures and low-income dwellings, it can be said that an upgrade from this wall type to at least the common wall type (wall 01) can lead to an improved standard of living among the low-income households based on thermal performances.

6. CONCLUSION

The foregoing IES-VE simulation and results focusing on the envelope as a building element suggests that environmental simulation tools can strengthen the performance-based nature of existing building design guidelines in Nigeria towards energy efficiency and sustainable built environment.

The study also suggests that more is required to buttress current building regulations obtainable in Nigeria to adequately facilitate the evolution of energy efficient and sustainable buildings. The result demonstrates that an understanding of the fundamental ideas behind energy efficiency and sustainable design can always be deployed towards optimising the performance of key elements such as the building envelope.

For a country such as Nigeria, these findings are of high importance as it enables curtailing energy demand in buildings mainly for cooling through informed design decisions. As such, it has the potentials to play a key role in reducing energy demand, utility cost and adverse emissions (from use of generators, amongst others,. to bridge energy supply) gaps cannot be over emphasized.

Hence, information in this research also holds potential to inform the development of local and national regulatory frameworks appropriate to Nigeria and possibly further informing such developments in similar contexts.

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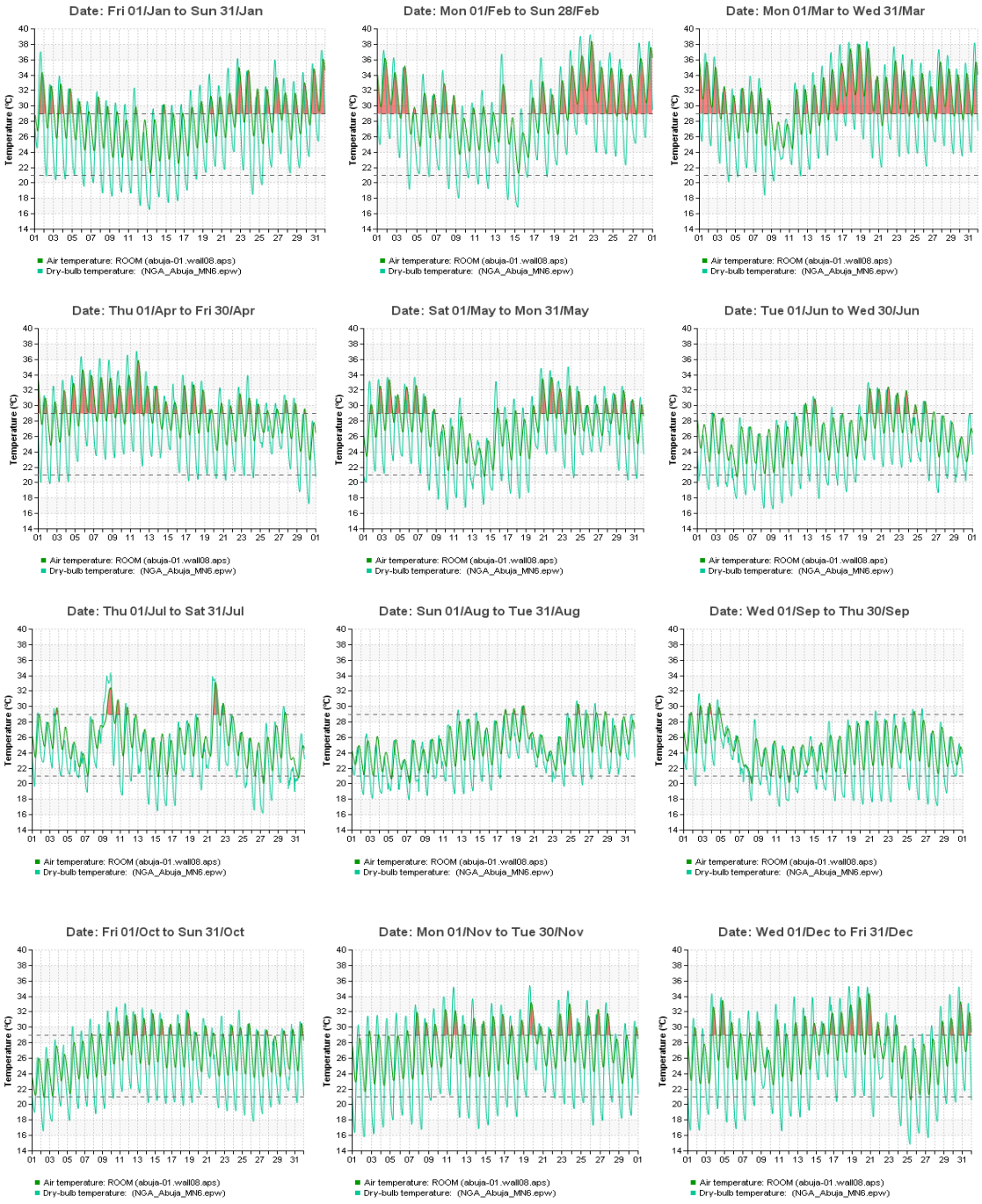
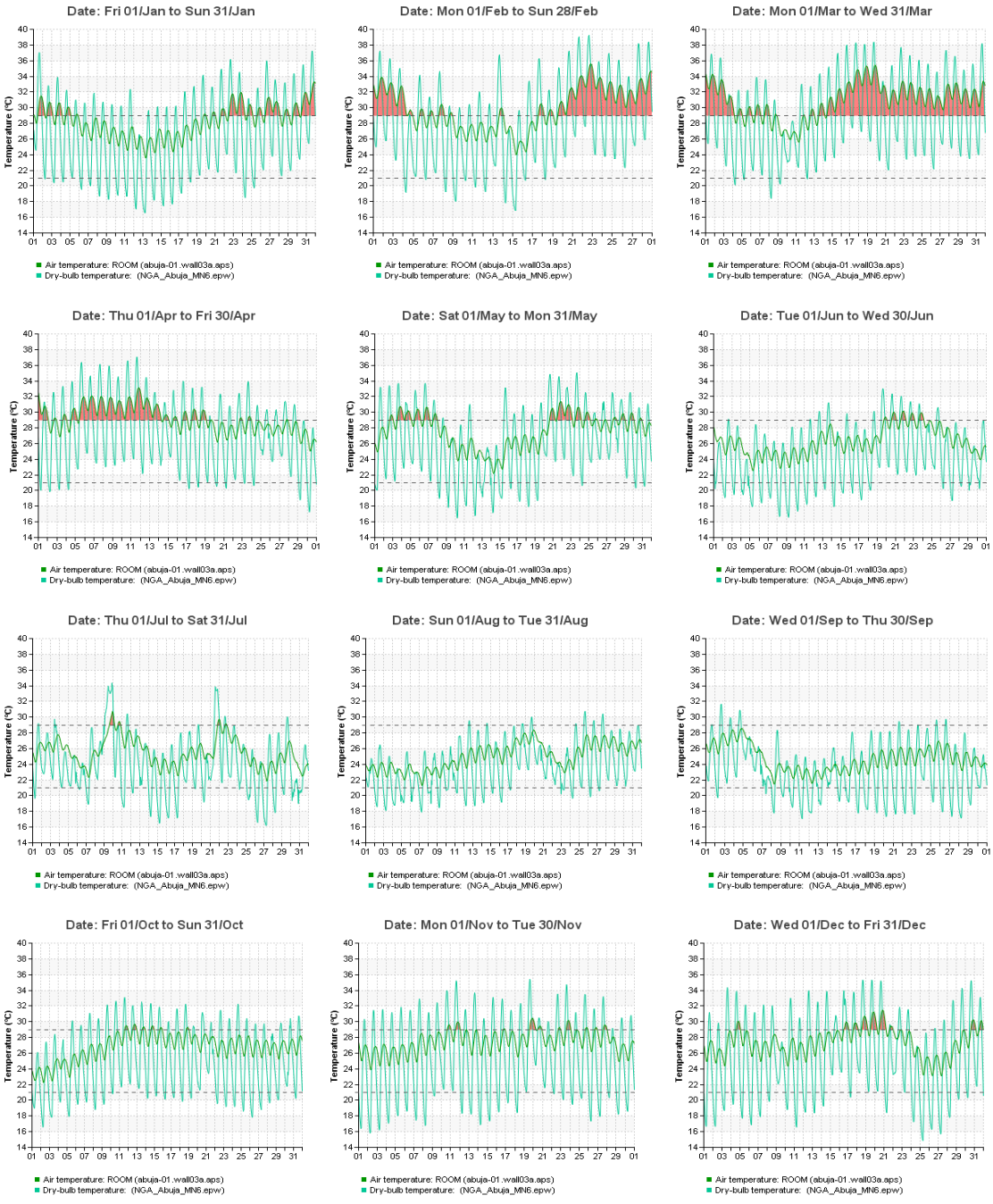
APPENDIX A: MONTHLY THERMAL PERFORMANCE OF WALL TYPES

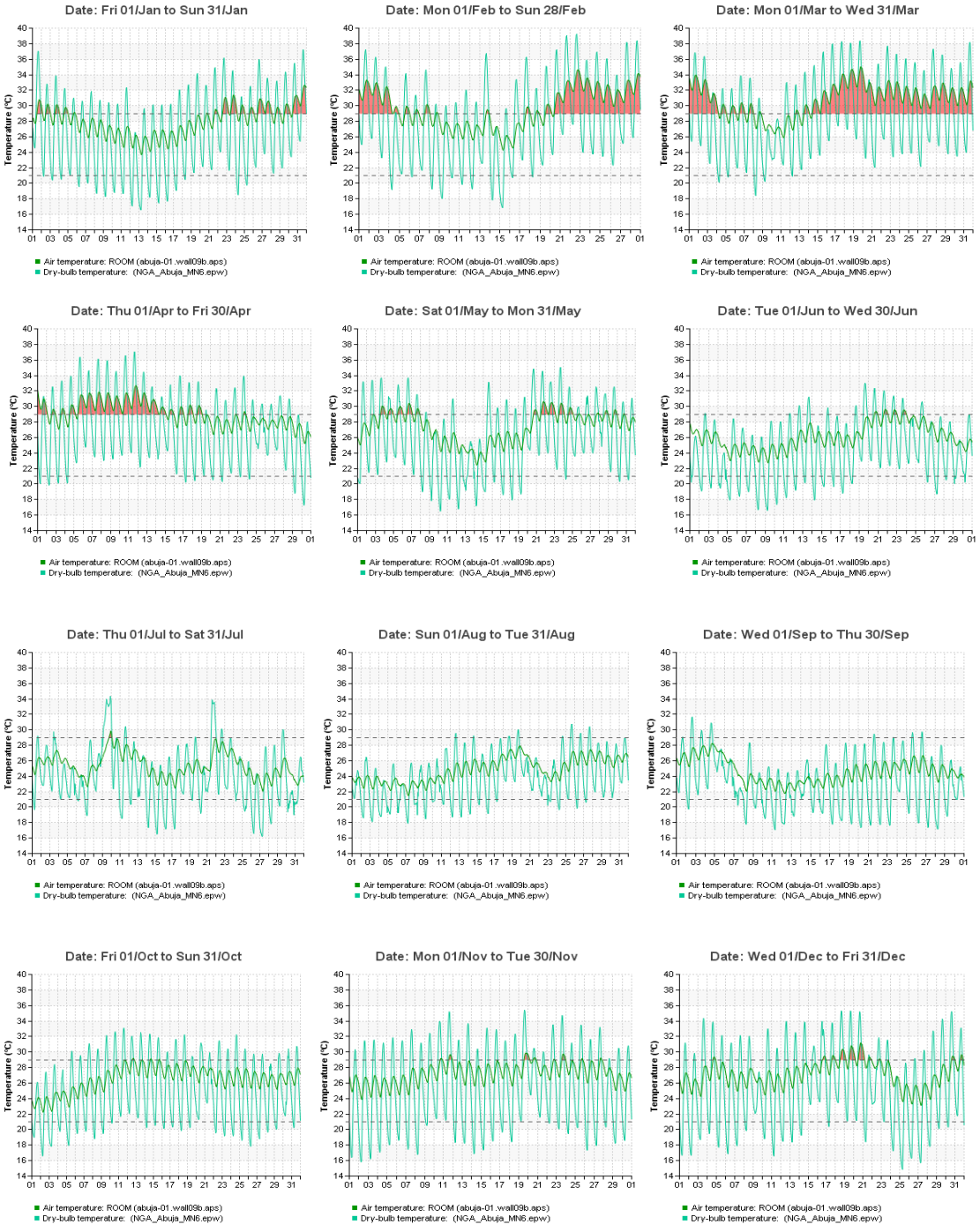
Descriptio	Wall ID: WALL – 01		Thermo physical properties			
	Material compositi (outside to inside	Thickn	U-value (W/m^{2}K)		2.4189	
	Common Brick		R-value (m^{2}K/W)		0.2363	
	Plaster		Mass (kg/m^2)		307.8	
			Thermal perfo (%)	Too cold <	Comfortable Between 21ºC and 29ºC	Too hot
			Annual		7	
			Hot months (Jan-Jun)		6	



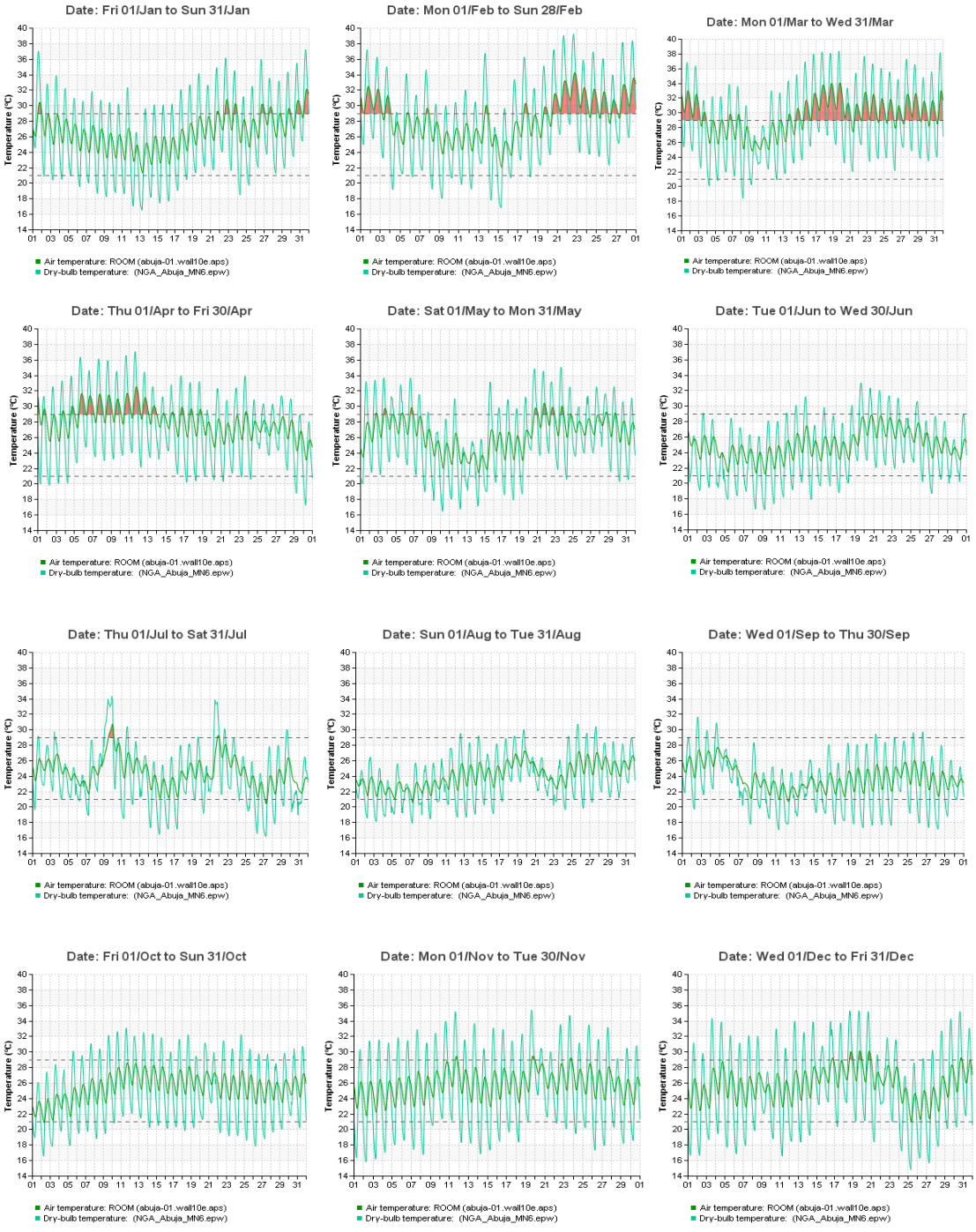
Descriptio	Wall ID: WALL – 02		Thermo physical properties			
	Material compositi (outside to inside	Thickn	U-value (W/m^{2}K)		2.0814	
	Granite		R-value (m^{2}K/W)		0.2982	
	Plaster		Mass (kg/m^2)		607.75	
	Hollow Concrete block		Thermal perfo (%)	Too cold <	Comfortable Between 21°C and 29°C	Too hot
	Plaster					
			Annual		8	
			Hot months (Jan-Jun)		6	



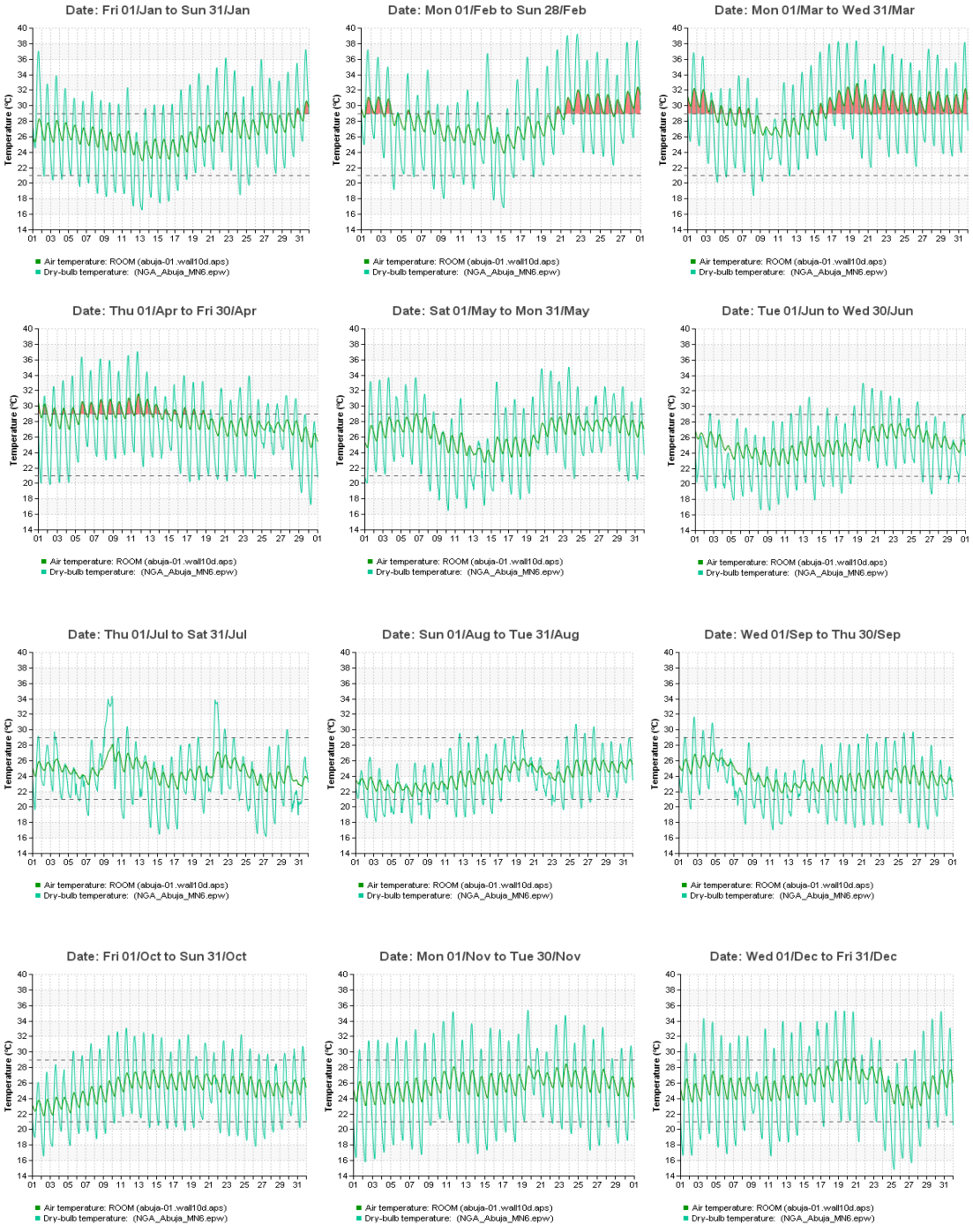
Descriptio	Wall ID: WALL – 03		Thermo physical properties			
	Material compositi (outside to inside	Thickn	U-value (W/m^{2}K)		1.5992	
	Aluminium sheet cladding		R-value (m^{2}K/W)		0.4482	
	Cavity		Mass (kg/m^2)		554.1	
	Hollow Concrete block		Thermal perfo (%)	Too cold <	Comfortable Between 21ºC and 29ºC	Too hot
	Plaster					
			Annual		8	
			Hot months (Jan-Jun)		6	

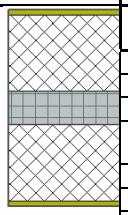


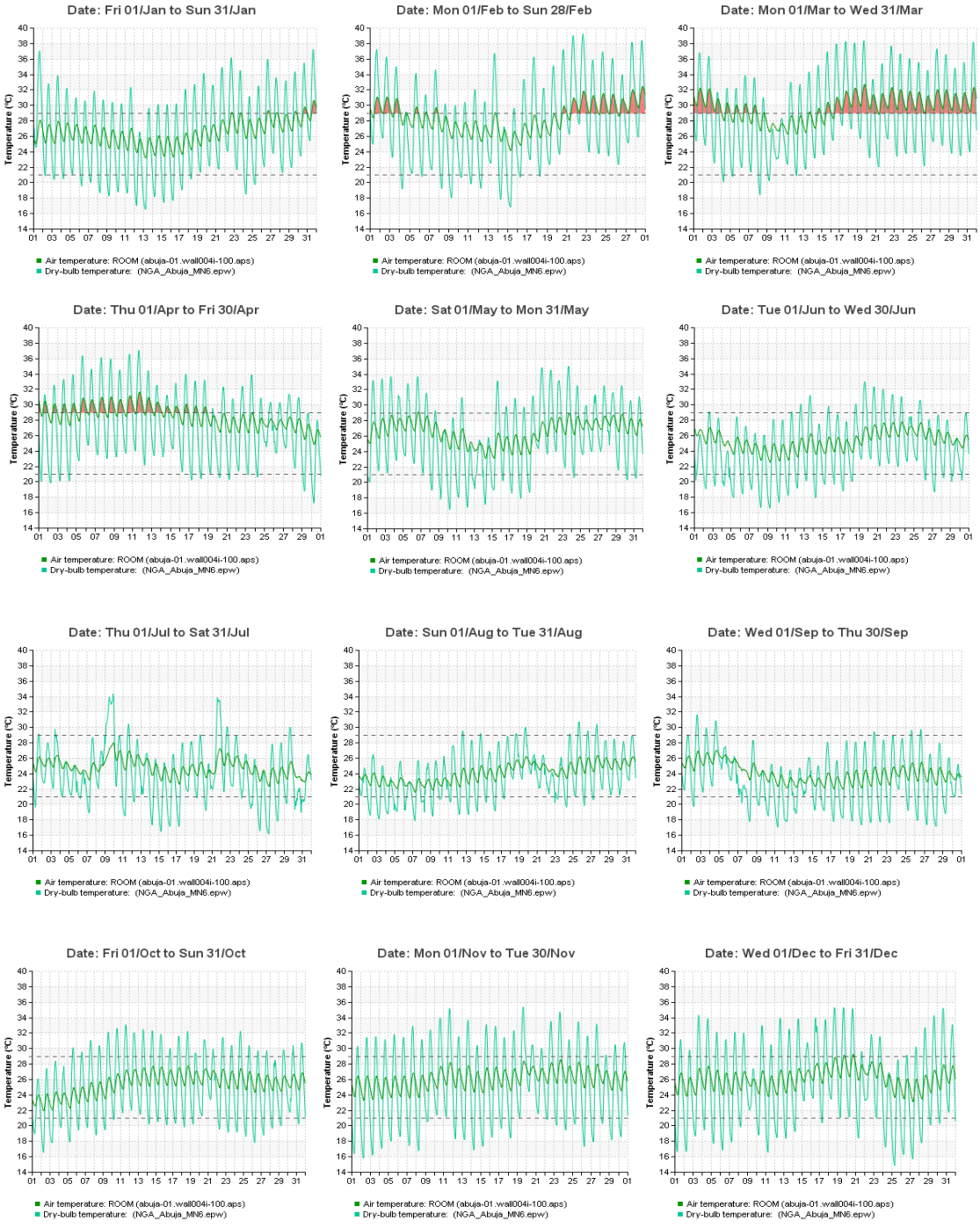
Descriptio	Wall ID: WALL – 04		Thermo physical properties			
	Material compositi (outside to inside	Thickn	U-value (W/m^{2}K)		0.0807	
	Plaster		R-value (m^{2}K/W)		12.2154	
	Hollow Concrete block		Mass (kg/m^2)		393.0	
	Insulation		Thermal perfo (%)	Too cold <	Comfortable Between 21^{o}C and 29^{o}C	Too hot
	Plaster		Annual		8	
			Hot months (Jan-Jun)		7	



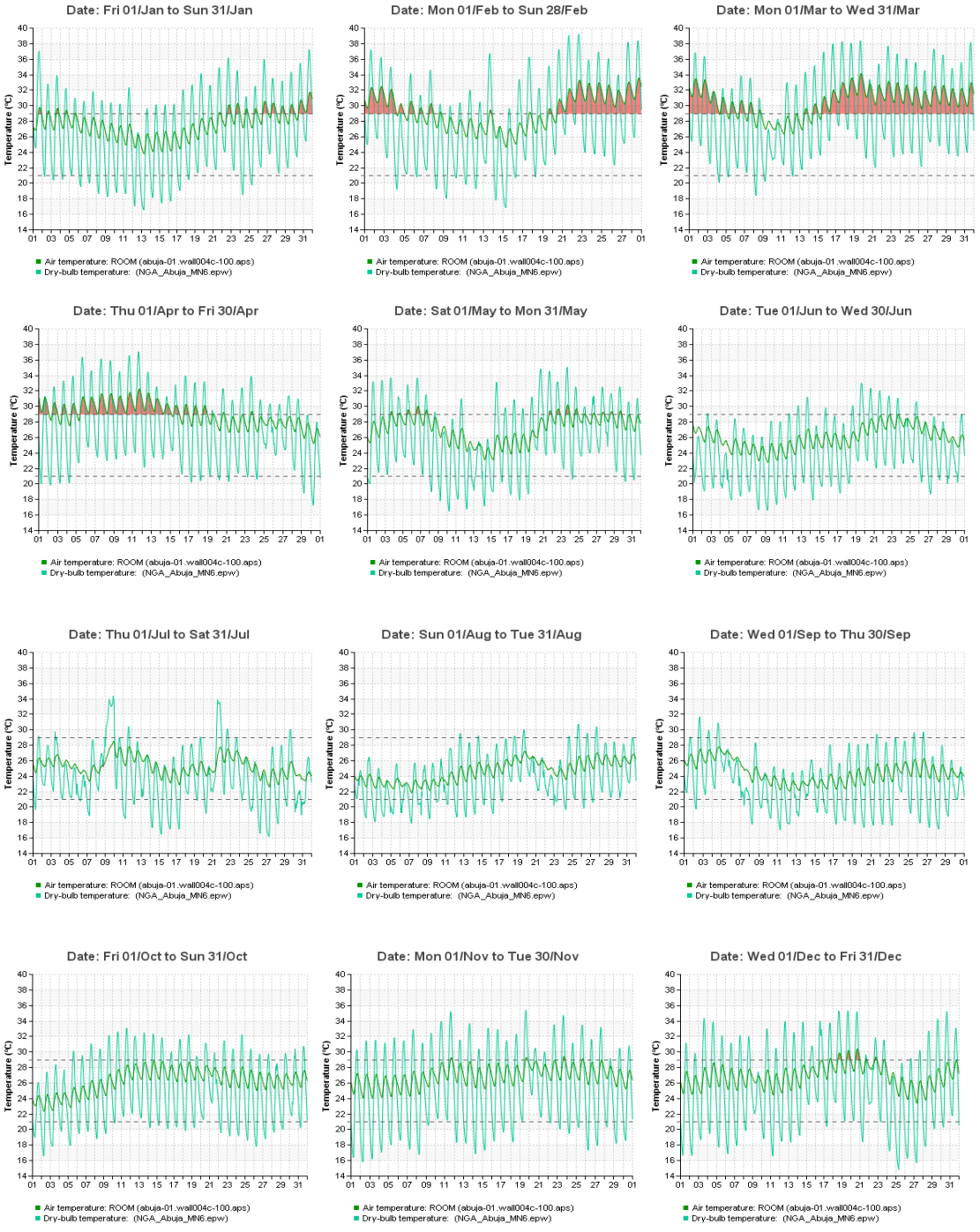
Descriptio	Wall ID: WALL – 05		Thermo physical properties			
	Material compositi (outside to inside	Thickn	U-value (W/m^{2}K)		0.0807	
	Plaster		R-value (m^{2}K/W)		12.2154	
	Insulation		Mass (kg/m^2)		393.0	
	Hollow Concrete block		Thermal perfo (%)	Too cold	Comfortable Between 21ºC and 29ºC	Too hot
	Plaster					
			Annual		8	
			Hot months (Jan-Jun)		7	



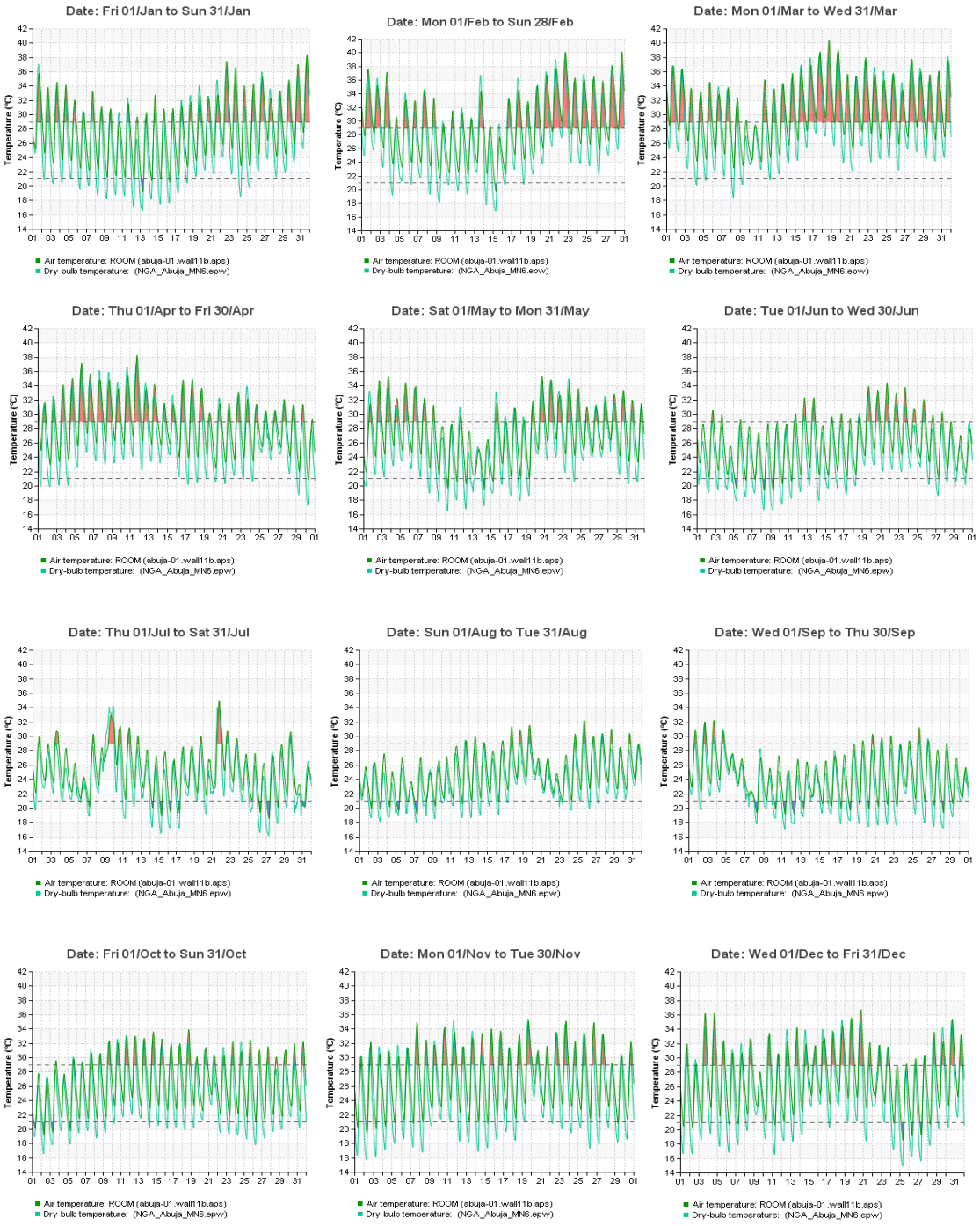
Descriptio	Wall ID: WALL – 06		Thermo physical properties			
	Material compositi (outside to inside	Thickn	U-value (W/m^{2}K)		0.0787	
	Plaster		R-value (m^{2}K/W)		12.5364	
	Hollow concrete block		Mass (kg/m^2)		1106.0	
	Insulation		Thermal perfo (%)	Too cold	Comfortable Between 21ºC and 29ºC	Too hot
	Hollow concrete block		Annual		8	
	Plaster		Hot months (Jan-Jun)		7	



Descriptio	Wall ID: WALL – 07		Thermo physical properties			
	Material compositic (outside to inside	Thickn	U-value (W/m^{2}K)		1.1192	
	Plaster		R-value (m^{2}K/W)		0.7164	
	Hollow concrete block		Mass (kg/m^2)		1097.00	
	Cavity		Thermal perfo (%)	Too cold <	Comfortable Between 21^{o}C and 29^{o}C	Too hot
	Hollow concrete block					
	Plaster		Annual		8	
			Hot months (Jan-Jun)		6	



	Material composit (outside to insid	Thickn	U-value (W/m^{2}K)		1.6071	
	Weather board		R-value (m^{2}K/W)		0.4452	
	Cavity		Mass (kg/m^2)		29.2	
	Gypsum plasterboard		Thermal perfo (%)	Too cold	Comfortable Between 21°C and 29°C	Too hot
			Annual		6	
			Hot months (Jan-Jun)		5	



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IMPACT OF SMALL AND MEDIUM CONSTRUCTION COMPANIES' HUMAN RESOURCES MANAGEMENT PRACTICES ON WORKERS PERFORMANCE

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ABSTRACT

Purpose: Studies in the human resources domain have made cases and brought forward evidence that human resources practices of organizations have an impact on worker`s performance. The challenge of understanding this assertion still exist in the construction industry especially in developing countries like Nigeria.

Design/methodology/approach: To clarify this, human resources management touchstones such as training and development, selection criteria in construction firms and employee`s participation were examined using questionnaire survey of 40 small and medium-sized construction companies in Kano state, Nigeria.

Findings: The finding revealed that human resources management practices such as: training and development, selection criteria in construction firms and employee's participation have an impact on worker`s performance in small and medium construction companies. The study concludes that human resources management practices have an impact on worker`s performance in small and medium construction companies.

Originality/value: Despite the importance of human resources management practices in achieving organisation objectives, research on the impact regarding small and medium construction companies in developing countries particularly in Nigeria is still scarce. Investigating the impact will increase worker`s performance and enhance productivity in the construction industry.

Keywords: Human resources management; small and medium construction companies; training and development.

1. INTRODUCTION

The construction industry is a major contributor to the Gross Domestic Product (GDP) of most countries and good employer of skilled and unskilled labour (Ibrahim and Shakantu, 2017). Naismith (2007) noted that variability in the number, type and size of construction projects undertaken by small and medium-sized construction company

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occurs frequently in the construction industry, which significantly affects the number of workers needed and available for the execution of construction projects. Buyens, Wouters and Dewettinck (2001) put forward that one of the most important resources a company can possess are workers. They further added that continuous training and development would encourage and retain key workers in a small and medium companies which enable them sustain competitive advantage over larger companies. Chen, Liaw and Lee (2003) submitted that successful human resource management is central to worker`s performance in the construction industry. Ameh and Daniel (2017) believed that low level usage of plants and machines in the construction industry in developing countries like Nigeria makes it imperative to heavily depend on human for its operations. Employees' competency and motivation is hinged on human resources practices adopted by construction companies (Moore, Cheng and Dainty, 2002). Human resources management involves, employment of qualified personnel, training and retraining of existing employees (Tabassi and Abu Bakar, 2009). Tabassi and Abu Bakar (2009) submitted that the level of training and motivation of construction workers determines the success of construction projects.

Huemann (2010) noted the acceptability of human resources management, as a panacea to development. Ogunyomi and Bruning (2016) noted the acceptability of human resources management in the behavioural sciences domain in order to achieve set targets. But on the other hand, Loosemore, Lingard and Dainty (2003) submitted that researchers in the construction industry have paid little attention to human resources management. Again, Tabassi, Ramli and Bakar (2012) believed that research regarding the impact of human resources management policies relating to workers training, development and participation is suboptimal in the construction industry. Furthermore, Price and Newson (2003) noted that large numbers of small and medium construction companies exist in most countries however, they often record abysmal performance with respect to human resources management. Empirical research on human resources management practice is lean in the Nigeria construction industry. Studies available on human resources management with respect to the Nigerian construction industry includes those of Ameh and Daniel (2017), who`s study focused on the challenges and practices of human resources management in Lagos, Nigerian. The study revealed that although, due process was often employed during recruitment process but interference from various quarters often disturb the process. The study further revealed that orientation and training for newly recruited staff members are hazily carried out. A study by Adeagbo and Oyemogun (2014) focused on factors influencing human resource development in the Nigerian construction industry. The study concluded that increase in performance and productivity and market forces/economy and technology are major drivers for human resources development among local construction firms in Nigeria. Even with the growing body of research in this area, none of these studies have specifically focused on examining the impact of small and medium construction companies' human resources management practices on worker's performance from a developing country`s perspective. The only research close to this research is the work of Ajayi, Akinsiku and Salami (2019) which focused on factors affecting human resources practices in small construction firms in Lagos metropolis, Nigeria. The study concluded that performance appraisal, training, employee involvement and strategic development of staff are majorly adopted human resources practices by small construction firms in Lagos metropolis, Nigeria. It is on this premise that the research examines the impact of small and medium construction companies' human resources

management practices on worker's performance for a developing country`s perspective and particularly the Nigerian construction industry.

2. LITERATURE REVIEW

2.1. Human resources management

Human resources management focuses on attracting, developing and retaining distinguished individual in an organization that will enable such organization to achieve set objectives (Ameh and Daniel, 2017). Jiang, Lepak, Han, Hong, Kim and Winkler (2012) submitted that selection criteria, participation of employees and training and development policies, and compensation policies are important human resources management policies employers need to focus on.

Beardwell and Holden (1997) noted that the development of employees' skills and ability solely lies in how effective companies' human resources management policies are effective. Chen et al. (2003) submitted that a robust and effective human resources management policy is a vital asset a company can own. This is not the case in the construction industry. Naismith (2007) provided evidence in his study why construction industry pays little attention to human resources management. He attributed the sensitivity of the construction industry to economic activity, continuous growth and development of cities which continuously demand for skilled and unskilled workers as the reasons why human resources management uptake is low. But Moore and Dainty (2001) specifically stated that the over-reliance on unskilled labour is the sole reason why the construction industry has paid little attention to human resources management. Shaffek (2016) believed that small and medium construction companies` nonchalant attitude to human resources management practices could be attributed to their over-dependence on the use of labour sub-contractor.

Zhai, Lui and Fellows (2014) study on the role of organisation`s management policies on human resources practices in enhancing organisational learning in Chinese construction organisation relived that management human resources practices have a significant positive effect on organisational performance. Similarly, Yankov and Kleiner (2001) noted in their study that human resources management practices have impact on worker participation, management and commitment and effective training. Tabassi and Abu Bakar (2009) study in Iran investigated the impact of human resources management practices such as: training, motivation on workers` performance. The finding revealed barriers to workers` performance are training and motivation. Ameh and Daniel (2017) study in Nigeria on the practices and challenges regarding human resources management in the Nigerian construction firms showed that the challenges inherent in the Nigerian construction industry are socio-cultural and training practices carried out are often shallow.

2.2. Training and development

Akdere (2003); Jon *et al*. (1999) defined employees training and development as the introduction of employees of an organisation to practices that improves their knowledge to carry out assigned duties effectively. To enhance employees' productivity, it is imperative to train and develop employees Huemann (2010) believed that workers training and development is imperative for a company continuous survival and existence. According to Jon *et al*. (1999), the onus of workers training development and skills acquisition lies

heavily on the shoulder of the executives, managers and supervisors. Tabassi *et al*. (2012) opined that current world development, particularly in the construction industry, requires employees with diverse experience, skills and knowledge. Loosemore *et al*. (2003) aver that the complexity and dynamism in the construction industry make training, development and workers participation a challenge to the industry.

2.3. Employee participation

Jiang, Lepak, Han, Hong, Kim and Winker (2012) posits that empowerment, employee participation, and dissemination of information are policies that determines employee's participation in an organization. Ichniowski, Kochan, Levine, Olson, and Strauss (1996) noted that training employees to recognize problems will enhance organization to achieve set objective, but given them the mandate to solve the problem will guarantee and enhance efficiency. Wilkinson (1999) submitted that small and medium companies do not give their employees the opportunity to have a viable trade union. Naismith (2007) opined that owners of organization do not support her employee`s participation in union activities due to individual ideological stance.

2.4. Selection and recruitment criteria in construction companies

Recruitment and selection of new workers with high competence could have an impact on worker`s knowledge and skills (Jiang et. al. 2012). Ostroff and Bowen (2000) added that proper recruitment and selection of job applicants with adequate skills, would have an impact on job applicants initial acquisition of knowledge and skills. Larraine and Cornelius (2001) suggested the criteria for the selection and recruitment of staff in organisation to be: assessment of needs skills and expertise, advertisement of vacancies to prospective applicants, establishment of appropriate remuneration for selected candidates. Naismith (2007) believed that when employees are poorly selected and recruited in small and medium construction companies without due diligence, discipline action could arise.

2.5. Compensation in construction firms

Compensation is an important human resources tool to motivate workers. Jiang *et al*. (2012) noted that a company compensation policy could be based on worker`s performance or worker`s seniority. Druker and White (1996) noted that organisations that fails to compensate it`s workers could lose its best workers to competitors. This might be a reason why Jiang et. al. (2012) believed that compensation policies are introduced by organizations in order to motivate an employee performance and effort rather than abilities when carrying out a task. Naismith (2007) opined that small and medium sized construction firms lack policies that caters for employee's compensation.

2.6. Small and medium construction companies

The small and medium construction companies are vital to the economic development of a nation. Kheni, Gibb, Gibb and Dainty (2006) noted that in developing countries, the small and medium-sized construction companies' carry out the majority of the construction project in developing countries. AbdulHafeez, Ibrahim and Mustapha (2016) posits that 80% of construction companies operating in Nigeria fall between micro, small and medium

scale business enterprises. DTI Statistical Bulletin (2004) put forward that 99% of the construction companies fall between small and medium-sized companies. Even with its constitution to the economy, Onugu, (2005) put forward that about 5–10% of small and medium companies fold up within their first 5 years of establishment. Mathis and Jackson (1991) attributed the early folding up of small and medium-sized companies to lack of adequate human resources management practices. Shafeek (2016); Dainty, Ison and Root (2004) noted that the emergence and rise in the use of small and medium construction companies as outsourced staff have made organization to pay little attention to human resources management. Furthermore, Naismith (2007) noted that little is known regarding small and medium construction companies key processes such as: selection and recruitment, employee participation and employees training and development.

3. RESEARCH METHODOLOGY

The study utilised a well-structured questionnaire for data collection for selected small and medium-sized construction companies in Kano state, Nigeria. Kano state was chosen due to the high rate of construction activities. According to the Directory of the Corporate Affairs Commission (CAC) 2019, there are Forty (40) fully registered small and medium construction companies in Kano state. The entirety of these companies were purposely sampled and a well-structured questionnaire was distributed to them. Purposive sampling was adopted in distributing questionnaires to the respondents in order to prevent bias as vigorously stated by Ngwenga and Aigbavboa (2017). All the distributed questionnaires retrieved, were valid and used for the analysis. The designed questionnaire was divided into two sections. The first section elicited response regarding respondent`s demographics while the other section focused on human resources management touchstones such as training and development, selection criteria in construction firms and employees participation. Thirty-three (33) numbers of questionnaires were returned and valid for analysis having 83% response rate. A 5-point Likert scale was adopted to seek information from respondents where: 1= Strongly disagree, 2= Disagree, 3= Neutral, 4= Agree and 5= Strongly agree. The Likert scale was transformed to Mean Item Score (MIS). Data from the field was analysed by using the relative importance index (RII) adopted by Ibrahim and Mbamali (2013) to determine ranking factors among the variables studied. The Interpretations of the mean values used are as follows:

RII < 0.60, item is assessed to have a low ranking

0.6 = RII < 0.80, item assessed to have high ranking

RII = 0.80, item assessed has very high ranking.

4. FINDINGS AND DISCUSSION

Table 1.1 shows that 36% of the respondents have more than 10 years of work experience working, 12% of the respondents have 6-10 years of work experience, 49% have 3-5 years of work experience and 3% of the respondents have less than 2 years of work experience. Table 1.2 depicts that 100% of the respondents are made up of males and non (0%) of the respondents were females. Table 1.3 shows that all of the respondents in the research are all graduates. None of the respondents fall under the undergraduate or postgraduate category. This means that all the respondents are capable to give valid response needed for the study.

Table 1.1: Work experience

S/N	Category	Frequency	Percentage (%)
1.	< 2 years	1	3
2.	3-5 years	16	49
3.	6-10 years	4	12
4.	> 10 years	12	36
	Total	33	100

Table 1.2: Gender

S/N	Category	Frequency	Percentage (%)
1.	Male	33	100
2.	Female	0	0
	Total	33	100

Table 1.3: Educational level

S/N	Category	Frequency	Percentage (%)
1.	Undergraduate	0	0
2.	Graduate	33	100
3.	Postgraduate	0	0
	Total	33	100

Table 1.4 depicts that the majority of the construction firms (70%) can be categorised as medium seized construction companies having 50-249 employees in their organisation while 30% of the construction firms can be categorised as small seized construction companies having 1-49 employees in their organisation. The classification adopted for the research is based on the Small and Medium Scale Enterprise of Nigeria (SMEDAN) classification.

Table 1.4: Company seize

S/N	Category	Frequency	Percentage (%)
1.	Small (1-49 employees)	10	30
2.	Medium (50-249 employees)	23	70
3.	Large (over 200 employees)	0	0
	Total	33	100

The impacts of training and development on worker`s performance in small and medium-sized construction companies are depicted in table 1.5. It can be seen that new knowledge and skills are imparted on employees periodically to work in teams (RII= 0.84) was ranked 1st by the respondents to impact on worker`s performance. Our organisation conducts extensive training programs for its employees in all aspects of quality (RII= 0.78) was ranked 2nd by the respondents while the respondents ranked employees in each job will normally go through training programs every year as least factor that impact on worker`s performance with (RII= 0.69). From the result of the impacts of training and development on worker`s performance, can be inferred that all the examined training and development

indices have between high and very high impacts. The implication of this finding is that worker`s output improves when management in small and medium construction companies see the need for training and development for its workers. This result is consistent with that of Tabassi and Abu Bakar (2009); Buyens *et al.* (2001) regarding the impact of training and developing on worker`s performance.

Table 1.5: Training and development

S/N	Training and Development	Frequency of Response					MIS	RII	Rank
		(1)	(2)	(3)	(4)	(5)			
1	New knowledge and skills are imparted on employees periodically to work in teams	1	1	2	20	10	4.18	0.84	1st
2	Our organisation conducts extensive training programs for its employees in all aspects for quality	1	2	2	27	25	3.91	0.79	2nd
3	There are formal training programs to each new employee's the skills they need to perform their jobs.	1	0	5	28	25	3.97	0.78	3rd
4	Training needs are identified through a formal performance appraisal mechanism.	1	0	5	31	21	3.85	0.76	4th
5	Employees in each job will normally go through training programs every year.	1	0	5	26	26	3.67	0.69	5th

Table 1.6: Employee participation

S/N	Employee`s participation strategies	Frequency of response					MIS	RII	Rank
		(1)	(2)	(3)	(4)	(5)			
1	Employees are provided opportunity to suggest improvements in the way things are done here.	0	0	4	22	7	4..09	0.82	1st
2	Employees in this organization are allowed to make decision related to cost and quality matters.	0	3	9	12	9	3.82	0.76	2nd
3	Employees in this organisation are asked by their superiors to participate in operations related decisions.	0	2	10	15	6	3.76	0.75	3rd

Table 1.6 indicated the impact of employee`s participation in small and medium-sized construction companies on performance. It can be seen that respondents ranked employees are provided with opportunity to suggest improvements in the way things are done as 1st with (RII= 0.82), employees in this organization are allowed to make decision related to cost and quality matters as 2nd (RII=.76) while employees in this organisation are asked by their superiors to participate in operations related decisions was ranked the third 3rd by responded with (RII= 0.75). From the result of the impacts of employee`s participation on worker`s performance, can be inferred that all the examined employee`s participation indices have between high and very high impacts. This result suggests that employee`s participation strategy has an impact on worker`s performance. This finding is consistent with the research of Moore *et al.*, (2002) who submitted that employees' participation is hinged on types of human resources practices adopted by construction companies.

Table 1.7: Selection criteria

Selection criteria	Frequency of response					Mean	RII	Rank
	(1)	(2)	(3)	(4)	(5)			
1. The selection system followed in our organization are highly scientific and rigorous.	0	0	2	13	18	4.49	0.90	1st
2. In our organisation, line managers and HR managers participate in selection.	0	0	4	20	9	4.16	0.83	2nd
3. Selection system followed in our organization are highly scientific and rigorous.	0	1	3	21	8	4.09	0.82	3rd
4. Valid and standardized tests are used when required in the selection process.	0	0	3	22	9	4.06	0.81	4th

Table 1.8: Compensation in small and medium-sized construction companies

Factors consider in Compensation	Frequency of response					Mean	RII	Rank
	(1)	(2)	(3)	(4)	(5)			
1. Job performance is an important factor in determining the incentive compensation of employees.	0	0	2	29	2	4.00	0.80	1st
2. The compensation for all employees is directly linked to his/her performance.	1	2	5	13	12	4.00	0.80	1st
3. In our organization, salary and other benefit are comparable to the market.	0	2	4	22	5	3.91	0.78	3rd
4. In our organization, compensation is decided on the basis of competence or ability of employee.	0	4	5	18	6	3.79	0.76	4th
5. In our organization, profit sharing is used as a mechanism to reward higher performance.	0	3	4	23	3	3.79	0.76	4th

Table 1.7 depicts the criteria adopted by small and medium-sized construction companies in selecting and recruiting their staff. The respondents ranked the selection system followed in our organization are highly scientific and rigorous as 1st with a relative importance index of 0.90. In our organization, line managers and HR managers participate in selection came 2nd with a relative importance index of 0.83. Selection system followed in our organization are highly scientific and rigorous was ranked 3rd with a relative importance index of 0.82 while valid and standardized tests are used when required in the selection process came 4th with a relative importance index of 0.81. This result shows that all the criteria adopted by organizations in selecting and recruiting their staff: the respondents ranked the selection system followed in our organization are highly scientific and rigorous, in our organization line managers and HR managers participate in selection, selection system followed in our organization are highly scientific and rigorous and valid and standardized tests are used when required in the selection process have very high impact, with RII values approximately equal or greater than 0.80. The result means that all

the criteria adopted by small and medium-sized construction companies have very high impact. The implication of this finding is that worker`s productivity in the small and medium construction companies will increase when the selection process is rigorous and standardised. This finding is in tandem with Tessema and Soaters (2006) regarding the impact of worker`s recruitment and selection process.

Table 1.8 shows the indices of compensation in small and medium-sized construction companies. Job performance is an important factor in determining the incentive compensation of employees, the compensation for all employees is directly linked to his/her performance were ranked 1st by respondents with relative importance index of 0.80. Next is in our organization, salary and other benefit are comparable to the market as 3rd with relative importance index of 0.78. In our organization, compensation is decided on the basis of competence or ability of employee and in our organization, profit sharing is used as a mechanism to reward higher performance followed in the 4th position with relative importance index of 0.76. from the result in Table 1.8, it can be observed that all the indices of employee's compensation were all ranked "very high" (0.60=RII< 0.80). The implication of this finding is that worker`s efficiency will increase when adequately compensation is paid to workers in small and medium-sized construction companies. This result confirms the study of Knick and Kreitner (2006) with regards to employee's compensation.

5. CONCLUSION AND RECOMMENDATIONS

The importance of human resources management cannot over-emphasised as it stands as a key factor that determines the success of an organisation. When an organisation pays greater attention to human resources management practices such as: training and development, selection criteria and employees participation, there is high tendency such organisation would meet her set objectives. Thus, the study examined the impact of small and medium construction companies' human resource management practices in small and medium construction companies' on worker`s performance in Kano state, Nigeria. Findings from the research revealed that, employees training and development, selection criteria, compensation and employees` participation have an impact on their performance. Therefore, when small and medium construction companies pay adequate attention to training and development, employees participation and selection criteria, these may enhance their efficiency in meeting organisation`s objectives. From the result obtained from this research, the study concludes that human resources management practices have an impact on workers' performance in small and medium construction companies. Based on research findings, the study recommends that small and medium-sized construction companies should pay special attention to compensation of workers, employees training and development and employees participation to enhance worker`s performance in order to engender over efficiency in the construction industry.

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STAKEHOLDERS' PERCEPTION OF THE CAUSES AND EFFECTS OF VARIATION ORDERS IN PUBLIC CONSTRUCTION PROJECTS IN SOUTH-SOUTH ZONE OF NIGERIA

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ABSTRACT

Purpose: The construction process is a complex and risky endeavour often associated with unexpected changes which can occur at any stage of the project and may eventually lead to issuance of variation orders. Variation orders are subject to numerous factors which have significant effects on project performance. The study examines the causes and effects of variation orders in construction projects within the South-South geopolitical zone of Nigeria. The choice of the study area is determined by its socio-economic importance to the nation.

Design/methodology/approach: The study adopts the exploratory survey design approach in order to obtain the perception of professionals in the building construction industry on the causes and effects of variation order on construction projects. 241 valid questionnaires were used giving a response rate of 62.27%. Data obtained are analysed using mean score method, and Kruskal Wallis tests.

Findings: The findings reveal that change of scope of work, errors and omissions in design, change in specifications by client, client`s financial difficulties and inadequate project objectives were the dominant causes of variation orders. In addition, the major effects of variation orders include the increase in overall project duration, increase in project cost, disputes, schedule delays, and rework. The conclusion is that, there is no difference in the perception of clients, consultants and contractors concerning the causes and effects of variation orders on the performance of construction projects.

Practical implication: Professionals in the building construction industry should find the results of this research useful in enhancing their knowledge on effective project delivery and understanding the nature of causes and effects of variation order.

Originality/value: Findings reveal that all the key stakeholders in the building construction industry; clients, consultants and contractors exhibit similar perceptions of the causes and effects of variation order in construction project delivery. This attests to the fact that variation is inevitable in construction projects.

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Keywords: Construction projects; implementation; project performance; stakeholders; variation order.

1. INTRODUCTION

Project execution in the construction industry is confronted with many challenges and unexpected changes with associated effects ranging from low quality work, schedule delay, cost overrun, litigation, disputes, project abandonment to outright project failure. (Lo, Fung and Tung, 2006; Odediran and Windapo, 2014). Construction projects are recognized as complex in nature due to the large number of parties involved, internal and external factors and a myriad of environmental problems. This affirms the view by Alsuliman, Bowles and Chen (2012) who observe that the nature of the industry is complicated and uncertain. The authors attribute this to the unique features and conditions of each of the projects, with a large number of interdependent and sequential tasks. Similarly, Ijaola and Iyagba (2012) also point out that the construction process is associated with changes due to its complex nature which consequently leads to variation orders. The nature of construction activities is also pre-disposed to various factors that could change, vary or alter the outcome from the initial plan. This `change` otherwise referred to as `variation order` indicates a unique factor which contributes to a large extent, to poor performance of projects in the construction industry. Researchers in the construction industry have used different terminologies to describe this alteration or modification with such terms as "change", "variation", "change order" or "variation order".

There are different schools of thoughts about the meanings of these terminologies. According to Jadhav and Bhirud (2015) `change` is any activity on the construction site which results in modification of original scope, executing time and cost of the project. Other schools of thoughts view `change` as risk, state, process or methods that deviate from an agreed upon or original construction plan and specification (Lokhande and Ahmed, 2015; Jadhav and Bhirud, 2015; Lokhande and Ahmed, 2015). On the other hand, `variation` has been defined as any type of deviation from an agreed upon well-defined scope or schedule of work (Osuman, Omran and Foo, 2009). In the same vein, `change order` is defined as a formal document that is used to modify the agreed constraints and agreement which become part of the project document (Jadhav and Bhirud, 2015; Zawawi, Azman and Kamar, 2010). This aligns with the definition of `variation order` by some scholars who defined the term as deviation, variation or any change or modification by the owner or the owner's representative experienced in any project from base contract or work scope mutually agreed upon at contracting time (Kaene, Sertyesilisik and Ross, 2010; Alsuliman *et al*., 2012; Jadhav and Bhirud, 2015). These overviews of the subject matter of this study connote that though the terms differ, they however depict the same meaning in practice. The differences in the terminology in the literature is insignificant; consequently, the use of the term `variation order` is adopted in this study.

Studies in different parts of the world - Malaysia, Kuwait, South Africa, Ethiopia, Addis Ababa and in Nigeria indicate that variation orders are common and inevitable in any construction project (Memon, Rahman and Memon, 2014; Alaryan, Emadelbeltagi and Elshahat, 2014; Tadesse (2009); Ngwepe, Aigbavboa and Thwala, 2015). Variation orders can be encountered at any stage of the construction project but is easier to manage at the initial phase than at other stages of the project due to possibility of reduction in rework. The effects of variation orders on projects are generally worrisome and are not

beneficial to the clients and contractors in most projects. Msallam, Abojaradeh, Jrew and Zaki (2015) observed that variation orders are destructive and unpleasant in a project because of the impacts on cost and completion date of project.

However, studies show that not all variation orders are detrimental; they could also be beneficial though rarely, depending on the circumstance. Beneficial variation orders are those that actually help to reduce cost, schedule or degree of difficulty in a construction project or even eliminate unnecessary costs (Arain and Low, 2005; Ngwepe *et al*., 2015). Fisk and Reynolds (2015) point out that since change is inevitable in construction projects, managing the effect of change is therefore paramount and of great importance to the success of construction projects. The attention of concerned individuals and stakeholders in the industry has been drawn to the negative effects of variation orders on project delivery in developing countries particularly in the South-South zone of Nigeria. This zone is a coastal area and is predisposed to unpredictable project environment which affects project delivery. Projects are hardly completed without exceeding budgets and scheduled dates as a result of incessant alteration in design, construction programmes, project assumptions and requirements which are evidences of variation orders. Cunningham (2013) asserts that many owners involved in construction claim that they do not get the desired performance from their projects. This has serious implications on the built environment, concerned project stakeholders and the nation at large. Successful construction projects are therefore projects that are finished as and at when due, within the budget, in accordance with specifications and to stakeholders' satisfaction (Yaman, 2007; Cheng, Tsai and Sudjono, 2011).

Previous studies attempt to proffer solutions to the effect of variation orders while research is still ongoing. Some studies single out causes of variation orders (Keane *et al*., 2010; Ijaola and Iyagba, 2012; Halwatura and Ranasinghe, 2013; Alaryan *et al*., 2014), while some centre on the effects (Leonard, 1987; Osman et al., 2009; Sunday, 2010; Lokhande and Ahmed, 2015; Gokulkarthi and Gowrishankar, 2015). Other researchers combine the investigation of causes and effects of variation orders (Alnuami *et al*., 2010; Memon et al., 2014; Jadhav and Bhirud, 2015). However, there is limited research on the combined study of causes and effects of variation orders particularly in the study area. This may be due to the underestimation of the impact of the problem on project delivery by both practitioners and academia. The objectives therefore are to investigate the causes and evaluate the potential effects of variation orders on project delivery in the study area. This study is significant as it expects to provide useful insights into the causes and potential effects of variation orders with the view to enhance effective project delivery. The null hypotheses formulated for the research are:

1. There is no significant difference in the perception of clients, consultants, and contractors of causes of variation order in construction project.
2. There is no significant difference in the perception of clients, consultants, and contractors of the effect of variation orders on project performance.

2. LITERATURE REVIEW

2.1. Variation orders and construction project performance

Variation order is a critical factor during implementation of construction projects especially large scale projects. The occurrence is not only on projects in developing countries but also on projects in the developed world. Koushki, Al-Rashid and Kartam (2003) in a related study on delays and cost increases in the construction of private residential projects in Kuwait, discover that projects that experience variation orders incur more than 58%-time delay and cost increases when compared to those with no variation orders. The study by the Joint Legislative Audit and Review Commission (JLARC, 2001) on 300 road construction projects in Virginia reveals that average project change was more than 11%. Homaid, Eldosouky and AlGhmdi (2011) in another study on the change order in Saudi Linear construction projects reveal that the overall average increase in total cost of construction projects due to change orders was found to be 11.3%. A similar study of variation orders on construction projects shows that the average cost escalation was 7% of the original project cost with an average time extension of 30% more than the original project duration (Charoenngam, Coquinco and Hadikusumo, 2003). Awad's (2001) analysis and management of change orders for combined Sewer flow construction projects shows that variation orders are responsible for up to 7% of cost escalation of the original project cost. Another study on the types, causes, and frequency of construction claims in Dubai and Abu Dhabi in the UAE, relies on data from 124 claims for a variety of projects by Zaneldin (2006). The results indicate that the "variation order" claims were the most frequent type of claims with an important index of 60.5% and variation order was also the most frequent cause of claims with an important index of 55%. Since construction projects are synonymous to variation order, effective identification of the causes and effect is critical in an attempt to minimize the impact on project delivery.

2.2. Key causes of variation order

A construction business is subject to a lot of variability due to the unique nature of projects in the industry. The variation order is one of the challenges that practitioners and academia in the built environment try to manage since it cannot be totally eliminated from projects. The provision of variation clauses in the conditions of contracts suggests the variable nature of building construction, as such, variation or change is inevitable. (Ssegawa, Mfolwe, Makuke and Kutua, 2002; Finsen, 2005). Mohamed (2001) also points out that variation orders cannot be avoided completely. Researchers from different countries have made efforts to identify causes of variation orders in construction projects. Results show that variation orders are caused by several factors. Desai, Pitroda and Bhavasar (2015) identify 10 factors in a study conducted in Central Gujarat region; Ijaola and Iyagba (2012) identify 23 factors in Nigeria, Memon, Rahman and Hasan (2014) identify 18 factors in Malaysia, Lokhande and Ahmed (2015) identify 21 factors in Yemen; Alaryan *et al*. (2014) identify 20 factors in Kuwait; and Yadeta (2016) identifies 36 factors in Addis Ababa. The factors were sorted out as identified from literature with the summary presented in Table 1. The factors are further categorized into four groups based on the previous studies by Harbans (2003); Arain and Low (2006); Sunday (2010); Alnuami, Ramzi, Mohammed and Ali (2010); Enshassi, Arain and Al-Raee (2010); Ngwepe *et al*. (2015).

Table 1: Key causes of variation order in construction projects

Category of Factors	Causes of Variation Order	Authors
Client related factors	Change in design by client, change of plans or scope of work, inadequate project objectives, client`s financial difficulties, obstinate nature of client, change in material by client, change in specifications by client, impediment in prompt decision making process, replacement of contractor due to non-performance	Lokhande and Ahmed, 2015; Gokulkarthi and Gowrishankar, 2015; CII, 1990; Arain, Assaf and Low, 2004; O'Brien, 1998; Memom *et al.*, 2014; Desai *et al.*, 2015; Jadha and Bhirud, 2015.
Consultant related factors	Inadequate working drawings, change in design by consultant, errors and omissions in design, inadequate scope of work for contractor, inadequate scope of work for contractor, consultant`s lack of historical data, design discrepancies, conflicts between contract documents, design complexity, design complexity, honest wrong belief of consultant, lack of consultant`s knowledge of available manpower and equipment, obstinate nature of consultant, technology changes, change in specifications by consultant, lack of coordination/communication, consultant's lack of judgmental experience, value engineering	Fisk, 1997; Arain *et al*., 2004; Lokhande and Ahmed, 2015; Desai *et al.*, 2015; Jadha and Bhirud, 2015; Gokulkarthi and Gowrishankar, 2015.
Contractor related factors	Differing site conditions, lack of contractor`s involvement in design, change of schedule by contractor, contractor's lack of judgment and experience, unavaibility of equipment, obstinate nature of contractor, obstinate nature of contractor, shortage of skill manpower, poor procurement process, contractor`s financial difficulties, contractor`s lack of historical data, unfamiliarity with local conditions, contractor`s desired profitability, lack of strategic planning, fast tracking construction, defective workmanship	Memo *et al.*, 2014; Lokhande and Ahmed, 2015; Desai *et al.*, 2015; Jadha and Bhirud, 2015; Gokulkarthi and Gowrishankar, 2015.
Other related factors	Non-conformance or new government regulations, weather condition, change in economic conditions, unforeseen problems, health and safety considerations	Desai *et al.*, 2015; Gokulkarthi and Gowrishankar, 2015.

2.3. Effects of variation order

Previous studies reveal that variation orders affect project delivery in different ways. The effects of variation orders on construction projects as reported by some researchers include increase in project cost, additional payment for the contractor, increase in overhead expenses, completion schedule delay, rework and demolition, dispute between owner and contractor, disruption and change in work condition, low productivity (Alaryan *et al.*, 2014; Arain and Low, 2005). Koushki (2005) reports that variation orders issued during various phases of construction projects negatively affect both the completion time and cost of project. Hanna *et al.* (2002) also affirm that projects with many variation orders cause the contractor to achieve lower productivity levels than planned. Findings from the study conducted by Arain and Pheng (2005) on the effects of variation orders on institutional building projects reveal that variation orders contributed substantially to increases in construction project costs. Similarly, Ssegawa *et al.* (2002) report that more than one-third of disputes pertain to how to determine losses that stem from variation orders. Alaryan,

Emadelbeltagi, Elshahat and Dawood (2014) identify 12 effects of change orders on construction projects in Kuwait. Studies carried out by Lokhande and Ahmed (2015) also identify11 possible consequences of change request impact in construction industry of Yemen. The effects of variation order collated from studies of different researchers are presented in Table 2.

Table 2: Major effects of variation order

Factor	Authors
Decrease in productivity	Jadhav and Bhirud, 2015; Ibbs, 1997; Hanna and Gunduz, 2004.
Delay of completion schedule	Mohamed, 2001; Koushki, 2005; Gokulkarthi and Gowrishankar, 2015.
Dispute between owner and contractor	Jadhav and Bhirud, 2015; Charoenngam *et al.*, 2003; Bower, 2000.
Decrease in quality of work	Gokulkarthi and Gowrishankar, 2015; Smallwood, 2000; Keane *et al*., 2010.
Increase in construction cost	Jadhav and Bhirud, 2015; Ibbs, 1997; Ssegawa *et al*., 2002; Arain and Pheng, 2005.
Additional money for contractor	Jadhav and Bhirud, 2015; Gokulkarthi and Gowrishankar, 2015.
Delay of material and tools	Gokulkarthi and Gowrishankar, 2015.
Work on hold	Gokulkarthi and Gowrishankar, 2015.
Increase in overhead expenses	Gokulkarthi and Gowrishankar, 2015; Osman, Omran and Foo, 2009.
Delay in payment	Gokulkarthi and Gowrishankar, 2015.
Demolition and re-work	Jadhav and Bhirud, 2015; Osman *et al*., 2009.
Health and Safety issues	Arain and Pheng, 2005

3. RESEARCH METHODOLOGY

The research adopts the exploratory survey design approach and Questionnaire sare used for data collection. Questionnaires are widely used for descriptive and analytical survey of this nature to find out facts, opinions and views of respondents (Enshassi, Arain and Al-Raee, 2010). The area under study is South- South geo-political zone of Nigeria prominent among other zones in Nigeria as a result of its natural endowment with oil and gas production. The socio-economic status of this zone determined to a large extent, its choice for this study. The target population is the construction sector. The sample frame of 577 for the study is established based on the list of registered contractors with various clients` organizations at state and federal levels, public institutions and parastatals while that of the professionals is obtained from the directories of registered professionals with their respective bodies. This comprises of the Nigerian Institute of Architects (NIA), the Nigerian Institute of Builders (NIB), the Nigerian Institute of Engineers (NSE), and the Nigerian Institute of Quantity Surveyors (NIQS). The sample size of the study is determined using Taro Yamane formula (Udofia, 2011). The breakdown of sample frame and sample size for each category is shown in Table 3. Thus, sample size of 387 which also determines the number of questionnaires to be administered on the respondents using random sampling technique is adopted for the study.

Pilot survey involving seven experts in the industry both in practice and academic is conducted for the purpose of verifying the completeness of the questionnaire before distribution of the final questionnaire. Their various inputs are collated and used to produce the final questionnaire administered on the respondents. The exercise which results to 46

variable factors of variation order and 12 factors of effects of variation order is used for the study. The variables that constitute causes of variation order used for the study are categorised into four groups based on the previous studies (Harbans, 2003; Arain and Low, 2006; Sunday, 2010; Alnuami, Ramzi, Mohammed and Ali, 2010; Enshassi *et al.*, 2010; Ngwepe *et al*., 2015). The groups are: client related (with 10 factors); consultant related (with 16 factors); contractor related (with 15 factors) and order factors (which constituted 5 variable factors). Random sampling technique is adopted for the study.

Table 3: Sample frame and sample size of the study

Professional	Clients	Consultants	Contractors	Total
Sample frame	223	152	202	577
Sample size	143	110	134	387

The questionnaire is divided into three sections. Section A of the questionnaire solicits data from on gender, educational status, profession, work experience, company`s classification and type of organization. The aim is to establish a relationship between responses and organisational characteristics of the respondents. Section B uses a 5-point Likert scale ranging from 1 (nil) to 5 (very high) to establish the level of prevalence of variation orders in construction projects. Section C seeks for the perception of the respondents on the effect of the factors on project performance using a five-point Likert scale ranging from 1 (no effect) to 5 (very high effect). 364 questionnaires are received in which 123 feedbacks are identified as invalid due to incomplete information. 241 valid questionnaires are used for the analysis giving a response rate of 62.27%. This consists of 91 clients, 64 consultants and 86 contractors with response rates of 63.64%, 58.18%, and 64.18% respectively. Data collected is processed using Statistics Package for Social Sciences (SPSS). The difference in the perceptions of clients, consultants, and contractors on causes and effects of variation orders are analysed using Kruskal Wallis tests. Mean Score (MS) is used to determine the level of significance of each factor by 5 expressions defined by the intervals 0.8 with 3.4 as a cut-off for high significance based on Kazaz, Manisali and Ulubeyli, 2008). The ranking of the factors is determined based on the mean item score of each item which is calculated using the following equation:

$$MS = \sum_{i=1}^{5} \frac{\mathrm{R}_{pi} R_i}{n} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1 \leq II \leq 5) \ldots\ldots\ldots\ldots\ldots Equation\ (1)$$

(Where R_{Pi}= Rating point; *i* ranges from 1 to 5; Ri= response to rating point, *i*; and n = total responses = summation of Ri from1-5

4. RESULTS AND DISCUSSION OF FINDINGS

Results arising from the analysis of the data collected for the study are presented below. This includes the evaluation of causes of variation orders, effects of variation order on project performance and comparison of agreement among the responding groups.

4.1. Evaluation of causes of variation orders

There are several factors responsible for variation orders of construction projects. Based on the objectives of the study, 46 factors constituting causes of variation orders in the construction industry are identified through literature review and a pilot survey. The factors are later categorized into four major groups to reflect the sources and originators of the factors. The groups are: client related, consultant related, contractor related, and other related group. The responses of the respondents on the factors are measured as described in the methods of the study. Data collected are scored, processed, and analysed using Mean Score (MS). The results are presented in Table 4.

As presented in Table 4, change of plan or scope of work, errors and omissions in design, change in specifications by client, client`s financial difficulties and inadequate project objectives are the first five key important causes of variation orders in construction projects based on the collective ranking of the respondents. The change of plan or scope of work is the most highly ranked among these factors responsible for variation orders by all three groups of respondents with mean scores of 4.65, 4.61 and 4.70 for clients, consultants and contractors respectively. This implies that this factor is a predominant cause of variation orders of construction projects in the study area. The importance of this factor can be attributed to inadequate planning at the project definition stage **(**Arain *et al*., 2004**).** This result agrees with the findings of the Construction Industry Institute (CII) (1990) which identifies change of plan or scope of project as one of the most significant causes of variations in construction projects.

Errors and omissions in design are ranked second overall as well as in the ranking orders of consultants and contractors with mean scores of 4.62, 4.60 and 4.67 respectively. However, the clients group considers the factor as third and have the same MS with the consultants group of 4.60. It is established in literature and practice that projects with insufficient information at design stage or a situation whereby the designers are given inadequate time to translate client`s brief into designs, amount to errors and mistakes which are often discovered late at the construction stage. This is in agreement with the observation of Enshassi *et al.* (2010) who note that if errors in design are not immediately rectified during the design phase, they would eventually show up in the construction phase and may degenerate into issuance of variation orders to implement the corrective measures. Ssegawa *et al.* (2002) point out that clients and architects are the major cause of omission which is attributed to financial issues and changes in designs. Results of the analysis presented in Table 4 also indicate that changes in specifications by clients was ranked third overall which is also in agreement with the ranking order of contractors with mean score of 4.58 and 4.58 respectively. Clients and consultants group however differ on the importance of the factor based on the result of the findings. The clients rank the factor second with mean score of 4.61 while contractors rank it sixth with mean score of 4.56. O`Brien (1998) observes that change in specifications is consequential action of inadequate project objectives which according to Memon *et al.* (2014) often lead to variation orders in the form of delay and increased overall cost in an attempt to make the changes.

The results in Table 4 show that client`s financial difficulties ranks fourth based on the overall ranking. The three groups of participants however differ in the ranking of the factor. While the ranking of the contractors was in agreement with the overall ranking with MS of 4.55 and 4.60 respectively, the clients rank it seventh while consultants rank it sixth with the same MS of 4.53. Sound client`s financial status is very critical in achieving overall project success. Lack of accessibility and inadequate supply of funds impedes progress of construction projects and may eventually lead to work stoppage.

Table 4: Causes of variation order in construction projects

S/n.	**Factors**	Client		Consultants		Contractors		Overall	
		Mean	Rank	Mean	Rank	Mean	Rank	Mean	Rank
	Client related factors								
1	Change of plans or scope of work	4.65	1	4.61	1	4.70	1	4.65	1
2	Change in specifications by client	4.61	2	4.56	3	4.56	6	4.58	3
3	Client`s financial difficulties	4.53	7	4.53	6	4.60	4	4.55	4
4	Inadequate project objectives	4.58	4	4.44	10	4.58	5	4.53	5
5	Impediment in prompt decision making process	4.49	10	4.56	3	4.39	18	4.48	8
6	Change of schedule by client	4.44	15	4.39	15	4.61	3	4.48	9
7	Change in design by client	4.33	20	4.19	26	4.54	7	4.36	19
8	Replacement of contractor due to non-performance	3.88	34	4.28	20	4.05	29	4.07	27
9	Change in material	4.12	27	4.23	24	3.81	37	4.05	28
10	Obstinate nature of client	3.25	44	3.11	46	3.18	45	3.18	45
	Consultant related factors								
11	Errors and omissions in design	4.60	3	4.60	2	4.67	2	4.62	2
12	Inadequate working drawings	4.56	5	4.49	8	4.54	7	4.53	6
13	Change in design by consultant	4.49	9	4.53	5	4.51	9	4.51	7
14	Design complexity	4.51	8	4.39	13	4.47	11	4.46	12
15	Inadequate scope of work for contractor	4.26	22	4.44	11	4.44	14	4.38	16
16	Design discrepancies	4.46	12	4.33	18	4.35	21	4.38	16
17	Change in specifications by consultant	4.46	13	4.25	23	4.39	19	4.36	18
18	Conflicts between contract documents	4.19	24	4.28	20	4.19	26	4.22	23
19	Lack of coordination/communication	4.07	28	4.18	27	4.32	22	4.19	25
20	Consultant`s lack of historical data	4.33	19	4.16	28	3.82	35	4.11	26
21	Lack of consultant`s knowledge of available manpower and equipment	3.96	32	4.09	31	3.98	32	4.01	30
22	Consultant's lack of judgment and experience	4.00	29	3.60	40	4.04	31	3.88	34
23	Honest wrong belief of consultant	3.42	40	3.91	33	4.11	28	3.81	35
24	Value engineering	3.28	43	4.12	29	3.65	38	3.68	39
25	Obstinate nature of consultant	3.37	42	3.39	41	3.51	40	3.42	41
26	Technology changes	3.07	46	3.32	43	3.47	41	3.29	44
	Contractor related factors								
27	Fast tracking construction	4.47	11	4.49	7	4.44	13	4.47	10
28	Differing site conditions	4.54	6	4.37	16	4.47	10	4.46	11
29	Defective workmanship	4.44	14	4.46	9	4.42	15	4.44	13
30	Contractor`s financial difficulties	4.35	18	4.42	12	4.39	17	4.39	15
31	Lack of contractor`s involvement in design	4.21	23	4.30	19	4.46	12	4.32	21
32	Contractor's lack of judgment and experience	4.30	21	4.25	22	4.35	20	4.3	22
33	Change of schedule by contractor	4.18	25	4.11	30	4.30	24	4.19	24
34	Lack of strategic planning	4.00	30	3.95	32	4.18	27	4.04	29
35	Shortage of skill manpower	3.89	33	3.79	37	4.26	25	3.98	31
36	Contractor`s lack of historical data	4.12	26	3.86	35	3.88	34	3.95	33
37	Poor procurement process	3.77	36	3.63	38	3.81	36	3.74	37
38	Unavailability of equipment	3.65	38	3.82	36	3.60	39	3.69	38
39	Contractor`s desired profitability	3.65	37	4.19	25	3.16	46	3.67	40
40	Obstinate nature of contractor	3.47	39	3.37	42	3.19	44	3.35	42
41	Unfamiliarity with local conditions	3.39	41	3.25	44	3.32	42	3.32	43
	Other related factors								
42	Change in economic conditions	4.40	16	4.39	14	4.40	16	4.4	14
43	Unforeseen problems	4.37	17	4.33	17	4.32	22	4.34	20
44	Weather condition	3.98	31	3.89	34	4.04	30	3.97	32
45	Health and safety considerations	3.79	35	3.63	39	3.96	33	3.8	36
46	Non-conformance or New government regulations	3.09	45	3.14	45	3.21	43	3.15	46

More studies show that financial difficulties lead to change in work schedules and specifications, and compromise on the quality of the construction (Memon *et al.*, 2014). O`Brien (1998) agrees that owner`s financial problems can affect progress and quality of construction project. Inadequate project objective is identified by the clients and contractors as one of the top five highly ranked factors that causes variation orders but the ranking is at variance with the consultants` ranking order of tenth with MS of 4.44. The results show that the clients rank it fourth while the contractors rank it fifth with the same MS of 4.58. Inadequate project objectives could be the result of ineffective communication among the stakeholders which may lead to ambiguities in planning and execution. The impact of the factor on project performance can be very detrimental and could be responsible for issues such as rework, increase in project cost, and change of schedule.

Inadequate working drawings rank sixth overall but the respondents disagree on the ranking of the factor due perhaps to differing priority they placed on it. The factor ranks fifth by the clients, eighth by consultants and seventh by the contractors with overall ranking of sixth position. These rankings show that the factor is among the top 10 factors, considered by the respondents that are responsible for variation orders in the study area. The significance of this factor lies in the fact that contractors programme of work is based on the scope of work as interpreted by the drawings which must be clear and concise (Geok, 2002), otherwise, the expectation of the stakeholders on project objectives may be jeopardized. Ranking among the first 10 top factors responsible for variation orders is change in design by consultants with overall ranking of seventh. The clients and contractors were in agreement on the ranking of the factor as ninth with mean scores of 4.49 and 4.51 respectively. Incidentally, the factor is however ranked among the first five major factors by the consultants who rather placed it fifth with MS of 4.43.

Impediment in prompt decision making is an organizational based responsibility of the client in every construction project. According to the results in Table 4, this factor is ranked eighth in the overall ranking with MS of 4.48. The consultants rather rank the factor third as a reflection of the priority placed on the factor in the delivery of construction projects. The priority given to this factor by the contractors is however very low as implied in the ranking as eighteenth factor with MS of 4.39. The contractors` perception regarding this factor could be as a result of their non-involvement in decision making regarding projects especially at pre contract stage. The effect of this factor can only be felt by the contractor at construction stage when it takes a considerable length of time for the client's organization to respond to a critical issue bothering on the project especially in traditional contract methods. Failure to make effective decisions at the right time may result in delay, temporary work stoppage and the need for change order due to cost increments (Memon *et al.*, 2014). The factor is however ranked tenth by the clients with MS of 4.49. Change of schedule by client is ranked ninth overall but is however ranked fifteenth by the clients and consultants group with MS of 4.48, 4.44 and 4.39 respectively. The importance placed on this factor by the contractors as a cause of variation order is reflected in the ranking order of third position with MS of 4.61. Change of schedule by client can disrupt contractor`s work programme resulting in reallocation of project resources with additional cost implications. These could be the reasons that informed the contractors on the choice of the ranking position of this factor. The result of the study is also in agreement with Alajishi and Marzong (2008) who reports that owners are the main originator of changes in projects. The last factor among the first 10 top factors that cause variation order is fast tracking construction with the overall MS of 4.47. The factor is however ranked eleventh by the client group, seventh by the consultant group and thirteenth by the contractor group with MS of 4.47, 4.49 and 4.44 respectively.

4.2. Evaluation of the effects of variation order on project performance

Variation order affects performance of construction projects. It impacts on client`s value, disrupts workflow and strains the relationships among the owners, engineers, contractors, subcontractors, and others stakeholders involved in the construction process. In order to achieve the second objective of the study twelve variables constituting effects of variation order are identified from literature review. The perception of clients, consultants and contractors are sought on the effect of variation order on project performance. The effects are measured as earlier described in the method of the study. The results are presented in Table 5.

Table 5: Effects of variation order on project performance

Factors	Client		Consultant		Contractor		Overall	
	Mean	Rank	Mean	Rank	Mean	Rank	Mean	Rank
Increase in construction cost	4.79	1	4.86	1	4.91	1	4.85	1
Delay in completion schedule	4.67	2	4.7	2	4.56	3	4.64	2
Demolition and re-work	4.42	3	4.49	3	4.77	2	4.56	3
Dispute among consultants	4.33	4	4.26	4	4.44	4	4.34	4
Work on hold	3.88	7	4.12	5	4.33	5	4.11	5
Decrease in productivity	4.16	5	3.98	6	3.4	9	3.84	6
Increase in overhead expenses	3.74	8	3.74	7	3.77	7	3.75	7
Delay of material and tools	4.09	6	3.56	8	3.05	10	3.57	8
Delay in payment	2.63	9.5	3.16	10	4	6	3.26	9
Decrease in quality of work	2.63	9.5	3.37	9	2.63	11	2.88	10
Additional money for contractor	2.05	11	2.42	11	3.56	8	2.67	11
Health and Safety issues	1.88	12	2.12	12	1.95	12	1.98	12

The results of Table 5 show that all the stakeholders individually rank increase in construction cost as the most significant effect of variation order on cost performance of construction project with the MS of 4.79, 4.86 and 4.91 for the clients, consultants and contractors respectively. The ranking of this factor as the most important may be attributed to the fact that any alteration, omission or addition to design at production or implementation stage may result in demolition or rework of any cost sensitive component of the structure which invariably adds to the cost of the project (Clough and Sears, 1994). This is also similar to the findings of Memon *et al*. (2014) who identifies increase in cost as the most common effect of variation order in Malaysian Public Works Department (PWD) known as Jabatan Kerja Raya, Malaysia (JKR). The delayed completion schedule is ranked second overall which is also in agreement with the ranking of the clients and consultants as second with MS of 4.64, 4.67 and 4.70 respectively. The factor is however ranked third by the contractor with MS of 4.56. The difference in the ranking suggests the practical disposition of the contractors as the first and direct professionals to the actual work on site. This is also in line with the result of the study of Zawawi (2010) who observes that schedule delay is one of the major effects of variation order on project performance. The clients and consultants also agree on the ranking of demolition and re-work as third factor with MS of 4.42 and 4.49 respectively but are however ranked second by the contractors with MS of 4.77. The results in Table 5 also show that the three least ranking factors based on the overall ranking includes decrease in quality of work, additional money for contractor

and health and safety issues as tenth, eleventh and twelfth factors with MS of 2.88, 2.67 and 1.98 respectively.

4.3. Comparison of agreement among the responding groups

The hypotheses of the study which were earlier stated to determine if there are significant differences in the perception of the respondents of the causes and effects of variation orders in the construction projects were both tested using Kruskal Wallis Test at $p \leq 0.05$. The decision rule is that if p-value > 0.05, the hypothesis is accepted, but if p-value ≤0.05, the hypothesis is rejected. The results of the tests are presented in Table 6.

Table 6: Result of Kruskal Wallis test

Groups	N	Client Mean Rank	Consultant Mean Rank	Contractor Mean Rank	U-value	P-value	Sig. level	Decision
Causes of Variation Order	46	68.9	67.64	71.97	0.29	0.87	0.05	Accept
Effects of Variation Order	12	17.8	18.33	19.42	0.15	0.93	0.05	Accept

The results of the Kruskal Wallis Test presented in Table 6 shows that the range of p-values is $0.87 \geq 0.05$. This implies acceptance of the first hypothesis that there is no significant difference in the perception of clients, consultants, and contractors of the causes of variation orders in construction project. Table 6 also shows that p-values of $0.93 \geq 0.05$ which implies the acceptance of the second hypothesis that there is no significance difference in the perception of clients, consultants, and contractors of the effects of variation orders on project performance. The agreement in the perceptions of the respondents is an indication of the prevalence of variation orders in construction projects of the study area. The clients, consultants, and contractors involved in the procurement and delivery of construction projects in the south-eastern part of Nigeria should give priority to the factors and its effects as identified in this study especially during planning and implementation.

5. CONCLUSION

This study investigated the causes and effects of variation order in construction projects. Based on the findings of the study, it was concluded that the five dominant causes of variation orders are: "the change of plans or scope of work", "errors and omissions in design", "change in specifications by client", "client`s financial difficulties", and "impediment in prompt decision making process". These causes can be further categorized into four major groups, namely; client related, consultant related, contractor related, and other related group. It was also concluded that, the prevalent effects of variation orders on performance of construction projects are: "increase in construction cost", "delay completion schedule", "demolition and re-work", "dispute among consultants", and "work on hold". Further conclusion was that there is agreement among stakeholders of the causes and effects of variation orders in construction projects executed in the South-South zone of Nigeria. Finally, the study adds that since variation orders cannot be practically eliminated from the projects, its occurrence and effect on project performance can be minimized if

adequate measures are taken at planning and design stages. The design team should therefore focus on the key decisions that are fundamental to the project and realization of the set goals through proactive approach of minimizing variation order. The study also recommends that the project team should ensure complete documentation before award of project; it should also be verified and approved by the necessary authorities before commencement of the project.

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FEDERAL INCOME EARNERS AND CONCERNS FOR QUALITY HOMES: AN EVALUATION FOR SUSTAINABLE HOUSING IN AKWA IBOM STATE

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ABSTRACT

Purpose: The study evaluated home qualities and sustainability concerns, with a view to providing an insight into the importance of sustainability concerns on quality of homes occupied by federal income earners in Akwa Ibom state.

Design/methodology/approach: This study adopted a cross-sectional survey design using structured questionnaire purposively administered on 208 households resulting in 193 valid responses. Data were analysed using descriptive, relative importance index and Kruskal Wallis tests.

Findings: The study concluded that there were 45.5%, 50.0% and 72.7% significant home quality attributes among low, medium and high-income earners respectively. There were 76.2%, 71.4% and 66.7% significant housing sustainability concerns among low, medium and high-income earners respectively, with minimal concerns attaining high level consideration. The study concluded that there is significant variation in the home qualities of the various income groups, but there is no significant difference in their housing sustainability concerns.

Practical implication: The study recommends that the low and medium income earners should put more consideration on economic sustainability concerns so as to further enhance the quality of their homes, while the high-income earners should include social concerns together with improved concerns of environmental sustainability for enhanced housing development and maintenance.

Originality/value: The study revealed the rate of importance of housing quality perceived by respondents as well as the moderate significance accorded the sustainability concerns, which have not significantly influenced home qualities among low and medium income earners.

Keywords: Building maintenance; federal income earners; quality homes; sustainable housing; sustainability concerns.

1. INTRODUCTION

According to Ibem, Opokoa, Adeboye, and Amole (2013), buildings are enclosed spaces (shelter) designed and constructed to provide occupants with conducive, safe, comfortable, healthy and secured indoor environment to carry out different kinds of

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activities. Over the years, the necessity for quality shelter has attracted global attention especially in developing countries where the urbanization process has been growing at an alarming rate (Ugonabo and Emoh, 2013). Good quality housing is essential to planning, ensures the safety and wellbeing of people, promotes beauty, convenience and aesthetics in the overall built-up environment (Jiboye, 2010). Oluwaseyi (2019) sees adequate housing as generally being more than having a roof over one's head, but encompasses protection from disposal of household and human wastes, sufficient spaces for health and privacy, security of tenure of occupancy, availability of safe drinking water, affordability and access to employment, health, recreation and educational services.

Irrespective of the importance of housing as one of the best indicators of a person's standard of living and its place in society, it has been observed that the quantity or quality of houses in Nigeria is neither adequate nor satisfactory. The problem of insufficient quality housing is more serious in urban areas in Nigeria as most people live in poor quality housing and unsanitary environments.

According to Ndubueze (2009), the increasing concerns over rising levels of homelessness, housing costs, mortgage defaults and foreclosures, negative equity experienced by households, together with the declining neighbourhoods and over-heated housing markets have concertedly pressed quality housing affordability into the centre of housing policy. The study noted further that the issue of managing the relationship between the price of quality housing and the capacity of the household to pay for their housing is fundamental to the achievement of adequate provision and distribution of housing. This however, depends to a great deal on the income group which it belongs as well as the pressure exerted by other needs on the family earnings. Omole (2010) noted that the problem of low income affects the level of capital formation, which deprives the people of sufficient resources to utilize in improving their homes and keep their environment healthy for comfortable living. The capacity of a household to pay for their housing development depends to a great deal on the income group it belongs as well as the pressure exerted by other needs on the family earnings. Similarly, Agburu (2012) observed that insufficient wages or income makes life extremely precarious for a worker and members of the family.

This study aims at providing an insight into the nature and quality of homes occupied by federal income earners and concerns for sustainability in Akwa Ibom State, with a view to enhancing sustainable housing development and maintenance in Nigeria. The objectives include to evaluate the quality of homes occupied by federal income earners in Akwa Ibom state, and examine the levels of concern for housing sustainability of the federal income earners.

1.1. Research hypotheses

Two hypotheses were postulated for this study.

i) There is no significant variation in the quality of homes occupied by the federal income earners' in Akwa Ibom state.
ii) There is no significant variation in the concern for sustainability among the federal income earners.

The results of these hypotheses will provide an insight into the importance of sustainability attributes for the improvement of quality of houses in the study area. The

results will also unveil the orientation of the stakeholders in real estate development on the basic social, economic and environmental concerns that can maximize the development and maintenance of houses among different social and economic strata.

2. REVIEW OF RELATED LITERATURE

A number of studies on building conditions, sustainability concerns and categories of federal income earners were reviewed as a basis for the questionnaire formulation for this study.

2.1. Housing quality indicators and attributes

Housing is one of the most significant factors contributing to individual's quality of life. The quality of housing accounts for both quantitative and qualitative dimensions of housing units, their immediate environment and the needs of the occupants. Quantitative dimension of housing includes objective attributes, which are assessed using physical features, services and environment; while qualitative dimension deals with psychosocial aspects of an individual such as perception, needs, satisfaction and disappointment (Meng and Hall, 2006; Mohit, Ibrahim, and Rashid, 2010; Tas, Tas and Aydin, 2014). Several housing quality indicators and attributes have been identified by various authors including security and privacy in building; ventilation in building; availability of good road network, water and electricity supply, and social infrastructure within the neighbourhood; waste disposal and drainage system; good building design which takes into consideration standardroom sizes, availability of basic facilities within house and neighbourhood interaction (Jiboye, 2004; Omole, 2010; Ibem *et al*., 2013; Adeleye *et al*., 2014). These attributes thus serve as sources for the variables of housing qualities adopted in this study.

2.2. Sustainability concerns in housing development

Attempts have been made to discuss the concepts of sustainability vis-à-vis sustainable development from different perspectives. The concept of Sustainable Development emerged in 1987 with emphasis on development as a process of change in the direction of investment, orientation of technology and institutional changes which are in harmony to meet human needs and aspirations. It recognizes the integration of environment with development, while emphasizing sustainability as a major attribute. To meet the needs of the present generation, Udoudoh (2014) noted that there must be a continued growth in general and supply of major consumables and services into daily lives and economic production must be considered and effectively managed. This is in recognition that sustainable development is a dynamic process which encompasses all aspects of life for everyone, now and for generations to come.

Sustainable housing therefore encompasses all the processes of providing housing which ensures better quality of life for the inhabitants both now and in the future. In order for development to qualify as sustainable, certain criteria have to be satisfied simultaneously. These are social progress which recognizes the needs of everyone; effective protection of the environment; prudent use of natural resources; and maintenance of high and stable levels of economic growth and employment (Asad and Khalfan, 2007 and Zabihi *et al*., 2012). Other scholars namely Saroop and Allopi (2014) developed the criteria which defined the essential components by which sustainability may be assessed

collectively. Each criterion relates to a key element of sustainability. Through the measurement and monitoring of these indicators or concerns, the social, economic and environmental effects of infrastructure solutions can be assessed and evaluated to meet stated aims and clients' objectives more effectively. These objectives are efficient layout planning, resources utilization, environmental quality, functional efficiency, future maintenance, economy, safety and social concerns.

Shen *et al*. (2011) also identified thirty (30) sustainability indicators categorized into economic, social and environmental aspects as follows: economical aspect- analysis of market supply and demand, technical advantage, project budget, project financing channels, project investment planning, life-cycle cost, life-cycle benefit/profit, financial risk, payback period, and internal return ratio (IRR). The social aspects are effects on local development, provision of employment opportunities, project function, scale of serviceability, provision of ancillary amenities to local economic activities, public safety, public sanitation, land use and its influence on the public, protection to culture heritage, and promotion of community development; while the environmental aspect includes ecological effect, effect on land pollution, effect on air quality, effect on water quality, noise effect, waste generation, influence on public health, environment protection measures in project design, energy savings, and protection to landscape and historical sites. These served as sources of twenty-one housing sustainability concerns used in this study.

2.3. Classifications of household income and earning capacity

There appear to be diverse opinions on the classifications of household income and earning capacity among the states and federal civil services in Nigeria. For instance, Ndubueze (2009) identified the low income group as those households whose per capita income are below N40,000.00 while the high income groups were identified as households with per capital income earnings above N100,000.00, implying that those between these two extremes are the middle income earners. Jaja (2013) categorized the low income earners as those earning less than N20,000 monthly salaries, the medium income earners as those earning between N20,000 and N50,000, while the high income earners earn more than N50,000 as average monthly salary. Nwude (2013) observed that the classification of households into income earning capacity can be done as: low income - those earning up to N100,000 per month; medium income – those earning up to N300, 000 per month and high income - those earning above N300,000 per month. The study also stated that the classification can also be through civil service salary scale thus: low income - those between Salary Grade Levels 01 and 06, medium income - between Salary Grade Levels 07 and 13, while the high income earners fall between Salary Grade levels 14 and 17. This differ from the categorization by Rukaiyat *et al.* (2015) in a study of housing affordability by federal civil servants in Minna, which grouped federal civil servants into lower cadre (Grade Levels 3 to 7), middle cadre (G/L 8 - 13) and higher cadre (G/ L14 -17). The approach in this study is consequent upon the observation by Omole (2010) that the problem of low income affects the level of capital formation, which deprives the people of sufficient resources to utilize in improving their homes and keep their environment healthy for comfortable living. The use of federal income earners is to allow for a wider level of generalization of result outcome for sustainability in Nigeria as a whole.

2.4. Some previous empirical studies on housing quality

Adedire and Adegbile (2018) assessed housing quality in Ibeju- Lekki, a peripheral settlement outside Lagos metropolitan region, using purposive sample of 370 housing units from clusters of 16 peri-urban. Data ware sourced through structured questionnaires, interview (with local planning personnel) and observation schedules administered through a field survey. Analysis of the data were done using descriptive analysis to generate frequencies and percentages on socio-economic profile, neighborhood quality, locational quality, dwelling quality, and building materials used. Tests of correlation were conducted on the mean of variables of neighborhood quality, locational quality and building materials, derived through recoding of variables by means of transformed statistical tool, to establish the factors influencing housing quality in the study area. The results showed a significant positive correlation between household income and housing quality influenced by respondents' socio-economic attributes, building materials, neighborhood quality, and locational quality in the study area. It was concluded that socio-economic characteristics, predominantly income of households, play a major role in the level of housing quality that can be accessed in the study area, and recommended that the state government and private developers should promote alternative building materials to enhance housing affordability by the low-income group, and align urban policy to eliminate disparity in infrastructural development.

Oluwaseyi (2019) employed both descriptive and inferential statistics to assess housing Quality in Osun State, Nigeria. The study used Likert scale to explain respondents' perceptions of condition of houses sampled in Osogbo Local Government. The result of the analysis, revealed that the quality of housing is not encouraging and this is due to the low level of income earned by the inhabitants. The study therefore recommends the use of housing micro-finance which consist mainly of giving loans to low income earners. It was also suggested that both the state and local government should embark on programmes that will encourage provision of social facilities such as pipe-borne water, public toilet facilities, and effective waste disposal system.

Yoade, Adeyemi and Yoade (2018), assessed the housing quality in Ede, Nigeria, and the impacts of urbanization on environmental degeneration of urban built environment. A total of 388 housing units, consisting of 236, 78 and 74 units were drawn for sampling from the high, medium and low density areas of the study area, respectively. The secondary data comprised available census data, official documents and other relevant secondary data were obtained from existing literature, on books and journals. The study revealed that household-size has a significant influence on the overall housing quality in the study area. The study concluded that it is imperative to check and prevent further decay for good living and working environment.

Morenikeji, Umaru, Pai, Jiya, Idowu and Adeleye (2017) examined the factors responsible for the spatial variation in housing quality across the 36 states and the Federal Capital Territory in Nigeria using 33 housing characteristics. The data used are the 2006 Housing Characteristics and Amenities tables which were sourced from Nigeria's National Population Commission, with Principal Component Analysis extracting three components. The first component which accounted for 38% has electricity, water closet toilet, hygienic sources of water and high quality roofing, walling and flooring materials highly loaded on it. The second which accounted for (31%) comprised inferior walling, roofing and flooring materials, pit toilet, traditional and semi-detached house types, while the third component (7%) had mainly zinc wall and public toilet highly loaded on it. These factor loadings were used as variables in discriminant analysis, three distinct regions of differing housing quality emerged corresponding to the western, eastern and northern geographical regions of the

country with 97.3% of the states correctly classified and with the western (high) and northern (low) states at the opposite ends of the quality scale. It was recommended that non-conforming buildings, particularly, residential, and insanitary environment should be put in check through very strict and proactive enforcement of development control edicts and sanitary laws.

Adeoye (2016) evaluated the housing infrastructure and quality in Akure, capital city of Ondo state, Nigeria. It tried to identify the problems that have aided the degradation of basic housing infrastructures, substandard housing, overcrowding and the likelihood of future incidences of disease and epidemics. The study area was divided into high, medium and low – density zones. Existing demographic and land use characteristics of the city, and both primary and secondary data were used. Questionnaire were administered, collection and updating of the base maps, observation checklists and the use of necessary field were the instruments for the study. Penalty scoring was used to assess the conditions and quality of 180 houses selected for the study. The study revealed that Houses in the high – density area have the worst property and environmental characteristics followed by houses in the medium – density area. Many of the houses were categorized as either sub – standard or unfit for human habitation. The study further suggested a regeneration by private investors with possible displacement of residents from the high – density zone to new towns; a vigorous programme of housing and health education; enhanced collaboration between stakeholders to develop enforceable standards for existing housing stock is necessary; while the government is also expected to improve the existing infrastructures.

These studies were limited to assessment of air quality outside Akwa Ibom, without assessing the concerns for sustainability which can have serious influence on the quality of homes.

3. METHODOLOGY

This study adopted a cross-sectional survey approach which is exploratory, descriptive and quantitative. The survey was carried out with the aid of structured questionnaire which was piloted by survey of experts who are conversant with the subject matter. This was to determine whether the questions were ambiguous, unambiguous or have substantially captured the required housing qualities and sustainability attributes. These were tested for reliability and validity and found to be of high level with Cronbach alpha (α) ranging between 0.71 and 0.89thus can be highly acceptable, since the value of alpha is desirable with the range higher than 0.6 (Gliem and Gliem, 2003).

The study population consists of federal income earners in Akwa Ibom State. The study purposively sampled 208 respondents resulting in 193 valid copies of mail questionnaire comprising 90 low, 62 middle and 41 high income earners. Through the guidance of the group discussion during the pilot study, twenty-two home qualities and twenty-one sustainability attributes were all identified from the related articles reviewed in this study. The measurements were on a five point Likert-scale namely: poor=1, low=2, moderate=3, high=4 and very high=5.

In analysing the collected data, the total weight value (TWV) was then calculated for each of the variables. The TWV was arrived at from the summation of the products of the number of responses for the rating of each variable and the respective weight value for each rating. The TWV helped to arrive at the relative importance index (RII) used to determine the respondents' perception of quality of homes and importance of the sustainability

concerns in line with the formula used by Ugwu and Haupt (2007) and Enshassi, Mohamed and Abushaban (2009) as shown in equation 1:

$$RII = \sum \frac{W}{A} x\, N \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where W is the weight given to each variable by the respondents and ranges from 1 to 5; A – the highest weight = 5; N – the total number of respondents.

The RII were then classified as: 0-0.359 very low quality (VLQ); 0.36-0.529 low quality (LQ);0.53-0.679 moderate quality (MQ); 0.68-0.839 high quality (HQ) and 0.84-1.0 very high quality (VHQ) (scale of 0≤RII≤1) as adapted from the classification by adapted from Kazaz, Manisali and Ulubeyli (2008). A cut-off score of RII computed was determined by summing the weights and dividing by the total number of weighting items and highest weight respectively: (1+2+3+4+5)/5/5 = 0.60. Thus, events that have RII that are higher than 0.60 are defined as having significant quality, those with RII equal to 0.60 are moderate, while those less than 0.60 have insignificant quality. This approach adapted from Ujene (2014) is with the expectation that the use of 0.60 as reference value will effectively cover only important variables in terms of their quality and consideration. The variation in the perceptions of homes quality and consideration for sustainability concerns were analysed using Kruskal Wallis test.

4. PRESENTATION AND DISCUSSION OF FINDINGS

After analysing data obtained from the described methodology, results and finding are presented in this section.

4.1. Characteristics of respondents used for the study

The respondents that supplied the data used for the study were analyzed for an understanding of the characteristics of the people whose perceptions were investigated. For this purpose, the type of house occupied, sex, marital status, working experience, age, and qualification of the respondents were evaluated and the result presented in Table 1.

The result indicated that majority of the low income earners live in separate rooms with shared facilities, self-contain and one-bedroom flat. Majority of the medium income earners live in two and three bedroom flats, while the high income earners live in four bedrooms flat and duplexes. The result also shows that male respondents were dominant among the three groups of income earners. Majority of the respondents were married, hence require quality housing for their families. The result also indicated that the low income earners who were mostly between 40 and 60 years had experience of work and housing issues ranging up to 15 years. The medium income earners were slightly higher in age and experience of work and housing issues, while majority of the high income earners were fast approaching retirement, justifying that they may have passed through housing problem for quite a long time.

Majority of the respondents also have basic educational background as most of them had at least senior school certificates. The results generally indicated that the selected respondents have the required characteristics to provide reliable information for this study.

Table 1: Descriptive results of respondents' characteristics

Characteristics of Respondents	Sub characteristics	GL 01-06 No (%)	GL 07-13 No (%)	GL 14-17 No (%)	Total No (%)
Type of House occupied	Separate rooms with shared facilities	55(61.11)	02(2.23)	00(0.00)	57(29.53)
	Self-contain&One-bedroom flat	23(25.56)	12(19.35)	05(12.20)	40(20.73)
	Two &Three-bedroom flat	12(13.33)	43(69.35)	10(24.39)	65(33.68)
	Four-bedroom flat & Duplex	00(0.00)	05(8.06)	26(63.41)	31(16.06)
	Total	**90(46.63)**	**62(32.12)**	**41(21.25)**	**193(100)**
Sex of Respondents	Male	64(71.11)	46(74.19)	31(75.61)	141(73.06)
	Female	26(28.89)	16(25.81)	10(24.39)	52(26.94)
	Total	**90(46.63)**	**62(32.12)**	**41(21.25)**	**193(100)**
Marital Status of Respondents	Single	11(12.22)	06(09.68)	00(0.00)	17(08.81)
	Married	62(68.89)	42(67.74)	31(75.61)	135(69.95)
	Separated/Divorced	09(10.00)	8(12.90)	07(17.07)	24(12.44)
	Widow/Widower	08(08.89)	6(9.68)	03(07.32)	17(08.81)
	Total	**90(46.63)**	**62(32.12)**	**41(21.25)**	**193(100)**
Experience of Respondents on housing issues	1-5yrs	10(11.11)	3(04.84)	00(0.00)	13(06.74)
	6-10yrs	21(23.33)	06(09.68)	03(07.32)	30(15.54)
	11-15yrs	34(37.78)	10(16.13)	08(19.51)	52(26.94)
	16-20yrs	18(20.78)	14(22.58)	13(31.71)	45(23.52)
	>20yrs	07(07.78)	29(47.77)	17(41.46)	53(27.46)
	Total	**90(46.63)**	**62(32.12)**	**41(21.25)**	**193(100)**
Age of Respondents	1-17yrs	00(0.00)	00(0.00)	00(0.00)	00(0.00)
	18-40yrs	31(34.44)	08(12.90)	04(09.76)	43(22.28)
	40-60yrs	43(47.78)	18(29.03)	14(34.15)	75(38.86)
	>60yrs	16(27.46)	36(58.06)	23(56.10)	75(38.86)
	Total	**90(46.63)**	**62(32.12)**	**41(21.25)**	**193(100)**
Qualification of Respondents	Ordinary Level & Trade Tests	19(21.11)	08(12.90)	00(0.00)	27(13.99)
	Ordinary /Higher National Diploma	10(11.11)	07(11.29)	08(19.51)	25(12.95)
	B.Sc	32(35.56)	14(22.58)	10(24.39)	56(29.02)
	M.Sc	24(26.67)	25(40.32)	16(39.02)	65(33.68)
	PhD	05(05.56)	08(12.90)	07(17.07)	20(10.36)
	Total	**90(46.63)**	**62(32.12)**	**41(21.25)**	**193(100)**

4.2. Evaluation of quality of homes occupied by respondents

In order to evaluate the quality of homes occupied by the respondents in the region, twenty-two attributes of home quality were identified from literature. Respondents were requested to indicate their assessment of the attributes as described in the methodology. The results are presented in Table 2. The results showed that although 45.5% of the quality attribute attained the 0.60 significance level among low income earners, yet only 22.7% attained high quality level. Among the medium income earners 50.0% of the quality attributes were of significant quality of which 27.3% attained high quality. Among the high income earners 72.7% of the attributes were of significant quality out of which 54.5% attained high quality. The result also shows that the home quality attribute of most significance among the low income housing is roof condition, followed by neighbor relationship condition, security and waste disposal facility. Among the medium income houses the attribute of most quality is security, followed by roof condition, state of neighbor relationship and waste disposal facility. The result suggested that the low and medium income earners mostly ensure that they have roof over their heads which provide security and good relationship with their neighbours. Among the high income earners, the result

showed that home quality attribute of most significance is noise control, followed by aesthetic condition, privacy in building and security. This suggested that the high income earners mostly ensure that they live in very quiet, beautiful and secured houses where they have privacy and devoid of neighbor interaction.

Table 2: Results of evaluation of quality of homes occupied by federal income earners

	Low Income Earners - N=90			Medium Income Earners - N=62			High Income Earners-N=41		
Home Quality Attributes	**TWV**	**RII**	**Rank**	**TWV**	**RII**	**Rank**	**TWV**	**RII**	**Rank**
Noise control	143	0.32	20	188	0.61	11	180	0.88	1
Aesthetic condition	256	0.57	14	96	0.31	21	175	0.85	2
Privacy in building	298	0.66	6	159	0.51	18	172	0.84	3
Security	352	0.78	3	260	0.84	1	166	0.81	4
Facilities within house	216	0.48	18	164	0.53	17	161	0.79	5
Landscape/Parking space	264	0.59	12	179	0.58	12	159	0.78	6
Kitchen condition	140	0.31	22	127	0.41	19	152	0.74	7
Wall condition	321	0.71	5	215	0.69	5	151	0.74	8
Ventilation/ air quality	232	0.52	17	192	0.62	9	148	0.72	9
Adequacy of room sizes	271	0.60	9	210	0.68	6	148	0.72	9
Toilet & Bathroom condition	141	0.31	21	127	0.41	19	140	0.68	11
Roof condition	385	0.86	1	253	0.82	2	140	0.68	11
Road network condition	248	0.55	16	174	0.56	14	136	0.66	13
Foundation condition	292	0.65	7	200	0.65	8	130	0.63	14
Doors & Windows condition	266	0.59	11	207	0.67	7	129	0.63	15
Floor condition	254	0.56	15	88	0.28	22	128	0.62	16
Drainage system condition	274	0.61	8	189	0.61	10	120	0.59	17
Electricity supply	152	0.34	19	168	0.54	16	119	0.58	18
Water supply	263	0.58	13	174	0.56	14	117	0.58	19
Waste disposal facilities	335	0.74	4	242	0.78	4	102	0.50	20
Adequacy of circulation spaces	270	0.60	10	178	0.57	13	98	0.48	21
State of neighbours relationship	354	0.79	2	249	0.80	3	75	0.37	22

4.3. Comparison of quality of homes occupied by the income groups

In order to compare the perceptions of quality of homes occupied by the income groups, the first hypothesis was postulated as previously stated. The results of the hypothesis which was tested with Kruskal Wallis test at $p \leq 0.05$ was meant to provide confidence of views and ascertain if significant variation exists in the qualities of homes occupied by the three groups of income earners. The decision rule is that if p-value > 0.050, the hypothesis is accepted, but if p-value ≤ 0.050 the hypothesis is rejected. The results are presented on Table 3.

The results in Table 3 showed that the p-value for the first hypothesis is 0.049 < the significance level of 0.050, hence the null hypotheses is rejected, implying that there is significant variation in the quality of houses occupied by the different income earners. The source of variation in the quality of homes occupied, though not covered in the scope of this work, but may be attributable to the level of poverty among the low and some medium income earners as well as lack of social and communal interaction among the rich who prefer to live in mansions in reserved areas with high fence around them and unsatisfactory

consideration for social and environmental sustainability as shown in Ujene, Udoudoh and Ozigbo (2017).

Table 3: Kruskal Wallis result for comparing homes quality of the income groups

Kruskal-Wallis Test							
Items compared among Income groups	Low income Mean Rank	Middle income Mean Rank	High income Mean Rank	Chi-Square	p-value	sig. level	Decision
Quality of homes	28.730	30.110	41.660	6.025	0.049	0.050	Reject

4.4. Evaluation of the consideration given to housing sustainability concerns

In order to evaluate theconsideration given to housing sustainability concerns by the respondents in the region, twenty-one housing sustainability concerns were identified from literature. Respondents were then requested to indicate their assessment of the consideration given to sustainability concerns in ensuring quality homes as earlier described. The results presented in Table 4 shows that 76.2% of the housing sustainability concerns attained the 0.60 significance level among low income earners, from which 66.7% attained high consideration level. Among the medium income earners 71.4% of the housing sustainability concerns were of significant consideration of which 52.3% attained high consideration.

Table 4: Results of evaluation of concerns for Housing Sustainability

	Low Income Earners - N=90			Medium Income Earners - N=62			High Income Earners-N=41		
Housing Sustainability Concerns	TWV	RII	Rank	TWV	RII	Rank	TWV	RII	Rank
Concern for air quality	360	0.80	3	248	0.80	2	171	0.83	1
Concern for profitability	258	0.57	19	184	0.59	16	160	0.78	2
Concern for natural lighting	366	0.81	2	267	0.86	1	157	0.77	3
Concern for financing channels	321	0.71	10	219	0.71	6	151	0.74	4
Concern for payback period	228	0.51	20	184	0.59	16	151	0.74	4
Concern for water quality	315	0.70	11	205	0.66	12	144	0.70	6
Concern for community development	351	0.78	5	216	0.70	8	141	0.69	7
Concern for maintainability	309	0.69	12	218	0.70	8	142	0.69	7
Concern for public health	324	0.72	9	211	0.68	11	137	0.67	9
Concern for public safety	348	0.77	6	242	0.78	3	135	0.66	10
Financial risk concern	285	0.63	16	193	0.62	14	135	0.66	10
Concern for conservation	348	0.77	6	224	0.72	5	131	0.64	12
Concern for stakeholders' satisfaction	354	0.79	4	239	0.77	4	128	0.62	13
Concern for market supply/ demand	260	0.58	18	176	0.57	18	126	0.61	14
Concern for pollution control	265	0.59	17	160	0.52	21	120	0.59	15
Concern for resources utilization	333	0.74	8	213	0.69	10	119	0.58	16
Ecological concern	288	0.64	15	195	0.63	13	117	0.57	17
Concern for environmental aesthetics	309	0.69	12	191	0.62	14	113	0.55	18
Concern for waste generation/control	300	0.67	14	173	0.56	19	111	0.54	19
Energy saving concern	222	0.49	21	167	0.54	20	109	0.53	20
Concern for communal interaction	393	0.87	1	219	0.71	6	99	0.48	21

Among the high income earners 66.7% of the sustainability concerns were given significant consideration out of which only 38.1% attained high level consideration. The result also showed that the sustainability concern of most significance among the low income housing is concern for communal interaction, followed by concern for natural lighting, air quality and concern for stakeholders' satisfaction. Among the medium income earners, the housing sustainability concerns of most significance is concern for lighting, followed by concern for air quality, public safety and stakeholders' satisfaction. The result suggests that the low and medium income earners give most consideration to social and environmental sustainability concerns than economic sustainability concerns.

Among the high income earners, the result showed that the housing sustainability concerns of most significance is concern for air quality, followed by concern for profitability, concern for lighting, financing channels and payback period. This suggests that the high income earners give most consideration to environmental and economic than social sustainability concerns.

4.5. Comparison of the considerations for sustainability concerns by the income groups

In order to compare the perceptions of considerations for sustainability concerns by the income groups, the second hypothesis was postulated as previously stated. The results of the hypothesis which was tested with Kruskal Wallis test at $p \leq 0.05$ was meant to provide confidence of views and ascertain if significant variation exists in considerations for sustainability concerns by the three categories of income earners. The decision rule is that if p-value > 0.05, the hypothesis is accepted, but if p-value ≤ 0.05 the hypothesis is rejected. The results are presented on Table 5.

Table 5: Kruskal Wallis result for comparing consideration for housing sustainability among income groups

Kruskal-Wallis Test							
Items compared among Income groups	Low income Mean Rank	Middle income Mean Rank	High income Mean Rank	Chi-Square	p-value	sig. level	Decision
Considerations for Housing sustainability	36.570	31.500	27.930	2.362	0.307	0.050	Accept

The results in Table 5 show that the p-value for the second hypothesis is 0.307 >the significance level of 0.050, hence the null hypotheses is accepted, implying that there is no evidence in the data to suggest that the perceptions of the different income groups are different. The results indicated that although there are some perceived differences in consideration given to sustainability concerns by the income groups, the differences are not statistically significant. The similarity may be attributable to the general low level of development, sustainability awareness and financial empowerment in developing countries.

4.6. Discussion of findings

It was found that that out of the 45.5% significant home quality attributes among low income earners only 22.7% attained high quality level. Out of the 50.0% significant quality

attributes among the medium income earners 27.3% attained high quality, while 54.5% attained high quality out of the 72.7% significant home quality attributes among the high income earners. The evaluation of federal income earners' home qualities shows that the low and medium income earners live in inadequate quality housing, while the high income earners live in better quality houses. These findings which may be attributable to the inadequate income being earned by these categories of inhabitants supports the similar finding of Oluwaseyi (2019).

The study established that there is significant variation in the quality of houses occupied by the different income earners. The variation in the quality of homes occupied was linked to the level of poverty among the low and some medium income earners as well as lack of social and communal interaction among the rich who prefer to live in mansions in reserved areas with high fence around them and unsatisfactory consideration for social and environmental sustainability. This finding supports that of Adeoye (2016) which revealed that houses in the high density and middle density area have the worst property and environmental characteristics than the low density area. This is attributable to the poverty level of the low income earners who live in high density zones. The implication of this finding is that the poor housing quality noticed among the two lower income groups who live in more crowded zone can exacerbate existing health problems.

The study also found that, out of the 76.2% significant housing sustainability concerns among low income earners, 66.7% attained high consideration level. Among the medium income earners out of 71.4% significant housing sustainability concerns, 52.3% attained high consideration. Among the high income earners 66.7% of the sustainability concerns were given significant consideration out of which only 38.1% attained high level consideration.

The study also found that there is no significant difference in the concern of the various income earners for housing sustainability attributes. This supports the assertion of Low demand for sustainable construction from clients as well as organisations' lack of sustainability strategies because of low awareness about sustainability issues in construction (Tunji-Olayeni, Mosaku, Oyeyipo, and Afolabi, 2018). The concerns for sustainability issues have been found to be fairly significant, but not of significantly high consideration especially among low and medium income groups. Hence, it may be responsible for the inadequate home qualities observed among the low and medium income groups.

5. CONCLUSION AND RECOMMENDATIONS

This study has evaluated federal income earners' home qualities and their concerns for housing sustainability so as to provide an insight into the nature and extent of quality of homes occupied by federal income earners importance of concerns for sustainable in Akwa Ibom state, with a view to enhancing sustainable housing development and maintenance in Nigeria. It concluded that the low and medium income earners live in inadequate quality housing, while the high income earners live in better quality houses The most significance home quality attributes among the low income housing is roof condition, neighbour relationship condition, security and waste disposal facility. Among the medium income houses the attribute of most quality is security, roof condition, state of neighbour relationship and waste disposal facility, indicating that because of the lean income of the low and medium income earners, they mostly ensure that their housing provide roof over their head, security and good relationship with their neighbours. The high income earners

significantly ensure noise control, followed by aesthetic condition, privacy in building and security, indicating high priorities on ensuring very quiet, beautiful and secured houses where they have privacy and devoid of neighbour interaction.

The study also concluded that, the concerns for sustainability issues have been found to be fairly significant, but not of significantly high consideration especially among low and medium income groups. The sustainability concerns of most significance among the low and medium income housing are concerns for communal interaction, natural lighting, air quality, public safety and stakeholders' satisfaction, indicating that the low and medium income earners give most consideration to social and environmental sustainability concerns than economic sustainability concerns. The housing sustainability concerns of most significance among high income earners are: concern for air quality, profitability, lighting, financing channels and payback period, indicating that they give most consideration to environmental and economic than social sustainability concerns. The study concluded that there is a significant variation in the qualities of homes inhabited by the various income groups, but no significant difference in their concern for housing sustainability concerns. The study therefore recommends that the low and medium income earners should enhance the quality of their homes by putting consideration on economic sustainability concerns, while the high income earners should include social concerns together with improving their concerns for environmental sustainability of housing in the study area. Government should also create enabling environment for the integration of social, economic and environmental sustainability concerns for the improvement of housing qualities through adequate legislature and enlightenment.

6. LIMITATIONS OF THE STUDY

This study is limited to the housing qualities and sustainability concerns selected from literature and the views of the selected construction managers who returned their questionnaire. The source of variation in quality of houses occupied by the different income earners has not been evaluated in this study through post-hoc test, because of the intended scope. The result could be improved by further studies on other housing qualities, sustainability concerns not covered in this study, other respondents from the built environment stakeholders, as well as determining sources of variation in housing qualities. In spite of these limitations, the result could provide reasonable insight into the relevance of housing qualities among income groups and the need for sustainability consciousness, with a view to enhancing sustainable housing, in quality, quantity and affordability in the study area, as well as guide for further studies.

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APPLICATION OF BUILDING INFORMATION MODELLING IN CONSTRUCTION PROJECTS DELIVERY IN NIGER DELTA, NIGERIA

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ABSTRACT

Purpose: Globally, there is tremendous increase in the use of Building Information Modeling (BIM) due to the fact that Governments around the world have recognized the inefficiencies affecting the construction industry in general, and have recommended and mandated the practice of Building Information Modelling (BIM) as a strategy to addressing a declining productivity. The study investigates on application of BIM in construction projects delivery in Niger-Delta region of Nigeria. The study focuses on the barriers associated with Building Information Modeling (BIM) in construction project delivery and classified them into three aspects.
Design/methodology/approach: Both the qualitative and quantitative approaches were employed in generating preliminary data for field testing. The survey involved one hundred and twenty participants in the six states of nine states of the Niger-delta with notable volume of construction projects and awareness of BIM tools. Data collected were analyzed using mean score and criticality index.
Findings: The study revealed that there are three main categories of the barriers in BIM based on the three main types of the stake holders in construction projects. The study unravelled the probability of occurrence and impact of the 14 barriers in construction project delivery. In addition, the study also reveals that seven barriers were fund to be most critical and that 4 of these 7 barriers were associated with the professional participating in construction projects and 3 were associated with the public sectors.
Originality/value: The study concluded that appropriate BIM development will enable construction industry to make expected contributions to the economic and development growth of Niger-Delta region of Nigeria. In order to pave way for BIM towards improving productivity and increased efficiency in Nigeria construction industry the research recommended that the Government should support the adoption and implementation of BIM in all capital projects at the three tiers of government and the professional bodies relevant in the construction industry should mandate training and retraining of their members on the application of BIM and forestall strong team work need in BIM concept for efficiency of construction industry in Nigeria.

Keywords: Building information modelling; construction; projects delivery; Niger Delta.

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1. INTRODUCTION

Recently, Building Information Modelling (BIM) has been recognized as a strategy to addressing the inefficiencies and declining in productivity of the construction industry. It has become very obvious that continuing to do things in the construction industry the way they had been done in the past may not lead to success due to technological advancements. The need for change and the rate of change across both large and small construction organizations is constantly increasing. A lot of organizations are realizing the need to improve their operations in order to remain relevant. Therefore, constantly improve both their managerial skill and technological know-how. The construction industry is not left out in the change taking place in the world, as a matter of fact, there has been a paradigm shift from the use of the conventional 2D-based documentation and staged delivery processes to a digital prototype and collaborative workflow. BIM is defined as the use of ICT to streamline the building lifecycle process in order to provide a safer and more productive environment for its occupants, to affect the least possible environmental impact from its existence and to be more operationally efficient for its owners throughout the building lifecycle (Arayici *et. al*., 2012).

The use of BIM which is a collaboration model is the most effective way of addressing the fragmentation in the construction industry, improve productivity and eliminate wastages. BIM architecture broadly enhance today's computer-aided design (CAD) capabilities with an improved ability to link design information with construction supply chain processes, such as estimating, offsite fabrication of elements, construction scheduling and cost control, materials procurement and tracking and general site operations. Furthermore, collaboration builds trust and common goals that serve the owner rather than competitive relationships where each team member often strives to maximize their individual goals (Eastman, Teicholz, Sacks, & Liston, 2011) BIM has modified the way construction projects are designed, constructed and operated. Using BIM in the construction, led to increase in the profitability, better time and cost management as well as improving in client-customer relationship. BIM is beneficial for all stages of construction as noted by many (Eastman, et. al., 2011 & Azhar, *et. al*., 2012). Alufohai (2012) attributed the low level of awareness and adoption of BIM to the low level of knowledge and use of BIM by professionals in the Nigerian construction industry.

Once BIM has been utilized on a project, its results speak for themselves and "firms that have switched to BIM don't switch back" to 2-D (Zeiger, 2008). Anecdotal results on one large firm's projects suggest that a 2 – 3 times payback is gained for the contractor for BIM expenditures (Post, 2008). The study investigates an application of BIM in construction projects delivery in Niger-Delta region of Nigeria. The study focuses on the barriers associated with Building Information Modelling (BIM) in construction project delivery and classified them into three aspects.

2. LITERATURE REVIEW

Globally, there is increase rate of using BIM either by governments for the public work or private sector and anticipated to continue to increase. BIM is mandated in some countries such as US and, UK and a number of other countries (Smart Market Report; 2010). The adoption of BIM has tremendously increased globally between 2010 and 2018. In USA it

was 54 % in 2012, in European countries it reached 36% in 2010. In the UK, BIM adoption between in 2012 was 39%, in the Middle East, only 10% in 2013 (Smart Market Report, 2014; Staff, 2014; NBS, 2014; NBS, 2013). Some countries in the Europe such as Finland, Denmark, Norway and Sweden are known as the BIM leaders in the word (Jensen & Johannesson, 2013; Khosrowshahi & Arayici, 2012). Accordingly, there are numerous publications, research results, and policies developed for BIM implementation in Europe. Even most private owners are also requiring the use of BIM in order to increase efficiency of the building, lower costs and to enable more creative designs.

In the days of master builders, the model of a building was in the mind of that master builder. Now, one person cannot possibly envision all the spatial relationships and requirements for all aspects of the building. Coordinating the many specialized fields involved in building has been difficult using 2-D because information is not centralized and communicating spatial relationships between the components is difficult. Returning to the concept of the master builder, BIM offers the single entity visualization and planning. The entity is a group of specialists who view and work a design concept made available by BIM software. Defining BIM is difficult because it refers to software tools, an independent created model, and to the process of designing and coordinating a project using BIM tools.

The term "BIM" often refers to the technology that helps organize the data concerning the relationships of the building components and represents them in 3-D. BIM tools are often more intuitive and easier to use than traditional 2-D software tools because images are represented more realistically. When an element is changed on one view, all related information, be it in charts, schedules, elevations, details, etc., is changed simultaneously and represented accordingly in other views. The power of BIM tools is not limited to its ability to help visualize the design, but includes the amounts of data that are related to the objects in the design and its ability to communicate this information about individual project components (Kymmell, 2008).

BIM can be used as a noun to mean a Building Information Model which is a compilation of building information. The data are interrelated objects with all pertinent information on each object attached to it. A door in a model is not just a few lines representing a door, but contains all information that pertains to manufacturing, locating, installing, finishing and maintaining it. Users needing access to information view only information pertinent to their interest without changing the overall relational data. Thus, the power of the model is that many parties can work with a common database and have current information.

When used as a verb, Building Information Modelling refers to the act of simulating real activity relating to a building or construction project (Eastman *et. al*., 2008). Similarly, the BIM Smart Market Report (2014) defines BIM as "the process of creating and using digital models for design, construction and/or operations of projects"). Whichever the case or tense, BIM refers to a relatively new technology that supports visualization and communication of building design and construction processes. Rather than a software, BIM is "a systems approach to the design, construction, ownership, management, operation, maintenance, use, and demolition or reuse of buildings" (Smith & Tardif, 2009). The most important part of BIM is not the software functionality, but collaboration in the design and planning process which speeds the process and clarifies design (Onuma, 2008). Depending on context "BIM" may be used to. Represent either of these definitions in this work.

In Nigeria public sector, the main challenges regarding efficiency and productivity here are poor budgeting and corruption. Also, Construction projects in Nigeria often involve wild inflation of costs. As such, the adoption of BIM will greatly enhance transparency, allowing different stakeholders (bidding contractors, parliament, civil society organizations etc) to have a better idea of true scope of projects (Alufohai, 2012). The current rebasing

of the Nigerian economy shows that construction contribution to GDP growth from 2010-2013 has risen to 7.2%. This cannot be compared to Manufacturing, with a contribution to GDP growth of 14.3% ((National Planning Commission, 2014). The low productivity in the Nigerian Construction Industry is attributed to the inefficiency in production processes that are prevalent in construction projects. As such, BIM serves as a practical and innovative approach whereby the planning, designing, building and management of infrastructure is done in a coordinated and integrated manner which improves efficiency and reduces waste, and thus, enables the increased productivity to support GDP growth in Nigeria.

The benefits of BIM are tangible to all the project teams throughout the entire project phases, beginning from the project inception, briefing, design, construction, operation and maintenance till demolishing of the construction (Hardin 2009; Jung & Joo 2011; Eastman et a., 2011). The following are some of the most recognized benefits resulting from the implementation of BIM: Improved collaboration and integration for the construction industry; Client's early involvement and decision; Acquired competitive advantage; Reliable sustainability analyses; Control of the construction site; Error-free design; Increased client satisfaction; Reduced project time and cost and Improved safety management.

Adoption of BIM entails an entire shift in practice both in term of technology and culture. As such culture transformation poses more challenges than technology because culture is a product of many years and cannot change overnight. Since, construction sector in Nigeria was developed prior to the era of digital evolution; its adoption will change most construction practices. According to Aibinu and Venkatesh (2013), there is absence of industry widespread standard for coding and classifying construction work. In addition, there is lack of skilled personnel, which leads to lack of BIM expertise and suitable conceptions to use BIM features in the market. Below are some of the barriers to the adoption of BIM in the Niger delta region of Nigeria classified into three main categories of stake holders in construction projects.

Table 1: Identification and classification of barriers associated with BIM in construction projects

Main category	Barrie items
Public sector	lack of enabling environment; Lack of standard to guide implementation; Frequent power failure; Client are not requesting the use of BIM on project; Structure/culture of the industry and Lack of protocols
Professional	Unavailability of appropriate technology and infrastructure; Individual/personal disposition; Compatibility between software platforms; Cost of required software upgrade; Lack of knowledge and level of awareness ; and Lack of professionals to handle the tools
Contractor	Inadequate BIM experience to (know- how) change; Poor internet connectivity; Low access to credit facilities

3. METHODOLOGY

Data were collected through structured multiple choice questionnaire. The questionnaire was divided into two parts; part A contained personal data of the respondents, part B comprised the barriers to BIM in construction projects and the drivers for BIM adoption and measure to remove the barriers. The survey respondents were asked to rate the criticality of these identified risks based on their perception and experience. The survey

respondents were asked to rate their probability or likelihood of occurrence and the magnitude of the potential impact based on their perception and experience on the 5-point Likert scale; whereby 5 represented very likely and 1 not likely to rate their probability. In terms of the magnitude of the impact: 1 Implied negligible impact; 2 Marginal impacts; 3 Substantial; 4 Severe; and 5 Disastrous. The intent was to use the results from this analysis and from the assessment of their impact to compute the Criticality Index (CI) for each risk factor. Criticality is assumed to be the combined effect of probability of occurrence and the impact of occurrence of the risk. The index developed by Wang et al. (2000) was used for measuring risk. The numerical scores assigned by respondents were transformed to a criticality index (CI) using the following formula:

$$Criticality\ index = \frac{(5n_1 + 4n_2 + 3n_3 + 2n_4 + n_5)}{5(n_1 + n_2 + n_3 + n_4 + n_5)}$$

Where: n1, n2, n3, n4 and n5 represents number of respondents who answered most critical, very critical, critical, less critical and not critical respectively.

A total of 180 questionnaires were distributed to professionals practicing in the six states of nine states of the Niger-delta with notable volume of construction projects, at the rate of 30 questionnaires to each state. 120 of 180 questionnaires administered were returned and analyzed using descriptive analysis and the relative importance index methods. The return rate of 66, 67% indicated that the result can be relied upon.

4. ANALYSIS AND RESULTS

4.1 Probability of occurrence of barriers of BIM in construction projects delivery in Niger-Delta Region of Nigeria

Table 2 shows that all the 14 barriers to BIM were rated to have some element of probability of occurrence; it is evident that none of the barriers has mean score less than 2.00 as a rating of 1.00 has represented not likely to occur in construction projects delivery. The analysis of survey respondent revealed that the first 5 most occurrence barriers were fund in the category of the professionals in the built environment this indicates that the professionals in the built environment are the main influencers of the application of BIM in construction projects delivery in Niger-Delta region of Nigeria. Successful of the application of BIM in the Niger-Delta region of Nigeria depend on the readiness of the professionals in the built environment to tackle: compatibility between software platforms; knowledge; technology; cost of software and team work. The result also showed that the barriers in the public sector category were ranked high. This implied that government need to mandate the use of BIM in public work for successful implementation of BIM.

4.2. Impact of barriers of BIM on construction projects delivery in Niger-Delta of Nigeria

In Table 3, all the 14 risk factors were rated as having a significant impact on application of BIM on construction projects delivery as they all had an overall MS ranging between 2.35 and 4.00 From the scale employed a score of 2 represented a marginal impact, 3

represented substantial impact; whilst 4 represented a severe impact.

Table 2: Probability of occurrence of barriers to BIM in construction projects delivery in Niger-Delta Region of Nigeria

Category	Barriers to BIM in Construction Projects in Niger-Delta region	MEAN	RANK
Public Sector	Lack of enabling environment	3.44	8th
	Lack of standard to guide implementation	3.56	6th
	Frequent power failure	3.40	10th
	Lack of protocols	3.31	12th
	Structure/culture of the industry	3.44	8h
	Client are not requesting the use of BIM on project	3.62	5th
Professionals in Built Environment	Lack of professionals to handle the tools	3.47	7th
	Non-availability of appropriate technology and infrastructure	3.65	4th
	Compatibility between software platforms	3.87	1st
	Cost of required software upgrading	3.76	3rd
	Lack of knowledge and level of awareness	3.82	2nd
	Individual/personal disposition	2.58	13th
	Poor internet connectivitv	2.55	14th
Contractors	Low access to credit facilities	3.33	11th

Table 3: Impact of barriers of BIM on construction projects delivery in Niger-Delta of Nigeria

Category	Barriers to BIM in Construction Projects in Niger-Delta region	MEAN	RANK
Public Sector	Lack of enabling environment	3.69	6th
	Lack of standard to guide implementation	3.58	7th
	Frequent power failure	3.40	8th
	Lack of protocols	3.00	9th
	Structure/culture of the industry	3.83	5th
	Client are not requesting the use of BIM on project	3.86	3rd
Professionals in Built Environment	Lack of professionals to handle the tools	4.00	1st
	Non-availability of appropriate technology and infrastructure	3.86	3rd
	Compatibility between software platforms	4.00	1st
	Cost of required software upgrading	3.00	9th
	Lack of knowledge and level of awareness	2.98	11th
	Individual/personal disposition	2.87	14th
	Poor internet connectivity	2.94	13th
Contractors	Low access to credit facilities	2.98	11th

4.3. Criticality of BIM on construction projects delivery

Table 4 shows that 7 of the 14 barriers were critical to the application of BIM on construction projects delivery while the remaining 7 were somehow critical. The decisional rule was that any barriers with CI greater than 0.5 are said to be critical; meaning that they are likely to occur and have a severe impact if they occur. In addition, any barriers with CI of less than 0.5, but not less than 0.3, are somehow critical on the project. None of the barriers were rated below a CI of 0.3 which implied that all of the barriers were likely to occur; and when they occurred they would have an impact ranging from a marginal impact

to a severe impact on the project.

Table 4: Criticality of BIM on construction projects delivery

Category	Barriers to BIM in Construction Projects in Niger-Delta region	PB Mean	IB Mean	CI	Rank	Remark
Public Sector	Lack of enabling environment	3.44	3.69	0.51	6th	critical
	Lack of standard to guide implementation	3.56	3.58	0.51	6th	critical
	Frequent power failure	3.40	3.40	0.46	8th	somehow critical
	Lack of protocols	3.31	3.00	0.40	11th	somehow critical
	Structure/culture of the industry	3.44	3.83	0.53	5h	critical
	Client are not requesting the use of BIM on project	3.62	3.86	0.56	2nd	critical
Professionals in Built Environment	Lack of professionals to handle the tools	3.47	4.00	0.56	2nd	critical
	Non-availability of appropriate technology and infrastructure	3.65	3.86	0.56	2nd	critical
	Compatibility between software platforms	3.87	4.00	0.62	1st	critical
	Cost of required software upgrading	3.76	3.00	0.45	10th	somehow critical
	Lack of knowledge and level of awareness	3.82	2.98	0.46	8th	somehow critical
	Individual/personal disposition	2.58	2.87	0.30	12th	somehow critical
	Poor internet connectivity	2.55	2.94	0.30	12th	somehow critical
Contractors	Low access to credit facilities	3.33	2.98	0.30	12th	somehow critical

4.4. Discussion of findings

This study was carried out with the aim of investigating the application of Building Information Modelling in construction projects delivery in Niger-Delta region of Nigeria. The study examines the probability of occurrence of the identified barriers that influencing the application of BIM in construction projects delivery and also determined the impact of these barriers. The rate of probability of occurrence and the impact of these barriers were used in determine the criticality of the barriers and seven of the fourteen barriers were the most critical barriers that influencing the application of Building Information Modelling in construction projects delivery in Niger-Delta region of Nigeria: Compatibility between software platforms; Non-availability of appropriate technology and infrastructure; Lack of professionals to handle the tools; Client are not requesting the use of BIM on project; Structure/culture of the industry; lack of enabling environment and Lack of standard to guide implementation in descending other. This implied that all of these barriers were likely to occur; and when they occurred they would have a severe impact on the project. Moreover, all the fourteen barriers have impact on the application of BIM in construction projects delivery. This indicates that all of the barriers were likely to occur; and when they occurred they would have an impact ranging from a marginal impact to a severe impact on the project.

Furthermore, four of these seven barriers were associated with the professional in the built environment. This implied that if the professional can acquire adequate skill through training and re-training and having good team work spirit together with the adequate role of the government in establishing standard to guide implementation of BIM, creating

enabling environment and re structure construction industry. Nigeria will be among the leading countries in the world with the adoption of BIM and improve the performance of construction industry which will has great impact in the GDP. Globally, it has been recognized that low productivity in the construction industry is attributed to the inefficiency in production processes that are prevalent in construction projects and the adoption of BIM is expected to enhance performance and profitability for the construction industry. This has making the developed countries mandated the adoption of BIM for public project.

Finally, it is imperative that the Government at the three arms supports the implementation of BIM in all capital projects. This can be achieved through the integration of BIM into the National Integrated Infrastructure Master Plan (NIIMP) which aims to develop infrastructure throughout the country between 2014 and 2043.

5. CONCLUSION AND RECOMMENDATIONS

The study has established that if BIM is deployed appropriately, can provide significant savings; enhance the quality of the built environment that gets delivered and allow the industry to make expected contributions to the economic and development growth of the country. Hence, this study also found that computer status and technological level of construction professionals needs to be improved through mandatory seminars, workshops and conferences by the various professional bodies and academic curriculum of the courses in the built environment. The government need to streamline duplications of duties among the professionals in other to have the required team spirit needed for the application of BIM in construction projects delivery.

In order to pave way for BIM towards improving productivity and increased efficiency in Nigeria construction industry the research seeks to recommend the following: The Government should support the adoption and implementation of BIM in all capital projects at the state three tiers of government; Professional bodies relevant in the construction industry should take steps for the training and retraining of its members on the use and application of BIM. And strong cooperation between the professional bodies; and the full integration of BIM into the academic curriculum of professional courses in the built environment in order ensure that the graduates have the background knowledge of the concept and implementation of BIM before graduate.

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UTILIZATION OF QUANTITATIVE TECHNIQUES IN DECISION MAKING AMONG CONSTRUCTION MANAGERS IN AKWA IBOM STATE, NIGERIA

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ABSTRACT

Purpose: Quantitative techniques are relevant in practically every aspect of production to assist in decision making for optimal use of resources. This study aimed at providing reasonable insight into the existing level of application of different decision techniques, as well as the prioritization the factors militating against their adoption with a view to enhancing construction projects delivery in Akwa Ibom state and Nigeria in general.

Design/methodology/approach: The aim of the study was achieved through, a cross-sectional survey of, Architects, Builders, Engineers and Quantity Surveyors, who practice as construction project managers in Akwa Ibom State. Data were collected using questionnaire administered on 150 staff, consisting of six managers chosen from each of the 25 purposively selected construction companies operating within Akwa Ibom state. The six managers comprised one top manager, two middle managers and three supervisory managers from each company. Twenty-one quantitative techniques and nineteen factors inhibiting the application of quantitative methods were identified and presented to the managers for evaluation, while quantitative analytical designs were utilized in the analysis and discussion of findings.

Findings: The result showed on the whole that there is inadequate utilization of quantitative techniques in decision making among construction managers, as not up to 50% of the identified quantitative methods are utilized by the construction managers, while the adoption of quantitative techniques are seriously plagued by many factors. The significance attached to, poor awareness by the supervisory managers may not be unconnected to their lower educational level and experience. The middle managers attached the most significance to, inadequate skills and knowledge attributable to inadequate training and experience. The top and middle managers rated data unavailability and inadequate training curriculum very high, attributable to poor data management by many companies, as well as inadequate course content to guide the teaching of these subjects in institutions.

Research limitations/implications: The limitations include the use of only perception of respondents from selected companies in Akwa Ibom. The contribution to knowledge is that this study established the current level of application of different forms of decision making tool, as well as the insight to prioritization the solution to tackling the factors militating against the adoption of the techniques.

Practical implication: It is recommended that construction managers should be encouraged through organisational polices which support the development of data bank, adequate training and skills. Government agencies should also ensure that quantitative method curricula

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adequately cover the required knowledge areas, which should be completely taught by the teachers in charge.

Originality/value: The study revealed the percentage level of utilization of the quantitative techniques as well as the extent to which the managers perceive the influence of the factors inhibiting the utilization of the techniques.

Keywords: Construction industry; construction managers; decision making; inhibiting factors; quantitative techniques.

1. INTRODUCTION

The work of managers in ensuring effective and effective outcome in any establishment concerns 'choosing issues that require attention, setting goals, finding or designing suitable courses of action, as well as evaluating and choosing among alternative actions (Esan, Akanbi, Esan, Fajobi and Ikenebomeh, 2016). These processes involve decision making, which is seen as a process of obtaining a team commitment to, and collective support for, sustainable results (Zulkiffli and Latiffi, 2019).

There are several theories or models to explain managerial decision making. Few of these include the pre-programmed organisational process model; the political views which is a personalised bargaining process. There is also the Simon's theory of rationality in decision making which entails the four steps of intelligence, design, choice and review assuming the manager has the needed information to make decisions. Simon also proposed the bounded rationality theory, where the manager is assumed to have incomplete information for decision making. The rationality models, ranks alternatives by calculating their subjective expected utility. The approaches employed in selecting the best alternative may include any or all of experience, experimentation, research and analysis (Esanet al., 2016).

Djordjević, Lepojević, and Janković-Milić (2008) opined that, all aspect of production and practically every aspect of daily living use quantitative techniques to assist in decision making. Barougha, Shoubia and Skardi (2012) noted that different decision-makers are involved at various stages of construction management such as design, construction, operation, utilization and maintenance. The importance of accurate decision making to overall goal of construction endeavours has also led to the use of quantitative methods in the construction industry. This according to The Institute of Cost Accountants of India (ICAI) (2014) is to help managers to make precise and perfect decisions for efficient utilisation of scarce resources. The method involves quantification of variables and determination of relationships among them through mathematical equations which helps the process of arriving at optimal decisions.

Application of quantitative techniques plays tremendous role in various aspects of the construction. For example, optimisation techniques (linear programming, assignment, and transportation) are needed to analyse construction demands and supplies, and to assess how to plan and allocate them. Game theory is needed for ascertaining optimal use of strategies in competitive situations between two or more opponents and for conflict resolution. The queuing theory is needed to analyse and manage waiting lines in workers, plants, vehicles and others utilisation of facilities. Simulation techniques are necessary for observing the behaviour of a system under several alternative conditions in an artificial setting. Program evaluation review technique(PERT) or the critical path method (CPM) are necessary in project

implementation control system. Other methods include; forecasting (regression, path analysis, and time series), cost-benefit analysis, sensitivity analysis, significance testing, benchmarking, correlation, variance analysis, index numbers and total quality management, all of which help in reduction of cost, proper deployment of resources and minimization the time required for completing tasks (Verma and Sharma, 2017). These techniques which rely on available information have been noted to be very helpful in tackling the complex problems of modern business and industry, with the current tendency of combining several of these techniques to form more sophisticated and advance programming models.

Decision making at various level of management do not depend on available information only, but also on knowledge, skills and experience of "decision maker" who are usually the managers. Tyrańska (2016) and ICAI (2014) identified the three management levels to include top level management, middle level management and low/supervisory level management. This study supports the view that the extent of utilisation of the quantitative techniques and the successes achieved at the various levels of management depend greatly on knowledge, skills and experience of the managers and other factors. In line with the observation by Jabar, Ismail, Aziz, and Nurul (2013) that a construction manager needs to have competence in those areas that have the most impact on successful outcomes, this study is of the view that quantitative decision making is one of such areas which should be properly investigated.

According to Chukwudozie (2014), the application of a wide range of quantitative techniques in production planning and control activities for optimal utilisation of resources, as well as for the production of the required quantity and quality of products that meet consumers' demands, have tremendously achieved the accruing benefits in overseas countries like United States of America, Britain, Japan, Korea and China where industries. The study sadly observed that this is not the case yet in Nigeria, an indication that the level of utilisation of quantitative techniques and its associated benefits have not yet been adequately investigated. This therefore lends credence to this study which aims to investigate the level of utilization of quantitative techniques in decision making among construction managers, for enhanced project deliver in Akwa Ibom state, Nigerian. The specific objectives are, (i) to evaluate the level of application of quantitative techniques in decision making among top, middle and low level managers in Akwa Ibom state and, (ii) assess the factors militating against the utilisation of the techniques in decision making among the different levels of management in the construction industry.

Two hypotheses were postulated for this study, the first states that there is no significant variation in the application of quantitative techniques in decision making among top, middle and low level managers in Akwa Ibom state, while the second states that factors militating against the utilisation of the techniques in decision making do not significantly vary among the different levels of management in the construction industry. The results of these hypotheses will provide reasonable insight into the existing level of application of different forms of decision making tools, as well as the prioritization the factors militating against the adoption of the techniques. These will help policy makers in government and private establishments to re-strategise both during training and use of managers for decision making and realisation of optimal use of resources in construction projects.

2. REVIEW OF RELATED LITERATURE

This section has attempted to provide insight into some of the quantitative techniques, factors influencing their application as well as some available empirical studies in literature on quantitative methods in construction.

2.1. Some quantitative techniques for decision making in construction management

Generally, Quantitative Technique (QT) is otherwise called Operations Research (OR), Decision Science (DS), Analytical Technique (AT), Quantitative Analysis (QA), among others (Anene and Oyelere, 2014). According to Walczak (2012), Quantitative methods of project management date back to the beginning of the XX century, with a variety of methods optimizing projects being developed. In corroboration, (ICAI) (2014) observed that several quantitative methods exist which have been very useful decision making in business and production management.

Some of the techniques which can be used in decision making while managing construction projects, as identified from Walczak (2012), ICAI) (2014), Cvetkoska (2016), and Patel and Solanki (2017), are highlighted thus:

Linear programming: The technique is valuable under conditions of sureness of linear relationship among variables. It is used for optimisation (maximisation or minimisation) of an objective function under given resources and constraints.

Assignment model: Assignment problems are classical combinatorial optimization problems, which comprises allocation of renewable resources (construction equipment, crews, or contractors) of limited availability to a set of activities. The classical model for this problem minimizes the total time or cost of completing all activities with the assumption that each activity is assigned to one particular resource (Sarbapriya, 2016).

Transportation model: Transportation problems are special form of linear programming problem used for inventory control, managing of fund, and resolving disputes of scheduling production over different time periods for construction materials. The transportation technique is concerned with the transportation of products from different sources to different destinations and deal with suitable data like capacity of various sources, requirement at the destination and the cost of transportation along each route because of the prime effect of transportation costs on total cost of products.

Probability decision theory: This theory is based on the principle that the behaviour of the future is probabilistic and not deterministic. Different probabilities are assigned to the 'state of nature' on the basis of available information or subjective judgment and the likely outcomes of the alternative courses of action are evaluated accordingly before a particular alternative is selected. Pay-off Matrices and 'Decision Trees' are constructed to represent the variables.

Queuing theory/waiting line models: The technique is designed to find solutions to waiting line problems for personnel, equipment or services under conditions of irregular demand. The objective is to find optimum volume of facilities to minimise the waiting period, on the one hand, and the investment associated with building up and maintaining

the facilities, on the other. Public transport systems, hospitals, and big departmental stores are some of the possible users of this technique.

Game theory: This theory which originated from the mathematical sciences helps the decision maker under conditions of competitive rivalry or conflict. The adversaries in the conflict are supposed to be involved in a game of gaining at the total or partial expense of each other. There are 'two-person', 'three-person' and 'n- person' games as also zero-sum and non-zero sum games.

Simulation: It is a technique for observing the behaviour of a system under several alternative conditions in an artificial setting. When the conditions of the environment are very complex and when it is not possible to find the one best way of doing things, it provides the manager a way out. The likely behaviour of events and variables is observed and evaluated in a simulated setting. It is possible to experiment with various possibilities or alternatives in a simulated setting rather than in a natural setting.

Network techniques: There are two powerful network techniques—Critical Path Method (CPM)and Programme Evaluation and Review Technique (PERT) which are useful for project planning and control. Complex projects involve considerable cost and time. The objective is to minimise both by working out a 'critical path' where managerial attention is to be concentrated. A diagrammatic net-work of activities required for completion of a project is prepared in detail to assess their interrelation, to segregate sequential activities from simultaneous ones and to estimate the probable time and cost of their completion.

Forecasting: According to Ezeliora, Umeh, Mbeledeogu, and Okoye (2014), forecasting is the process of making statements about events whose actual outcomes (typically) have not yet been observed. Forecasting is similar to Prediction in that, both might refer to formal statistical methods employing time series, cross-sectional or longitudinal data, or alternatively to less formal judgmental methods. In specific term while 'forecasting" is sometimes reserved for estimates of values at certain specific future times, "prediction" is used for more general estimates, such as the number of times floods will occur over a long period. Hence, regression, path analysis, and time series belong to almost the same class of purpose

Other methods: Other quantitative methods which cannot be described for brevity of this article include, break even analysis, inventory models, integer programing, goal programing, non-linear programing, dynamic programing, project management, Markov processes and multi-criteria decision making (Cvetkoska, 2016).

2.2. Factors affecting quantitative decision making

Anene and Oyelere (2014) observed that in applications of quantitative techniques to actual management of any organization generally, certain important aspects are often overlooked which constitute impediment to success of decision making. These are the cost in time and the cost of required resources for developing and using QTs. The manpower requirements, financial cost, staff skills and in recent time, sophisticated information technology (IT) equipment required to develop and use quantitative techniques (QTs). Chukwudozie (2014) also revealed unawareness, lack of qualified manpower and lack of

financial resources, as factors inhibiting the application of Quantitative Techniques to production process.

It is obvious that life for any manager in any organization is becoming increasingly difficult and complex, because of many factors which exert pressures on decision making and increasingly becoming problematic to organizations operating in complex construction environment. These factors include: Changes in government policy, privatization, increasing complex business environment, increasing competition from both home and abroad, more complex business structures, changing markets, complex information need, changing customer expectation, increased risk and uncertainty, larger error costs, and reduced reaction time (Edounand Mbohwa, 2016).

2.3. Some related previous empirical studies

Anene and Oyelere (2014) evaluated the Applications of Quantitative Techniques(QTs) to Production Planning and Control as well as the factors that affect applications of Quantitative Techniques (QTs) to production planning and control in selected Nigerian manufacturing industries. Data were collected using questionnaire administered on 160 staff of 20 companies randomly chosen from each of the 8 purposively selected Small-Scale Industries. Analysis of data done descriptively and quantitatively showed that, the types of QTs commonly in use include: Control Charts, Graphical and Charting Techniques, Forecasting Techniques (Simple Regression and Time Series Analyses), Inventory Model, Range, Variance and Standard Deviation, Capacity Utilization Model, and Acceptance Sampling. Control Charts topped the list. The study concluded that certain QTs are being applied to production planning and control by a significant number of companies from the selected Nigerian small-scale industries. Lack of adequate financial resources was the most important of all the assessed factors. The emphasis of the study was on small scale manufacturing industries, with consideration on very few influencing factors.

Onukwuli, Onwuka and Nwagbala (2014) examined the application of quantitative techniques in small scale business management in Anambra State, Nigeria. The study used a sample of 225 managers of small scale business determined at 5% level of significance for sample error, using Eastman Kodak's sample size for inventory formula, selected from a population of 12,627 managers using stratified random sampling method for the purpose of questionnaire administration. Data analysed using quantitative techniques, reveal that there is no significant variation between the impact of information communication technology and the use of quantitative techniques in small scale business in Anambra State, Nigeria. The result also revealed that there is no significant variation between business decision areas and quantitative techniques application. Such business decision areas include; production, marketing, advertising, packaging and finance. The study recommended that subjective approach be avoided as much as possible especially where records are available and called for government intervention in making quantitative techniques a compulsory subject in schools for sustainable development since quantitative techniques is used to quantify variables in any discipline. The study however, focused on small scale business management in Anambra state, without also investigating the factors influencing the application of the quantitative techniques.

Chukwudozie (2014) carried out an empirically, analysis from results of 160 randomly chosen companies from eight purposively selected Nigerian small-scale industries to examine whether, Qualitative Techniques are applied by the studied companies and the actual number of these companies that apply Qualitative Techniques, as well as factors inhibiting the use of Qualitative Techniques. A wide range of 11 Qualitative Techniques

(QTs) tools were found to be applicable to Production Planning and Control with 35(23.2%) of the companies actually applying QTs, while three factors were found as inhibiting factors. The study is similar to this study, except that it was not based on the perceptions of various categories of construction managers, the focus of the study area is different, and while very few factors were considered.

Esan, Akanbi, Esan, Fajobi and Ikenebomeh (2016) compared the applicability of quantitative techniques and its relevance in decision making by clinical and non-clinical healthcare managers and administrators. A comparative cross-sectional study in design conducted at the Obafemi Awolowo University Teaching Hospital, Ile-Ife amongst 52 clinical and 50 non-clinically related healthcare managers and administrators. Data were collected using semi-structured self-administered questionnaire and analysed using descriptive and inferential statistics. The result shows that a higher proportion of the non-clinical healthcare managers and administrators were familiar and had used more quantitative techniques than their clinical counterparts. There was no statistically significant difference in the respondents' perceived effectiveness of the current methods guiding decision making, while statistically significant difference was found in the methods preferred by both study populations. The study concluded that approach to decision making in the Nigerian health sector is still largely experiential and more of a personalised bargaining process. Thus, recommended the application of the relevance of quantitative techniques by clinical and non-clinically related health managers and administrators improved health service delivery and health outcomes. This study was found to be limited to the perception of managers in the health sector, as well not considering influencing factors.

3. METHODOLOGY

This study is a cross-sectional survey study with quantitative approach. The population consists of Quantity Surveyors, Architects, Builders and Engineers who practice as construction project managers (Ameh & Odusami, 2014) in Akwa Ibom State. Data were collected using questionnaire administered on 150 staff, consisting of six managers chosen from each of the25 purposively selected construction companies operating within Akwa Ibom state. The six managers comprised one top manager, two middle managers and three supervisory managers from each company. The choice of project managers as respondents is due to the observation that they are the decision-makers involved at various stages of construction management (Barougha, Shoubia and Skardi, 2012; Edoun and Mbohwa,2016). The managers are usually fewer at the top and more at the lower level with varying degrees of tasks (Tyrańska, 2016). This study identified Twenty-one quantitative techniques and nineteen factors inhibiting the application of quantitative methods inthe study area. The managers were then requested to evaluate the extent of application of the identified quantitative techniques as well as the factors militating against the use of the techniques. The measurements were on a five point Likert-scale namely: poorly used=1, low used=2, moderately used=3, highly used =4 and very highly used=5. The relative Usage index (RUI) method was used, similar to the formula used by Ugwu and Haupt (2007) and Enshassi, Mohamed and Abushaban (2009) as shown in equation 1:

$$RUI = \sum \frac{TWV}{A} x\ N \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.. (1)$$

TWV is defined as the summation of the products of the number of responses for the rating of each variable and the respective weight value for each rating. 'A' represents maximum weight = 5; 'N' represents the total respondents.

A cut-off score of RUI computed was determined by summing the weights and dividing by the total number of weighting items and highest weight respectively: (1+2+3+4+5)/5/5 = 0.60. Thus, events that have RUI that are equal to or higher than 0.60 are defined as 'used', while those less than 0.60 are 'less used'. This study adopted a threshold of 0.60 representing above average, since there is no specific threshold of a RUI similar to RII (relative Importance Index) available in the literature as authors use threshold of 0.6 or 0.7, while others select the top 5 or top 10 variables for explanation (Alashwal and Al-Sabahi, 2018). The variation in the application of quantitative techniques and the influencing factors were analysed using Kruskal Wallis tests.

4. RESULTS, ANALYSIS AND DISCUSSION OF FINDINGS

The result arising from the data analysis and the discussion of finding are presented in this section.

Table 1: Descriptive results of construction managers Features

Features	**Sub features**		
		N	**%**
Category of Manager	Top Managers	25	16.7
	Middle Managers	50	33.3
	Supervisory Managers	75	50.0
	Total	150	100
	Builders	28	18.7
Professional Affiliation	Architects	48	32.0
	Engineers	45	30.0
	Quantity Surveyors	28	19.3
	Total	150	100
	1-17yrs	0	0
Age	18-60yrs	112	75
	>60yrs	38	25
	Total	150	100
Senatorial District	Uyo	61	40.7
	Eket	40	26.7
	IkotEkpene	49	32.6
	Total	150	100
	OND	6	4.0
	HND	21	14.0
Qualification	B.Sc	74	49.3
	M.Sc	48	32.0
	P.hD	01	0.7
	Total	150	100
	1-5yrs	04	2.7
Experience	6-10yrs	12	8.0
	11-15yrs	74	49.3
	16-20yrs	40	26.7
	>20yrs	20	13.3
	Total	150	100

4.1. Characteristics of respondents used for the study

For the purpose of comprehending the characteristics of the people whose perceptions were investigated, the managerial level, professional affiliation, age, senatorial district of operation, qualification and experience of the respondents were evaluated and the result presented on Table 1. The result shows that the managers were fairly spread according to their presence in companies, the professional affiliation and the three senatorial districts in Akwa Ibom state. Majority of the respondents equally have the basic qualification and experience expected of construction managers. Hence, the results generally imply that the selected respondents have the required features to provide reliable information for this study.

4.2. Utilisation of quantitative techniques by construction managers

To achieve the first objective of this study, twenty-one identified methods were presented to the categories of managers for evaluation, with the expectation that the various categories of managers should be knowledgeable in these techniques for adequate application in all aspects of production planning and control (Djordjević, Lepojević and Janković-Milić, 2008). The result of this evaluation presented in Table 2 shows that the supervisory managers utilize 28.57% of the quantitative methods identified, the middle level managers utilize 33.33% of the quantitative techniques, while the top level managers utilize 42.86% of the quantitative techniques identified.

Table 2: Application of quantitative techniques in decision making among categories of construction managers in Akwa Ibom State

Quantitative techniques for decision making	**Supervisory managers, N=75**			**Middle managers N=50**			**Top managers N=25**		
	RII	**Rank**	**Rmk**	**RII**	**Rank**	**Rmk**	**RII**	**Rank**	**Rmk**
Critical Path Method	0.62	4	UD	0.66	1	UD	0.73	1	UD
Programme Evaluation & Review Technique	0.64	3	UD	0.63	5	UD	0.71	2	UD
Break-Even Analysis	0.65	2	UD	0.65	2	UD	0.68	3	UD
Regression Analysis	0.50	16	LUD	0.61	7	UD	0.67	4	UD
Probability decision theory	0.56	9	LUD	0.64	4	UD	0.66	5	UD
Probability & Probability Distributions	0.57	8	LUD	0.57	10	LUD	0.65	6	UD
Forecasting	0.60	5	UD	0.65	2	UD	0.64	7	UD
Time Series Analysis	0.44	19	LUD	0.59	8	LUD	0.63	8	UD
Inventory Models	0.66	1	UD	0.63	5	IP	0.61	9	UD
Multi-Criteria Decision Making	0.58	7	LUD	0.44	18	LUD	0.58	10	LUD
Goal Programing	0.59	6	LUD	0.55	12	LUD	0.57	11	LUD
Linear Programing	0.55	10	LUD	0.53	14	LUD	0.56	12	LUD
Assignment model	0.60	5	UD	0.52	16	LUD	0.54	13	LUD
Transportation Models	0.54	12	LUD	0.56	11	LUD	0.53	14	LUD
Markov Processes	0.53	13	LUD	0.53	14	LUD	0.52	15	LUD
Simulation	0.55	10	LUD	0.58	9	LUD	0.51	16	LUD
Integer Programing	0.52	14	LUD	0.55	12	LUD	0.50	17	LUD
Nonlinear Programing	0.50	16	LUD	0.45	17	LUD	0.49	18	LUD
Dynamic Programing	0.52	14	LUD	0.44	18	LUD	0.47	19	LUD
Queuing model	0.40	20	LUD	0.36	20	LUD	0.44	20	LUD
Game Theory	0.28	21	LUD	0.32	21	LUD	0.40	21	LUD

RUI= relative usage Index; Rmk= Remark; UD= Used; LSD= Less Used

The result shows that the supervisory managers utilize such techniques as; Inventory Models, Break-Even Analysis, Programme Evaluation & Review Technique, Critical Path Method, Forecasting and assignment models. The middle managers mostly use; Critical Path Method, Break-Even Analysis, forecasting, probability decision theory, Programme Evaluation & Review Technique, Inventory Models and regression analysis. The top managers mostly utilise, Critical Path Method, Programme Evaluation & Review Technique, Break-Even Analysis, Regression Analysis, Probability decision theory, Probability & Probability Distributions, Forecasting, Time Series Analysis and Inventory Models. These results generally indicate inadequate utilization, as not up to 50% of the identified quantitative methods are utilized by the construction managers. This study supports the findings by Chukwudozie (2014), and Onukwuli, Onwuka and Nwagbala (2014), that the application of a wide range of quantitative techniques in production planning and control activities for optimal utilisation of resources in Nigeria has not attained the desired level, as obtainable in most developed countries. The implication of the result is that inadequate utilization of appropriate decision technique may affect the course of building works as well as the final shape of an edifice or a structure, while consequences of the decisions will often be felt in many years to come, when the erected construction is being used as noted by Szafranko (2017).

4.3. Comparison of level of utilisation of quantitative techniques by construction managers

In order to ascertain if there exists statistically significant variation in the level of utilisation of quantitative techniques among the categories of construction managers, and that the variation does not occur by chance, the first hypothesis was postulated as earlier stated. The hypothesis was tested with Kruskal Wallis test at $p \leq 0.05$. The decision rule is that if p-value > 0.05, the hypothesis is accepted, but if p-value ≤ 0.05 the hypothesis is rejected. The results presented on Table 3 show that the p-value for the first hypothesis is 0.603, which is more than the significance level of 0.05, thus the null hypotheses was accepted, indicating that there is no significant variation in the level of quantitative technique utilisation by the project managers.

Table 3: Results of Kruskal-Wallis test for comparison extent of use of quantitative techniques by construction managers

Items compared	**Extent of use of quantitative techniques by construction manager**
No of variables (N)	21
Supervisory Managers	29.67
Middle level managers	31.17
Top level managers	35.17
Chi-Square	1.012
P-value	0.495
Significance level	0.603
Decision	Accept

This lack of difference in the level of utilization of the identified quantitative techniques may be attributable to the general low level of application among all the managers resulting from unawareness and lack of qualified manpower (Chukwudozie, 2014). The implication of this is that the top, middle and supervisory managers may be making similar decisional

errors, which will increase cost, hamper deployment of resources and minimization the time required for completing tasks against the observation of Verma and Sharma (2017).

4.4. Factors inhibiting the application of quantitative methods in construction management

Having established a low level application of quantitative techniques by the construction managers, the second objective sort to assess the possible factors that inhibit the application of the quantitative methods in construction management decision. Hence, nineteen factors were identified from literature and presented to the three categories of managers for evaluation. The expectation is that, since, the managers operate at different levels and different tasks, the application of the techniques may be differently influence by the identified factors. The result is presented in Table 4.

Table 4: Factors inhibiting the application of quantitative methods in construction management decisions.

	Supervisory manager N=75			**Middle managers N=50**			**Top managers N=25**		
Factors inhibiting application of QT	**TWV**	**RII**	**Rank**	**TWV**	**RII**	**Rank**	**TWV**	**RII**	**Rank**
Data unavailability	300	0.80	3	200	0.80	2	109	0.87	1
Inadequate training curriculum	248	0.66	12	195	0.78	3	105	0.84	2
Inadequate skills & Knowledge	311	0.83	2	205	0.82	1	103	0.82	3
Poor awareness	323	0.86	1	193	0.77	4	99	0.79	4
Lack of financial resources	293	0.78	5	173	0.69	7	98	0.78	5
Complex information need	206	0.55	17	168	0.67	10	94	0.75	6
Sophisticated information technology & equipment required	296	0.79	4	178	0.71	6	89	0.71	7
Unfavourable organisational policies	270	0.72	9	170	0.68	8	88	0.70	8
Increasing complex business setting	233	0.62	14	160	0.64	11	86	0.69	9
more complex business structures	293	0.78	5	180	0.72	5	85	0.68	10
Changing markets,	214	0.57	16	148	0.59	16	83	0.66	11
Increased risk and uncertainty	225	0.60	15	170	0.68	8	81	0.65	12
larger error costs,	240	0.64	13	158	0.63	12	80	0.64	13
Parameter selection	278	0.74	8	143	0.57	17	76	0.61	14
Parameter estimation	293	0.78	5	155	0.62	13	75	0.60	15
Limited decision time	255	0.68	11	153	0.61	14	71	0.57	16
Changing customer expectation,	263	0.70	10	150	0.60	15	68	0.54	17
Increasing competition from both home and abroad	199	0.53	18	130	0.52	19	64	0.51	18
Changes in government policy,	191	0.51	19	138	0.55	18	59	0.47	19

The results in Table 4 show that only 21.1% of the factors identified were perceived not to have significant influence on the utilization of the quantitative methods by all the levels of construction managers, while 78.9% of the factors were perceived to have significant influence. The supervisory managers perceived that poor awareness, inadequate skills & knowledge, data unavailability and sophisticated information technology & equipment requirement have most significant influence on their adoption. The middle level managers perceived that, inadequate skills & knowledge, data unavailability, inadequate training curriculum, and poor awareness have most significant influence on their adoption. The top level managers on the other hand perceived that, data unavailability, inadequate training curriculum, inadequate skills & knowledge and poor awareness are the most significant

factors influencing the adoption of the quantitative techniques. The results generally indicate that adoption of quantitative techniques are seriously plagued by many factors. The significance attached to, poor awareness by the supervisory managers may not be unconnected to their lower educational level and experience. The middle managers attached the most significance to, inadequate skills & knowledge this may be attributed to inadequate training and experience. The top and middle managers rated data unavailability and inadequate training curriculum very high, this may be attributable to poor data management by many companies, as well as inadequate course content to guide the teaching of these subjects in institutions.

The findings of this study is somehow similar to those of Chukwudozie (2014) and Anene and Oyelere (2014) by identifying poor awareness and inadequate skills and training, but slightly differs in that it does not see finance as the ultimate factor, instead it sees data unavailability as the greatest challenge. This is noticeable in the study by Oladimeji and Aina (2018), where the research on the financial performance of locally-owned construction firms in south west, Nigeria was limited by paucity of financial data due to poor data storage and management by the firms. Data storage and management is very vital, because quantitative techniques rely on data which have been kept over time. This information is not bought in the market, they must be obtained accurately and preserved for future quantitative use. The management of this data and application of the techniques also require some level of training and knowledge which is lacking in most organization possibly due to unfavourable organizational policies. The implication of this result is that if organization do not bring up policies that support the development of data bank, provide adequate training and experience, before looking at other factors, then construction managers will continue to make intuitive decision which are not scientific and this may spell doom for construction firms.

4.5. Comparison of factors inhibiting application of quantitative techniques

The second hypothesis was postulated to establish if there exists statistically significant variation in the factors influencing the utilisation of quantitative techniques among the categories of construction managers, and that the variation does not occur by chance. The second hypothesis was tested in similar condition as the first. The results presented on Table 5 show that the p-value for is 0.495, which is more than the significance level of 0.05, thus the null hypotheses was accepted, indicating that there is no significant variation in the perception of factors influencing quantitative technique utilisation by the project managers.

Table 5: Results of Kruskal-Wallis test for comparison of factors inhibiting application of quantitative techniques

Items compared	Extent of use of quantitative techniques by construction manager
No of variables (N)	19
Supervisory Managers	31.13
Middle level managers	26.74
Top level managers	29.13
Chi-Square	0.669
P-value	0.495
Significance level	0.716
Decision	Accept

The similarity in perception of the influence of these factors may be attributable to the common organizational culture and generally poor implementation of relevant management practices by most operators in the construction industry (Osuolale, 2019). The implication of the result of this hypothesis, is that if construction managers do not imbibe enough different decision making techniques, and device varying approaches among the levels of management, the industry will continue to be plagued by poor performance and constraints which may cause undesirable consequences that hinder organizational goals as noted by Iheme and Chiagorom (2018).

5. CONCLUSION AND RECOMMENDATIONS

The study has provided reasonable insight into the existing level of application of different forms of decision making tool, as well as the prioritization the factors militating against the adoption of the techniques with a view to enhancing construction projects delivery in Akwa Ibom state and Nigeria in general.

The study has evaluated identified Twenty-one quantitative techniques and nineteen factors inhibiting the application of quantitative methods in the study area with the perception of respondents who have adequate features to provide reliable information. It was concluded on the whole that there is inadequate utilization of quantitative techniques in decision making among construction managers, as not up to 50% of the identified quantitative methods are utilized by the construction managers. This has the implication of project failure and consequences of the decisions will often be felt even years after the decision had been made. The level of utilization of the identified quantitative techniques was also found not to vary significantly among the levels of management, probably because of the generally low level of application among all the managers resulting from unawareness and lack of qualified manpower.

The study concluded that the adoption of quantitative techniques is seriously plagued by many factors. The significance attached to, poor awareness by the supervisory managers may not be unconnected to their lower educational level and experience. The middle managers attached the most significance to, inadequate skills & knowledge this may be attributed to inadequate training and experience. The top and middle managers rated data unavailability and inadequate training curriculum very high, this may be attributable to poor data management by many companies, as well as inadequate course content to guide the teaching of these subjects in institutions. The implication of this result is that if organization do not bring up policies that support the development of data bank, provide adequate training and experience, before looking at other factors, then construction managers will continue to make intuitive decision which are not scientific and have grievous consequences on the overall goals of organisations. The perceptions of the influence of these factors were found to be similar probably due the common organizational culture and generally poor implementation of relevant management practices by most operators in the construction industry. The concludes the if construction managers do not imbibe enough different decision making techniques, and device varying approaches among the levels of management, the industry will continue to be plagued by poor performance arising from poor and unscientific decisions.

Arising from these conclusions it is recommended that construction managers should be sensitised and encouraged through favourable organisational polices which support the development of data bank, provision of adequate training and experience. Government

agencies should also ensure that quantitative method curricula adequately cover the required knowledge areas, which should be completely taught by the teachers in charge.

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PERFORMANCE CHARACTERIZATION OF WASTE POLYETHYLENE TEREPHTHALATE MODIFIED MORTAR AND CONCRETE: A REVIEW

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ABSTRACT

Purpose: The aim of this paper is to present a state-of-the-art review of recent studies on performance properties of concrete and mortar production using waste plastic with a view to identifying areas of further improvement.

Design/methodology/approach: The method relies on literature review on application of plastics in concrete and mortar production. Papers employed for the study were majorly gathered from online repositories of Google Scholar, Elsevier and Taylor and Francis publishers.

Findings: The study found that waste plastics have been successfully incorporated into concrete and mortar production at various modes and levels of applications as aggregates, fibres, binding agent and as an encapsulate in eco-bricks production. Also, strength performance of plastic modified concrete and mortar are considerably reported in contemporary literature but studies on determination of life span of building components produced with waste plastics are currently not available.

Practical implication: The application of waste plastics as an alternative material for the production of concrete and mortar with special mix design would help reduce and partly prevent the environmental nuisance caused by plastic waste.

Originality/value: This paper contributes to the understanding of concrete and mortar production using plastic waste as an alternative material from a state-of-the-art-review perspective, to the knowledge on the modes and level of waste plastic application in concrete and mortar production, and to the identification of knowledge gap in contemporary studies.

Keywords: Compressive strength; plastic aggregates; plastic fibres; plastic waste; splitting tensile strength.

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1. INTRODUCTION

Concrete is one of the major building materials that are employed in several wet construction works due to its malleability and ability to acquire remarkable strength within a short period. It is usually produced with a mixture of binder, fine and coarse aggregates in the presence of calculated amount of water. A mixture of binder and fine aggregate in the presence of water without coarse aggregate is mortar which is often used in binding building components together. Concrete has been considerably employed in the production of building components such as slabs, beams, column, foundation bases and roofs while construction of masonry walls are often done with mortar. These building components and materials are in high demand as infrastructure remains a major indicator of nations prosperity. Consequently, the mining of virgin resources use in the production of construction materials is on the increase.

Mining of virgin resources for construction contributes to global warming as the emission of greenhouse gases such as carbon dioxide, hydro fluorocarbons, and methane into the atmosphere accompanies mining process (Sukontasukkul, Pongsopha, Chindaprasirt & Songpiriyakij, 2018). Also, environmental concerns arising from over-dredging of sand have been raised in some parts of the world and have led to restrictions on sand extraction in some cases (Thorneycroft, Orr, Savoikar & Ball, 2018). Such policies have direct economic impact on concrete production and have driven some studies in search of alternative materials.

On the other hand, the environmental challenges posed by the disposal of waste plastic are devastating. Discarded soft drinks and water bottles, for instance, are a common eye-sore on the streets; blocking drains and impeding the free flow of water channels and canals. Badejo, Adekunle, Adekoya, Ndambuki, Kupolati, Bada, and Omole (2017) remarked that plastic waste constitutes a major part of municipal solid waste in developing countries. The economic and environmental impacts of this plastic waste are increasing. Hence, the search for alternative means of waste plastic disposal has necessitated studies on potential applications of waste plastic in the construction industry.

To assess the potential of using waste plastic as an alternative construction material several studies are being conducted. Thorneycroft et al., (2018) investigated the performance of structural concrete with recycled plastic waste as a partial replacement for sand. Borg, Baldacchino and Ferrara (2016) studied the early age performance and mechanical characteristics of recycled PET fibre reinforced concrete. In another study, Foti (2011) investigated the preliminary analysis of concrete reinforced with waste bottles PET fibres. Taaffe, O'Sullivan, Rahman and Pakrashi (2014) examined the characterisation of Polyethylene Terephthalate (PET) bottle Eco-bricks. The study remarked that the cost of eco-brick in Central America is zero whereas the cost of a block averages out at roughly 75cent per block and there is a potential saving of approximately €1500 in construction of three-room building made of 8000 eco-bricks. The alternative materials are expected to offer structural, environmental and economic benefits.

On the contrary, Twumasi – Ampofo and Oppong (2017) reported that the cost of 10 m2 bottle bricks wall is approximately 640 Ghana cedi while similar wall made of sandcrete blocks cost 527.5 Ghana Cedi. Besides the controversies on the economic benefits of waste plastic application in production of building materials, the performance characterization of waste plastic modified construction materials has attracted several criticisms.

Against the backdrop, the current study presents a state-of-the-art review of performance characterization of waste plastic modified mortar and concrete. Also, direct application of waste plastic as binder and encapsulate for brick production is considered in the study.

2. Structural Characterization of Waste PET Modified Brick

The structural characterization of mortar and concrete modified with waste plastic has been reported in several studies. However, literature on direct application of waste plastic in production of building components such as beams, slabs, masonry walls or units is scarce. Therefore, the review is more focused on the structural characteristics of concrete and mortar produced with waste plastic. The structural characteristics considered include compressive strength, flexural strength, splitting tensile and Poisson's ratio.

2.1. Compressive strength

Compressive strength is a distinctive value which denotes the amount of stress for units of construction under axial load. Compressive strength has been known to be influenced by several external factors such as loading rate, specimen size and shape, and specimen boundary conditions. Figure 1 represents the compressive strength behaviour of a typical brick unit during compression loading.

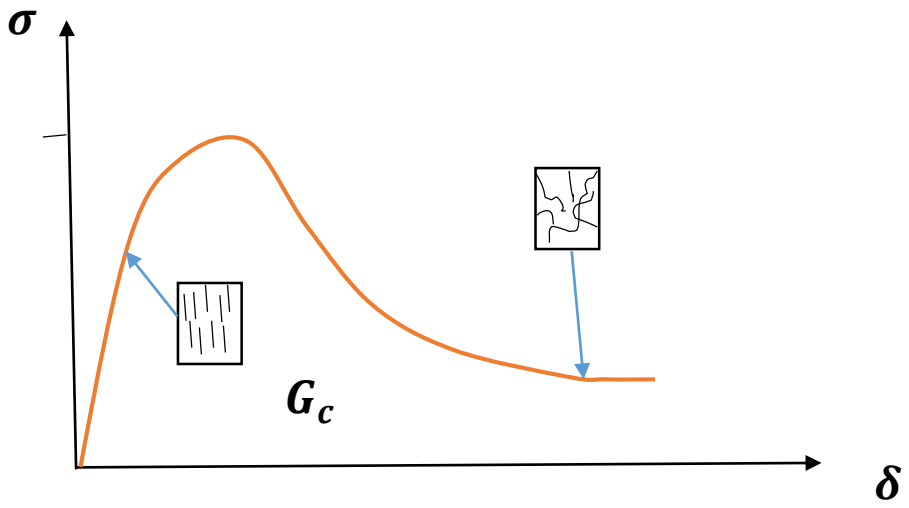


Figure 1: Typical behaviour of brick unit under compressive loading
Source: Koltsida (2017)

In Figure 1, the compressive behaviour starts with a linear elastic part up until the first micro-cracks appear. The hardening commences at this moment, which means that the stiffness of the material starts to decrease as the load increases. Mokhtar *et al.* (2016) investigate the application of plastic bottle as a wall structure for green house and conclude that compressive strength of 250ml and 1.5L plastic bottles filled with sand is 38.34 N/mm2

and 27.39 N/mm2 respectively, while a maximum stress of 8.58 N/mm2 was recorded for clay brick. It can be deduced from the study that the larger the waste plastic bottle the less the compressive strength. Similar study reports a compressive strength of 1.4 kPa (0.0014 N/mm2) and 25 kPa (0.025N/mm2) for bottle bricks filled with water and sand respectively (Oyinlola *et al*. 2018). Kim, Wisniewski, Baker and Oyinlola (2019) investigate the behaviour of sand-filled plastic bottled clay panels for sustainable homes and found a horizontal row of 6 sand filled bottle bricks yielding at approximately 298.05kN. The study reported continues increase compression resistance of the bottle bricks beyond the failure of the PET bottle, thus the test was stopped at 300kN.

Again, for the use of waste PET as an encapsulate, Taaffe *et al*. (2014) observe a linear relationship between the weight of a brick and the compressive strength of PET waste bottle eco-bricks filled with waste plastic. The study concludes that compaction/packing ratio is the main variable that affects the strength of eco-bricks. A maximum compressive strength of 2960 kN/m2 (2.96 MPa or 2.96 N/mm2) was recorded at a maximum mass of 260g. The maximum compressive strength of 2.96 N/mm2 achieved in the experiment falls short of the minimum 5 N/mm2 recommended for external building works in BS 3921 1985. Hence, the PET waste bottle eco-brick manufactured using plastic infill materials cannot be recommended for building works unless further improvement is made on the compressive strength to meet the minimum requirement standard.

The compressive strength of plastic aggregate (PA) concrete or mortar depends on many parameters such as the w/c, RPA, and the types and shapes of waste plastic (Gu & Ozbakkaloglu, 2016). The study notes that the use of PAs with a low elastic modulus (e.g. EPA and EVA aggregates) result in substantial reduction in the compressive strength of concrete than those result from the use of PAs with a high elastic modulus (e.g. PET aggregates).

Previous studies on recycled plastic concrete have shown that the compressive strength of PA concrete with the same w/c decreases with increasing recycled plastic aggregate, RPA (Thorneycroft, et al., 2018; Akinyele & Ajede, 2018; Ferrandiz-Mas, Bond, Garcia-Alcocel & Cheeseman 2014; Saikia & de Brito, 2014). Similarly, Ge, Sun, Zhang, Gao and Li (2013) report decrease in compressive strength of mortar with increasing PET RPA content at the same w/c. The low compressive strength of concrete and mortar containing PAs has been attributed in some studies to the elastic modulus of PAs being lower than that of natural CA or FA; the low bond strength between the surface of the PA and cement paste; the restrained cement hydration reaction near the surface of PA resulting from the hydrophobic nature of PA; high air content and porosity of PA concrete; and the possible deterioration of PET aggregates exposed to the concrete pore fluid (an alkaline environment).

Wang and Meyer (2012) report the compressive strengths of mortar prepared with 10, 20, and 50% fine high-impact polystyrene (HIPS) FA decreased almost linearly with the increase in the substitution level, and the reduction in the strengths of the mortar were 12%, 22%, and 49%, respectively, at 28 days curing age. In addition, Thorneycroft et al., (2018); Saikia and de Brito (2014) present that different shape and size distribution of waste PET aggregates resulted in different compressive strengths of concrete with the same substitution levels of PAs. The effect of size, with smaller particle size of PA similar to size of sand being substituted at 10% yielded higher compressive strength than PA (2 – 4mm) of larger sizes was reported in Thorneycroft, et al., (2018) at equal volume of sand replacement. Figure 2 shows the graph of percentage change in compressive strength with plastic aggregate sizes.

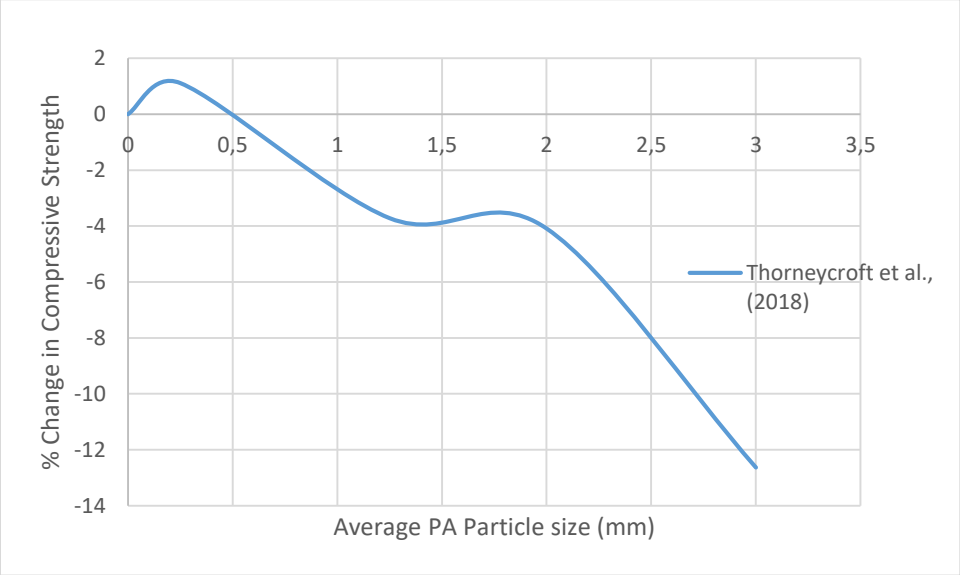


Figure 2: Effect of PA size on Compressive Strength.
Source: Thorneycroft *et al*. (2018)

Figure 2 indicates slight increase in compressive strength with small and graded PA sizes below 0.5mm. As the PA size increases beyond 0.5mm, loss of compressive strength occurs at 10% volume substitution of sand.

To reduce the loss in compressive strength due to inadequate bond between the plastic and surrounding matrix of concrete or mortar produced with waste plastic, some studies have adopted the use of chemical, physical or gamma ray treatment of the plastic prior to concrete mixing. For instance, in one of the novel mixes employed by Thorneycroft et al., (2018) sodium hydroxide and sodium hypochlorite were used to treat waste PET shredded into 2 – 4mm and washed. The result shows a considerable improvement in loss of compressive strength to approximately 1.9%. The study further reveals the improvement in reduction of loss of strength by washing PA after treatment.

On the use of waste plastic as fibre, there is wide variability on the findings of researchers. Some researchers reported improvement on the compressive strength of concrete upon addition of plastic fibre (Pereira, Junior & Fineza, 2017); while some others have shown that when the fibre content increased, the compressive strength of FRC degrades (Nibudey, Nagarnaik, Parbat & Pande, 2013). Nibudey et al., noted that beyond 1.0% fibre content the compressive strength decreases. Also, increase in ductility and reduced shrinkage cracking have been reported in Foti, (2011) including improvement on residual life of concrete as a result of fibre reinforcement. Figure 3 shows a stress – strain diagram of ordinary concrete and fibre reinforced concrete at various fibre content.

Again, previous studies have shown that the compressive strength of concrete or mortar with recycled plastic fibre varies with the type of plastic fibre. The use of recycled plastic fibres with a high ultimate tensile strength (such as recycled PP fibres) results in a more significant improvement in the compressive strength of concrete than that when fibres with a low ultimate tensile strength (e.g recycled PET fibres) are used.

In summary, qualitative study of previous research has revealed that utilizing PA with graded small particle sizes and at low percentage (not more than 10%) can yield concrete or mortar with improved compressive strength higher than larger particle sizes with rigorous treatment. Concrete or mortar modified with RPF of low aspect ratio (less than 100), short strands (not more than 30mm), treated with gamma ray or NaOH and washed,

deformed is likely to improve the compressive strength and residual life of mortar or concrete.

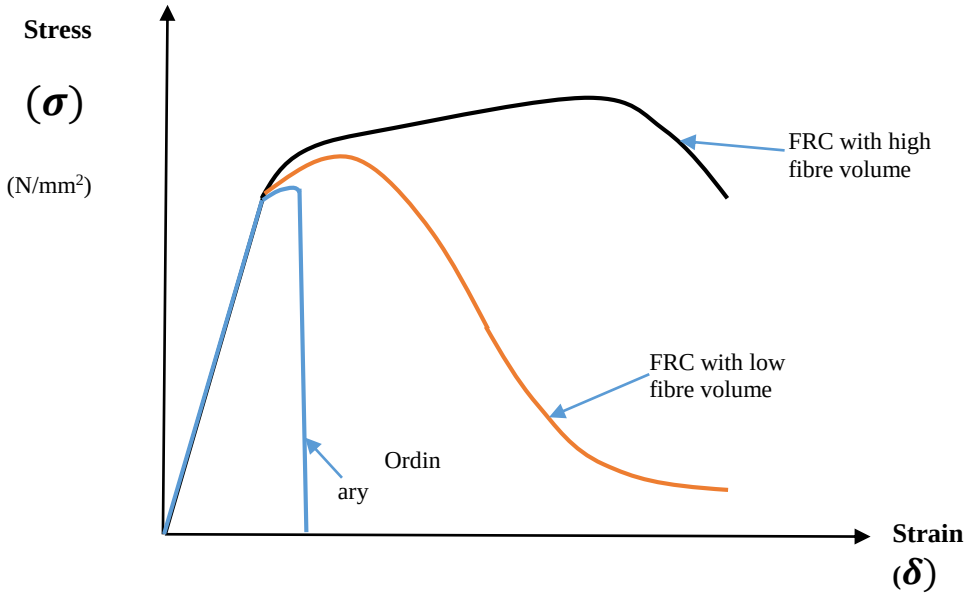


Figure 3: Stress – Strain behaviour of concrete reinforced with various amount of fibre
Source: Foti (2011)

On the use of waste PET as binding agent, few studies have reported the compressive strength of PET-sand mortar/brick. Ge, et al., (2013) investigate the physical and mechanical properties of mortar using waste Polyethylene Terephthalate bottles and found that the compressive strength is considerably influenced by aggregate sizes, gradation and curing temperature. In the study, 32.7 N/mm2 compressive strength was achieved at room temperature using 1:3 PET-to-sand mix ratio. The study reveals that 24-hour curing is adequate for sand-PET mortar as evident in the compressive strength result - 32.7 N/mm2 for both 24 hour and 7 days curing at 1:3 PET-to-sand ratio. At a curing temperature of 180 0C a compressive strength of 34.9 N/mm2 was achieved. This implies that high curing temperature enhances the compressive strength of PET-sand mortar. A maximum compressive strength of 35.7 N/mm2 was achieved with a 1:4 PET-to-sand mix ratio by weight. The compressive strength of sand-PET mortar in the study is considerably high compare to Dinesh et al. (2016) in which 5.12 N/mm2 optimum compressive strength was found at 1:4 PET-to-sand mix ratio by weight. The differences on the results might be attributable to the products, type of sand and experimental procedures such as loading rate. Hence, there is need for further studies to understand the strength characterisation of PET-sand mortar and bricks.

2.2. Splitting tensile strength

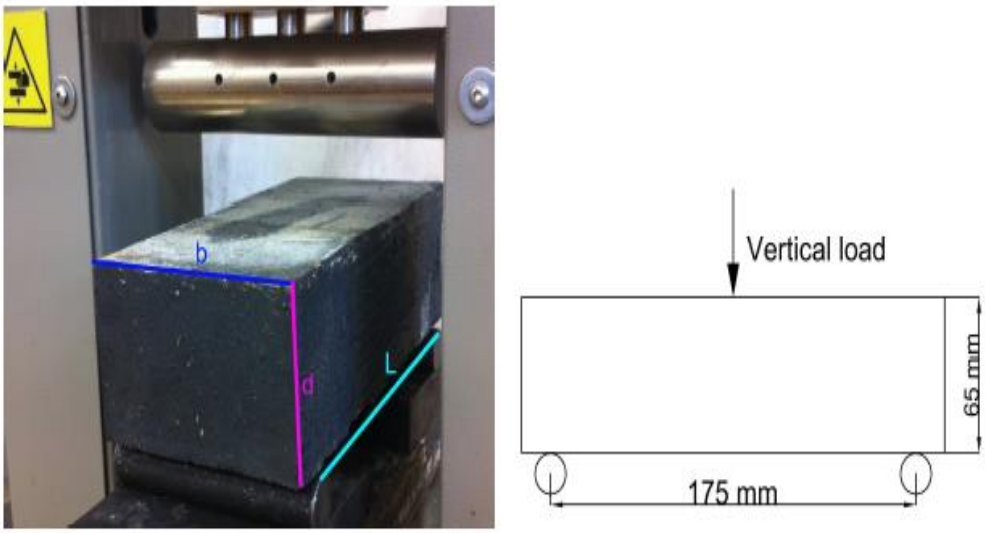
Varying results have been reported by researchers on the effect of RPA on the splitting tensile strength of concrete and mortar. Thorneycroft et al. (2018) report 25% improvement on splitting tensile strength at 10% substitution of sand with graded small size RPA. Also, Chaudhary, Srivastava and Agarwal, (2014) found that the split tensile strength of concrete

produced with less than 1% fine aggregate replacement with waste plastic increases with increase in waste plastic aggregate content. On the contrary, considerable number of studies, Saikia and de Brito, (2014); Wang & Meyer, (2012) found that splitting tensile strength of PA concrete decreases with increasing RPA. Gu and Ozbakkaloglu (2016) note that more significant reductions in the splitting tensile strength occur in concrete containing non-uniformly shaped PAs than that containing uniformly shaped PAs. In addition, the splitting tensile strength of PA concrete decreases with a reduction in the elastic modulus of low modulus PAs.

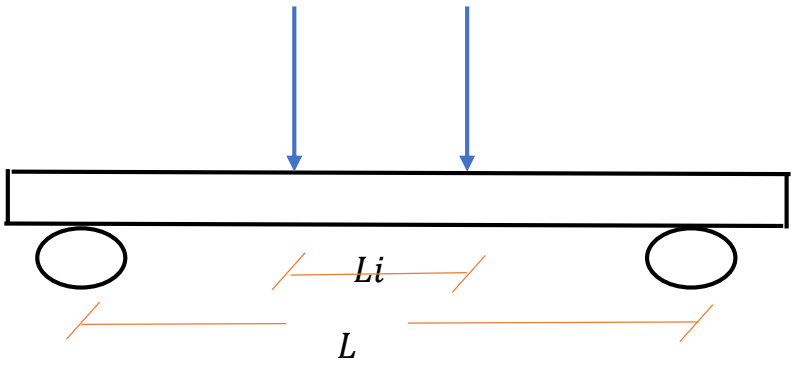
On the application of waste plastic as fibre, previous researches demonstrate that the splitting tensile strength of concrete increased upon the addition of PF (Nibudey et al., 2013; Bagherzadeh Sadeghi & Latifi 2011). The improvement on the splitting tensile strength is a function of the tensile strength of plastic fibres. Nibudey et al. (2013) observed that the splitting tensile strength of concrete containing PET fibre increased by 18.6% at 1% fibre level, and then reduced by 19% at 3% fibre content. The fibres bridging across the split portions of the matrix acts through the stress transferred from the matrix to the fibres, therefore gradually supporting the whole load. The stress transfer improved the tensile strain capacity of the two FRCs, and therefore, the splitting tensile strength of the reinforced concretes was higher than that of the unreinforced control counterpart. Nibudey, et al., (2003) also found that the splitting tensile strength improved only when the concrete had small fibre content up to 0.56% beyond which the splitting tensile strength decreases.

2.3. Flexural tensile strength (modulus of rupture)

Flexural strength is the stress in a material just before it yields in a transverse bending test. It is also known as bend strength, or transverse rupture, or modulus of rupture. The flexural strength signifies the maximum stress experienced within a material at its moment of yield. The test is usually conducted on specimen with either rectangular or circular cross-section under the influence of a three-point or four-point flexural loading. Typical set up rig for flexural test is shown in Figure 4 and the numerical models employ in the determination of flexural strength is stated in equations 1 and 2.



(a) (b)



(c)

Figure 4: Typical flexural strength test set-up for brick specimen (a) test rig (b) schematics (c) four-point set up

Source: Sukontasukkul *et al*. (2018)

$$\sigma = \frac{3FL}{2bd^2} \ldots\ldots\ldots\ldots\ldots\ldots \text{eq. } 1 \ldots\ldots\ldots three - point\ bending\ support$$

$$\sigma = \frac{3F(L - L_i)}{2bd^2} \ldots\ldots\ldots\ldots\ldots\ldots \text{eq. } 2 \ldots\ldots\ldots four - point\ bending\ support$$

Where, σ= flexural strength (N/mm2); F= maximum load at yield point (kN); b= width of section (m); d= depth of section (m); L= distance between supports (m); L_i= distance between applied load in a four-point bending support test.

Studies have shown that the shape of PF affects plastic modified concrete and mortar's modulus of fracture. Foti (2011) examines the preliminary analysis of concrete reinforced with waste bottles PET fibres and found that fibre reinforced concrete produced using fibre strips (lamellar) exhibits better bending strength than fibre reinforced concrete manufactured with round shape PET fibres. The study was conducted using 32 mm PET fibre strips and 30 – 50mm diameter round fibre as additives in separate concrete mixes. In the study, 4.8 N/mm2 flexural strength was record at 0.75% optimum content of concrete mass for fibre reinforced concrete produced with round fibres, whereas, concrete produce with the PET strip at 50% strip fibre content and the control (without any fibre) achieved 3.7 N/mm2 and 4.7 N/mm2 flexural strength. In a similar study, Pereira et al. (2017) observe increase in flexural tensile strength with the addition 10mm to 20mm PET PF from 0.1% to 0.3% of total volume.

Results of flexural tensile strength have been presented in two forms – as load deflection curves and as a single stress in N/mm2. Some studies, for instance Sukontasukkul *et al*. (2018), have presented findings on flexural strength of fibre reinforced mortar with respect to load-deflection (deformation) curve which is considerably an appropriate method of presenting the fibre performance rather than single parameters such as the compressive strength. Figure 5 presents the graph of fibre reinforced mortar under flexural loading.

The Figures 5 (a) and (b) indicate that the load increases in unswerving proportional to the increasing deflection at the beginning. Immediately after the initial cracks, a high-pitched drop in load occurs. In Sukontasukkul *et al*. (2018), Figure 5 (b), the load increases again after the drop due to the effect of fibres spanning across the cracks. This section of the graph is known as post-peak response region and it is the region that actually signifies the performance of the fibres. Similarly, high-pitched drop in load was reported in Foti (2011), Figure 5 (a), but the post-peak response region was found below the peak value

contrary to Sukontasukkul *et al*. (2018) where the post-peak region lies above the peak value. Although, different types of plastic fibres and steel were used, the implication of these studies is that the true responses of waste plastic fibre to flexural loading is not yet established and therefore requires concerted research efforts.

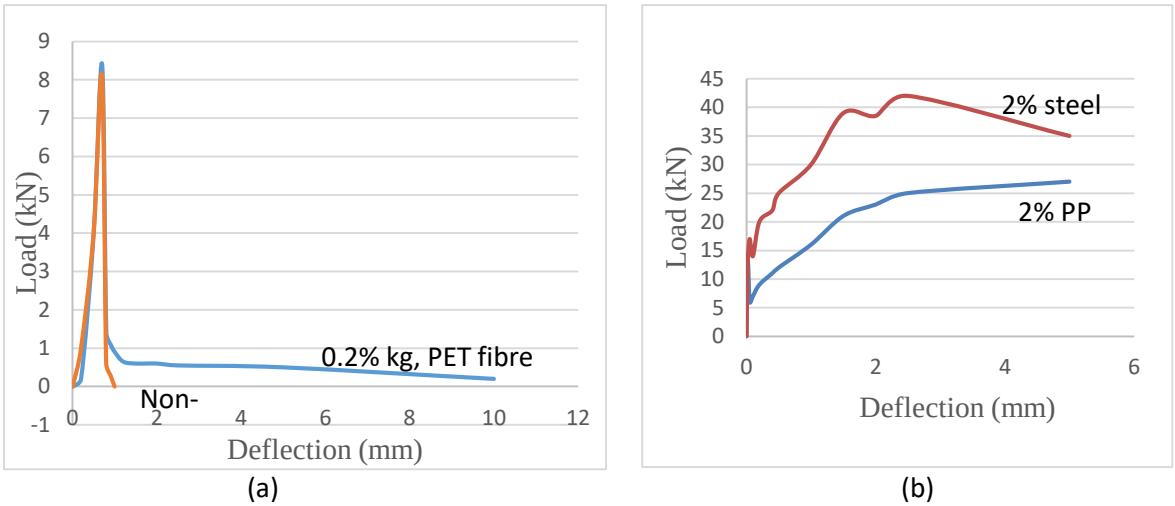


Figure 5: Typical Fibre reinforced mortar response to flexural loading
Sources: (a) Foti (2011) (b) Sukontasukkul *et al*. (2018)

Furthermore, the area under the load deflection curve represents the Toughness (kN-m) of the brick (Sukontasukkul *et al*., 2018). Toughness designates the amount of energy the brick is able to absorb under loading up to specific deflection. Usually, two toughness values are determined at 2 different deflections - L/600 and L/150. The corresponding flexural strength denotes the load bearing capacity of the brick after first cracking as a percentage of the first peak load.

2.4. Poisson's ratio

Poisson's ratio is a ratio between a change in the direction of an applied load on a material and a corresponding change in dimension in a direction perpendicular to the applied load. It describes the constraining relationship between a finite transverse strain and the originating axial stain. When a specimen is squashed to a contraction in the direction of an applied load, there is a corresponding extension in a direction perpendicular to the applied load. The ratio between these two quantities is estimated as the Poisson's ratio. Poisson's ratio is therefore estimated by comparing the axial and transverse stain of material at failure.

Taaffe *et al*. (2014) note that eco-brick produce using PET bottle as an encapsulate exhibits slight elastic rebound and regains some of its shape when load is removed and therefore suggest that measurement of axial strain should be taken as the distance between the two platens of a compression test machine upon failure and then divided by its original length. However, assuming the distance between the platens of a compression test machine at sample failure may not give a truly axial stain rather the change in distance of the platens divided by the distance between the platens at the point of loading may give a better picture of axial strain. The study (Taaffe *et al*., 2014) recorded Poisson's ratios of Eco-bricks within a range of 0.27 – 0.35.

2.5. Bulk density

The bulk density of a material is the mass of particles of the material with respect to the volume the particles occupy. Aouba, Coutand, Perrin and Lemercier (2015) observe the bulk density of virgin EPS aggregates is 35 kg/m3, and that of recycled EPS aggregates is 24–27 kg/m3. The study measured open porosity and bulk density through a vacuum saturation test. The formulae for computing bulk density and porosity are stated in equations (3) and (4) respectively.

$$p = \frac{m_{dry}}{m_{air} - m_{water}} X\, p_{water} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots eq. 3$$

$$\varepsilon = \frac{m_{air} - m_{dry}}{m_{air} - m_{water}} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots eq. 4$$

where $\boldsymbol{m_{dry}}$ is the oven-dry weight (kg), m_{air} is the saturated air weight (kg), $\boldsymbol{m_{water}}$ is the saturated submerged weight (kg) and $\boldsymbol{p_{water}}$ is the density of water at 200C. ε is the porosity (%).

Bulk density of 2282 kg/m3 to 2111 kg/m3 was found in Thorneycroft et al., (2018) at 10% PET substitution by volume of sand in the production of concrete. Taaffe et al., (2014) report a bulk density of 520 kg/m3 for bottle bricks filled with waste plastics. The low bulk density may be attributed to the eco-bricks being filled with waste plastic but if filled with soil materials it expected that higher bulk density will be achieved.

2.6. Thermal characterization of brick modified with waste PET

The UK Building Regulations (2010) recommends that the limiting external wall thermal transmittance (U- Value) of both new and existing building should not exceed 0.30 W/m2K for energy efficiency of buildings. This is expected to guide the optimization of waste PET content in PET modified bricks in relation to the value (0.30 W/m2 K) and in comparison, with other building walling materials. Previous studies have reported considerable improvement on thermal transmittance by the substitution of natural aggregate with waste plastic aggregate. For instance, Yesilata *et al*. (2009) investigated the effect of waste PET material addition on the thermal transmission properties of ordinary concrete. The study found that waste PET substantially reduced the thermal transmittance of ordinary concrete. Yesilata *et al*. (2009), further noted that thermal improvement was highest circa 17.16% when irregular waste PET fibres were used compare to 10.27% improvement when square PET fibres were used. Hence, the thermal property of polymeric concrete does not only depend on the waste plastic content but also on the shape of the waste plastic.

In another study, Wang and Meyer (2012) studied the performance of cement mortar made with recycled high impact polystyrene (HIPS) and found remarkable improvement on the thermal conductivity - approximately 87% at 10% fibre content in mortar. The study attributed the improvement to the low thermal conductivity of HIPS compared to that of natural sand. Furthermore, previous studies have also shown that thermal conductivity reduces with increase in waste plastic fibre content. Fraternali *et al*. (2011) found that the thermal conductivity of concrete containing 1% volume of PET fibres decrease by 18% while the same fibre content with polypropylene, PP fibres had 21.8 % reduction in thermal conductivity compared to conventional concrete.

Mokhtar *et al*. (2016) conclude that both plastic bottle green house and normal brick house use in the study did not achieved the thermal comfort zone as temperature range is 30℃ to 34℃. Same goes to the normal brick house which range from 29℃ to 34℃ for plastic bottle green house and normal brick house respectively. However, the study noted that both standard brick house and plastic bottle green house (59% - 73%) have met the indoor air quality standard at the aspect of relative humidity which are 40% - 70%.

Fioretti and Principi (2014) examine the thermal performance of hollow clay brick and blocks with low emissivity treatment in surface enclosures. The study utilized a two-dimensional steady-state simulation using a simplified and standardized equivalent conductivity method. The method combines the effects of heat conduction, convection and radiation through algorithm developed in accordance with the calculation procedure suggested in EN 1745 (Annex D) and EN ISO 6946 (Annex B-C).

2.7. Sound insulation

The sound insulation property of a material is usually determined on an entire room where the walls are built with the material to be tested. However, researches have been conducted on the sound insulation of materials using the sound reduction index, R. Sound reduction index (R) is a quantity, measured in laboratory which characterises the sound insulating properties of a material or building element in a stated frequency band. The sound reduction index R is a viable option where construction of entire room is not feasible. Taaffe *et al*. (2014) calculated the sound reduction index of bottle eco-brick and compare the result with other bricks used in construction as a method of assessing the sound insulation property of eco-brick. Another method of determining the sound reduction index of a wall is the application of Mass Law provided the mass per unit area is known.

Furthermore, the main frequency range used to assess sound insulation lays in building acoustics is between the 100 and 3150 Hz one-third octave- bands and an optional extended frequency range is defined between the 50 and 5000 Hz one-third-octave-bands. The range between 50 and 5000 Hz is referred to as the building acoustics frequency range. It is possible to define frequency ranges using one-third-octave-band centre frequencies low frequency range (50–200 Hz), mid-frequency range (250–1000 Hz) and high frequency range (1250–5000 Hz). Taaffe *et al*. (2014) assumed that 'typical rooms' have volumes between 20 and 200 m3 and this covers the majority of practical situations. Measurements of sound insulation may be laboratory measurements that provide information at the design stage, field measurements validate whether the required sound insulation has been achieved in a building, and field measurements also help in disentangling sound insulation problems in existing buildings.

For many buildings the acoustic requirements are described in building regulations; hence repeatability, reproducibility, and relevance (i.e. the link between the measured sound insulation and the satisfaction of the building occupants) are particularly important for airborne and impact sound insulation. Laboratory measurements of the acoustic properties of materials and building elements (e.g., walls, floors, windows and doors) are primarily used for comparing products and calculating the sound insulation in situ. Measurements of material properties are particularly useful in assessing whether one material in the construction could be substituted for a different one, and for use in prediction models. Testing may also be carried out in situ with limited number of samples. Sound insulation is heavily dependent on the quality of construction and workmanship.

3. METHODS

Research method of the study involved review of relevant literature to explore the characterization of PET modified concrete and mortar. In addition, PET related articles such as PET bottle bricks were considered relevant in the review process to understand the potential application of such waste in construction. Literature materials were gathered from a range of databases and online repositories of Elsevier, Emerald Insight, Google Scholar, Springer link and Taylor and Francis publishers. The databases were searched for peer review papers that reported the application of waste PET in concrete, mortar or brick production between 2009 and 2019. The research design (Figure 6) adopted for the study involves four stages similar to the three-stage research approach employed in Ramafalo, Awuzie and Aigbavboa (2018) study on probable challenges facing servitization in the construction industry.

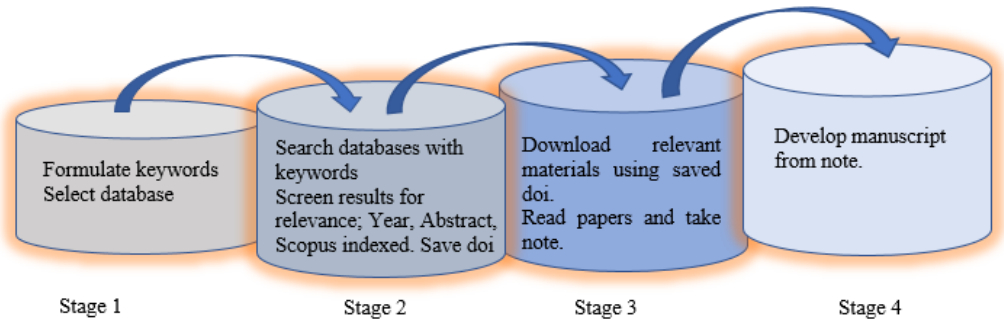


Figure 6: Research approach

In the first stage of the research, keywords and keywords combinations were selected based on relevance to the research topic. Also, preliminary search was conducted on several databases to selected suitable databases and time range. At the second stage, each of the selected databases were searched using the keywords in combination with either concrete, mortar, brick or masonry and the total number of papers within the required period was record (see Table 1).

Table 1: Keywords and databases

Keywords	Elsevier		Emerald Insight		Google Scholar		Springer
	Result	Relevant	Result	Relevant	Result	Relevant	Result
Pet aggregate mortar	1060	21	8	0	1700	28	31
Pet aggregate concrete	2820	61	28	0	4010	35	122
Pet fibres concrete or mortar	1502	12	155	5	3560	18	33
Bottle brick	2809	6	90	0	6550	8	260
PET bottle brick	402	5	2	0	16500	6	49

Note: Some papers appeared in more than one database and keywords.

For instance, a search for "pet aggregate mortar" between 2009 and 2019 on Elsevier database yielded 1060 results of which 21 of the articles were considered relevant to the current study. Search results were screened for relevance through analysis of the topics,

abstracts, year publication and journal indexes with emphasis on Scopus. The doi of articles that were considered relevant were saved for down. At the third stage, relevant and accessible papers were downloaded using the saved doi and thereafter, thorough reading of the downloaded papers and notetaking was carried out. The manuscript was then developed from the in-depth analysis of the findings of previous studies summarized in the note and research gaps identified.

4. RESULTS AND DISCUSSION OF FINDINGS

The distribution of studies on performance properties of waste plastic modified building materials is presented in Table 2. From the Table, majority of the studies (Thorneycroft et al., 2018; Pereira et al., 2017; Borg et al., 2016; Chaudhary et al., 2014; Saikia & de Brito (2014); Nibudey et al., 2013; Bagherzadeh et al., 2011; Foti, 2011; Yesilata et al., 2009) considered the application of waste plastic in the production of concrete. Sukontasukkul, et al. (2018); Ferrandiz-Mas et al., (2014); Ge et al., (2013); Wang & Meyer (2012) discuss the application of waste plastic in production of mortar and a study (Gu et al., 2016) examine the application on both productions of concrete and mortar. Badejo et al., (2017) applied waste plastic for asphalt modification.

On the use of waste plastic for brick production, only a few studies (Oyinlola et al., 2018; Mokhtar et al., 2016 and Taaffe et al. 2014) considered the application of waste PET bottle as an encapsulate for eco-brick (bottle brick) production. However, the inconsistency of the findings of the studies demands further studies on the mode of application to enable characterization of such eco-bricks.

On the mode of application of waste plastic in the production of construction material, the use of recycled waste plastic as an aggregate or fibre has attracted considerable number of studies in the area of concrete and mortar production but studies on the application of RPA or RPF in the manufacture of bricks is not substantial. Hence, studies should be directed towards utilization of RPA or/and RPF in the production of eco-bricks.

The use of waste plastic, especially waste PET, as a binding agent has not been substantially explored. For instance, in the table above only Ge et al., (2013) considered the use of waste plastic as a binding agent in place of cement in the production of mortar. Another study that considered waste plastic as a binding agent is Dinesh et al., (2016). However, the variability of the results of the two studies necessitates further investigation of such mode of application of waste plastic in construction.

On the performance properties, the strength tests of concrete and mortar are significantly considered. However, the characterization of masonry walls constructed of waste plastic material (bricks) has not been explored as indicated in the young modulus and probability of survival columns in Table 1. Oyinlola et al. (2018) report an average compression yield load of 25.30 kN at failure for six 440mm×480×200mm bottle bricks masonry prisms while Budiwati (2009) investigate the compressive strength and modulus of elasticity of masonry prisms constructed of clay bricks and concrete blocks. It is expected that masonry prisms constructed with different material may yield at different stress levels, exhibit unique strains and modulus of elasticity. The Young Modulus of masonry is essential in the determination of the characteristic strength of masonry; an indispensable parameter employed in the analysis and design of masonry walls. The probability of survival is also one of the important parameters in S-N-P curve use in the investigation of the serviceability limit of masonry. These parameters have not been explored with waste plastic impregnated brick masonry.

Table 2: Distribution of studies on performance properties of waste plastic products

Authors	Products and Performance Properties																
	Pro.	CS	FS	PR	SI	LT	RS	Tou	STS	ME	WA	E	FR	H	T	YM	P	Country
Kim, et al. (2019)	bb	✓							✓							cs		UK
Sukontasukkul, et al. (2018)	mor	✓	✓				✓	✓										Thailand
Oyinlola et al. (2018)	bb	✓							✓							cs		UK
Akinyele & Ajede, (2018)	A; co	✓	✓						✓									Nigeria
Thorneycroft et al., (2018)	A; co	✓							✓									UK
*Twumasi – Ampofo et al., (2017)		✓													✓			Ghana
Badejo et al., (2017)	F; aspt	Bulk density, Marshal flaw, Marshal Stability, Void in Total Mix, Void Filled with Bitumen																Nigeria
Pereira et al., (2017)	F; co	✓	✓															Brazil
Borg et al., (2016)	F; co	✓	✓															Italy
*Gu et al. (2016)	mor/co	✓	✓						✓	✓	✓		✓	ab				Australia
Mokhtar et al., (2016)	bb	✓													t			Malaysia
#Auoba et al. (2015)			Bulk density, porosity and thermal conductivity												Thc			France
Fioretti & Principi (2014)	brick														Thc			Italy
Chaudhary et al., (2014)	A; co	✓							✓									India
Ferrandiz-Mas et al., (2014)	A; mor	✓													Thc			UK
Taaffe et al. (2014)	bb	✓		✓	✓	✓												Ireland
Saikia & de Brito (2014)	A; co	✓	✓						✓	✓				ab				Portugal
Ge et al., (2013)	B; mor	✓	✓								✓							China
Nibudey et al., (2013)	F; co	✓	✓						✓									India
Wang & Meyer (2012).	A; mor	✓							✓	✓					Thc			China
Bagherzadeh et al., (2011)	F; co	✓	✓					✓	✓		✓							Iran
Foti (2011)	co	✓	✓					✓										Italy
#Budiwati (2009)	Masonry	✓														✓		UK
Yesilata et al., (2009)	F; co														#			Turkey

[Pro]Product; [CS]compressive Strength; [FS]Flexural Strength; [PR]Possion's Ratio; [SI]Sound Insulation; [LT]Light Transmission; [RS]Residual Strength; [Tou]Toughness; [STS]Splitting Tensile Strength; [ME]Modulus of Elasticity; [WA]Water Absorption; [E]Efflorescence; [FR]Fire Resistance; [H]Hardness; [T]Thermal transmittance; [YM]Young Modulus of masonry; [P]Probability of survival; *A review paper; [bb]bottle brick; [t]temperature; [co]conctrete; [mor]mortar; *Review; [#]Study not involving waste plastic; [F]Fibre; [A]Aggregate; [B]Binding agent.

Hence, further studies should be directed towards investigating the characteristic strength and probability of survival of eco-brick masonry wall to enable understanding of the behaviour of waste plastic modified bricks (eco-bricks) masonry for wider applications in construction.

5. CONCLUSION AND RECOMMENDATIONS

The study concludes that there are variations in the percentage loss of compressive strength results due to different sizes of plastic aggregate employed in the production of concrete and mortar in previous studies. Although the usage of plastic might cause reduction in compressive strength because of a weak bond to the surrounding matrixes, the reduction could be checked by suitable mix design and choice of plastic. Concrete or mortar produced of waste plastic with special mix design satisfies minimum standard requirement. Concrete or mortar produced with plastic aggregate (PA) below 10% substitution of natural virgin aggregates results in concrete or mortar of considerable strength performance. Beyond the 10% the concrete or mortar strength degrades. On the application of waste plastics as fibre reinforcement (PF), less than 1% addition in concrete or mortar results in improvement of strength performance. Thermal transmittance of concrete or mortar improves with increase in waste plastic content.

The utilization of plastic waste as an alternative material for the production of concrete and mortar with special mix design for the construction of nations infrastructure would help reduce and partly prevent the environmental nuisance cause by plastic waste. However, there is need to understand the behaviour and life span of whole building component constructed of waste plastic products. Hence, further studies should be directed towards investigating the characteristic strength and probability of survival of eco-bricks masonry wall to enable understanding of the behaviour of waste plastic modified brick (eco-bricks) masonry for wider applications in construction.

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PUBLIC PRIVATE PARTNERSHIP FOR EFFECTIVE AFFORDABLE HOUSING DELIVERY IN ABUJA, NIGERIA

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ABSTRACT

Purpose: The aim of this research is to evaluate the efficacy of public-private partnership arrangements for affordable housing delivery in Nigeria by investigating obstacles to PPP's efficacy in affordable housing supply, and examining variables that could enhance PPP's efficiency in affordable housing delivery in the research region.
Design/methodology/approach: Survey research design was used for the study. The population of the study was drawn from Architects, Quantity Surveyors, Civil Engineers, Contractors and Project Managers. A structured questionnaire was used to collect data for the study. The questionnaire was distributed to a total of 80 respondents of which 51 were returned. This reflects a 64 percent response rate. The Social Sciences Statistical Package (SPSS) was used for data analysis using descriptive statistics.
Findings: The results from the analysis revealed that the main variables influencing housing delivery through Public Private Partnership (PPP) were the issues of inaccessibility to land in good place and insufficient financing by the mortgage scheme. The assessment further disclosed factors that challenge PPP's efficiency in housing delivery, as government failure owing to absence of political will to reduce housing construction costs, lack of anti-corruption measures, absence of powerful legislative structure, and absence of adequate mortgage scheme for interested parties to acquire the housing units.
Originality/value: In conclusion, the government should prioritise the provision of land in attractive location for affordable housing projects. the research recommends that the government develop an enabling atmosphere for developers in the private sector by subsidising construction costs for affordable housing projects. The study ultimately adds to existing body of knowledge and provides an insight to strategies that could enhance affordable housing delivery through public private partnership in Abuja, Nigeria.

Keywords: Abuja, housing; land; Nigeria; public private partnership.

1. INTRODUCTION

A major challenge is the growing population in developing countries such as Nigeria, where the need for housing is growing. The Nigerian federal government estimates that there are 17 million families in Nigeria (Makinde, 2014). The government has used various approaches to improve the provision of affordable housing, but with few results.

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One recently adopted strategy was public-private partnership (PPP). This is a contract that uses public funds and the power of private entrepreneurship and governance to make the best use of public services in a low-resource environment. Since its introduction in 1992, this global purchasing approach has evolved rapidly to meet the requirements of global building and infrastructure services. (Ayeyemi, 2018). At the same time, the effectiveness of PPPs in providing affordable housing in Nigeria is being questioned and used by governments around the world as a magic tool to solve problems with equipment and infrastructure. PPPs are not effective in providing universal housing. Nigerian house. This is especially true for Abuja. Therefore, this study aims to elucidate the main reason for the slow supply of popular homes when buying PPPs.

2. REVIEW OF RELATED LITERATURE

This section of the paper has attempted to provide insight into the concept of PPP in housing delivery, the concept affordable housing, challenges in the provision of affordable housing and the prospect of PPP in affordable housing delivery.

2.1. The concept of public-private partnership in housing delivery

The purpose of the PPP is to encourage governments to move away from the immediate provision of construction and infrastructure services, but primarily to provide a positive regulatory and economic environment. The goal is to improve the optimal performance of the private sector in various businesses. Abdel-Alqawi (2017) noted that PPPs around the world see a sustainable approach to addressing public service shortages in developing countries. The overall estimate given to PPPs as an alternative to the utility strategy is based on the idea that it encourages the involvement of multiple stakeholders in the provision of critical infrastructure, contributes to government spending and encourages the efficient use of funds and improve service delivery at an equal cost for all (World Bank, 2006).

Dabak (2014) argued that the following benefits could be obtained from PPP projects: (a) value for cash: project services are delivered effectively at low cost, using knowledge and technology to private investors, which improves the quality of the product or service at lower cost; (b) Quicker project delivery: with PPP, bureaucracy, if not eliminated, projects are carried out quickly and on time, funded and managed by the public sector; (c)Risk Transfer: the risks associated with the project, such as financing, schedules, planning permits and public consultations, are transferred, inter alia, to the site best prepared for dealing with them. PPPs also allow the private sector to gain access to long-term investment opportunities to reduce risk. Such agreements provide private capital inflows, provide investment potential, and strengthen the local sector and labor market.

Jamali (2004) reported that the obvious advantages of PPPs have put pressure on many developing countries to force important international financial institutions, such as the World Bank and the International Monetary Fund, to move from providing national infrastructure to focusing efforts on liberalization and privatization of services provision. This means encouraging PPPs to abandon the direct provision of services and infrastructure, focusing primarily on providing regulation and an economic environment that promotes optimum private sector performance under various growth factors (Mazouz et. al. 2008). With this knowledge, the main function of the PPP public sector organization is to remove key constraints that impede the optimum efficiency of the private sector in delivering infrastructure and services.

2.2. The concept of affordable housing

Housing is an important right that everyone can have. But, there is some confusion and debate about what makes a home affordable. The definitions of housing policy land use planning, differ across government discourse. (UN-Habitat, 2008; Milligan, 2009). Australia's Minister of Housing, Planning and Local Government describes affordable housing as "housing that is affordable to low- and moderate-income families across home ownership, personal rent, and government rent" (HLGPM, 2005).

This concept of affordable housing is not limited to a specific housing model or financial model, but recognizes traditional social housing for rent through personal housing for renting and buying houses. The UN says affordable housing is good quality and in a good location, that people are not paying enough to prevent other basic living expenses or to threaten the enjoyment of basic human rights. (UN-Habitat, 2011). According to UN projections, Nigeria's population will reach 289 million by 2050, and more than 40% of the population will live in cities, which may increase pressure on housing demand for urban residents (Enisan & Ogundiran, 2013).

In addition, the current trend of countries investing in affordable housing for those who are not for low-income groups, for profit in the first place, but for those who have private developers disadvantaged, to significantly increase domestic housing resources need to change. (Adedeji and Olotuah, 2012).

2.3. Challenges in affordable housing delivery

Affordable housing investment is not a priority for local planning policies, so it is a short term to collect budget resources. In addition, one of the main problems for home developers is funding for development and funding sources for those who want to buy an apartment. Especially the emerging low-income class. Failure of long-term PPP loans due to the size of Nigerian banks is a problem to be solved. If the loan is not available, the interest rate is very high (Dabak, 2014).

Moreover, land development is one of the challenges facing housing development in Nigeria. According to the Nigerian Land Use Act of 1978, land ownership is granted to governors of different states. The bill was aimed at introducing new land reforms in Nigeria, but over the years, land and infrastructure costs represent about 25 to 30% of housing costs and in most cases attract entrepreneurs, housing project costs will always go up and housing costs will be higher due to the need to provide land infrastructure distributed in each place (Mabogunje, 2011; Ayedun and Oluwatobi, 2011).

Cheap housing can be obtained, but the government should continue to review import restrictions for cement and other building materials to reduce construction costs and further develop housing. The second challenge is that large complex residential properties always involve massive investments that require multiple guarantees to prevent use by contractors. For PPP to work with private developers, there must be credible dispute resolution departments to resolve disputes between the contracting parties. (Roberts, 2013).

2.4. The prospect of PPP in affordable housing delivery

The potential of PPP as an alternative to effective housing delivery is very high and it is difficult to assess the importance of housing in a country. Housing is usually the single largest item in the household budget and therefore has fundamental effects on household consumption (Majale, 2004). Living has a profound impact on our lives, which are often

underestimated and provide privacy and safety against unwanted physical and emotional robberies (Stone, 2004). It directly affects our quality of life, health and well-being; it determines our transportation requirements and often our decision to work; this affects our family members and our friendship networks (Majale, 2004).

Housing affects our local economic well-being, growth rate and well-being. This affects the distribution of resources between regions, people and generations (Parker, 2003). Developing low-income housing under a PPP contract can increase employment, but if the supply of low-income housing is inadequate, low-income people seek other low-income housing You can move to a reasonable location. Therefore, the need to develop PPP can be emphasized in the development of social housing.

3. RESEARCH METHODOLOGY

Research methods are the different processes, systems and algorithms used in study, while research methodology is a science of how to conduct studies, research design involves scientific research methods and processes. (Bishop & Herron, 2015). The study is a research survey involving the use of cross-sectional survey design. The data used in the study was made up of variables of the same sample observed at one point in time in Abuja. The population of this study includes in particular, the Architects, Quantity Surveyors, Contractors, Project Managers, Estate Surveyors, Civil Engineers and Builders. The sampling techniques used in this research is purposive methods of sampling. This technique was used as participants were chosen among professionals with expertise in PPP projects. Saunders, Lewis, and Thornhill, (2009) recommend the use of such technique when a researcher wishes to select respondents that have particular information in fulfilling the research objective. A total of 80 copies of questionnaire were distributed and 51 were returned. This reflects a 64 percent response rate. With the help of Statistical Packages for Social Science (SPSS), data collected from the administration of the research tool were analysed using descriptive statistics where the mean was used as a basis to rank the factors studied. This data analysis technique is informed by the works of (Bishop & Herron, 2015).

4. RESULTS AND DISCUSSION OF FINDINGS

The result arising from the data analysis and the discussion of findings are presented in this section.

4.1. Results

Table 1 shows the professional affiliations of various professionals constituting the respondents of the study. The result from Table 1 indicates that 26% of the respondents are Builders, 29% are Architect, 8% are Quantity Surveyors, 31% are Civil Engineers, while the remaining 6% are Project Managers. This by implication means that the built environment professionals, which is well trained in subjects related to the focus of the study participated in the study.

Also, the years of professional experience of the respondents was sought. The result of this is presented in Table 2. From Table 2, it is crystal clear that 20% of the respondents have 1-5years of requisite work experience, 25% have 5-10years of experience, while 55% have above 10years experience. It can be deduced from the result that about 80% of the

respondents have work experience of more than five years. The implication of this result is that the respondents have requisite knowledge to participate in the study.

Table 1: Profession of respondents

S/N	Professional cadre of Respondents	No of Respondents	Percentage
1	Architect	15	29
2	Builders	13	26
3	Civil Engineers	16	31
4	Quantity Surveyor	04	08
5	Project Manager	03	06
	Total	**51**	**100**

Table 2: Respondents years of experience

Years of Experience	Respondents population	Percentage
1-5yrs	10	20
5-10yrs	13	25
Above 10yrs	28	55
Total	51	100

Table 3: Factors challenging PPP in housing delivery

FACTORS	Mean Score	Rank
High cost of construction	4.58	3
Developmental control	2.34	10
Accessibility of land in attractive location	4.62	1
Funding and mortgage system	4.62	1
Government failure due to lack of political will	3.54	6
High cost of building materials	2.88	8
High population growth	3.54	6
Development of infrastructural facilities	3.64	5
Functional legal regulatory framework	2.47	9
Level of Poverty	4.58	3

Table 3 shows the factors affecting housing delivery as ranked by the respondents. It is evident from the result in Table 3 that the most ranked important factors were problem of land accessibility in attractive location and funding and mortgage system and high cost of construction with a mean score of 4.62 each. This was closely followed by the level of poverty and high cost of construction with a mean score of 4.58 each. The least ranked important factors were Functional legal regulatory framework and developmental control.

Table 4: Enabling factors for PPP in affordable housing delivery

Enabling factors	Mean	Rank
Government financial support to Private sector	4.62	1
Accessibility to land	4.62	2
Strong legal framework to reduce uncertainty	4.58	3
Monetary policies to reduce inflation	4.58	3
Government subsidy to increase affordability	3.64	5
Creation of viable secondary mortgage market	3.54	6
Appropriate sharing of risk	3.54	7
Promoting Competitive Bidding	2.88	7
Monitoring and proper evaluation of projects	2.47	9
Transparency	2.34	10

Table 4 presents the enablers to PPP in affordable housing development. From the table, the most ranked important enabling factors are: Government financial support to private sector with mean score 4.62; Accessibility to land in attractive location was ranked second with mean score 4.62; Strong regulatory framework was ranked third with mean score 4.58; and monetary policies to reduce inflation with mean score 4.58. The least enabler for PPP in affordable housing were appropriate sharing of risk, monitoring, proper evaluation of projects, and transparency.

4.2. Discussion of findings

For the national development of each country, the government must be able to provide housing, food and clothing, which are important necessities. Through this study, land accessibility in attractive locations, inefficient mortgage and financing systems, and high construction costs are reported as the main factors affecting housing delivery. This result is consistent with Mabogunje (2011) and Ayedun and Oluwatobi (2011), which report that in most cases, developers must provide infrastructure to land allocated to unattractive locations, which constantly increases the cost of the housing projects, and makes cost of houses expensive. As respondents have shown, the factors enabling PPP to provide affordable housing are government financial support for the private sector, land accessibility in attractive locations, and a solid legal framework. Providing these factors creates an environment that allows PPP contracts to thrive in affordable home delivery.

5. CONCLUSION AND RECOMMENDATIONS

As a result of people relocating from rural to urban areas, limited availability of lands is available to accommodate the increased population of urbanisation especially Abuja, thus the government and the private sectors need to strategize to meet the increasing demand for housing. The PPP challenges are linked to the economic and political context, to the high construction costs and to the allocation of the land in unattractive conditions. To solve this problem, the government must create a real environment through collaboration with the private sector. The environment, as mentioned above, must include reducing interest rates and creating a viable secondary mortgage industry to meet the needs of interested mortgage applicants.

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STRENGTHENING THE IMPLEMENTATION OF TOWN PLANNING LAWS AND PROPERTY MANAGEMENT: PANACEA FOR REDUCING INCIDENCE OF BUILDING COLLAPSE IN NIGERIA

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ABSTRACT

Purpose: The incidents of Building collapse in Nigeria is becoming increasingly alarming with a lot of aspersion on the integrity of professionals in the built environment. Despite many efforts aimed at ameliorating the urban problems through the enactment of plethora of planning laws and regulations, the administration and implementation of these laws and regulation have been problematic. The research is aimed at strengthening Town Planning Laws and property management as a measure of reducing the incidence of building collapse in Nigeria.

Design/methodology/approach: The research relies mostly on secondary source of data.

Findings: Findings revealed that the lack of proper implementation of town planning laws has contributed to the incidence of building collapse. Corruption seems to be a "canker worm" that has eaten deep into the fabric of professionals in the built environment. Furthermore, non-involvement of Estate Surveyors and Valuers in the management of private and public properties has to some extent contributed the menace.

Originality/value: The study recommends that all states of the federation should domesticate and implement Urban and Regional Planning Law; and that all stakeholders, contractors, building developers, state government and the general public should be more proactive at addressing this scourge and nib the problem of building collapse in the bud. More so, professional bodies saddled with the responsibility of regulating building development should find ways of raising the standard of practice; develop sustainable approach to tackle the emerging development challenges.

Keywords: Building collapse; implementation; laws; property management; town planning.

1. INTRODUCTION

The spates of building collapse of recent have assumed a very worrisome dimension. Although building collapse is a common phenomenon all over the world but the trend

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of its occurrence in developing countries is begging for attention by stakeholders and professionals in the built environment. As observed by Uzokwe (2001) that the causes of building failure are due to the quality of the blocks used, quality of concrete used, poor compaction, consolidation of foundation soil and weak soil. Also Ede (2010) identified that the causes of building collapse is not limited to design flaws, ageing, material fatigue, extreme operational and environmental conditions, accidents, terrorist attacks and natural hazard.

The idea of strengthening the implementation of Town Planning Laws in Nigeria is hinged on the fact that Planning Agencies are the regulatory body for every development on land and also being that a lot of human and material resources have been lost. According to National Building research and Road Institute NBRRI, (2018) between 2014 and 2016 four major building collapses have claimed 199 lives. Furthermore, Yaqub, (2019) says that Nigeria has recorded over 56 cases of building collapse in the last four years. Lawal, (2016) reported that there are a total of 178 casualties and 226 injuries recorded in 33 cases of building collapse. Out of the statistics, Lagos State records the highest cases of deaths and is closely followed by Abuja the Federal Capital Territory (FCT) with a total of 131 deaths and 26 injuries. Considering the statistics, there is the need for all stakeholders, building owners, contractors, policymakers, state planning agencies, state and the general public to put more effort at addressing this scourge and nib the problem of building collapse in the bud. More so, professional bodies saddled with the responsibility of regulating building development should find ways of raising the standard of practice; develop sustainable approaches to tackle the emerging development challenges.

Political interference has been one of the issues resulting in building collapse in the country. It is a known fact, that Urban Planning in Nigeria usually encounters service problems as a result of political interference which is sequel to the observation made by Mosher (1978) that one of the most obscure sectors in professional education and much of its practice is the realm of government and politics. The action of politicians have resulted in politically motivated urban plans, layouts, buildings plans and construction of houses on unplanned locations which at the instance of hurriedly developing the site without recourse to laid down standard results in building collapse.

The rate of urbanization is having a corresponding increase in demand for housing development in developing countries. As reported by UN- Habitat III (2016) which says that more than 90% of urban growth is occurring in the developing countries and is estimated that 70 million new residents are added to urban areas of developing countries each year. However, many new urban dwellers projected to be low-income groups are not able to participate in the formal housing market rather they develop the informal housing which constitute slum. The most worrisome aspect is that properties are not properly managed which result in decay existing housing facilities. Also, the private developers have controlled the prices in such a way that low income groups are unable to afford decent housing. This action usually results in a rush to meet up with the demand for housing thereby increasing the incidence of building collapse.

Town Planning laws in some states of the federation have not given statutory powers to Planning Agencies to initiate, approve and monitor development from planning to completion. Some Planning Agencies are still operating the 1946 Town Planning ordinance which is aching and not in-line with our prevailing environment and culture. The Urban and Regional Planning law of 1992 is an improvement of the 1946 Town Planning Ordinance and was adopted for the whole country yet very few states have

domesticated the law but no state has fully implemented the law which has contributed to the occurrences of building collapse in the country.

Considering the above background, this work is aimed at strengthening the implementation of Town Planning Laws and Property Management as an essential remedy to reducing the incidence of building collapse in Nigeria.

2. AN OVERVIEW OF BUILDING COLLAPSE IN NIGERIA

Building collapse has been a recurrence incidence in major cities of Lagos, Abuja and Port-Harcourt causing serious damages on lives and investments. Oloyede, Omoogun and Akinjare (2010) report that in the year 2006, Lagos recorded two building collapse in Ebute Meta and that incidence claimed 37 lives. Likewise, Adegoreye (2010) reported that Industrial Development Bank building collapsed, killing two (2) persons and injuring 23 others. Also, Folagbade (2001) enumerated that forty-two (42) cases of building collapse have been reported between 1980 and 1999. Consequently, Makinde (2007) listed fifty-four cases of building collapse occurring between January, 2000 and June 2007.

Furthermore, the National Building research and Road Institute NBRRI, (2018) collaborated other researchers' position and further summarized that between 2014 and 2016 four major building collapses have claimed 199 lives. It is worthy of note that the years 2011, 2012, 2014 and 2016 are important watershed in the history of building collapse in Nigeria because of its occurrence and the number of casualties recorded, most of which happened in the churches (NBRRI, 2018). In the year 2012 Lagos alone recorded 33 building collapses while Abuja witnessed 22 building collapses. In the year 2014, a building collapse occurred at Synagogue church, where 115 people were reported dead with several injuries. Likewise, another tragic incident of building collapse occurred in Uyo, Akwa Ibom State at Reigners Bible Church and about 27 persons were killed (Vanguard News, 2018). The above scenarios leave us with thought provoking questions begging for answers. Who is to be blamed for incidence of building collapse? What are the causes of building collapse? Which Professionals in the built environment should be blamed? Should we blame the structural engineer for giving structural calculations to the development? Should we heap the blame on builders or contractors who use poor building materials for construction? Should we blame the Town Planning Agency for compromising standards in granting approvals? Are they Town Planning Laws to regulate the activities of developers? How effective is the implementation of these Laws?

Whichever side of the divide one chooses to stand does not negate the fact that building collapse menace is gradually casting a slur on the competence of building professionals in the country which does not collaborate the assertion made by Oyewobi *et al.* (2011) that the mark of major profession is in its ability to accept responsibility to act in the public interest which requires an overt commitment in the development of environment.

According to Al-sweity (2013) a professional is a person who has attained a high degree of professional competence in a particular activity, noting that such person must be highly educated, enjoys work autonomy, earns a comfortable salary and engages in creative and intellectually challenging work. A professional usually belongs to a given profession; an individual uses skills and intellectual based on an established body of knowledge and practice to provide specialised services to the public. This is not the case in most construction site as contractors or developers may decide to override the decision of professionals and take irrational decision which the aftermath may be disastrous. This is why Alamu and Gana (2014) suggested that professionals should not bear the blame alone because, it has been proved that owners of buildings under construction derail from their

approved plans relying more on imagination and fantasy. Secondly, some approving agencies are known to fail to monitor compliance with approved plans. Thirdly, some building owners shun professionals in order to cut costs. Fourthly, the high cost of building materials has led greedy contractors with eyes on profits, to patronize substandard materials. These short-cut measures have contributed immensely to the occurrence of building collapse in the country.

3. TOWN PLANNING ORDINANCES EXPERIENCE IN NIGERIA

The ordinances have experienced series of transformation since they started in the pre-colonial, through the colonial and post -colonial eras. They have been called laws, bye-laws, edicts, acts and decrees, depending on the ruling force at each of the eras.

3.1. Pre-colonial era

Contemporary Planning started in Nigeria with Ordinances which were put in place during the colonial period by the then Colonial Masters. Prior to this period, traditional Nigerian settlements were structured according to the local custom and practice, the traditional land tenure system, the Agrarian nature of the economy and the existing mode of transportation. The Legal role as the trustee, beneficiary, allocator, the re-allocator and supervisor of land was vested on the ruler and head of the communities such as the Obas, the Obis, the Ezes and the Emirs. Traditional Nigerian settlements were established around the palaces of traditional rulers and the development and control of the total environment was the joint administrative responsibility of the entire community. This is why Sanni (2006) noted that though there were no professional planners as we do at present, physical development and growth even in villages were coordinated and regulated by considering the relationship of any proposed development to the existing structures, and making adequate provision for circulation and other conveniences. In the opinion of Obialo (1999), planning and control of development in the pre-colonial period in Nigeria was effectively done. Interestingly some of the cities (Kano, Zaria, Koton-Karfi in the North and Abeokuta and Ondo in the South-West) still retain their pre-colonial inner-city settlement structure.

3.2. Colonial planning ordinances in Nigeria

In 1861 Lagos was ceded as an annexation of the British Colony and consequently the 1863 Town Improvement Ordinance to control development and urban sanitation. The Land Proclamation Act of 1900 (Title to Land in Northern Nigeria) introduced indirect rule system in respect of land administration and settlement development. In 1904, the Cantonment Proclamation was enacted to segregate Europeans expatriate officials from the native areas. According to Oyesiku (2010), the different planning standards were specified for various segments of the city with physical planning and infrastructure provisions concentrated in the European or Government Reserved Area. The Township Ordinance No. 29 of 1917 constituted the first attempt at introducing spatial orderliness in the Land Use pattern of Nigerian cities. Mabogunje (1968) reported that it was done to advance the segregated tendency of major Nigerian cities.

In 1924, Town Planning Committees were established for the Northern and Southern Provinces mainly first class towns to initiate and develop planning schemes as well as

approve building plans. In 1928 the Lagos Executive Development Board (LEDB), was established and was charged with the development of Lagos territory. It was set up in 1928 under the Lagos Town Planning Ordinance of 1928 in response to the outbreak of bubonic plague. Nigerian Town and Country Planning Ordinance No 4 of 1946 provided for the planning, improvement and development of different parts of the Country through planning schemes carried out by Planning Agencies.

3.3. Post-colonial experience

After the Colonialist gave the Country Independence in 1960, the 1946 Town and Country Planning Ordinance was retained. Also retained were the Chapter 123 of the Town and Country planning Law of Western Nigeria of 1959, Chapter 130 of the law of Northern Nigeria and Chapter155 of the Law of Eastern Nigeria. As the law was retained so was the problem of discriminatory legislations, inappropriate standard amidst poor and ineffective administrative framework and high level of politics.

The first attempt at organising the administration and development of Land at the grassroots was the enactment of the Local Government Law (1976). The Law made Town and Country Planning a Local Government affair. Thus the State Governments created a Local Planning Authority to control developments and initiate planning schemes at the Local levels.

Land use decree No 6 of 1978 was established to curb land speculation, ease the process of Land Acquisition by the government, co-ordinate and formulate land tenure modernization.

3.4. Urban and regional planning law, degree No 88 1992

The Nigerian Urban and Regional Planning Decree No 88 of 1992 came into effect on the 1st of October, 1992. This is the latest in the sense that the Town and Country Planning Law that was last enacted for the whole of Nigeria before was the 1946 Town and Country Planning Ordinance which came into effect in 1946. The Nigerian Urban and Regional Planning Decree No 88 of 1992, is the latest Law in Urban and Regional Planning that is applicable to the whole Country. However, some States of the Federation are yet to domesticate this law and other States that have passed it into law have not fully implemented it. Lawal (2000) summarizes the main features of the Nigerian Urban and Regional Planning Decree No 88 of 1992 as follows:

1. Assigning roles to the three tiers of government of the federation;
2. Emphasizing development control with each tier of government having responsibility for control of development in respect of lands belonging to that tier of government;
3. Encouraging public participation in physical planning with a view to promote acceptability and support for planning decisions;
4. Establishing Planning Tribunal to allow for appeals by aggrieved developers and also ensure enforcement by Development Control Departments.

4. EMERGING ISSUES AS AFFECT BUILDING COLLAPSE IN NIGERIA

4.1. Urbanisation and the rate of building development

After independence in 1960, Nigeria experienced rapid urbanization as a result of the urban transformation force of rural-urban migration. According to Agbola, (2005) the rapid urbanization was accompanied with a plethora of challenges such as unemployment, environmental degradations, deficiencies in urban services, inadequate housing, deterioration of existing infrastructures, lack of access to key resources, armed robbery and violence. Furthermore, Oyesiku (2010) has reported that as at 1921 when the first Nigeria's population was estimated to be 18.6 million, about 1.5 million were already living in 29 Cities whose population were 20,000 and above. The 2006 census put the figure at 150 million which by 2019 must have risen to 200 million with about half of the population living in Cities and about 130 Cities whose population exceed 20,000 Nigerians (Oyesiku, 2010). It is obvious that the rate of urbanization is having a corresponding increase in demand for building development in major Cities of Nigeria hitherto increasing the rate of building collapse.

4.2. The land use Act

In 1978, the Land Use Act was promulgated and designed to curb land speculation, ease the process of land acquisition by government, coordinate and formulate tenural modernization. However, the provision of the law did not make provision for physical planning of the nationalized land. As posited by Obateru (1986) that the omission of physical planning has caused the greatest disaster to physical planning in Nigeria. This could be the reason why there are so many shanty cities with slums and improper development control which hitherto result in building collapse.

4.3. Administration of physical planning

Administration of physical planning has been the responsibility of all three tiers of government in Nigeria over the years. The extent of involvement of each level of government is dictated by the operations of various Town and Country Planning Legislations as well as the Federal constitution. Currently, there are arguments that, in many parts of the world especially developing countries, Urban Planning Systems have changed very little and are often contributors to urban problems rather than functioning as tools for human and environmental improvement. This situation raises concern for the practice of urban planning to find ways of raising the standard of practice, develop sustainable approach to tackle the emerging urban development challenges.

The issues of technical and administrative manpower are very crucial yet, this is grossly lacking in Nigeria. Currently there are over 4000 registered Town Planners in Nigeria which is a shortfall compared to the over 200 million people in Nigeria. This therefore present a poor City Municipal Management Units which some planning agencies are composed mainly of inexperienced staff with very little or no formal training whatsoever in planning affairs. In such instance giving their best technically becomes a problem as emerging physical planning problem goes beyond marking and demolition of structures.

4.4. Ethical issues

The legal systems underpinning planning regulation are not flexible to accommodate the presence of large-scale land and property developers which often linked to competitive city policies. This process is expanding substantially, creating challenges for national and local planning practices in Nigeria. The situation is even more worrisome when institutions saddled with the responsibility of regulating building development have to compromise ethics in return for money. This is why Ekong, Ofem and Effiong (2018) posited that corruption seems to be a "canker worm" that has eaten deep into the fabric of professionals in the built environment. This situation raises serious lapses in terms of upholding ethical conduct in a polarized environment where professionals juggle between urbanization and inadequate infrastructure at the same time relegating ethical conduct to the background. There is serious over-politicisation of physical planning which is the reason some states are yet to domesticate Urban and Regional Planning Law while states where the law is domesticated; there seems to be no full implementation.

4.5. Property management

Non- involvement of professionals is not peculiar to property management but is evident even from the inception of the building process. The use of inappropriate building materials, below standard materials and lack of professionals in every stage of the building process has contributed to the increase in the incidents of building collapse in our nation.

Property Management is the process of planning, organizing, leading, staffing and controlling the earth's surface extending downward to the centre of the earth and upward into space, including all things permanently attached to it by nature or by people as well as interests, benefits and rights inherent in the ownership with the aim of attaining the objectives of the owner (Udechukwu and Johnson, 2011).

The duties of a property manager include achieving the objectives of the property owner, generating income for the owner and preserving or increasing the value of the investment property. In order to preserve the value of the property and subsequently avoid building collapse, maintenance of the property becomes paramount to the property manager. Property maintenance could be preventive, repair or corrective, routine and new construction. All of which are necessary for the extension of a building lifespan and subsequent reduction of physical deterioration.

5. CONCLUSION AND RECOMMENDATIONS

The Nigerian Urban and Regional Planning Decree No. 88 of 1992 is a detailed law and an all-encompassing one which is capable of bringing considerable development to every part of the nation if fully implemented. However, Lagos and few other states have implemented a part of the law by establishing its own Urban and Regional Planning law in line with the Decree. There are number of the provisions of the law which has not been either implemented or enforced at all levels of government. Development in the nation has thus been slowed down and developmental contraventions and series of building collapse pervade the cities of the nation.

To achieve the objectives of strengthening Town Planning Laws, all States of the federation should domesticate and implement Urban and Regional Planning Law. Stakeholders should more proactive at addressing the incidents of building collapse. More

so, professional bodies saddled with the responsibility of regulating building development should find ways of raising the standard of practice; develop sustainable approach to tackle the emerging development challenges.

To achieve the objectives of strengthening Town Planning Laws and property management, there is need for an adequate vertical and horizontal coordination of planning activities and well-structured administrative framework. The local councils should be given support by other tiers of government to be able to participate more actively and diversely in urban and regional planning development process. According to Oyesiku (2004), a successful institutional framework for urban and regional development and planning in Nigeria depends on a good interrelationship between appropriate planning legislation and an effective administration framework. In order to fully reduce the incidence of building collapse government need to functional mechanism which is aimed at achieving urban settlements goals through enactment and careful administration of land use or land development control measures

Also, the professional bodies in the built environment especially the Nigerian Institution of Estate Surveyors and Valuers should sensitive the public on the need to involve professionals' right from the inception of their building process and more especially in Property management.

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FACTORS AFFECTING COST PERFORMANCE OF CONSTRUCTION PROJECTS IN ABUJA, NIGERIA

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ABSTRACT

Purpose: Cost deviation from initial cost plan, has been prevalent in construction projects and the issue calls for serious concern. It is against this background that this study made attempt to investigate factors responsible for this phenomenon despite past research efforts.
Design/methodology/approach: Purposive sampling method was used to collect data from primary source consisting of structured questionnaire designed on Likert scale in rating of 1 to 5. The field survey was carried out with 80 questionnaire distributed to the professionals handling public construction building projects in Abuja and a response rate of 68 questionnaire returned was used for the analysis. The data collected was analysed using statistical package (SPSS).
Findings: It was discovered from the data analysis that delayed payments to contractors, inflation, fraudulent practices, and inadequate financial planning are top critical factors contributing to poor cost performance. In addition, mobilisation of financial resources in advance, proper and realistic planning, efficient estimation process, training on value management, change management and procurement management are also crucial to minimise poor cost performance in construction industry.
Originality/value: The study concludes with recommendations that payments should be made to contractors without delay, decision making on projects should always be fast tracked, establishment of preventive measures against unethical practices should be in place. Management should focus more on human resource related issues and adequate planning using modern technology these could serve as mitigating measures for minimising poor cost performance in construction projects.

Keywords: Causes; construction projects; cost performance; mitigation measures.

1. INTRODUCTION

One of the important criteria for project success is project completion within budget time and the satisfaction of clients. The construction industry contributes to the overall economy of our nation, but it is plagued by cost overrun due to various factors. Achieving a steady cost projection on construction projects had been an issue of serious concern, both to the client and project contractors. Cost deviation from initial Cost plan, had been prevalent on Construction sites. Iheme and Chiagorom (2018) noted that the construction industry is of crucial importance to the economy and national development

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of a nation and that there cannot be much progress in national development without the provision of basic infrastructure and amenities. The Construction sector is a crucial factor of competitiveness in the economy, it provides the infrastructure and buildings on which every other sectors rely on (Nasiru *et al*., 2012).

Improving construction efficiency by means of cost effectiveness and timeliness would certainly contribute to cost saving for the country as a whole. One of the important criteria for project success is project completion within budget, time and the satisfaction of the client's requirement. In the construction industry, completing a project within budget is even more critical, as companies work on narrow margins. Completing a project within budget is a complex task, even with various cost control software and techniques, and cost overruns in construction projects are not uncommon all over the world (Olawale & Sun, 2010). Kasimu (2012) stated that construction cost overrun is a universal reality not only in Nigeria, but in all countries across the globe. Cost overruns, whether they are due to delay or estimation errors or any other factors, do not just happen; they are caused and measures can also be put in place to minimise the problem and reduce the impact significantly on the economy of all countries.

Mamman and Omozokpia (2014) opined that the overall success of a project is determined to a large extent by the proper management of the resources which are considered as an essential aspect of project implementations. It was further asserted that if the resources are adequately used and controlled, issues that related to cost overrun would not arise. Cost escalation in projects varies from one project to another and it has adverse effects on clients and contractors, increased costs, loss of productivity, and contract termination (Nasiru *et al*., 2012). However, with the rapid increase in construction failures, this research becomes necessary so as to have a basis for investigating the causes and factors contributing to cost overruns on construction projects in Nigeria. Several researches had been conducted on factors affecting project performance in construction industry, only a few have addressed the issue of cost overruns in recent time in a developing economy like Nigeria This study builds on the vast research works in order to identify a list of factors contributing to cost overruns in public construction projects and more importantly propose a mitigation strategy that could serve as mitigating measures to minimise the problems of cost overrun in public construction projects.

2. REVIEW OF RELATED LITERATURE

2.1. Construction industry

Construction industry is a major index factor in the social and political integration of the society and ranks as one of the major budgetary areas of developing economies. The construction industry has been proven to stimulate rapid economic growth of any nation and there cannot be much progress in national development without the provision of basic infrastructure. (Iheme *et al*., 2015). This sector is a crucial factor of competitiveness in the economy as it provides the infrastructure and buildings on which every other sectors relies on. Construction is considered unique in that it can stimulate the growth of other industrial sectors. Nasiru *et al*. (2012) noted that one of the most dynamic and responsive industrial sector is that of construction. It is an industry in which the output is usually visible, which gives it political appeal, as well as having strong backward and forward linkages with other industries, which makes it a powerful tool for economic manipulation. Construction

Industries are desired mainly for the services which they help to create as most business, social, religious, economic, and industrial activities, operate on her structural base (Iheme *et al*., 2018).

2.2. Factors affecting cost performance

In construction industry, it is important to have control on cost performance of projects to ensure that the construction cost is within the budget. Various researches have been conducted all over the world to investigate factors influencing construction cost overruns. For instance, Olawale and Sun (2010) discovered that top five ranked causes of cost overruns in UK are design changes, risk and uncertainty associated with projects, inaccurate evaluation of projects, time/duration, non-performance of subcontractors, nominated suppliers and complexity of works. Memon, Rahman and Aziz (2011) conducted a research in Malaysia and concluded that top five (5) factors causing cost overruns to be: poor design and delays in design, unrealistic contract duration, lack of experience, late delivery of materials/ equipment and lack of good relationship between the work force.

Other critical factors causing cost overruns as identified by Muralidran, (2018) in United Arab Emirates are: poor productivity, insufficient early planning, lack of motivation, lack of training, clients' financial difficulties, rework, and error in estimating. Other factors are, human resource management, time management, planning, procurement, quality, estimation, change Management, and Project finance. Other critical factors affecting cost performance in Nigeria as identified by Nasiru *et al*. (2012); Malumfashi (2012) and Hellen (2016) are contractors' inexperience, inadequate planning, inflation, incessant variation order and change in project design. Causes of cost overruns are mostly based on the actions and inactions of the project members whether the project is large or not.

Ramanathan, Narayenan and Idrus (2012) after reviewing factors of overruns, found that it was difficult to generalise the root cause of overruns as each study had a unique approach and unique rankings of the causes. They also found, for instance, that some factor that were found to be contributing to cost overruns in the past, have be addressed after some years. However, they noted that the factors appeared to be country, location and project specific. In the Middle East, study revealed that time and cost overruns were viewed to be mostly caused by the client through design changes, late payments to the contractor and delays in decision making. The contractor was seen to contribute through inadequate planning and scheduling, poor supervision and site management and poor productivity (Saleh, 2009; Ramanathan *et al*., 2012).

2.3. Effects of poor cost performance

Nigeria as a country has witnessed a substantial increase in the number of stalled projects due to inappropriate project organisation structures and ineffective leadership. There is evidence that the performance of the construction in Nigeria is poor as time and cost performance of projects are to the extent that over 70% of the projects initiated are likely to escalate with time with a magnitude of over 50% and over 50% of the projects likely to escalate in cost with a magnitude of over 20% (Nyangilo, 2012).

Cost overruns when nor addressed over time, always have significant effect on the economy of every nation. For instance, Ayodele (2011) discovered that there are about 4000 uncompleted or abandoned project belonging to the Federal Government of Nigeria with an estimated cost of above N300 billion which may take up to 30 years to complete at the execution pace and capacity of the present Government, because this issue has been left

without adequate attention for too long which is now having a multiplier effect on the construction industry in particular and the national economy as a whole.

2.4. Mitigating measures for poor cost performance

There are several mitigating measures that could minimise cost overruns in construction projects. Olawale and Sun (2010), revealed that the application of value engineering concept with the elimination or modification of anything that can add to project cost, without adding to the function would improve the overall project cost. This could be through cost investigation, cost planning and cost benefit analysis. Mitigating measures against cost overruns as suggested by Doloi (2013), are: mobilisation of resources by client on time, organisation of cost control workshops, proper procurement planning, proper cost estimation, incentive scheme for motivational purposes and establishment of cost monitoring scheme. Additional mitigating measure discovered is the provision of comprehensive error free designs to avoid misinterpretation of designs by contractors caused by missing drawing details (Ayodele, 2011). Muralidran (2018) discovered that measures such as human resource Management, procurement management, value management, accurate estimation, risk management, quality management and engagement of experience professionals could minimise cost overruns in construction. Additional mitigating measures against cost overruns are: making project team to endorse clauses that disallow unnecessary changes while the project is underway, project tracking to discern early signal of cost overrun and effective human resource management through motivation.

3. RESEARCH METHODOLOGY

Field survey was carried out with 80 questionnaire distributed to professionals handling public building construction projects in Abuja and 68 were returned and this was used for the analysis of data collected from construction professionals. The primary data were collected with the aid of structured questionnaire designed on Likert Scale of 1to 5 rating scale, using mean score to rank the factors discovered. Very relevant was rated 5, relevant was rated 4, just relevant was rated 3, irrelevant was rated 2 and very irrelevant was rated as 1. Secondary data were collected with the aid of Journal articles and past research works. Simple severity index was used in determining the extent to which the variables were accorded and their order of priority. Simple percentages and severity index were used as analytical tool of the generated data. SPSS (Statistical Packages for Social Science Students) was used in determining pattern of variables.

4. RESULTS AND DISCUSSION OF FINDINGS

The results from the data analysis and the discussion of findings are presented in this section.

4.1. Results

Results emanating from the analysis performed are presented here. Table 1 shows the professional affiliation of the respondents.

Table 1: Professionals in small and medium construction firms

S/N	Respondents	Small Frequency	Percentage	Medium Frequency	Percentage
1	Architect	7	17.00	5	18.00
2	Builders	10	25.00	6	21.00
3	Civil Engineers	14	35.00	9	32.00
4	Quantity Surveyor	5	13.00	5	18.00
5	Project Manager	4	10.00	3	11.00
	Total	40	100	28	100

The professional affiliation of various respondents as presented in Table 1 shows that 17% of the respondents in small construction firms are Architects, 25% are Builders, 35% are Civil Engineers, 13% are Quantity Surveyors while Project Managers are 10%. For medium construction firms, the result as shown in Table depicts that 18% of the respondents are Architects, 21% are Builders, 32% are Civil Engineers, 18% are Quantity Surveyors while Project Managers are 11%. The implication of this result shows that the targeted respondents are professionals practising within the built environment.

Table 2: Causes of poor cost performance

S/N	Items	Small Firms		Medium Firms	
		Mean	Rank	Mean	Rank
1	Delay in payment to contractors	4.16	1st	4.60	1st
2	Fraudulent Practices	4.01	4th	4.54	2nd
3	Inadequate financial planning	4.06	3rd	4.50	3rd
4	Inflation	4.10	2nd	4.46	4th
5	Non-performance of sub-contractors and nominated suppliers	3.91	5th	4.37	5th
6	Change in project design	3.71	12th	4.32	8th
7	Lack of value management	3.69	13th	4.28	12th
8	Error in estimating cost of materials	3.78	9th	4.34	6th
9	Unrealistic contract cost	3.74	11th	4.29	11th
10	Inadequate training on cost control techniques	3.59	14th	4.32	8th
11	Lack of proper human resource management	3.90	6th	4.19	14th
12	Engagement of inexperience contractor	3.75	10th	4.21	13th
13	Lack of proper project planning and control	3.81	7th	4.32	8th
14	Inadequate risk management	3.59	14th	4.25	1th
15	Uncoordinated design change management	3.79	8th	4.02	15th

In order to explore the causes of poor cost performance of construction projects, the respondents belonging to both the small and medium construction firms were asked to rank already identified causes from the literature. As such, Table 2 depicts the causes of poor cost performance that are considered for construction projects by organisations as perceived by various construction professionals. It can be seen that even though all the causes of poor cost performance considered have been highly rated by all construction the professionals, delay in payment to contractors is perceived as most important factor to small and medium firms; while second most paramount cause of poor cost performance to professionals in medium firms and small firms are, fraudulent practices and inflation respectively.

Table 3: Mitigating measures for poor cost performance

S/N	Items	Small firms		Medium Firms	
		Mean	Rank	Mean	Rank
1	Mobilisation of financial resources in advance	4.31	1st	4.53	1st
2	Proper and realistic procurement planning	4.25	2nd	4.47	2nd
3	Inflation control mechanism	4.21	4th	4.43	3rd
4	Productivity and cost control training workshops	4.18	5th	4.25	8th
5	Motivational incentive scheme for cost control	4.06	7th	4.28	7th
6	Proper and realist cost estimating	4.03	8th	4.35	5th
7	Stability in Government	3.97	10th	4.19	12th
8	Monitoring against fraudulent practices	4.12	6th	4.24	10th
9	Monitoring against fraudulent practices	4.22	3rd	4.22	11th
10	Sanctions against contractors for non-performance	3.88	12th	4.38	4th
11	Engagement of experience contractor	3.75	14th	4.07	15th
12	Project planning and control	3.91	11th	4.13	14th
13	Human resource management	3.88	12th	4.25	8th
14	Value management	3.81	15th	4.18	13th
15	Project design change management	4.01	9th	4.34	6th

Table 3 indicates the factors for mitigating poor cost performance as perceived by small and medium firms professional. Mobilisation of financial resources in advance was ranked first, while proper and realistic planning was ranked second by both small and medium firms. Monitoring against fraudulent practices was ranked third by small firms while inflation control mechanism was ranked third by medium firms.

Table 4: Effects of poor cost performance

S/N	Items	Mean	Rank
1	Adversarial relations among stakeholder	3.74	5
2	Bad reputation and inability to secure project finance	3.81	1
3	Budget shortfall for project owners	3.78	3
4	Liability of companies due to bankruptcy	3.75	4
5	Project abandonment	3.79	2
6	Supplementary agreement	3.71	6
7	Tying down of clients capital	3.69	7
8	Under-utilisation of manpower resources	3.59	8

Table 4 shows the effects of poor cost performance. Bad reputation and inability to secure project finance was ranked first with mean of 3.81 by all the professionals. It could lead to project abandonment with mean of 3.79 was ranked second, it could lead to budget shortfall for project owners with mean of 3.78 was ranked third.

Table 5: Benefits of effective cost performance

S/N	Benefits of Effective Cost Performance	Percentage
I	Giving clients value for capital invested	80%
Ii	Minimising Company insolvency problems	70%
Iii	Reduction of bad debt or bankruptcy issues	65%
Iv	Improvement of human resource productivity	55%
V	Improvement in project cost, and quality performance	93%
Vi	Minimise projects abandonment	90%
vii	Optimisation of plants and equipment utilisation for the projects.	60%

The benefits of minimising cost overruns in construction projects from the respondents are; It could lead to improvement in project cost and quality performance (93%), project abandonment could be minimised drastically (90%), and it could promote the concept of client having value for his investment (80%). Also, there is likelihood of reduction in construction project cost, resulting from non - payments for unproductive time (70%). The tendency of firms going bankrupt as a result of bad debt could also be minimised (65%).

4.2. Discussion of findings

Delay payment to contractors was indicated by all the respondents in small and medium firms as the main factor responsible for cost overrun on the project they were engaged at. This factor could result in exceeding initial project budget and which could culminate in poor cost performance. This would in turn force the owner of facilities being constructed to seek for an additional funding to pay the extra cost. The respondents agreed that proper financial and material procurement planning is also critical to reduce the effect on project cost and prevent cost overrun. This is in conformity with Muralidran (2018) that Planning is often pivotal to the success of construction operations. For successful execution of project works, various financial planning techniques that could be applied are: short-term planning, medium-term planning and long term planning.

Mitigating measures to poor cost performance as suggested by the respondents in small and medium firms are mobilisation of financial resources in advance, proper and realistic procurement planning, value management, proper and realist cost estimating, sanctions against contractors for non-performance, monitoring against fraudulent practices and establishment of Inflation control mechanism. The responses from this study is in conformation with the work of Doloi (2013) that mobilisation of resources by client on time, organisation of cost control workshops, proper procurement planning, proper cost estimation, incentive scheme for motivational purposes and establishment of cost monitoring scheme is crucial in promoting effective cost performance.

Effects of poor cost performance in projects as perceived by all the respondents are; it could lead to Bad reputation and inability to secure project finance. It could lead to project abandonment and it could lead to budget shortfall for project owners. The effects of poor cost performance could be devastating to the project participants. The benefits of minimising cost overruns in construction projects as revealed by the respondents could lead to improvement in project cost and quality performance. Project abandonment could be minimised drastically and it could promote the concept of client having value for his investment. Also, there is likelihood of reduction in payments for unproductive time which has the tendency to minimise the incidence of construction firms going bankrupt as a result financial problems.

5. CONCLUSION AND RECOMMENDATIONS

Based on the findings, it could be concluded that factors affecting cost performance construction projects in Abuja Nigeria construction industry have direct performance on project delivery. The need to put in place sound construction management practices to minimise poor cost performance cannot be over emphasised. Factors identified in this study, as major factors contributing to cost performance based on the respondents' opinion in small medium firms are: delay in payment to contractors, fraudulent Practices, Inadequate financial planning, and inflation. Other factors are: unrealistic contract cost,

lack of adequate precaution against fraudulent practices, and inadequate sanctions against contractors for non-performance.

The study, therefore, make recommendations that measures such as: mobilization of financial resources in advance, monitoring against fraudulent practices, proper and realistic procurement planning, establishment of Inflation control mechanism, proper and realist cost estimating, value management and sanctions against contractors for non-performance, should be giving adequate priority.

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STUDIES TOWARDS UNDERSTANDING ARCHITECTURAL WAYFINDING

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ABSTRACT

Purpose: Wayfinding, a concept that has been in existence since antiquity has however, in recent times been ignored by architects and other key players in the industry resulting in the prevalence of situations in which buildings' internal and external spaces are clogged and plagued with signs and directional signboards; thereby defeating the core intent and purpose of such spaces and facilities. This paper was aimed at educating Architects and other key players in the building industry on the concept and principles of wayfinding as it relates to architectural practice.

Design/methodology/approach: The information relevant to the research were derived from the review of related literature followed by the survey research design. Data were collected by administering 80 copies of questionnaire to Architects comprising 40 Architects in Port Harcourt, Rivers State and 40 Architects in Akwa Ibom State respectively. The structured questionnaire targeted towards revealing the level of knowledge and familiarity of Architects with the concepts and principles of wayfinding; level of consideration of wayfinding as key design element; level of adoption of concepts and principles of architectural wayfinding as key design elements; amongst others. The responses were collated, grouped and results from each point above was represented graphically using pie charts.

Findings: The study revealed that the level of knowledge of Architects on the concepts and principles of architectural wayfinding is very poor. Reasons for the poor level of knowledge about the concept of wayfinding, its principles as well as methods of application as deduced from the questionnaires were: Lack of what wayfinding was in general; Inadequate knowledge of what the concept of architectural wayfinding; Little or no familiarity of what the principles of wayfinding was and what they had to do with architecture; amongst others. The study also revealed that Architects found it difficult to navigate in internal building spaces once it becomes more complex with instances of being lost in such spaces or being totally confused.

Originality/value: The concept of architectural wayfinding as well as the principles of architectural wayfinding was discussed and subsequently, the principles of architectural wayfinding was grouped into two possible implementation phases - (*Design and Post Design Phases*) by the author. The study recommended that for buildings to be easily navigable, architects must understand the concept of architectural wayfinding and incorporate the various principles of wayfinding into their designs.

Keywords: Architectural wayfinding; circulation; planning; urban design; wayfinding.

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1. INTRODUCTION

Architecture may be defined as the art and science of creating spaces, modification of space into form for human habitation and activities (lawrence & Low, 1990). The science of space creation for human use and interaction encompasses diverse intricate processes which include but are not limited to the following: (i) Study of human needs and characteristics; (ii) the conception of abstract space, its prospective function and its relation with other spaces and activities and to the environment; (iii) the creation of abstract links or spaces for navigation (circulation spaces) for movement between activities; (iv) Development of sketches into fully developed architectural drawings - floor plans, site layouts, sections, perspectives and subsequently fully constructed structures that makeup the built environment. (Herbert, 1966)

More often than not, architects, when commissioned to create building designs such as hospitals, universities, shopping malls, airports, museums, and so on; do so such that the end users of these buildings experience key issues in navigation (wayfinding issues) (Passini, Rainville, Marchand, & Joanette, 1998). This is mostly because, architects, at the conceptual and development stages of creating buildings focuses on the creation of facilities with activity spaces as well as accompanying circulation or navigation spaces but invest little or no thought into the ease for which the end users of such facilities will likely orient themselves and navigate through such created spaces in reality (Passini, Rainville, Marchand, & Joanette, 1998). Some of the reasons responsible for the above are: wayfinding is not seen as a major part of the design process from the onset and as such knowledge about its existence is given little or no thought; if and when factored into design, it is often seen in a disembodied style way; and lack of adequate knowledge about wayfinding, its principles, methods of implementation and systems of wayfinding available.

Thus, the following questions are posed: what is wayfinding? Should wayfinding be considered an aspect of architectural design thought? What ways can wayfinding be implemented towards creating more navigable internal and external built spaces? The paper thus sets out to answer those questions. As such, the research work is aimed at educating Architects and other key players in the building industry in Nigeria on the concept and principles of wayfinding as it relates to architectural practice. The above aim will thus be achieved through a study into the concept of wayfinding as it pertains to urban design and planning; discuss on architectural wayfinding; wayfinding principles and grouping of architectural wayfinding principles into two phases (Design and Post Design Phases).

2. REVIEW OF RELATED LITERATURE

2.1. What is wayfinding?

Wayfinding encompasses all the ways in which humans and animals orient themselves in spaces and navigate through spaces and from places to places both in the natural and built environment. The concept of wayfinding has been in existence from antiquity. Early sailors and navigators traversed vast expanses of waters and land on end reading stellar objects such as position of stars, sun, moon, tides and wave movements, seasonal changes and animal migrations (birds in flight). As civilizations advanced, transportation networks

were developed (roads, bridges, aqueducts, water charts and channels) and way pointers in form of stone pillars were erected along such paths to denote distances, destinations, mile markers, and so on.

In recent times, the advancement of societies into complexes with the creation of complex road networks, urban spaces, as well as means of transportation thus instituted the need to augment movement through these complex urban spaces using objects, markers, maps, directions, graphic symbols, buildings, and so on. Studies of wayfinding emanated and the first mention of wayfinding was in kevin Lynch's book "The image of the City" published in 1960; where he described wayfinding as user experience of orientation and choosing a path within the built environment. He defined wayfinding as "a consistent use and organization of definite sensory cues from the external environment".

Subsequently, other scholars tried defining and explaining wayfinding based on their diverse fields of discipline and areas of expertise. Brunye, Mahoney, Gardony & Taylor (2010) postulated that wayfinding is the process of identifying a current location and knowing how to get to a desired destination as quickly as possible. (Fewings, 2001 in Charisse Farr, Anna & Kleinschmidt, Tristan & Yarlagadda, Prasad & Mengersen, Kerrie, (2012)). Wayfinding is the propensity to get to desired destinations in the natural and built environment. (Passini, Rainville, Marchand, & Joanette, 1998). Allen, Knasic, et al (2010) also expressed wayfinding as the specific way in which wayfinding depends upon the research field.

Wayfinding and its application cannot be discussed, isolating circulation and circulation plans; as circulation is directly related to orientation in spaces. Bitgood (2010) identifies three paramount elements to visitor orientation and circulation: conceptual orientation, wayfinding and circulation. Orientation incorporates a mindfulness and comprehension of the subject matter of the facility. Circulation portrays how guests advance through the facility; and poses questions such as:

a. What pathways do they take?
b. Do visitors circulate the way the designers intended?
c. Do visitors miss key spaces because of the architectural design of the facility?
d. Which direction do visitors turn when they reach choice point?
e. Do visitors have a circulation strategy?
f. Do they simply wander more or less aimlessly?

Wayfinding or "Locational orientation" a term used by Bitgood (2010) involves being able to find or locate places in a facility. (Bitgood, 2010). Natapov, Saskia, Dalton, & Holscher, (2015) points out that methods for circulation plans are based on analyses of the physical characters and capabilities of diverse user groups (Physical strength, age, disabilities, and others.) which sets architectural models for the components of roofs, entryways, windows, steps, walkways and others.

Most of practical compositional arrangements and environmental settings are not founded on unitary examples of development but rather involve a mix of circulation designs that can be built from different geometric guidelines or by joining components from the diverse sorts (Natapov, Saskia, Dalton, and Holscher, (2015). Clark & Pause, (2005) characterizes circulation designs casually, in spite of the fact that, there is no immovably settled circulation typology. Passini (1996) in Natapov, et al (2015) proposes that 'gestalt' or 'great structure' of the circulation frameworks (for example a square, a cross, a L-shape) can help in the comprehension of complex layouts when the individual notices the particular single shape as a hidden underlying rule; this can in turn educate and, in this manner, help wayfinding attitudes.

Urban planners and other allied professionals are mostly concerned with the physical properties of circulation frameworks which are ordered with the accompanying base

structures: Linear, Circular, Network and others. (Natapov, Saskia, Dalton, and Holscher, 2015) for which they utilize in the creation of urban spaces and cities, planning of transportation networks and others. Architects deal with circulation in respect to movement of people between different activities and zones in buildings in built environment.

2.2. Wayfinding in urban design and planning

Urban designers and planners incorporates the use of signages; landmarks in form of buildings, statues; natural elements such as streams, rivers, lakes, mountain ranges, etc.; meteorological and astronomical phenomena (direction of sun, position of moon, stars) as well as movement of animals to aid orientation of people as well as movement of people in urban spaces. Over the years new and innovative technologies such as GPS systems; Adaptive spatial engines; Human interface devices with interactive features; conceptual maps, detailed street maps with street panoramic views; traffic information services; and others; have been developed, tested and marketed with the sole aim of improving navigation through the urban landscape. Some of the techniques adopted by various developed nations of the world include although not limited to the following:

Pavement Painted Directions: This incorporates the detailed graphical description of proposed direction on curbsides or pavements. The city of Las Palmas has adopted this rather cost effective and simple method to inform navigators of their positions and possible route choices through careful colour delineation and directional markings.

Figure 1: Painted sidewalk showing direction of movement; destination point; as well as estimated time of arrival on foot.

Source: www.travelwayfinding.com/urban navigation design/#Pavement_Sidewalk_Painted_Directions

The Thin Blue Line: The 'walking line' a technique which is not new, has been in use in places such as coach and train stations, airports and hospitals. The cost for wayfinding of a clear blue line, which tourists and pedestrians can trace, tends to be very significantly cost and time effective when compared to designing, manufacturing and installing what otherwise would require a dozen or so signs. Once again, maintenance is the key to making this form of wayfinding system effective.

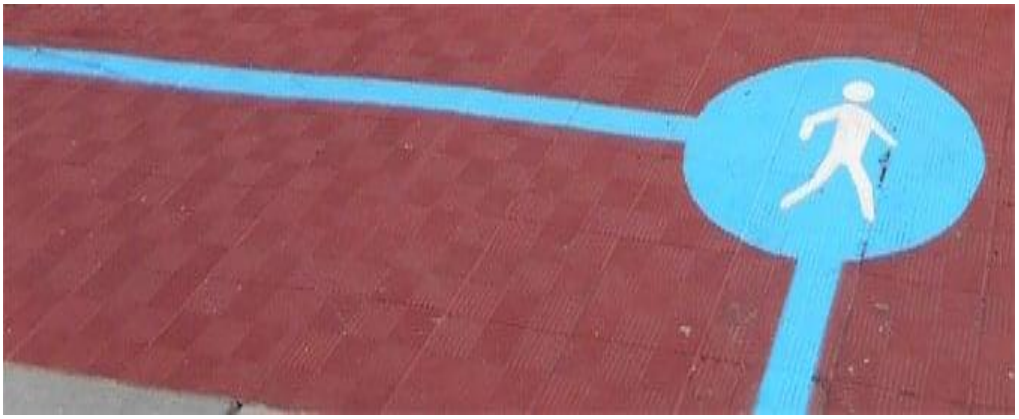

Figure 2: Blue line marking direction for pedestrian movement
Source: www.travelwayfinding.com/urbannavigationdesign/#Thin_Blue_Line_A_Simple_Solution_in_Urban_Navigation_Design

Working with Local Transportation Providers: It is comforting and relieving to know that you are in safe hands whilst visiting and navigating an unfamiliar terrain or place. Other developed countries of the world have adopted and coerced with transport providers to make navigation easier. Buses are painted and decorated with informative city-scape information, colours and codes.

Figure 3: Local city sighting bus in Madeira
Source: www.travelwayfinding.com/urban-navigation-design/#Workin_with_Local_Transportation_Providers

The Use of Street Maps and Directional Aids: This is not a new technique but it is a very effective technique for easily navigating through complex terrains and city-scapes. This is made available to people in form of billboards, posters, *etc*.

In Nigeria however, the exploration of wayfinding solutions and techniques has been over the years, limited to the adoption of GPS and static Highway as well as inter-state signage and road furniture. This is has thus proven useful over the years but, with the rapid rate of changing city-scape and environments, new and innovative technologies must thus be sought after and implemented.

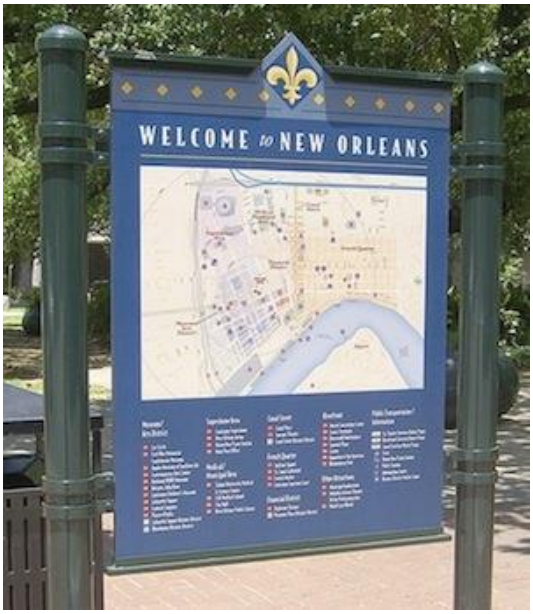

Figure 4: City map of New Orleans highlighting way-pointers and notable places
Source: www.googlesearch.com

2.3. Architectural wayfinding

Architectural wayfinding configuration addresses-built components, including spatial arranging, enunciation of form-giving highlights, circulation frameworks and environmental communication. Wayfinding configuration is integral to universal design since it advances simple comprehension and utilization of built elements at all scales. Successful wayfinding design allows people to attain the following:

1. Determination of location within a setting (building or urban setting)
2. Determination of prospective destination
3. Development of a movement plan (from location to destination).
4. Execute the plan and negotiate any required changes (Mayor's Office for People with Disabilities, 2001) in (Hunter, 2010).

Characterized as far as spatial critical thinking, Passini et al, (1998) places that wayfinding is made out of three interrelated procedures:

1. Decision-making and the development of a plan of action
2. Decision executing, converting the plan into action and behaviors at the right place and time
3. Information gathering and treatment which sustains the two choice-related procedures. (Passini, Rainville, Marchand, & Joanette, 1998)

Passini graphically illustrated three levels of decision making using a scenario of moving from a location x to "Turtle Atoll". Here, he breaks down the series of choices to be processed and actions to made based on the above three decision making processes. The trend of thought and decision-making processes is evident in everyday activities – decision to visit a museum, decision on what exhibits to visit, decision of museum curator on the proposed paths to be followed during exhibitions, movement plans, and a lot more.

Fewings (2001) in (Farr, Kleinschmidt, Yarlagadda, and Mengersen, 2012), distinguished two fundamental sorts of wayfinding – 'recreational', 'resolute or crisis'. Farr, et al (2012) goes on further to clarify that 'Recreational wayfinding affords an individual the chance to tackle issues that can be a wellspring of fulfillment and delight. Resolute or

Emergency wayfinding presents a situation where the essential thought process is to discover one's way in the most methodological way. This sort of wayfinding manages time when contrasted with the previous and the multifaceted nature of the earth impacts enormously and straightforwardly on the time taken in this sort of wayfinding.

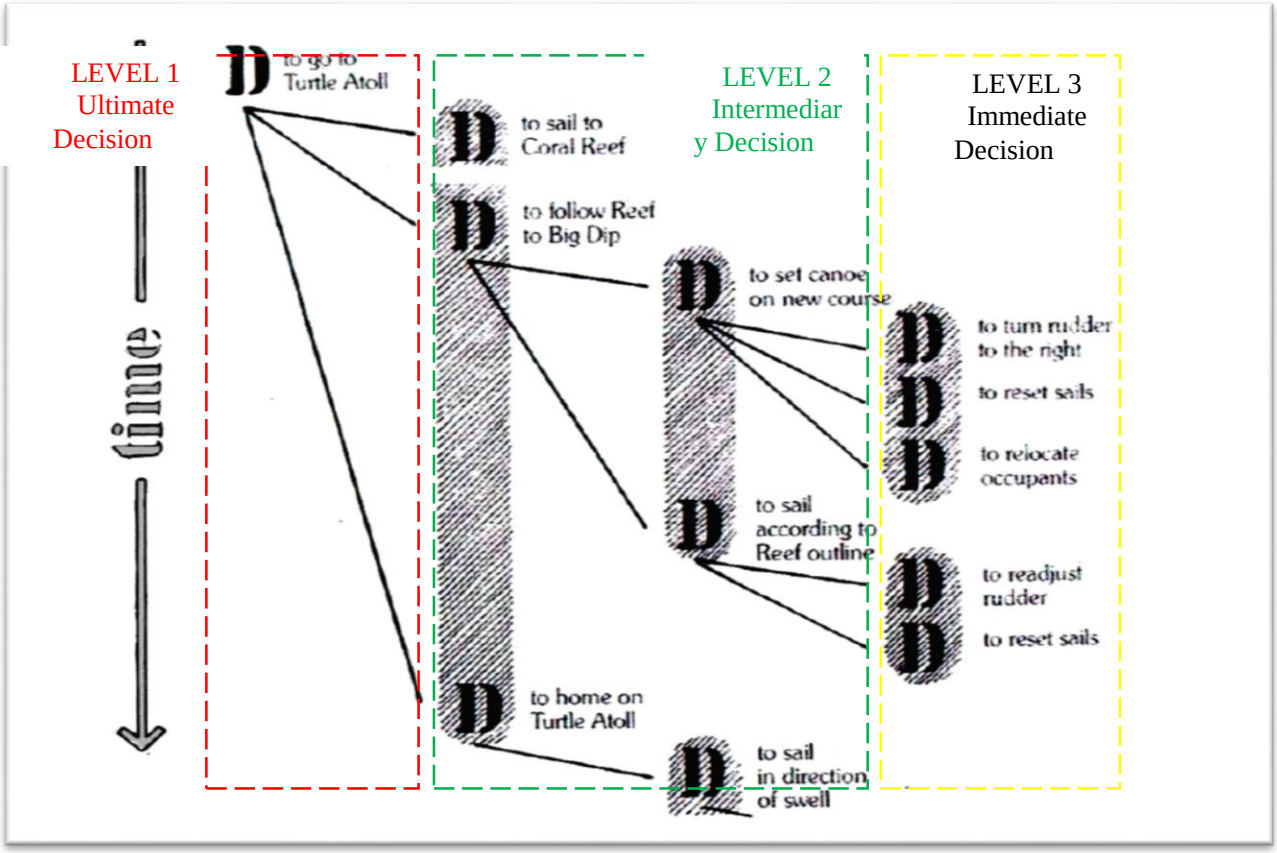

Figure 5: Decision Diagram Adopted from Passini (1984, p.156)
Source: (HAO, CHING, & Yen, 2009)

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When the concept of wayfinding is mentioned, there is the great temptation to think only of signs and graphics. Architectural and interior design components are just as important. Adequately planned Architectural spaces will have signals inalienable to the building's design which can intuitively direct a user. (INTERNATIONAL HEALTH FACILITY GUIDELINES, 2016).

The main architectural wayfinding elements include the following:

1. Zones: Regions described by a specific component or capacity and given a unique personality
2. Paths/Circulation: distinct areas for movement to and from destinations.
3. Landmarks or Markers: objects/components used to demonstrate a position/region along a course or at an end point.
4. Nodes: a point in a system/framework at which pathways meet or branch; for the most part a point where a choice should be made.
5. Edges: how the borders of a path, zone or hub is characterized. (INTERNATIONAL HEALTH FACILITY GUIDELINES, 2016)

These elements are explored in the layout of spaces and circulation and the design of physical spaces to enhance wayfinding and minimize the use of tags, slings and arrows which most times, only aids in confusing the end user.

2.4. Principles of wayfinding

Downs and Stea (1973) in Farr, Kleinschmidt, Yarlagadda, and Mengersen, (2012) suggested that wayfinding could be separated into a four-step procedure involving:

Orientation: The ability of a user to find out where they are with respect to nearby markers and the required destination
Route Selection: Picking a course that will in the long run lead to the ideal goal.
Route Control: The constant control and confirmation that the individual is following the selected route.
Recognition of Destination: The person's capacity to understand that they have arrived the ideal destination. (Farr, Kleinschmidt, Yarlagadda, & Mengersen, 2012).

It is on the back drop of the above that the principles of wayfinding were developed and these principles as presented here comes from both the research of museum exhibits and the study of environmental psychologists, cognitive scientists, and others who study how humans represent and explore their physical environment; (mfoltz, 1998). As listed in the International Health Facilities Guidelines, these principles being eight (8) in number are consequently the methods and ways in which wayfinding can be incorporated into the internal spaces of buildings and these are listed and discussed below:

Create an Identity at Each Location, Different from all others: spaces should be different from others in an overall design layout as this aid in recognition and overall cognitive mapping of position and orientation with respect to the overall layout of the design. This guideline demonstrates that each spot should work, to some degree, as a milestone – an unmistakable perspective in the bigger space. (mfoltz, 1998) This principle was deduced from the Research work of Arthur and Passini (Arthur and Passini 1992), where the notions of ‘identity’ and ‘equivalence’ for speaking of perception of places were introduced. They went further to clarify that personality is the thing that makes one piece of a space discernable from another, and comparability is the thing that enables spaces to

be gathered by their regular traits. (INTERNATIONAL HEALTH FACILITY GUIDELINES, 2016); (mfoltz, 1998).

Use Landmarks to Provide Orientation Cues and Memorable Locations: Landmarks serve two useful purposes. The first is as an orientation signal; the second is as a particularly significant area. While the former enables the navigator or user of a space to identify his current location, he can say something about where he is, and which way he is facing in the space he imparts to the milestone (Locational Orientation). The later creates a shared vocabulary platform for which verbal and written descriptions of locations or routes can be achieved. 'Landmarks related with choice points, where the guide must pick which way out of numerous to pursue, are particularly valuable as they make the area and the related choice increasingly important (INTERNATIONAL HEALTH FACILITY GUIDELINES, 2016); (mfoltz, 1998)

Create Well-Structured Paths: For a path to be well-structured, they must possess a set of characteristics such as: continuous; having clear headings (beginning, middle and end) when viewed in each direction (mfoltz, 1998). They should confirm progress and distance to their destination along their length; and a navigator should easily understand which direction he is moving along the path by its 'directionality' or "sidedness". (INTERNATIONAL HEALTH FACILITY GUIDELINES, 2016); (mfoltz, 1998)

Create Regions of Differing Visual Character: This principle deals with the division of spaces into regions of distinct set of visual attributes (colors, textures, forms, shapes, and others) to assist in wayfinding. The character that separates a space can be some part of its visual appearance, a refinement in capacity or use, or some property of its substance that is reliably kept up inside the area of room yet not without.

Locales of spaces in structures might not have promptly characterized limits as they will in general cover, or their degree might be in some part subjective; yet there is a generally agreed space said to be within a sector of space, and an encompassing territory said to be outside it (mfoltz, 1998).

Minimal Navigation Choice for Users: In the event that there is a story to tell, spaces ought to be structured so it is intelligible for each course the navigator may take. The fundamental story ought to be imparted by each way the navigator can consume through the space. Opportunities for temporary routes, side-visits, and investigation can fan out the primary way, in the long run coming back to continue the fundamental story (mfoltz, 1998).

Use of Sight Lines to Reveal what is ahead: This principle deals with creating a visually accessible space(s) for which view in a distinct direction is made extensive and tailored with a purpose to attract visitors to that direction. In a display space, in which the first-time guest has questionable desires as to its degree and reason, sight lines are significant methods for giving enough data about what is ahead to urge the guest to move further. Sight lines give long narrow samples of unfamiliar spaces. To make a sight line more interesting, the design can adopt a strategy of creating an "attractor" – a goal to navigate toward. This might be some feature (sculpture, art work, and others) that is striking and unusual (mfoltz, 1998).

Provide Signs at Decision Points to Help Wayfinding decisions: Signs should be placed, where necessary, at decision points on the floor layout (most preferably, the use of sculptures, or multi directional arrow heads or beacons). decision points are points where

the visitor must settle on a wayfinding choice (regardless of whether to proceed with a specific course or alter course). (mfoltz, 1998)

Use Survey View (Navigational Floor maps or Vistas): make floor maps which visitors will use as a navigational guide. It puts the entire space inside the guide's view, and a couple of sorts of choices can be made instantly. Outline points of view can similarly give reason to the visitor's mental guide; and the mental guide, arranged with the image of his environment, can be amplified expeditiously with experience grabbed from genuine course in the space. (mfoltz, 1998)

The above set of principles can thus be classified into two main categories - *during design* and *post-design*; and these intrinsically affect the circulation design designs and results. Principles such as – *creation of distinct spatial identities, Use of Land marks, Creation of differing visual characters, Minimal Navigational Choices, Use of Sight lines to reveal what is ahead*; can be integrated and achieved during the design stages. The *provision of signs at decision points as well as use of survey views* are achievable post design.

3. RESEARCH METHODOLOGY

The information relevant to research were derived from both primary and secondary sources of data collection. Survey method was adopted for the primary source of data collection involving issuing of questionnaires to 80 architects comprising 40 architects in Port Harcourt, Rivers state and 40 architects in Akwa Ibom State respectively; which served as respondents to a structured questionnaire comprising 13 questions targeted towards revealing the level of knowledge and familiarity of architects with the concepts and principles of wayfinding; level of consideration of wayfinding as key design element; level of adoption of concepts and principles of architectural wayfinding as key design elements; and others. Questionnaires were rated on a 5-point Likert ordinal scale for which scale points were presented as follows: 80-100% = 5 (very good); 60-80% = 4 (good); 40-60% = 3 (average); 20-40% = 2 (poor); 0-20 = 1(very poor); the responses were collated, grouped and results from each point above was represented graphically in percentages using pie charts. Secondary sources of information were derived from literary publications, textbooks, online journals.

4. DATA ANALYSIS AND DISCUSSION OF FINDINGS

4.1. Data presentation and analysis

Information derived from the questionnaires are thus presented and discussed as follows. The questionnaires comprised of 13 questions of which information derived from the different questions. On the background section of the questionnaire (Figure 6), 15(18.75%) of respondents identified themselves as theorist and educators in Architecture; 30(37.5%) identified themselves as practicing/commissions architects only; while 35(43.75%) of the respondents identified themselves as players in both fields of theory and practice. It also revealed that 12.5% were 0-6years into practice; 18.75% were 7-12years into practice; 25% were 21-30years into practice; 6.25% above 30years of practice

experience, with a majority of the respondents (37.5%) having an average of 16years of practice experience.

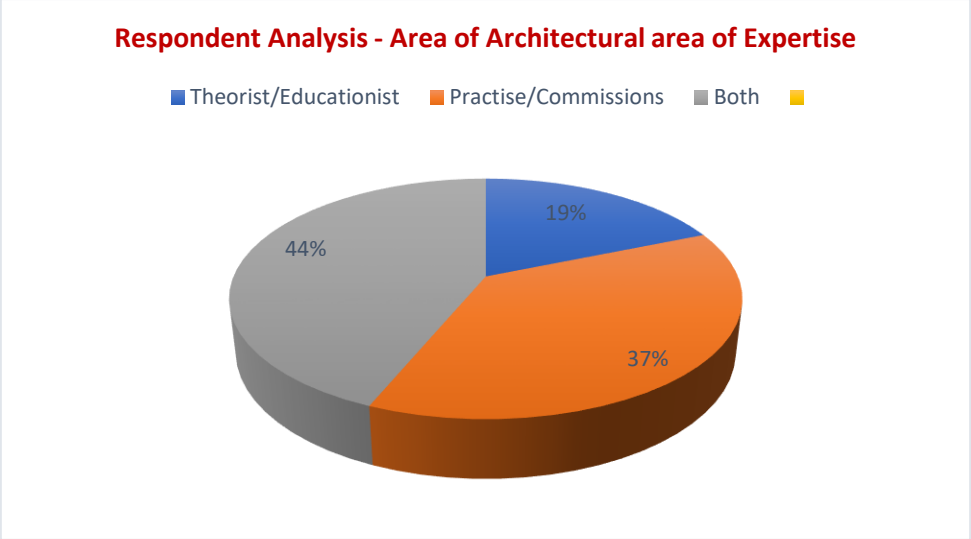

Figure 6: Graphical presentation of responses on the area of architectural area of expertise

It was revealed, from the pie chart below (Figure 7); that 50% of the total number of respondents had very weak knowledge about the concept of wayfinding; 25% of the total respondents had fair (weak) knowledge of the concept of wayfinding; 10% had average knowledge of the concept of wayfinding; 12.5% of the respondents had a strong knowledge and only 2.5% of the total number of respondents had very strong knowledge of the concept of architectural wayfinding.

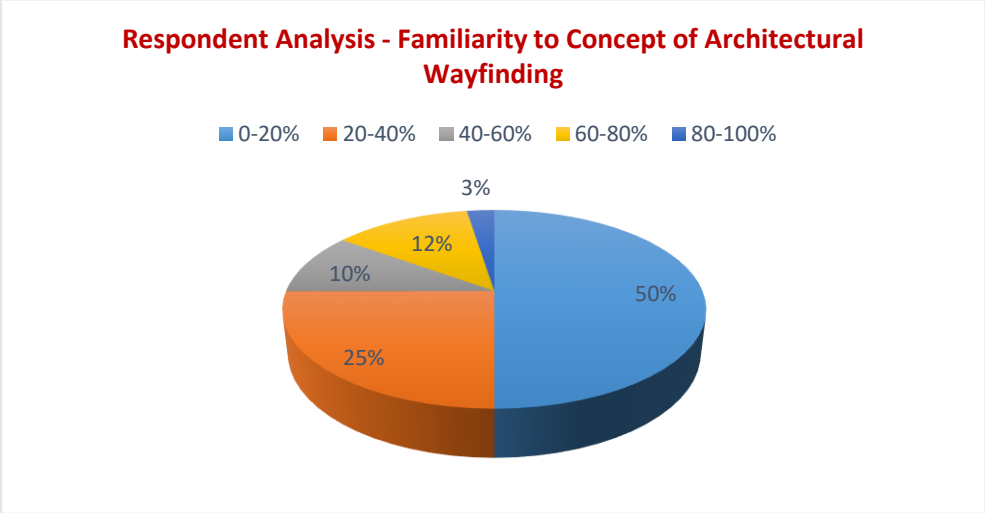

Figure 7: Graphical presentation of responses on the level of familiarity with the concept of architectural wayfinding

In Figure 8, it was revealed that 43.75% of the total number of respondents had very poor knowledge about the principles of architectural wayfinding; 50% of the total respondents had poor (weak) knowledge of the principles of architectural wayfinding; 3.75% had average knowledge of the principles of architectural wayfinding; 2.5% of the

respondents had a strong knowledge and none of the respondents had a very strong knowledge of the principles of architectural wayfinding.

In theory and practice of architecture (Figure 9); 12.5% (10 respondents) of the total respondents agreed that wayfinding should be considered a key design element; while 12.5% (10 respondents) totally disagreed on considering architectural wayfinding, a key design element. 75% (60 respondents) were not sure of their stance on the issue. The respondents pointed out several reason(s) for the above choices; and these will thus be discussed subsequently.

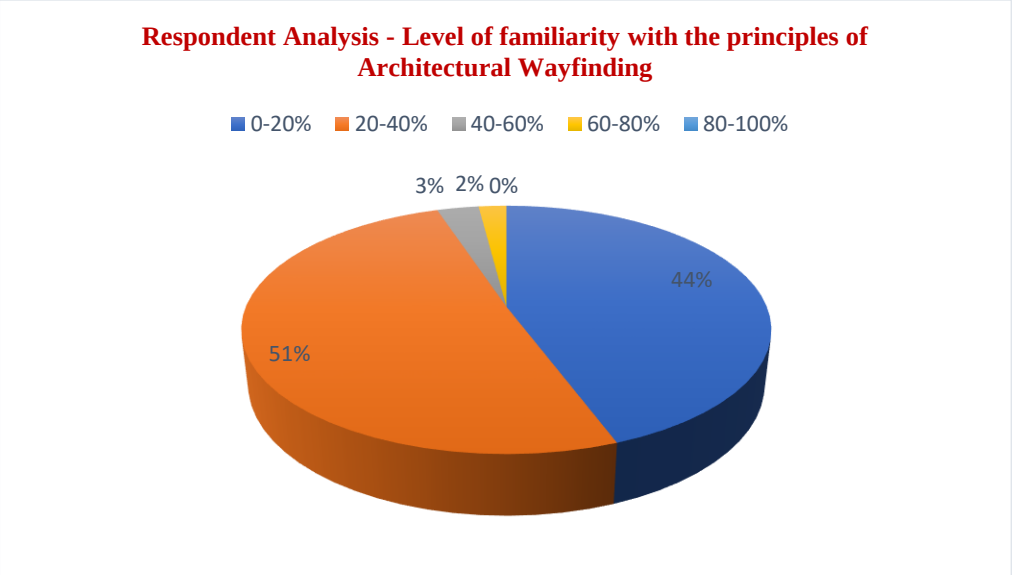

Figure 8: Graphical presentation of responses on the level of familiarity with the principles of architectural wayfinding

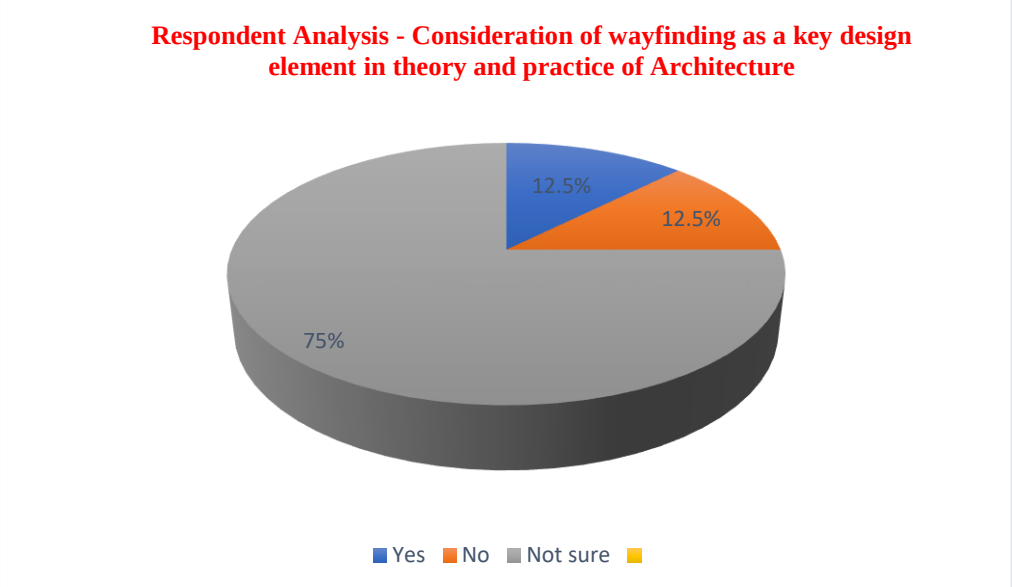

Figure 9: Graphical presentation – consideration of wayfinding as a key design element in theory and practice of architecture

Furthermore**,** 6.25% of respondents considered adopting wayfinding as a key design element; 31.25% did not consider adopting wayfinding as a key design element; and 62.5%

of the total number of respondents were not sure whether they adopted wayfinding as a key design element

4.2. Discussion of findings

From the presentation of data above, it is evident that 12.5% of respondents had an average knowledge of what the concept of architectural wayfinding was; only 2.5% of the total respondents had a very strong knowledge of the concept of architectural wayfinding. Also, 3.75% and 2.75% of the total number of respondents had knowledge of the principles of architectural wayfinding respectively. In theory and practice of architecture; 12.5% (10 respondents) of the total respondents agreed that wayfinding should be considered a key design element. 6.25% of respondents considered adopting wayfinding as a key design element.

In contrast to the above, 50% of the total number of respondents had very weak knowledge about the concept of wayfinding; 25% of the total respondents had fair (weak) knowledge of the concept of wayfinding; 10% had average knowledge of the concept of wayfinding. 43.75% of the total number of respondents had very poor knowledge about the principles of architectural wayfinding; 50% of the total respondents had poor (weak) knowledge of the principles of architectural wayfinding. 12.5% (10 respondents) totally disagreed on considering architectural wayfinding, a key design element. 75% (60 respondents) were not sure of their stance on the issue. 31.25% did not consider adopting wayfinding as a key design element; and 62.5% of the total number of respondents were not sure whether they adopted wayfinding as a key design element.

The reasons for the poor outcomes in responses based on the questions as presented on and collated from the questionnaires are:

i. Lack of what wayfinding was in general.
ii. Inadequate knowledge of what the concept of architectural wayfinding.
iii. Little or no familiarity of what the principles of wayfinding was and what they had to do with architecture.
iv. Poor consideration of wayfinding as an integral design element and as such, little or no thought into its importance and effects.
v. Wayfinding was generally attributed only to urban and city planning
vi. wayfinding thought of as just the placement of graphic signs and symbols as seen in airports, large malls, train stations, etc.
vii. Wayfinding is considered a field of study on its own and as such architects should not be bored with the task of acquiring such skills.
viii. some respondents gave no reasons.

The glaring effect is pointed out where 50% of respondents confessed to being lost in internal building spaces as deduced from the questionnaires. It is quite unbelievable; an architect being lost in the complex of spaces that he is presumed a master of. This thus greatly necessitates the need for this paper as it will greatly educate the masters of the building society as well as other key players on the various ways in which the intelligibility of internal building spaces can be enhanced towards user experience satisfaction.

For the minority of architects that had an average to strong knowledge of what wayfinding was, its principles and methods of application as well as respective implications with respect to inadequate consideration into its relevance; outlined some interesting reasons such as: wayfinding is an essential aspect of every design endeavor as it outlines how easily people will move and respond to directional changes in a complex navigational spaces in the internal building environments created by the architects. Another reason is

that the incorporation of wayfinding thus aids in revealing key design issues with respect to choice of material types, shape and configuration of spaces; type of circulation plan(s) to adopt with respect to ease of navigation. Also, it aids in paying more attention to salient details during design. The salient details being choice of colors and exploration of user cognitive ability whilst using the internal spaces. Above all, the overall user experience in the buildings created are thus greatly enhanced.

Considering wayfinding in the early stages of design thus eliminates the need to flood internal building's spaces with signs and directional symbols; thus defacing the intended aesthetic as well as utilitarian purpose of such building's spaces.

5. CONCLUSION AND RECOMMENDATIONS

This study aimed at educating architects on the architects and other key players in the building industry on the concept of architectural wayfinding. The study adopted a survey method in which questionnaires were issued to 80 respondents (architects). Data from the questionnaires were analysed and it was revealed that the level of knowledge of architects on the concepts and principles of architectural wayfinding is very poor. Several reasons were pointed out to be the cause of such results; some of the reasons pointed were: Architects do not consider wayfinding as a major part of the design process and as such knowledge about its existence is given little or no thought; if and when wayfinding is factored into design thought, it is often seen in a disembodied style; lack of what wayfinding was in general; inadequate knowledge of what the concept of architectural wayfinding; amongst others.

The glaring effect is pointed out where 50% of respondents confessed to being lost in internal building spaces as deduced from the questionnaires. It is quite unbelievable; an architect being lost in the complex of spaces that he is presumed a master of. This thus greatly necessitates the need for this paper as it will greatly educate the masters of the building society as well as other key players on the various ways in which the intelligibility of internal building spaces can be enhanced towards user experience satisfaction.

It is not only pertinent to design buildings which are aesthetically pleasing; but also buildings in which her internal spaces are as easily navigable as possible without the use of extensive signage and symbols which not defaces the building, but creates a negative user experience index which can be very detrimental in situations of emergencies. Architects in all fields of disciplines are thus implored to avail and acquaint themselves with the various concepts and principles of wayfinding as listed and discussed in this paper and further enrich the quality of their architectural master pieces.

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