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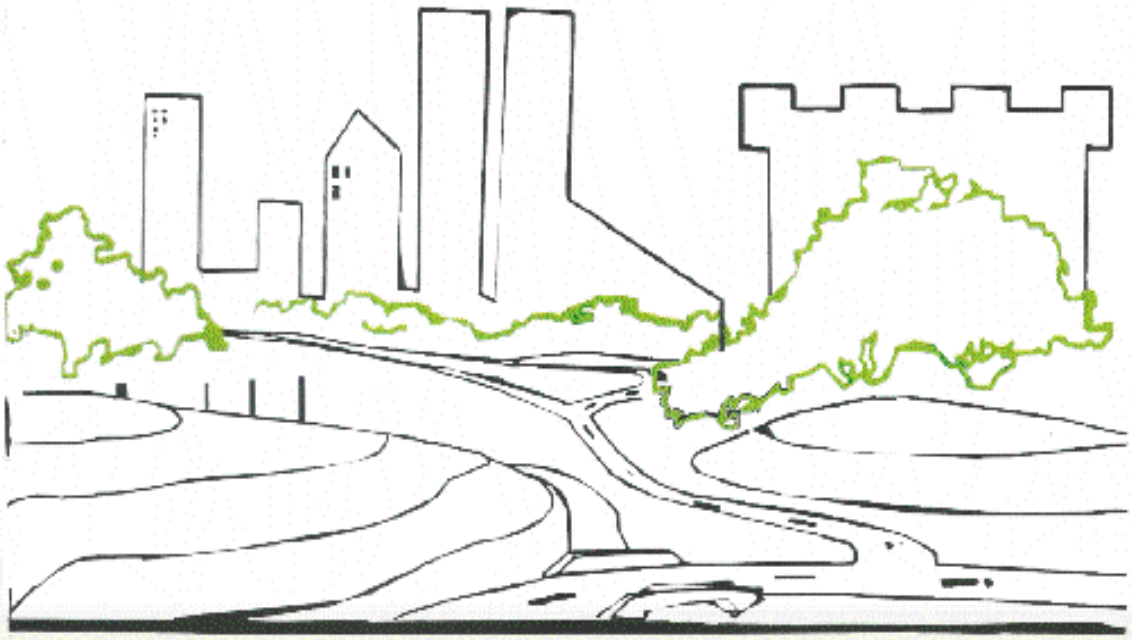

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EDITORIAL COMMENTS

Welcome to yet another volume of the Journal of Environmental Design. Volume 14 of the JED contains several thought-provoking well researched papers on the various dimensions of the built environment. It must be stated that environmental problems in general have become intricate phenomena requiring a wide range of interests and experts in their planning, management and design. The JED continues in its 14th volume to highlight the works of these experts and presents their informed views and cutting edge research findings for the benefits of policy makers and students of environmental studies. The papers have been peer-reviewed and carefully selected to ensure intellectual balance and intelligent discourse.

Professor Best Ochigbo

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EDITORIAL STYLE GUIDE FOR AUTHORS

Please submit your manuscript double spaced in MS Word 2003 - 2007 version. Provide tables and figures in a separate file (or files) in MS Excel MS Word or EPS format. Maps should be supplied in EPS format. Because manuscripts will undergo a blind review, submit two title pages; the first showing the title of the manuscript, author name, title, affiliation, telephone number, email address and the date of the manuscript. The second title page should contain only the title of the paper. Third-person style is always preferred. If appropriate, authors may make limited use of first-person singular, but a single author should not refer to himself or herself as "we."

Biography: The manuscript should include; on a separate page or the "first" title page described above a sentence listing each author's name and affiliation.

Abstract: Include a one-paragraph abstract not exceeding 150 words and place it on the first page of the text. The abstract describes the issue(s) or question(s) the paper addresses and states the major findings, conclusions and recommendations.

Keywords: To help users reference the JED published research, keywords are included with journal articles. Please suggest at least two keywords for your manuscript.

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Text Headings: Headings are not numbered and are placed to the left. First-level headings are bold; second-level headings are italicized; and third-level headings are italicized and lead directly into text.

Tables and Figures: Use Arabic numerals to number tables-and figures consecutively in separate series in order of appearance. Include a brief descriptive title at the top of each. Tables and figures should be in separate page not integrated into the text. The text must contain a reference to each table or figure.

Equations: Make sure that all symbols in equations are clear and that all equations (except those in footnotes) are numbered. Single-letter variables should be italicized. Multiple-letter variables, abbreviations (e.g. AGE) and functions (e.g. expo min. In) should not be italicized neither should be numbered. Parentheses or mathematical operations, vectors and matrices should be in bold (not italicized).

References: The manuscript must include complete and accurate citations of all materials referenced in the manuscript that are not of your original authorship. Please double-check your references to ensure that names and dates are accurate, that Web pages are still active, and that there are no discrepancies between the text and the reference list. The APA style is strongly recommended.

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ASSESSMENT OF THE ORGANISATIONAL CULTURE OF CONSTRUCTION FIRMS AT THE ORGANISATIONAL AND PROJECT LEVELS IN NIGERIA

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A b s t r a c t
The study assessed the organizational culture of construction firms at the organization and project levels. The previous studies have investigated the influence of culture at different levels such as natural, industry, professional and organization. However, less attention is focused on the culture at the organization and project levels in terms of their influence on project delivery. The study aimed at identifying the existing organizational culture and its influence on project success with a view to promoting the adoption of best practices. Some factors such as honest communication, getting the job done, goal achievement, cohesive relationship, and outcome excellence were investigated. The study utilized a descriptive survey research design. A total of 1962 construction firms constituted the population of study, out of which a sample of three hundred and thirty five (335)projects/construction managers from three hundred and thirty five (335) construction firms in FCT Abuja, Nigeria were identified for this study. Data was collected through self-administered questionnaire to construction managers using random sampling method while descriptive statistics were utilized in data analysis. The results of the study revealed that the Culture of construction firms depends on teamwork and relationships among the people as the environment can only be managed through teamwork. The construction firms placed more emphases on getting the job completed or done (mean = 3.92) than making the job outstanding (mean = 3.28) while Clan oriented cultures (mean = 3.50) produced better quality outcomes in construction firms. It is recommended among other things that in order to reach a task-oriented culture, hierarchical elements of the project must be eliminated by adopting a flattered project organizational structure as well open group decision making and efficient communication so as to increase responsiveness and flexibility..
Keywords: Construction Firms, Culture, Teamwork, Project success

Introduction

Construction is the world's largest and most challenging industry. Human resource today has a strategic role for productivity increase of any organization, and this makes it superior to the industrial competition. With the effective and optimum uses of it, all the advantages supplied by the productivity growth can be obtained. Construction is a key sector of the national economy in countries all around the world, as traditionally it took up a big portion in nation's total employment and its significant contribution to a nation's revenue as a whole. However, until today, construction industries are still facing a number of problems regarding the project success in term of cost, time and insufficient quality. Productivity is the one of the most important factors that affects overall performance of any small or medium or large construction industry. There are number of factors that directly affect the productivity of labour, thus it is important for any organization to study and identify those factors and take an appropriate action for improving their performances. At the micro level, if we improved productivity, ultimately it reduces or decreases the unit cost of the project and gives the overall best performance of the project. The loyalty of employee relies upon knowledge and awareness of culture that improves behavior of organization (Brooks, 2006). The value and norms of employee is based upon management identification that helps in improving employee performance. The awareness of quality helps in improving organizational and employee development.

The concept of culture is one that has been borrowed from the discipline of anthropology, where it has been used to describe the way of life of a particular group of people. Culture is commonly discussed in terms of nations, societies and ethnic or regional groups, but it can be applied equally in other human collectivities or categories, an organization, a profession, or a family. Terje (2003) described culture in construction project scenarios as the culture of the project team comprising different contracting parties in the supply chain and also include companywide interdepartmental members and others who contribute in some ways to the final product or service to be delivered. In fact, the term culture can be used to refer to any grouping in society such as client, consultant/architect contractors and workers at organizational and project levels, in which the members share a common set of assumptions, values,

attitudes, beliefs and expectations in their policies, procedures, and in their view of authority relationships. This means that as groups evolve over time, they face two basic challenges: integrating individuals into an effective whole, and adapting effectively to the external environments in order to survive. As groups find solution to these problems over time, they engage in a kind of collective learning that creates the set of shared assumption and beliefs called culture (Ojo 2010).

Organizational culture, according to (Hooijberg and Petrock 1993) is defined as an organization's values, assumptions and expectations. It serves as a filter through which strategies are decided and performance results. Specifically, Saint-Onge (2002) and Wu & Lin (2013) refined this definition as the set of values and assumptions that underlie the statement: "This is how we do things around here". Organizational theorists are interested in the influence of organizational culture on the behaviour of people within organization in particular with its influence on construction project success. The place of construction industries in the life of a nation cannot be overemphasized because it linked with the place of development in that nation. As a major contributor to national economy, the construction industry is said to have contributed about half of the total stock of fixed capital investment in the economy. The close relationship between the construction industry and the national economy can be better illustrated by comparing the output within the industries and the Gross Domestic Product (GDP) (Ajayi, 2005). About 69% of the nation's fixed capital formation is produced by the construction industry (FOS 1998). This implies that the construction firms represent nearly 70% of the capital base of the national economy and is an indication of the significance of the industry within the economy.

Despite the relative importance of construction industries, it is very disappointing to note that the construction industries have remained poor in their performance. The stakeholders in construction industries have put up noble and spirited efforts aimed at identifying the major problems associated with the construction project success. Despite all these noble efforts, the problem of poor performance by the construction industries has continued to rear its head in the nation's economy. It is acknowledged that the poor performance of the construction industry could be related in some ways to the poor state of the overall economy. Nevertheless, the premise upon which the study reported in this research is based is that notwithstanding the prevailing economic climate, the poor performance of the construction industry can be improved through the implementation of appropriate and relevant management practices by operators within the industry.

Researches into the performance of the construction industry are largely focused on building projects rather than on organizations responsible for the projects. Many have therefore called for a critical consideration of the culture within the construction organization handling construction projects to enhance efficient project delivery in construction (Ankrah, Proverbs and Debrah, 2009). Performance, according to (Luqman, Ahmed, Bashir and Inalegwu 2011) is measured largely in terms of time, quality and cost (performance indices) rather than in terms of other variables that affect project success. Yet the performance of the construction firms does not improve and it continues to be a source of concern. A major criticism that faces most construction firms today is the alarming growth rate in delays of building project delivery (Aibina and Jagboro 2002). The study shows that seven out of ten projects surveyed suffered delays in their completion due to one reason or the other. According to (Chan and Tse. 2002), timely delivery of project within budget and to the level of quality standard specified by the client is an index of successful project delivery. With respect to project success, historically, projects have been managed as a technical system instead of behavioural systems. That is, there has been a tendency to use a mechanistic approach focused on results with the main objectives of attaining target dates, achieving financial plans and controlling the quality of the final project (McCollum & Sherman 1991; Adnane & Clothilde 2003).

Black (1999) and Sai-On, Thomas, Shek-Pu & Henry (2003) identified mutual trust, effective communication, commitment from senior management, clear understandings of different parties, roles, consistency of objectives, and flexibility to change as essential factors for success in project. Trust is an attitude of human acts or beliefs and can only be built on a strong degree of predictability. That means one party can comfortably assume that for a cooperative move to be made, a reciprocating cooperative

move will be returned. The potential negative impact on the workforce is that people may direct their energy elsewhere and in extreme cases create conflict and trouble. He further stated that effective communication and interaction among parties are essential for parties to understand others' needs and difficulties. Kamsaris (2010) stated that "organizational culture represents the distribution of information by taking into account the duality of the communication in construction processes. Therefore, organizational culture, according to Saint-Onge (2002) serves as a filter through which strategies are decided and performance results particularly in construction project processes. In view of the above, organizational culture becomes very important in an organization as stated by Griffin (2003) that culture determines the 'feel' of the organization regardless of its nature; it is a powerful force that can shape the firm's overall effectiveness and long-term success.

A healthy and robust organizational environment will provide various benefits such as competitive edge derived from innovation and customer service; consistent, efficient employee performance; team cohesiveness, high employee morale and strong company alignment towards goal achievement (Jagboro 2002). This situation in no doubt could influence the timely delivery of construction project in general and in particular the construction cost. This study will not only inspire creativity among the stakeholders in construction industry but also enable opinions to be shared and respected by exposing some organizational members to view organizational culture as an opportunity for finding creative solution to solve construction problems. Culture can inspire members to brainstorms ideas, while examining problems from various perspectives. As organizational members work together to solve conflict, they will be more willing to share their opinions with group. These will invariably cause members to actively listen to each other as they work to accomplish the organization's goals. In this regards, a major aspect of this research is expected to empirically assess the organizational culture practices of construction firms at organization and project levels and its influence on project delivery with a view to promoting the adoption of best practices.

Four models of culture are determined through an organizational culture assessment instrument (OCAI) (O'Neill & Quinn 1999). The OCAI approach uses two sets of questionnaires to access current and ideal organizational values in six essential dimensions of culture respectively. The International Council for Research and Innovation in Building and Construction (CIB) conducted the "OCAI-questionnaire' worldwide to evaluate cultures in construction processes. This research examines the four models where the problems of project success occur most in construction industries. The four models of culture are Hierarchy, Market, Clan and Adhocracy. Hierarchy culture is considered as the earliest approach, recognized by a formalized and structured working place (Jian & George 2005). This culture emphasizes internal issues and intends to provide a stable environment to increase productivity, or to generate efficient and reliable products by setting up rules, policy or specialization. Market culture focuses on management of external affairs. This is regarded as a results-oriented and customer-based culture. It contributes to organizational effectiveness and operates as a market. Clan culture is about people and sharing between individuals. This organizational culture concentrates on teamwork, loyalty, commitment and participation of employees. It ultimately helps human resources development. Adhocracy Culture is dynamic and creative. This culture has a higher ability to assume risk and encourages employees' initiative and innovation. Organizations generally would like to have unique products and aims at seeking new resources.

Research Methodology

The methodology of a research is the procedure used in collecting information and data in order to make contribution in area of study. Therefore the process in this study involves assessing the impact of organizational culture on project success in construction firms through the collection of detailed data on the existing condition of organizational culture practices and using the data to justify the actual conditions to make improvement in building construction firms. Therefore, a quantitative research method was adopted for this study through a questionnaire survey as did by other researchers on a similar related area of study (Alharbi and Alyhya 2013; Dasanayake and Mahakalanda 2008). The use of questionnaire survey to collect data was adopted for this study. Kasimu, Roslan & Faghhlin (2013) highlighted that the beliefs, perception, ideas views and thought of construction managers about area under study can be

obtained very easily due to the flexible nature of questionnaire survey, which can also be in structured format and can covered large number of sample of individuals from a population. The study only covered organizational culture in building construction firms with respect to the practice of organization's culture at both organizational and project levels. The study area for this research work is Federal Capital Territory FCT Abuja. The choice of FCT for this study was premised on the fact that the city has a fair concentration of building construction firms. The population size of 1962 managers was used in this study, which constitutes numbers of registered building construction firms retrieved from CAC 2014. These companies are made up of small and medium enterprises (building construction firms) as categorized by (Abdulazeez, 2012). This has a corresponding employee's size of 11 to 99 and 100 to 299 respectively. Also Odediran, Adeyinka, Opatunji, & Morakinyo (2011) classified construction firms into small, medium and large in Nigeria. The nature of the large firms (over 300 workers) are said to have large number of workers. Therefore, 1000 construction managers in small and 962 construction managers in medium firms serve as source of primary data for this research respectively. Three hundred and thirty five (335) projects were randomly sampled. Therefore construction managers in construction firms in Federal Capital territory constitute the population of the study. Sample of a research is described as a limited number of observations from a population. Usually samples are drawn because it is impossible to cover all observations in a population (Ibrahim, 2011). Since the population size, N is known for a categorical data with margin of error = 0.05, p = 0.05 and t = 1.65; therefore the sample size, n = 239 using the table from Bartlett, Kotrlik, & Higgins (2001). According Bartlett, Kotrlik, & Higgins (2001) a margin of error between 3% and 5% is acceptable for educational research. Salkind Neil (1999) stated that 10% - 50% of the corrected sample size can be added to the initial sample size. Therefore, 40% of No of calculated sample is added to account for lost questionnaires or uncooperative respondents as recommended by (Salkind, 1999). Therefore final sample size is obtained as shown

$$\underline{No} = 239 \times 0.40 = 95 + no = 95 + 239 = 335$$

Therefore, the study finally administered 335 questionnaires to building construction managers in building construction firms where building construction managers in those firms serve as respondents in FCT. To this end, random sampling system was used to select the building construction firms that were issued the structured questionnaires through hand delivery to managers in their offices.

Results and Discussions

A total of 335 copies of questionnaire were issued. However, after series of follow-up and reminders, only 300 questionnaires were completed and returned. The number of questionnaire completed and returned was higher than the sample size computed for the study (239). Based on this, the numbers of questionnaires completed and returned were therefore considered adequate for analysis as 300 represents 90% of the total questionnaire administered (335). Of the completed questionnaires received, 85% of the respondents were at managerial level (Manager Grades). The others held positions such as senior project manager. Some did not specify the names of their organizations; therefore the distribution of company's participation could not be connected.

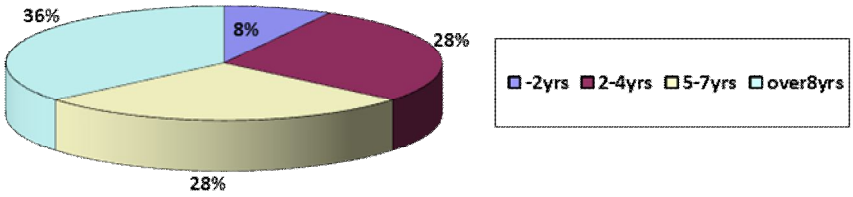

Fig.1. Working Experience in current position
Source: Field Survey 2017

Figure 1, the working experience of the construction managers in current position shows that the respondents have vast experience in building construction projects. 80% of the people that filled in the questionnaire have more than 2 years of experience in managerial positions, while 61% have experience 5 years or more. Therefore responses and other data obtained from a sample like this can be characterized as "informed". The high quality of the sample precision when answering the research questions can also be supported by the fact that the vast majority of the respondents were involved in the building construction firm in their last project. The respondents were generally experienced practitioners in the building construction industry. Table 1, the mean scores of organizational value at project level ranged from 3.11 to 3.72. These scores show that the general project value is relatively high. The top four project values in ascending order are getting the job done, honest communication, trust and goal achievement. These four values obtained scores over 3.50. Conversely, the top five organizational values in ascending order are honest communication (mean 3.72) getting the job done (mean 3.67), goal achievement (mean 3.63), trust (mean 3.62), and cohesive relationship (mean 3.60) which are very similar to project values. The fact that the two of the top three organizational values are the same as the project values, it indicates that the core values in projects and organization are connected and are very similar.

Table 1: Organizational Value in Project and Organisational Levels

Value	Mean Project	S.D.	Rank	Mean Org.	S.D	Rank
Getting the job done	3.72	.392	1	3.67	.387	2
Honest communication	3.62	.382	2	3.72	.392	1
Trust	3.53	372	3	3.62	.382	4
Goal achievement	3.51	.370	4	3.63	.383	3
Cohesive Relationship	3.42	.361	5	3.60	.380	5
Analysis and Control	3.37	.355	5	3.58	.377	6
Innovation	3.36	.355	7	3.53	.372	7
Respect for people	3.33	.351	8	3.47	.366	8
Trying New Concepts	3.30	.348	9	3.47	.362	8
Outcome excellence	3.28	.346	10	3.41	.360	10
Stability and Continuity	3.15	.332	11	3.40	.358	11
Predictability & efficiency	3.11	328	12	3.38	356	12

Source: Field Survey 2017

However, the mean scores of organizational value ranged from 3.38 to 3.67. This was lower when compared with that of project values. Looking at the three core values, honest communication, getting the job done and trust can therefore, be assumed as the cultural strength in both project and organization. According to Koening (2002), project management success does not work without trust. Nothing a supervisor does will increase communication if there is no trust between the people involved. This indicates that project success can only be made possible in the presence of trust in the construction firms. As described before, the average mean values are higher in projects the fact that members of different professions work closely together. The relationships between members are closer in projects than in organizations because they have clear goals behind them; that is, to coordinate well and get the job done. With this regards, it should be noted that only honest communication between members and trust in each other's professionalism will allow them to achieve these goals.

The great difference between project and organizational values is in trying new concepts, which ranks 9 for project value (mean = 3.30) but 8 for organization value (mean 3.47). This is understandable, the fact that the principle value in a project is getting the job done on a tight schedule despite the multiple problems faced on site each day. One can see that there is relatively little extra effort required to try a new concept or innovation. Innovation and trying new concepts is not something that can be executed

instantaneously, because it requires support from the organization. From the perspective of organizational value, innovation and trying new concepts are more popular than in projects, ranking middle, 7 and 8 out of the total 12 values. Innovation is now regarded as a key success factor for an organization, and creative ideas are seen as a strong parameter for an organization's competitiveness. Clan culture which is honest communication, respect for people, trust and cohesive relationship is the dominant value applied in both projects and organizations, while hierarchy culture is the least often applied. The market culture which is goal achievement, getting the job done and outcome excellence is more popular in projects than in organizations, whereas the adhocracy culture is more common in organizations than projects.

Table 2: Culture means

Clan Culture	Mean	Market Culture	Mean
Honest communication	3.62	Goal achievement	3.51
Respect for people	3.37	Getting the job done	3.72
Trust	3.53	Outcome excellent	3.28
Cohesive relationship	3.42		
Average Mean	3.50		3.48

Source: Field Survey 2017 Means difference = 0.018

Table 2 shows the mean difference between the clan and market cultures in projects. This implies that clan and market cultures are dominant values as there is no significant difference (means difference = 0.018). Clan cultures concerns teamwork and people relationships, and Market culture focuses on goal achievement. This again proves that Nigerian Construction firms are a people-based industry, in which interaction among project stakeholders is highly appreciated and encouraged. The findings overlap some of the studies of Cameron & Quinn (1999), where they reported that clan and market culture are dominant values in construction firms and become important for project success. It is surprising that respect for people has a rather low ranking. Although it is a value considered typical of clan culture, it only ranks 8 for both project and organization values, despite the fact that other items of clan culture have a higher score. This does not signify that respect is not necessary; it simply reflects the fact that even if a relationship is close in a project or organization, there might be different personal values and beliefs, or different personal or organizational objectives that have affected respect among people. However, senior management should be aware of this phenomenon because it will be difficult to manage people if employees lack respect for one another, a situation which can occur at any time.

There is a distinct difference in means score between the items in "Market" culture; getting the job done ranks 1 and 2 in projects and organization respectively. In contrast, Outcome excellence ranks 10 and 10, almost the lowest priority. The low score indicates that the construction firm places more emphasis on getting the job completed than on making the job outstanding. Respondents indicated that the adoption of Hierarchy culture is the minimum (mean = 3.11) at project levels and (mean 3.38) at organization level. This score is still above 2.50. Hierarchy culture establishes rules and provides a stable workplace. On top of that, the lowest mean value of Hierarchy culture does not suggest that hierarchy is not essential. Analysis and control, stability and continuity, predictability and efficiency are basic elements for the development of an organization and project, therefore awareness of these three values may be undermined by participants. In view of the above, organizational culture becomes very important in an organization as stated in Griffin (2003) that culture determines the 'feel' of the organization regardless of its nature; it is a powerful force that can shape the firm's overall effectiveness and long-term success.

Conclusion and Recommendations

This study assesses the organization culture of construction firms at the organization and project levels in Nigeria. This study has proved that clan culture is the dominant value applied in both projects and organizations. Thus this finding shows that the culture of construction firms depends on teamwork and

people relationships. These characteristics were evidenced by semiautonomous work teams that received rewards on the basis of team (not individual). In clan culture, the environment can be best managed through teamwork and employee development, clients are best thought of as partners, the organization is in the business of developing a humane work environment thus it is suggested that partner projects are less likely to have problems with contractual conflicts. There is joint problem solving attitude and the common goal of the participant includes successful completion of the projects at the right cost and at the right time. Clan culture is a friendly place of work where people share a lot of themselves. It is like an extended family. Leaders are thought of as mentors and perhaps, even as parent figure. However, senior management should be aware of this phenomenon because it will be difficult to manage people if employees lack respect for one another. The construction firms place more emphases on getting the job completed or done, on a tight schedule and in spite of the multiple problems faced on site each day, than on making the job outstanding. Hence there is relatively little extra effort required to try a new concept or innovation. Concerning hierarchy culture, analysis and control, stability and continuity are basic elements for the development of an organization and project, therefore awareness of these three values may be undermined by participants. Undermining this values result to organization poor planning and control. This study has also presented the findings from research that shows that clan type culture correlate with better quality outcomes whereas market cultures, more common on construction projects, are found to correlate with weaker quality outcomes. This shows that clan oriented cultures produced better quality outcomes than market. Therefore, culture of organization is a powerful force that can shape the firm's overall effectiveness and long – term success if properly managed. Finally the study recommends that a project culture should be designed to align organizational goal and objectives with those of the individual participants. Commonly accepted social, economic, political and procedural understandings reduce conflict within the organization and enhance communication and project objectives are achieved. To reach a task-oriented culture, hierarchical elements of the project must be eliminated by adopting a flat project organization structure, group decision making, open and efficient communication. This approach can increase both responsiveness and flexibility. It also recommended that the project culture on construction projects should be shifted from the current common market culture to a clan culture while deeper relationships should be created rather than those common in the construction industries today. This suggests that construction would greatly benefit from the development of forms of management which are culturally motivated rather than the more traditional competitive project environments which are supported by coercion. The above areas have a significant influence on the likelihood of success of project and should not be ignored.

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EFFECTS OF URBAN SPRAWL ON PERI-URBAN FARMING COMMUNITIES IN UYO CAPITAL CITY, AKWA IBOM STATE

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Abstract
The study analysed the trends in urban sprawl between 1986 and 2016 and its consequences on peri-urban farming communities in Uyo capital city. Remote sensing data on landuse activities were collected using Geographic Information System (GIS) while a structured questionnaire was used to acquire data from respondents on the effects of sprawl. The results indicated significant changes in land use/land cover activities during the period of study. The findings revealed that urban expansion has encroached significantly on peri-urban communities thereby leading to loss of farmlands, diminishing yields, and worsening food insecurity due to conversion of arable land for other uses such as residential, commercial, and institutional activities. Based on this, integrated agricultural landscape development through planned urban farming, urban forestry and greening is recommended so as to conserve and manage the existing fragments of vegetation in the face of increasing urbanization.
Keywords: Urban sprawl, trends, rate, GIS, Uyo

Introduction

In recent times, there has been phenomenal growth in population and spatial extent of urban centres in developing countries especially Nigeria. Consequently, the peri-urban areas are undergoing a two-fold transformation; arable land coming under increasingly intense cultivation and both arable and non-arable lands being increasingly built up to provide space for commercial, industrial institutional, recreational, transportation and residential uses (Ifatimehin and Ufuah, 2006). The expansion takes place either in radial direction around a core or linearly along the highways. This dispersed and unplanned development along highways, or surrounding the city and rural countryside is often referred to as sprawl (Theobald, 2001). The concept of urban sprawl has been described by different scholars using major themes such as transportation sprawl (Madre, Berri and Papon, 2002 & Nechyba and Walsh, 2004), economic sprawl (Anas and Rhee, 2006) and geographical sprawl (Pirotte and Madre, 2011). Other writers have interpreted urban sprawl as resulting from increasing urban densities, land use and racial segregation (Powell, 2000 & Glaeser and Kahn, 2004) as well as population growth. From the foregoing, urban sprawl has been conceptualized as a non-contiguous and uncontrolled expansion of urban areas which is characterized by low density physical development and the non-existence of basic municipal infrastructure usually beyond the urban fringes. It can be explained as the expansion of human settlements to accommodate a growing population while depleting natural resources.

Urban sprawl is commonly used to describe physically expanding urban areas consisting largely of a pattern of low density expansion of large urban areas into mostly surrounding agricultural areas. Uncontrolled urban expansion into peri-urban farming communities can lead to diminishing yields and worsening food insecurity situations (Ifatimehin and Ufuah, 2006) especially in rural areas mostly at the fringes of rapidly growing urban centres. Thus, faced with the problem of sustainable agriculture mainly practised in the rural areas, there is a high rate of rural-urban migration propelled by economic development, which exacerbates the problem of food shortage and food insecurity particularly in the underdeveloped and developing countries (Odudu, 2003).

Since the creation of Akwa Ibom State in 1987, urban centres have grown in number and size. Uyo, the State capital in a bid to accommodate the high influx of people and satisfy their developmental needs has sprawled to surrounding suburbs leading to widespread changes in land use and land cover(Ekpenyong, 2008). This has given rise to the depletion of the natural vegetation. As the urban centre grows, continuous destruction of the natural vegetation has resulted, and this trend has continued for some years

now. In the past, effective monitoring of urban sprawl faced serious difficulties due to non-access to adequate information and appropriate technology (Ituen, 2007). But in recent times, the integration of Remote Sensing (RS) and Geographic Information System (GIS) has been widely applied and recognised as a powerful and effective tool in detecting the trends and rate in urban sprawl. Hence, in order to effectively monitor urban growth, it is not only necessary to have the information on existing Land Use Change (LUC) but also the capability to monitor the dynamics of land use resulting from both changing demands of increasing population and forces of nature acting to shape the landscape.

Uyo capital city, Akwa Ibom State is situated in the tropical rainforest belt. The area was once evergreen with a variety of tropical trees; today those species cannot be seen anymore. Few of these trees found in the suburbs are either planted in homestead gardens or in abandoned farmlands. This shows that Uyo capital city landscape has been badly de-vegetated due to wide spread changes in land use. In specific terms, this environmental ill is as a result of lack of considerable checks on unprecedented expansion of Uyo city coupled with rapid growth in population since the creation of Akwa Ibom State in 1987. The astronomical increase in the construction industry has serious implications on human environment. Since Uyo urban had already been built up, people seek alternative means by transforming the outskirts originally covered by lush vegetation into sub urban residences. This uncontrolled expansion has resulted in altering the vegetation cover and thus reducing the spatial extent in agricultural land in the study area, thereby threatening the means of livelihood and food security. It is sufficient to say that more peripheral agricultural lands in peri-urban communities in Uyo capital city are converted to sprawl development while the remaining peripheral lands are intensively cultivated to augment the food needs of the large urban population. This may have direct impacts on food supply, and a serious threat, if the trend and projection of further encroachment in the near future are not visualized for proper policy making. Consequently, this research utilised a combination of Remote Sensing data and field survey in a Geographic Information System (GIS) environment to assess the trends and rate of urban sprawl as well as its consequences on peri-urban farming communities in Uyo capital city over a 30 year period (1986-2016). An understanding of this would aid in developing policies that would ensure sustainable use of land.

Study Area & Method

Uyo capital city which is the area under study consists of all the areas within a radius of 10 kilometres measured from Ibom connection (a major roundabout at the heart of the city) as shown in Figure 1. It was demarcated by Uyo Capital City Development Authority law, CAP 136 of 1988. The city limit incorporates parts of nearby Local Government Areas (LGA), such as Itu, Uruan, Ikono, Nsit Ibom, Ibiono Ibom and Ibesikpo Asutan. Uyo capital city doubles as the municipal council headquarters of Uyo LGA as well as the capital of Akwa Ibom State (Ofem, and Udida, 2014). The city became the State capital on September 23, 1987 following the creation of Akwa Ibom State from the erstwhile Cross River State. Uyo capital city lies between latitudes 4°58' and 5°04'N and longitudes 7°51'E and 8°01'E. It is bounded in the North by Ikono, Itu and Ibiono Ibom LGAs. In the East, it shares a boundary with Uruan LGA, while in the South it borders with Ibesikpo Asutan and Nsit Ibom LGAs (Figure 1). Uyo capital city is situated on an average elevation of 60.96 metres above sea level (Njungbwen and Roy, 2010). The city covers an area of about 214.31 square kilometres (Ofem and Udida, 2014). Uyo capital city is one of the fastest growing cities in Nigeria.

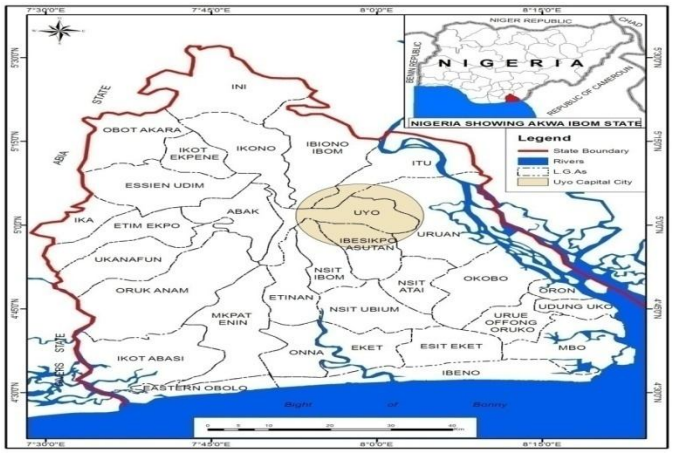

Fig. 1: Location of Uyo Capital City on the Map of Akwa Ibom State

In terms of vegetation, Uyo capital city is located within the tropical rain forest belt which is often evergreen in nature, and is characterized by tall trees and hard tropical woods with thick ground cover. However, urbanisation and unsustainable environmental practices have resulted in the disappearance of this ideal vegetation type. Few of the tropical trees striving in the suburbs are either planted in homestead gardens or in abandoned farmlands. The area is now in the state of modified rain forest locally known as the oil palm bush (Okon, 2008). This vegetation type is dominated by wild growing palm trees, tall grasses and secondary re-growth in abandoned farmlands for soil fertility restoration. Even this vegetation type is fast disappearing as it is constantly being cleared for road construction, building of houses and other land requirements of urbanisation. In fact, more than 70% of the vegetation has disappeared while the remaining 30% is found in small areas especially at the periphery of the city (Okon, 2008).

In terms of landuses, compound farmlands are common in the area and occupy a significant portion of the study area. The farmlands are characterized by annual farming with mixed and sequential cropping or monoculture (Ituen, 2007). This form of land use is found mostly in the Itu and Uruan axes of the capital city. Scattered trees including cocoa, oil palm, mango and papaya make up this land use type. The area is used for annual cropping with very short fallow periods. Crops planted include maize, plantain, yam, banana, cassava and sweet potato (Ituen, 2007). Built up area is another form of land use, this type of land use comprises of buildings example; residential, educational, industrial, commercial and so on. This land use pattern occupies a significant portion of the study area; this is due to the influx of population to the area. The land use class gain significance as a result of increase in population from low threshold settlements in Akwa Ibom State as well as other states in Nigeria. In terms of population, the 1991 population census revealed that Uyo capital city had a population of about 276927 persons. However, projections into the year 2016 showed that Uyo capital city population is about 642471 persons. Since the creation of Akwa Ibom State, Uyo city has continued to experience such high population growth rate. The initial urbanization of Uyo which concentrated around the city centre of what is today designated as the Ibom Plaza, has spread engulfing parts of surrounding local government areas like; Itu, Ibiono Ibom, Ikono, Nsit Ibom, Ibesikpo Asutan and Uruan. As the population keeps increasing the limit of Uyo capital city keeps expanding.

Remote sensing data were collected and analysed using Geographic Information System (GIS) to assess the trends and rate of urban sprawl. The trends and rate of urban sprawl were analyzed using satellite images for the years 1986, 1996, 2006 and 2016. These images were pre-processed and classified with the aid of Anderson's classification technique using supervised classification method. After this, the land use/land cover statistics that were obtained for the different time periods identified the changes that occurred by comparing the figures (in hectares) to obtain the trends and rate of change. Also, survey

design method and quantitative techniques were employed in data collection and analysis. This was done so as to gather appropriate information from respondents.

Literature Review

The complexity of urban systems makes it difficult to adequately address their changes using a model based on a single approach (Allen and Lu, 2003). Therefore, it is ideal to use a tool such as a GIS as part of research on urban sprawl because of its capacity to reveal the trend and rate of sprawl, as well as handle many different types of spatial data. A study conducted on the Washington-Baltimore Consolidated Metropolitan Statistical Area (CMSA) used a cellular automata model combined with historical maps in a GIS to determine where future development may occur (Clarke and Gaydos, 1998). The cellular automata model assumes an action within a given space, viewed in this case through a GIS grid, a set of initial conditions, and a set of behaviour rules (Clarke and Gaydos, 1998). GIS grid data layers were incorporated into IDRISI, GIS software, and iterations were performed to show different growth scenarios given different behaviour rules (Clarke and Gaydos, 1998). The same study was also able to use the GIS to produce maps of different growth scenarios, which allowed visualization of the results. A GIS will not only allow for powerful visualization of urban sprawl within the study area by providing maps, but it will also allow for an in depth analysis of the data by providing the capability to examine all of the data in one system therefore facilitating the measurement of urban sprawl.

A GIS is also an extremely powerful tool for creating new data from existing data and is often referred to as a decision support system (Burrough and McDonnell, 1998). In China, A GIS was used as a decision support system to test different development scenarios and land consumption parameters for use by planners and local government officials (Yeh and Xia, 1998). Using the neighbourhood function in the GIS, the researchers were able to test development scenarios that would reduce the fragmentation of new growth, a component of urban sprawl. In another study by the same authors, it was concluded that Landsat TM images coupled with an entropy integrated GIS was successful in measuring and monitoring urban sprawl patterns when the area is large and land use changes quickly (Yeh and Xia, 2001). In 1998, they employed a Shannon's entropy technique with the integration of remote sensing and GIS. Shannon's entropy is another landscape metric calculation technique whereby the authors measured urban sprawl patterns statistically based on the spatial variation and temporal changes of growth areas (Yeh and Xia, 1998). A numeric value was given to the new growth areas to quantitatively describe how dense and connected growth areas were (Yeh and Xia, 1998).

The methods used to quantify urban sprawl throughout the literature are dependent on the intended purpose and the individual aim of each piece of research. The objective of the research conducted on the Washington-Baltimore Consolidated Metropolitan Statistical Area (CMSA) was to relate observed changes in land cover to economic and demographic drivers of that change (Masek, Lindsay and Goward, 2000). They used historic and present-day satellite imagery to measure land use change, but it was unclear how the researchers were going to link those changes to economic and demographic data. The purpose of the study was to quantify and map urban growth thereby determining the geographic extent, pattern, and class of such growth over time. The researchers categorized satellite-derived imagery into three classes: developed, non-developed, and water. Then, a window technique was used within a GIS to analyse each picture element (pixel) according to its neighbouring pixels. The value of each pixel was added up and attributed to the centre cell of the window each time it passed over the study area. This is an extremely effective method to measuring urban growth patterns over time and therefore classifies that growth as urban sprawl.

In East and West St. Paul, Winnipeg, Manitoba, Canada, most urban sprawls were occurring on prime agricultural land (Hathout, 2002). In that study, a GIS was used to predict future growth patterns and the impacts that such growth would have on agricultural land. Hathout (2002) used the data base analysis

capabilities found in a GIS to analyze aerial photographs of the study area from 1960 to 1989 to determine impacts on agricultural land. For that study, land use derived from the aerial photographs in the GIS was placed in one of three main categories: urban, agriculture, and others (Hathout 2002). In South Carolina, a GIS-based integrated approach to modelling and prediction of urban growth in terms of land use change was employed to meet the challenge of studying urban sprawl (Allen and Lu, 2003). The researchers used satellite imagery incorporated into a GIS to map predictions of urban growth in the study area. The predictions were based on variables such as road density, forest, slope of the land, and population density. Each variable was entered into the system as a data layer and multiplied by a coefficient to determine how likely it was that a given parcel of land would be converted to urban land use (Allen and Lu, 2003).

In Nigeria, Zubair (2008) used GIS and Remote Sensing in monitoring settlement (built-up) growth in Ilorin between1972 and 2001 so as to detect the changes that have taken place between these periods. His main aim was to document the growth of Ilorin Township as obtained from satellite data and GIS between 1972 and 2001 and also predict the pattern of growth in same over a given period. Landsat data for three epochs were used in the study. Supervised classification was carried out to identify five land use and land cover types with particular emphasis on settlement. Subsequently, an attempt was made at projecting the observed growth in the next 14 years. In achieving this, Land Consumption Rate and Land Absorption Coefficient were introduced to aid in the quantitative assessment of the change. The result of the work showed a rapid growth in built-up land between 1972 and 1986 while the periods between 1986 and 2001 witnessed a reduction in this growth. It was also observed that change by 2015 may likely follow the trend in 1986 to 2001.

Additionally, Vanum and Hadgu (2009) analysed the urban sprawl dynamics in Greater Visakhapatnam for three temporal periods of 1975, 1990 and 2009 using GIS and Remote Sensing techniques in conjunction with Shannon's entropy. The sprawl pattern was mapped and measured from various viewpoints to identify the specific local factors which control the growth pattern in the study area. The study revealed that spatial growth of the city was restricted by physical barriers on the north, south and east. The city was growing along the southwest, northwest and northeast directions. The rate of land development was as high as 78% during a 35 year study period while the population growth rate was 26%. Thus the per capita land consumption had increased remarkably especially at the peripheral zones, a strong indicator of sprawl. The distribution of population density in various wards also justifies the above characteristics of sprawl – "dense core and dispersed suburbs". The higher entropy values at different points during the study period indicate high rate of sprawl even in early seventies and sustained throughout. Therefore, the entropy approach proved to be efficient in measuring and monitoring the spatio-temporal patterns of urban phenomena. According to Al-Dosary and Khan (2010) urban sprawl has turn out to be an issue of worldwide interest, mainly because of its alleged negative impacts on the social, economic and environmental aspects of the city. Many studies indicate that it is the pattern, density, and rate of new urban growth that lead to sprawl. The proportion of the total population in a region to the total built-up area of the region is a measure of quantifying sprawl. This paper presented a quantitative method to analyse urban sprawl based on computation of indicators and GIS techniques. It was found out that for the study area, the percentage change in the built-up area between 1980 and 2005 was 14 times higher than the percentage change in the population growth, and also, the analytical capabilities in GIS software determined the patterns and densities of new growth thereby classifying some of those areas as sprawl patterns.

Analysis of Data and Discussion of Findings

The status of land use/ land cover class distribution for the four decades 1986, 1996, 2006 and 2016 as derived from the analysis is presented in Table1 below.

Table 1: Inventory of Land Use/Land Cover Status

Land use/ cover	1986	%	1996	%	2006	%	2016	%
Thick Bush	9567.97	28.41	7974.18	23.68	5304.07	15.75	3547.98	10.53
Cultivated Land	8583.70	25.48	9092.33	26.99	8806.17	26.14	5662.53	16.81
Fallowed land	6830.70	20.28	5985.80	17.77	5197.75	15.43	4303.36	12.78
Built Up	8702.45	25.83	10632.51	31.56	14376.83	42.68	20170.95	59.88
Total	33684.82	100	33684.82	100	33684.82	100	33684.82	100

Note: Values represent land size in hectares
Source: Digitized data from Satellite Imageries (1986, 1996, 2006 and 2016) of Uyo capital city

In 1986, thick bush occupied 9567.97 hectares representing 28.41%, cultivated land 8583.70 hectares (25.48%), fallowed-land 6830.70 hectares (20.28%), and built up areas occupied 8702.45 hectares representing 25.83%. While in 1996 thick bush occupied 7974.18 hectares (23.68 %), cultivated land 9092.33 hectares (26.99%), fallowed-land 5985.80 hectares (17.77%) and built up areas occupied 10632.51 hectares (31.56%). Also, for 2006, thick bush covered 5304.07 hectares representing 15.75%, cultivated land occupied 8806.17 hectares representing 26.14%, and fallowed-land occupied 5197.75 hectares representing 15.43% and built up areas covered 14376.83 hectares representing 42.68%. In 2016, thick bush covered 3547.17 hectares representing 10.53%, cultivated land covered 5662.53 hectares representing 16.81%, and fallowed-land covered 4303.36 hectares representing 12.78% and built up occupied 20170.95 hectares representing 59.88%. The data in Table 1 are derived from the satellite imageries, shown in Figures 1 and 2 representing the base year 1986 and 2016 respectively. Owing to limited space, these two years are used for illustration. Figures 3 and 4 are pie charts showing the percentage distribution of land use/land cover in 1986 and 2016 respectively. However, with population growth being responsible for these changes, the implication is that land for cultivation would be lost and this may have direct negative impact on food security in the study area.

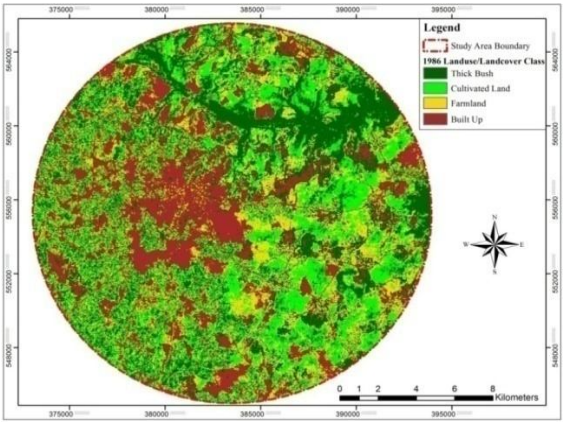

Figure1: 1986 Landuse/Landcover Classes.
Source: Classified Satellite Image of Uyo Capital City (1986)

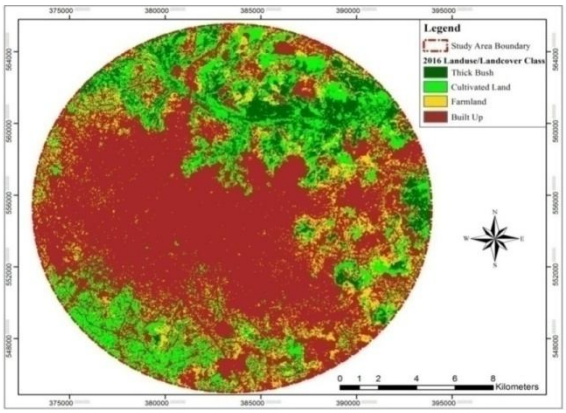

Figure 2: 2016 Landuse/Landcover Classes
Source: Classified Satellite Image of Uyo Capital City (2016)

From the analysis of satellite imagery of 1986, Figure1 the result of the image classification identified four land uses/ land cover classes as thick bush, cultivated land, fallowed land and built up. However, thick bush occupied 9567.97 hectares, cultivated land occupied 8583.70 hectares, and fallowed land occupied 6830.70 hectares and built up areas covered 8702.45 hectares. From this analysis, although all the land use/ land cover classes are of almost the same status conversely, it shows that thick bush was the only land cover that occupied the largest proportion of the study area while built up areas were sparsely distributed in its various positions but not so overwhelming. It is important to note that as at 1986 Uyo was not a state city. In 1996 the analysis shows that thick bush occupied 7974.18 hectares, cultivated land occupied 9092.33 hectares, fallowed land 5985.80 hectares and built up areas occupied 10632.51 hectares. This is a clear indication that the year 1996 marked the beginning of urbanisation in the study area, as thick bush and fallowed land gradually reduced due to the increase in urbanisation as built up areas increased to 10632.51 hectares occasioned by population increase in the study area. Also cultivated land increased to 9092.33 hectares as a result of interest in agriculture, perhaps to meet increasing demands of the ever growing population. In 2006, it is clear that thick bush covered 5304.07 hectares, cultivated land was 8806.17 hectares, and fallowed land occupied 5197.75 hectares while built up areas occupied 14376.36 hectares. The analysis shows that thick bush and fallowed land have drastically reduced as built up areas and cultivated land occupied significant portions of the study area. This shows that, these land use classes gained significantly as a result of increase in population in the study area occasioned by various interest towards land use. From the analysis of satellite image (Figure 2), it is clear that thick bush covered 3547.98 hectares, cultivated land covered 5662.53 hectares, and fallowed land covered 4303.36 hectares and built up areas occupied 20170.95 hectares. However, the result shows that Uyo capital city is going through changes at a faster rate as thick bush, cultivated land, fallowed land have drastically declined while built up is the only land use type that records an appreciable and continuous increase. This may be due to population increase through rural-urban migration and from other parts of the country and this serves as a major driver of land use change in the study area.

Table 2: Status of vegetation and built up (Urban Sprawl)

Year	1986	**A**	1996	2006	**B**	2016	**C**
Vegetation	24982.37	**193**	23052.31	19307.99	**374**	13513.87	**579**
Built up	8702.45	**193**	10632.51	14376.83	**374**	20170.95	**579**
Total	33684.82		33684.82	33684.82		33684.82	

Note: Values represent land size in hectares. **A=** Average Yearly Built up from 1986 to 1996;
B= Average Yearly Built up from 1996 to 2006; **C**= Average Yearly Built up From 2006 to 2016
Source: Digitized data from Satellite Imageries (1986, 1996, 2006 and 2016) of Uyo capital city

From Table 2 above, the spatial extent to which vegetation has been taken by urban sprawl in the study area is considered from the total coverage extent being 33684.82 hectares minus(-) the current year 2016 being 20170.95 hectares. Thus, the remaining portion of vegetation is 13513.87 hectares. However, the average yearly built up from 1986 to 1996 was 193 hectares, and from 1996 to 2006 was 374 hectares as a

result of an increase in demand for housing by the increasing population while from 2006 to 2016 the expansion of built up continued at the rate of 579 hectares per year. Thus comparing the current average yearly values with the past two decades, it can be inferred that the built up is on the increase in the study area.

Land Cover/ Land Use Change Detection

With reference to Table 3 below, it is clear that between 1986 and 1996 the first 10 year period of the study, thick bush changed by -1593.79 hectares while cultivated land gained by 508.63 hectares, fallowed land decreased by -844.9 hectares and built up changed to 1930.06 hectares. However, changes between 1996 and 2006 indicate that thick bush decreased by -2670.11 hectares; cultivated land went down by -286.16 hectares, fallowed land reduced by -1632.95 hectares while built up increased by 3,744.32 hectares. For changes between the year 2006 and 2016, it is revealed that there is a reduction in thick bush by -1756.09 hectares, cultivated land reduced by -3143.64 hectares and fallowed land lost -1632.95 hectares, while built up increased to 5,794.12 hectares. On the overall trend of changes between the base year 1986 and 2016, thick bush reduced by -6,019.99 hectares, cultivated land reduced by -2,921.17 hectares, fallowed land lost -2,527.34 hectares, while built up (urban) increased by 11,468.5 hectares.

Assessment of the Trends and Rate of Change

With reference to Table 4 below, this shows the percentage change and the annual rate of change that occurred between 1986 and 2016. It is clear that between 1986 and 1996 the first 10 year period of the study, the percentage change that occurred in thick bush was 32.68% and decreased at annual rate of 3.27%, cultivated land increased by 10.43% at an annual rate of 1.04%, while fallowed land lost by 17.32% at an annual rate of 1.73% and built up increased to 39.57% at an annual rate of 3.96%. Change between 1996 and 2006 indicates that thick bush decreased by 35.66% at 3.57% annual rate of change, cultivated land went down by 3.82% at 0.38% annual rate of change, fallowed land which reduced by 10.52% at an annual rate of 1.05% while built up increased by 50% at annual rate of 5%.

Table 3: Landuse/Landcover Change Detection

Classes		Thick Bush	Cultivated	Fallowed	Built Up	Total
Change between 1986	1986	9567.97	8583.70	6830.70	8702.45	33684.82
& 1996	1996	7974.18	9092.33	5985.80	10632.51	33684.82
	Change	-1593.79	508.63	-844.9	1930.06	4877.38
Change between 1996	1996	7974.18	9092.33	5985.80	10632.51	33684.82
& 2006	2006	5304.07	8806.17	5197.75	14376.83	33684.82
	Change	-2670.11	-286.16	-788.05	3744.32	7488.64
Change between 2006	2006	5304.07	8806.17	5197.75	14376.83	33684.82
& 2016	2016	3547.98	5662.53	4303.36	20170.95	33684.82
	Change	-1756.09	-3143.64	-1632.95	5794.12	12326.8
Overall Change	1986	9567.97	8583.70	6830.70	8702.45	33684.82
between 1986 & 2016	2016	3547.98	5662.53	4303.36	20170.95	33684.82
	Change	-6019.99	-2921.17	-2527.34	11468.5	22937.00

Note: Values represent land size in hectares

Source: Digitized data from Satellite Imageries (1986, 1996, 2006 and 2016) of Uyo Capital City

For changes between the year 2006 and 2016, the study shows a reduction in thick bush by 14.25% at an annual rate of 1.43%, cultivated land also reduced by 25.5% at 2.55% annually, and fallowed land reduced by 13.25% at 1.33% annually, while built up increased to 47% of the total change at an annual rate of change of 4.7%. On the overall trend of changes between the based year 1986 and 2016, thick bush reduced by 26.25% at an annual rate of 2.63%, cultivated land reduced by 12.74% at 1.27% rate annually and fallowed land reduced by 11.01% at 1.10% annual rate, while built up increased by 50% at annual rate of 5%.

Table 4: Assessment of the Trends and Rate of Change

Classes	Thick Bush	Cultivated	Fallowed	Built Up	Total
Change between 1986 & 1996	-1593.79	508.63	-844.9	1930.06	4877.38
% Change 1986 & 1996 (Trend)	32.68	10.43	17.32	39.57	100
% Annual Change 1986 & 1996 (Rate)	3.27	1.04	1.73	3.96	
Change between 1996 & 2006	-2670.11	-286.16	-788.05	3744.32	7488.64
% Change 1996 & 2006 (Trend)	35.66	3.82	10.52	50	100
% Annual Change 1996 & 2006 (Rate)	3.57	0.38	1.05	5	
Change between 2006 & 2016	-1756.09	-3143.64	-1632.95	5794.12	12326.8
% Change 2006 & 2016 Trend)	14.25	25.5	13.25	47	100
% Annual Change 2006 & 2016 (Rate)	1.43	2.55	1.33	4.7	
Overall Change between 1986 & 2016	-6019.99	-2921.17	-2527.34	11468.5	22937.00
% Change 1986 & 2016 (Trend)	26.25	12.74	11.01	50	100
% Annual Change 1986 & 2016 (Rate)	2.63	1.27	1.10	5	

Note: Values represent land size in hectares
Source: Digitized data from Satellite Imageries (1986, 1996, 2006 and 2016) of Uyo Capital City

Effects of Urban Sprawl on Uyo Capital City

The effect of urban sprawl on Uyo capital city was investigated. Respondents were asked to indicate the major effects of urban sprawl in their villages. Table 5 shows the effect of urban sprawl on Uyo capital city as reported by the respondents. Out of the 390 sampled respondents, 25.3% claimed that urban sprawl leads to loss of farmland in their villages, 9.3% claimed it leads to diminishing or reduction in crop yield, 7.4% said it leads to loss of means of livelihood as many of the residents (respondents) may have been cultivating the farm lands and depending on the farm proceeds as their major means of livelihood, while 4.0% observed high cost of living as the major effect of urban sprawl in the villages. 6.5%of the respondents also observed damage to environment as a result of urban sprawl. The table also shows that 21.1% of the respondents observed that the major effect of urban sprawl is development of erosion and flooding in the area while 26.3% observed that urban sprawl leads to forest depletion with its attendant effects on environmental protection and safety. From the analysis of the satellite imagery, it was revealed that thick bush decreased continually in every decade, with the highest decrease of -2670.11 hectares (35.66%) between 1996 and 2006 possibly due to the fact that the period marked the beginning of the present democratic dispensation where a lot of wealth circulated that led to massive construction of both private and public infrastructure to take care of the people's needs of course the situation was further worsened by the fact that, politicians influenced the land use for their personal gains.

Table 5: Effects of Urban Sprawl on Uyo Capital City

Villages	LF	DCY	LML	ICL	DTE	DE/F	FD	Total
Afaha Etok	46	13	12	3	6	46	48	174
Afia Nsit no.1	9	3	2	1	2	9	9	35
Eniong	149	60	49	31	35	142	145	611
Ifa Ikot Ubo	8	0	16	4	1	16	18	63
Ikot Ebido Oku	24	21	8	7	23	31	11	125
Ikot Obio Ama	16	3	2	1	3	6	16	47
Ikot Udo Ekop	9	3	3	0	2	9	19	45
Mbiabam	7	2	2	2	1	1	7	22
Mbierebe Obio	74	19	4	5	14	14	74	204
Nung Udoe Ediene	14	4	4	1	2	14	14	53
Okobo Ibiono	4	5	4	2	4	13	14	46
Total	360	133	106	57	93	301	375	1425
Percentage (%)	25.3	9.3	7.4	4.0	6.5	21.1	26.3	100.0

Key LF = Loss of farmland, DCY = Diminishing crop yield, LML = Loss of means of livelihood,
ICL = Increasing cost of living, DTE= Damage to Environment,
DE/F = Development of erosion/flooding, FD = Forest depletion
Source: Field Survey, 2016

Also, cultivated land gained 508.63 hectares of land in the first decade and subsequently lost in the remaining two decades of the study perhaps due to abandonment of agriculture for politics and other occupations. Fallowed-lands also recorded negative trend (change) by -2527.34 hectares (11.01%) at annual rate of 1.27% on the overall trend of changes between 1986 and 2016, this cannot be disputed as the hitherto fallowed lands are converted to build environment to accommodate the population increase.

For instance the population of 1986 as determined by extrapolation method was 77521 people and in 1991 population census Uyo capital city population was 276927, but currently the number of people has increased to 642471 as determined by 2016 projected population calculation. The progressive increase in Built-up (urban) from 25.83% of the entire study area in 1986 to 59.88% in 2016 implies that a vast vegetative cover in the study area was being converted to urban land. This is due to factors such as rapid population growth as a result of migration from other areas to the study area for greener pastures. In an attempt for the massive population to be accommodated, since the planned urban areas cannot carry them or become too expensive to secure, they seek alternative means by transforming the outskirts originally occupied by vegetation into a sub urban residence. The graphical representation indicates that in the years between 1986 and 1996, the land mass taken up by urban sprawl and vegetative cover were almost equal. But in subsequent years, urban sprawl (built-up) increased across the years and got to the peak in 2016. If the trend is allowed to continue in the next few years there will be no or very little vegetative area in the study area.

Conclusion & Recommendations

This study assessed the trends and rate in urban sprawl between 1986 and 2016, and its consequences on vegetation in the study area. The study established that urban sprawl is a serious problem and life-threatening in agricultural areas of Uyo capital city, and must be reduced. The study established that several factors led to urban sprawl on agricultural land in the city; the increase in population which therefore increases the demand for housing construction to meet the needs of the population as well as the propelling growth in economic activities. The study also established that urban sprawl was significant in influencing the variance in the vegetation of the study area and that there is significant variation in the vegetative land area available in the study area due to urban sprawl when comparing 1986 with 2016. It is therefore logical to conclude that urban sprawl has affected agricultural lands in the study area negatively. To avoid the attendant problems emanating from urban sprawl on vegetation it is important to organize our use of land, such that economic activities, buildings, roads and other land uses secure maximum economy and convenience, which would be conducive for the populace. Meaning that, land uses need special arrangements so that people could live conveniently, secured and at the same time maintain a beautiful environment devoid of chaos for us to have a desirable environment. The result of the study has revealed that the status of the land use and land cover of 2016 has changed significantly from what it was in 1986, hence, there is need to regenerate secondary vegetations in the study area. This could be achieved practically through tree planting and re-afforestation. It is also revealed that the rate of urban sprawl in the study area is on a rapid increase. Nevertheless, with rapid increase in human population, there is going to be continuous increase in urban sprawl in the study area. This has raised alarm on future threat in vegetation of the area. As such, the use of bungalow should be discouraged and government should support storey buildings to reduce space used for building per person since more people are likely to build on this fixed land area in the future. Besides encouraging vertical development to conserve horizontal space, the physical development agency of government should introduce integrated agricultural landscape schemes such as planned urban farming, urban forestry and greening the city.

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OPERATION AND ENFORCEMENT OF ON-STREET PARK-AND-PAY IN WUSE II DISTRICT, ABUJA

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Abstract
The on-street park-and-pay strategy adopted in 2012 by Federal Capital Territory Abuja has resulted to reduction in road width leading to constricted road carriage capacity causing delay and prolonged journey time for motorists. The study identified the existing land uses, building distributions and compiled an inventory of parking demand on each land use with a view to get public perception on the effectiveness of the on-street park-and-pay operation in managing the parking demand. The study adopted descriptive research method and questionnaire survey, on the perception of on-street parking. Data collected was analyzed using descriptive and inferential statistical. The finding revealed that the on-street parking is effective in managing parking at the designated parking spaces though; the operation lacks legislative backing. It is generally established that effective parking management should be seen beyond revenue generation and implementation of the park-and-pay strategy has a multi-functional effect on urban parking management, socio-economic, environmental quality and standard of living of the residents. This study recommends that on-street park-and-pay operation be re-adopted, maintained and backed by required legislation for a functional Federal Capital City.
Key words: On-street parking, Park-and-pay, enforcement

Introduction

One of the greatest concerns of transportation planning and management is the conduct of the road users and the way transportation facilities are used to enhance smooth traffic flow (Bekir and Surhid, 1997)as also observed by Ukpata and Etika (2012); Takyi, Kofi and Anin (2013). Parking is a component of transport facilities which needs to be used as a management tool to achieve an inclusive and functional circulation system. Every car on the road requires parking space as an origin for the next travel or the destination to end a travel. This makes parking management an indispensable aspect of transportation system. Failure to effectively manage the available parking facilities especially in urban areas results in obstructions and chaos, the resultant effect being decline in aesthetic quality and functionality of such areas. The challenges posed by the rapid expansion of development and population in Lagos city when it was the Federal Capital of Nigeria, necessitated the creation of Abuja as the new Federal Capital. The new capital was conceived when Lagos was plagued with traffic grid locks. However, today similar problems have emerged in the federal capital territory Abuja in spite of the heavy investments in road networks across the Federal Capital City (FCC). It is on this backdrop that this study was carried out to assess the on-street park-and-pay operation and enforcement strategy in solving the traffic flow within the built up Wuse II district area.

In an attempt to solve the parking problems, the FCTA redesigned the road width and provided on-street parking lots which led to the introduction of the Abuja on-street park-and-pay strategy as a parking management option. However, the FCTA was flooded with series of petitions and litigations on the legality regarding its on-street parking operations (Puma, 2014). Consequently, a Court Order was granted for the suspension of the operation. Shortly after, counter-agitations were expressed by a group of residents, about their concerns on the perennial traffic congestion caused by unlawful parking and the resultant effects earlier stated, thus prolonging journey time within Abuja metropolis. They therefore requested for the reintroduction of the park-and-pay operation. Currently, no specific parking intervention is in effect even as undesignated and unlawful parking contributes to parking challenges within the study area and the FCC. This therefore, necessitated the need to determine whether the operation was effective

and deserves to be readopted, using Wuse II district as a study area. The study aimed at determining the impact of on-street park-and-pay operations in managing parking in Wuse II. The objectives to achieve this aim are to: verify existing land uses and building distributions within Wuse II; compile an inventory of parking demand by each land use; and assess public perception on the effectiveness of the on-street park-and-pay operation in managing parking demand in the study area.

The concept of on-street park-and-pay operation

The "Abuja on-street Park-and-Pay operation" was introduced by the Federal Capital Territory Administration (FCTA) in May, 2012, through a guideline framework drafted in March 2010 (All Nigeria, 2012; Mohammed, 2015). The guideline was conceived from the second objective of the land transport operation policy for the Federal Capital Territory (FCT) which states that "to integrate transport modes and services to encourage complementary and seamless travel, public/ private partnership should be encouraged in providing integrated transport infrastructure, electronic ticketing and payment system". In order to keep the scheme running effectively, the following were to be implemented:

i. All operatives of parking concession should be informed and courteous.
ii. The on- street parking payment should be e – ticketing and integrated with other transport modes of payment FCT.
iii. The concessionaire should not clamp any vehicle without giving a grace period of less than 10 minutes.
iv. Vehicle should be towed from the bay only after being clamped for two hours.
v. Parking payment must be displayed appropriately.
vi. All signage must be approved by the secretariat before production.
vii. All road markings, signage installation must be done only with the permission and supervision of the secretariat.
viii. All field operators must be properly kitted with name tag displayed.
ix. Parking is prohibited on the portion between the end of a property (demarcated or not demarcated) and road kerb.
x. The concessionaire complaint desk must be linked with the secretariat
xi. No parking bay should be marked around fire hydrant
xii. Diplomatic vehicles must be respected at parking bays
xiii. Trucks and tankers are not allowed on parking bays
xiv. No concessionaire should charge parking fees, fines and penalty above the approved charges. (Federal Ministry of Transport, 2010).

The strategy was initiated and introduced as a dual-pronged traffic management solution, first to ease the rather constant vehicular gridlock and second, to serve as a revenue stream for Government (Onyekwere, 2015). The Park-and-Pay operation has come under a lot of criticism that led to its suspension in May 2014 by a Court order on the strength that it was not supported by any legal instrument for its operation (Ochela, 2014; Spotlight Reports, 2014). In line with the spirit of the operational guideline, it was made mandatory for all vehicle owners to pay stipulated fees between the hours of 7am to 7pm (Onyekwere, 2015). with a view to manage and order parking within the FCC, in line with Litman (2010) who explained that a commercial parking tax is a special tax on priced parking as a measure for parking management and control within locations with high demand for parking.

Plate 1: Parking Charges and penalties by the FCTA ; Source: Onyekwere (2014)

As noted earlier, the enforcement of the operation has since been suspended by a court order, due to complaints from members of the public that felt dissatisfied with its operation and management system. The Abuja Metropolitan Management Council (AMMC) and the Transport Secretariat of the Federal Capital Territory Administration (FCTA) are constantly under immense pressure to manage the growing traffic that besieges the FCC especially during working days (Ochela, 2014; Spotlight Reports, 2014).

The Study Area and Methodology

Wuse II District is located within the Phase I area of the Federal Capital City (FCC) which is divided into five residential districts namely; Garki, Wuse, Maitama, Asokoro and Guzape districts (Figure 1). This is further located in the Federal Capital Territory (FCT) which is located at the geographical 'centre' of Nigeria, north of the confluence of the Niger and Benue rivers. It lies between longitude 6^0 45N - $9'^0$ 4'N and latitudes 7^0 29' E - 6^0 45'E. Wuse II district is well developed with infrastructure (except for a few areas) and zoned with different densities (high, medium and low) and various landuses which seem to be increasingly tilting towards commercial activities due to inflow of people, most especially around WuseII area of the district, thus making it an area worth studying.

The study adopted descriptive research method and questionnaire survey.Data was collected between August and October 2015. Questionnaire questions were administered to vehicle drivers, while 25 field assistants were involved in collecting data. Observation was equally adopted to compliment the questionnaire as a means to determine the adequacy of on-site parking provided on the commercial and public buildings. The Preliminary survey carried out on Wuse II using the District land use map (2015) of the FCDA Transport secretariat as a guide, revealed that there are 2,066 on –street parking spaces. This attracts an average daily population of 2,435 on-street vehicular parking. This figure (2,435 parking car owners) was adopted as the study population. Two different models of sample size guidelines were adopted, these include Research advisors, 2006 used to sample on-street parking demand and the dwelling unit sampling table used to sample the parking demands by each dwelling/ building. These models helped to simplify the lengthy calculations in determining the sample sizes and the building types sampled for on-street parking demand. The 5.0%margin of error was adopted in this study to give latitude to varied opinions subject to human error in the perspective study of the effectiveness of the park-and-pay operation.

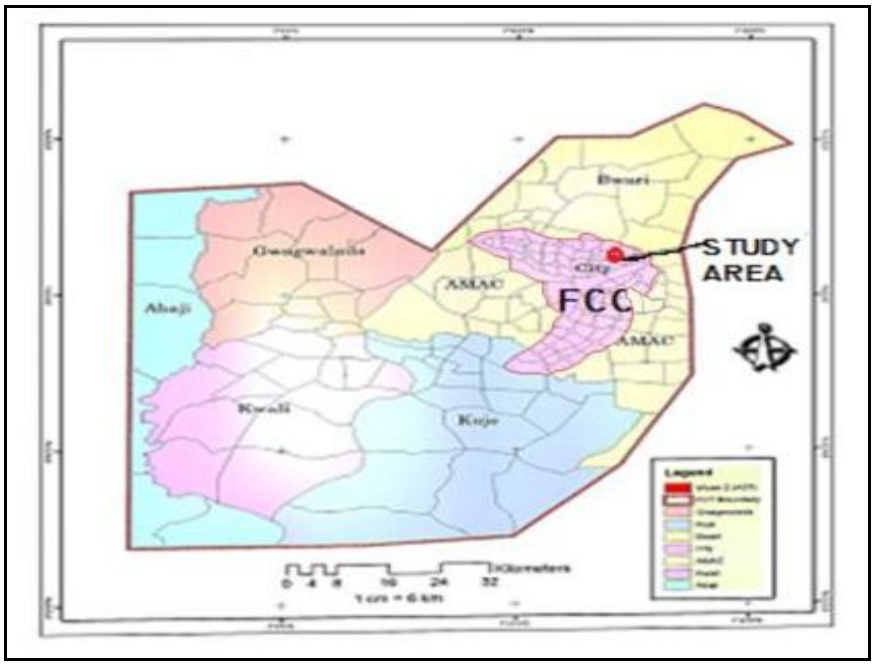

Fig 1: Map of FCT showing the study area
Source; AGIS 2015

The systematic sampling technique was adopted in sampling on-street parking demands while cluster sampling technique was used to sample dwellings to know the parking demand of various building types. The average daily number of on-street parkers as obtained from the FCDA transport Secretariat was used as the population size for this research; hence the sample size was determined in accordance with Research Advisors (2006). Average daily on-street parking demand of 2435 was considered as the study population. 333were adopted as the sample size with a 95% confidence interval and a 5.0% margin of error using the sampling table (Research Advisors, 2006); a total number of 333 copies of questionnaire were distributed using systematic sampling by administering the questionnaire after every 10th parker. A sampling table was used as a guide in sampling selection for buildings to obtain the daily parking demand of various building types/ land uses. A total number of 250 developed plots exist in the study area which attracts on-street parking; these buildings were clustered, with each cluster containing fifteen (15) buildings among which one was selected for sample to determine the on-street parking demand.

Research Findings

Figure 2 shows the land use and building use distribution map of the study area. Further examination shows that the study area has a total land mass of 230.738 hectares which is allocated to different land uses. The commercial landuse had 39.327 hectares which represent 17.04%, public use 5.91% (13.637 ha), residential landuse 50.73 % (117.061 ha) and circulation landuse had 25.80 hectares or 11.18% of total landmass. The residential landuse accounts for more than 50 % of the total landmass. Table 1 shows the landuse budget of the study area.

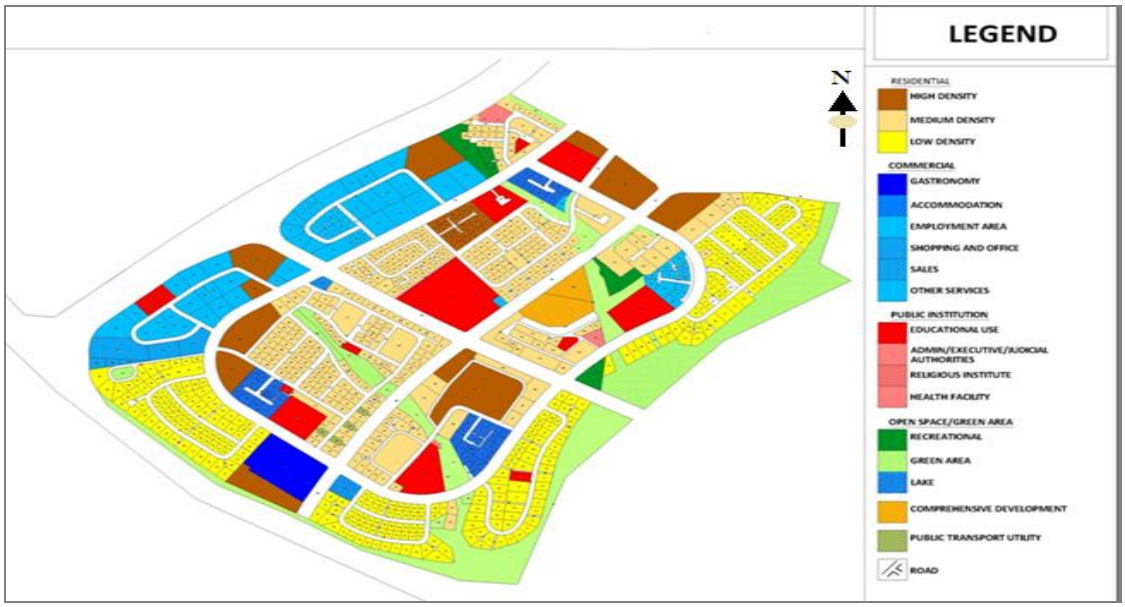

Fig 2: Land use map of Wuse II
Source: AGIS 2015.

Table 1: Land use distribution

Land Use	Size (M^2)	Size (Ha)	Percentage (%)
Public Use	136373.679	13.637	5.91
Open Space/Green Area	349176.112	34.917	15.13
Commercial	393277.400	39.327	17.04
Residential(High Density)	230939.510	23.094	10.01
Residential (Medium Density)	432241.444	43.224	18.73
Residential (Low Density)	507419.337	50.742	22.00
Circulation	.105	25.797	11.20
Total Land use	2,297,397.587	230.734	100

Source: Author's extract from AGIS Land use Map 2015.

On-street parking has been designed from the 11% allotted to circulation. This development has reduced the carriage way and vehicle-carrying capacity by 15 % and increased parking supply. Figure 3 shows the cross section of the on-street parking space designed from the circulation as a component of the land use.

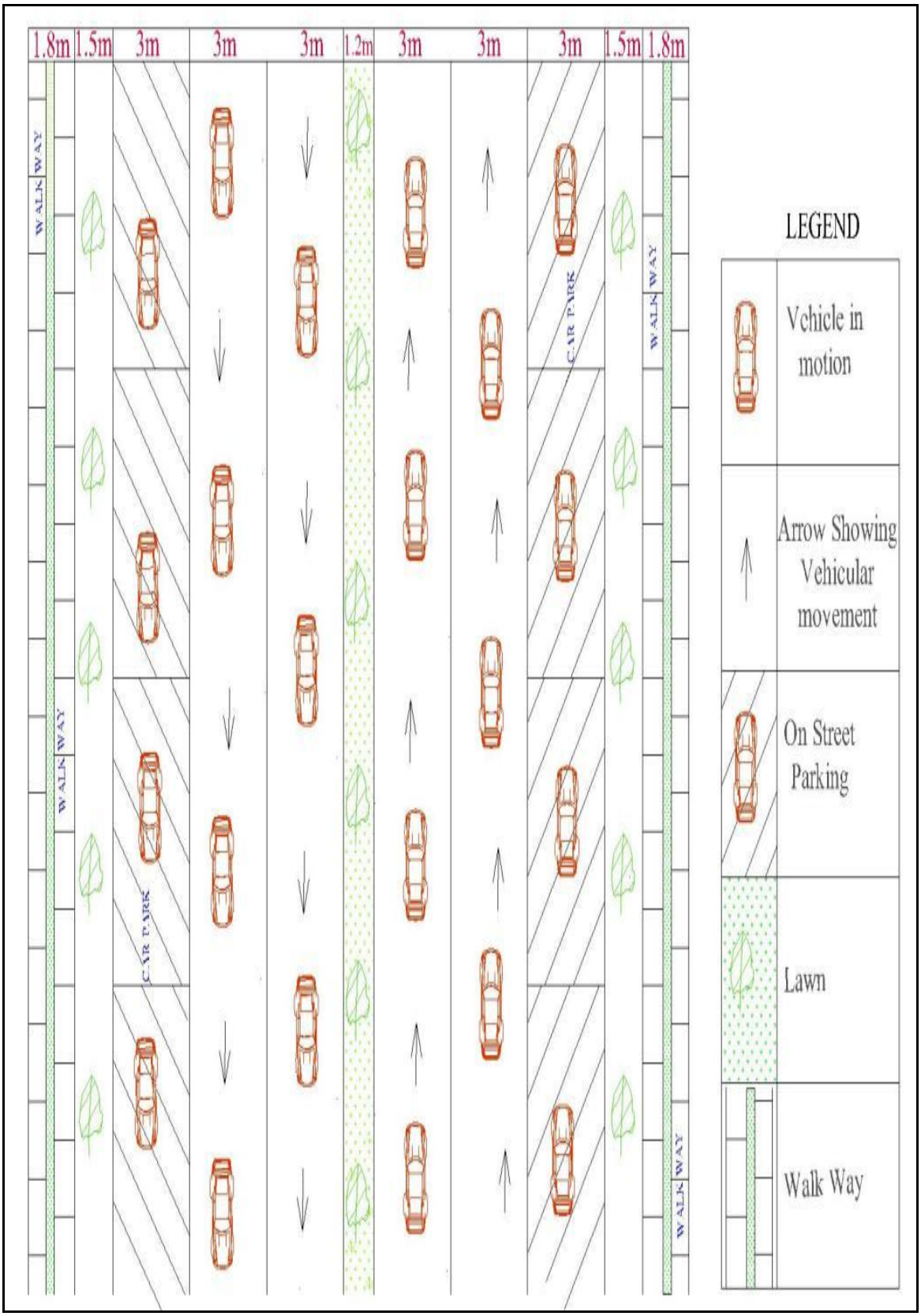

Fig 3: Horizontal cross section of Wuse II access showing on-street parking: Source; Field survey 2015

The inventory of parking demand in the study area shows that the commercial landuse attracts about 33.7% of the on-street parking (Table 2), although the commercial landuse occupies only about 17% of the total land mass of the study area as shown in Table 1.

Table 2: On-street parking demand from different landuses

Days	Commercial	Public	Residential	Educational	Recreational	Religious	Total	%
Mon	1,233	318	163	458	431	458	3,061	13.6
Tue	1272	324	230	587	447	997	3,840	17.1
Wed	1314	226	167	374	423	921	3,425	15.2
Thur	1157	398	266	513	440	1023	3,797	16.9
Fri	1295	956	427	539	417	1306	4,941	22.0
Sat	976	151	125	139	320	198	1,909	8.5
Sun	327	20	135	57	394	589	1522	6.8
Total	7574 (33.7%)	2393 (10.6%)	1513 (6.7%)	2667 (11.9%)	2872 (14.7%)	5492 (24.4%)	22,495	100

Source: Field survey 2015

The implication therefore, is that commercial land use constitutes a significant contributory factor to high parking demand in the study area. This is further buttressed by Figure 4 which shows the frequency of visits to the different land uses and the volume of parking demand.

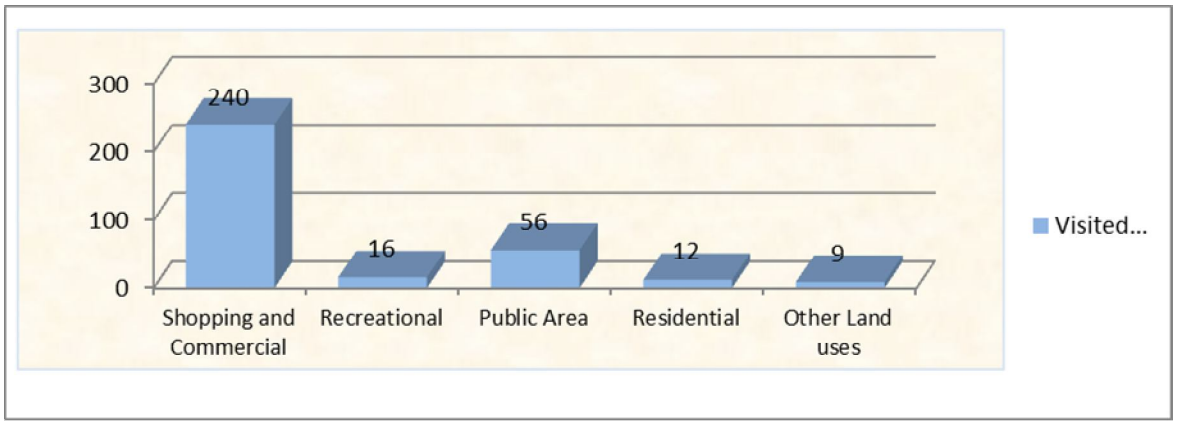

Figure 4: Volume of parking demands from different land uses
Source: Field survey 2015

It was observed that the active on-street parking space were located directly at the frontage of commercial and public buildings and drivers'/parkers' parking behaviour makes the available parking space around the buildings highly competitive, especially when they want to park in front of the buildings at all cost, thereby causing parking problems even when some of the spaces were not highly patronized to full capacity. Data on daily parking was collected for a week during and after the suspended operation as a unit to compare and determine the effectiveness of the on-street parking operation. Table 3 presents the on-street parking demands during and after the park-and-pay operation. The data presented in Table 3 shows a significant increase of on-street parking demand after the operation was suspended. The effect of the on-street park-and-pay operation was put to test in determining the level of significance the operation has on parking demand. The hypothesis to be tested was that no significant difference exists in on-street parking demand during and after the operation. This was subjected to the chi-square test which supported the claim that the park-and-pay operation has an effect in reducing parking demand since all the p-value across the days are < 0.05 which is enough to reject the null hypothesis that there is no significance difference during and after on-street park-and-pay operation (Table 4).

Table 3 On-street parking demand in Wuse II

Days	On-street parking demand during the operation (May, 2013)	On-street parking demand after the operation(Sept, 2015)
Monday	2,961	3,061
Tuesday	3,116	3,840
Wednesday	3,318	3,425
Thursday	2,726	3,797
Friday	3,511	4,941
Saturday	1,632	1,909
Thursday	714	1,522
Weekly Average	17,978	22,495
Daily Average	2,568	3,213

Source: Transport secretariat and Field survey 2015

Table 4: Chi Square Test

	Monday Observation	Tuesday Observation	Wednesday Observation	Thursday Observation	Friday Observation	Saturday Observation	Sunday Observation
Chi-Square	1.660577881	1392.946565	990.80868	175.8456	241.9427	21.66874	291.9785
Df	1	1	1	1	1	1	1
P-value	0.02	0.00	0.00	0.00	0.00	0.00	0.00

Source: Author's computation 2015

It was observed that unlawful parking was a major issue within the study area. Cars were parked on the pedestrian tracts, on utility lines, on carriage ways and at entrances. These compounded travel time, delay journey and obstructed the smooth running of the urban system. The fact that most commercial outfits within the study area had limited parking space to sufficiently accommodate their parking demands, the spillover parkers unlawfully parked outside the perimeter of the commercial outfit thereby causing parking and transportation issues. The study area witnessed a significant decline in the number of unlawful parking. This is evident in the parking trend during the period of enforcement of the operation (Figure 6).

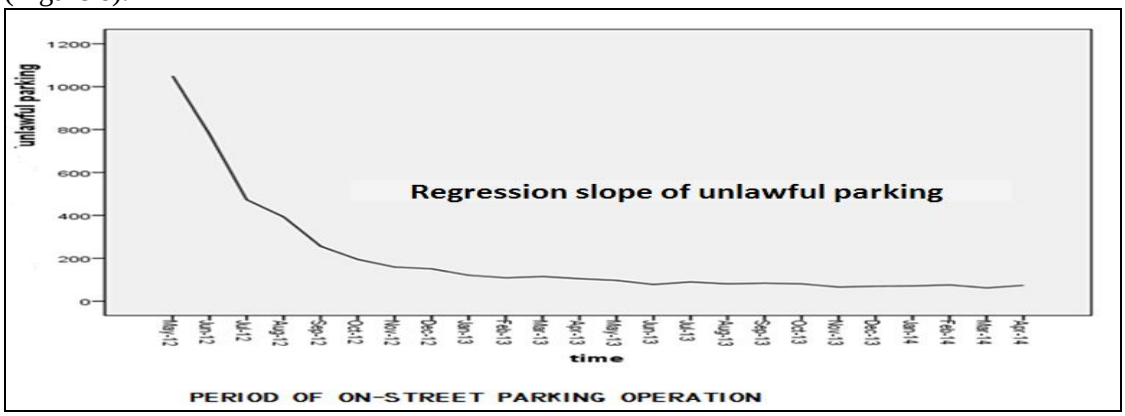

Fig 6: Unlawful parking trend during period of implementation
Source: FCDA Transport Secretariat and Author's computation 2015

Public perception on the effectiveness of the on-street park-and-pay operations

Majority of the respondents agreed that on-street parking operation helped in reducing unlawful parking, however, in terms of affordability, 48.3% of the respondents believed that the tariff/charges on parking were moderately affordable while 29.7% opined that the charges were not affordable. On the other hand, 21.9% felt that the charges were not only high but also exploitative (Figure 7). This implies that if the

tariff/ charges are reviewed, the operation would receive a greater level of acceptability and conformity to parking laws.

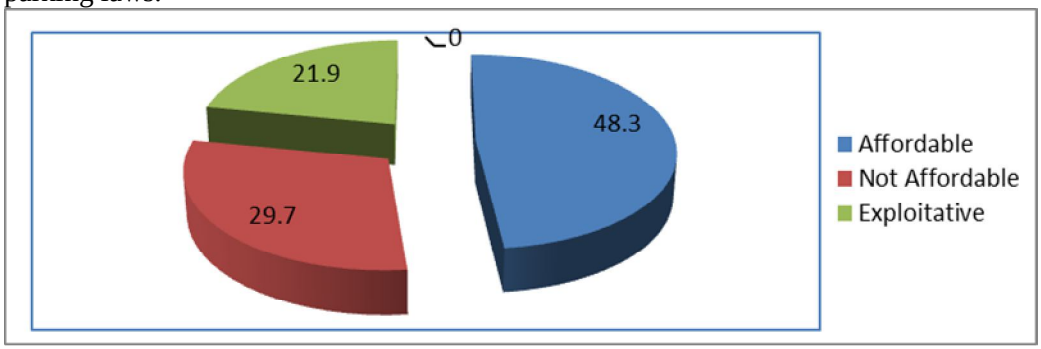

Fig: 7: Affordability of Park-and-Pay tariff/charges
Source: Author's Field Survey, 2015

Public opinion was sought using questionnaire on the effect of the on-street parking and based on the assigned ratings on a Likert scale, Majority (185 out of 333) of the respondents believed that the on-street parking management measure was efficient (Figure 8).

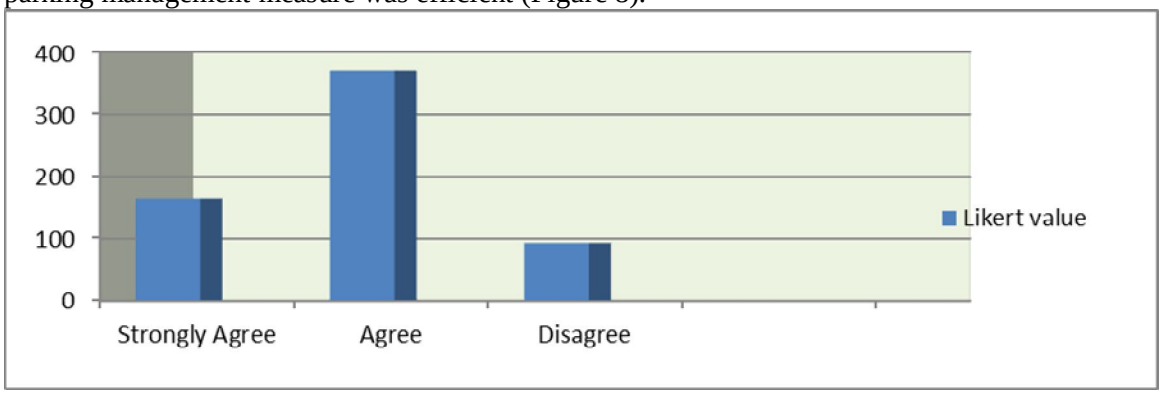

Fig 8: Public perception on the Effectiveness of park-and-pay strategy
Source: Author's Field Survey,

Issues arising from the suspension of the operation include an increase in unlawful parking and traffic congestion. 11% of the respondents experienced an increase in traffic congestion while 29% experienced increased unlawful parking. 59% observed an increase of both traffic and parking issues. This implies that the operation developed the correct attitude in the use of parking space, thereby enhancing urban functionality. The operational measure of clamping and towing away of offending vehicles (Plate II) were met with mixed reactions. While 47.4% of the respondents found it unsatisfactory and 25.8% finding it fairly satisfactory, 25.2% found the process completely unacceptable (figure 9).

Plate II: Clamping of Tires as an enforcement measure; Source: Authors field survey; Sahara Reporters (2013)

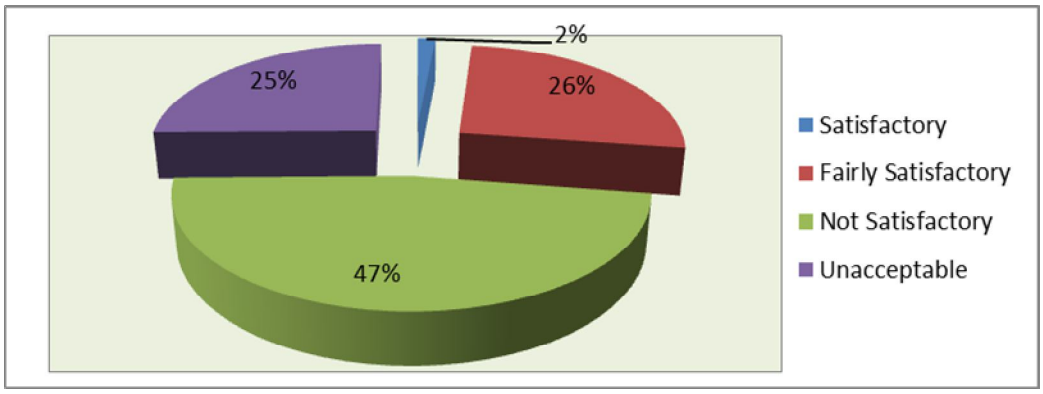

Fig 9: Respondents' reactions to Clamping and Towing of Vehicles; Source: Authors field survey, 2015

This is an indication that the operation of the park-and-pay parking management needs to be improved upon to achieve a higher degree of public acceptance, even though it helped to reduce spontaneous parking. A cross tabulation and comparative analysis of the perception of amount paid for the parking management operation showed that the lesser the amount paid for the on-street parking operation, the more positive their perception and acceptance towards the operation. Most respondents paying ₦150 regarded it as being exploitative, while respondents paying ₦100 had a negative disposition towards the parking operation. Only those paying ₦50 had a positive disposition towards the operation. Achieving more positive response will require reviewing the fare paid for parking. Having attested to the fact that the park-and-pay operation had led to increased car carriage capacity and decreased incidences of unlawful parking in both designated and undesignated areas of Wuse II, the respondents observed and appreciated the effectiveness of the operation as an effective management measure especially when considered for re-adoption (Fig 10). This indicates that despite the initial outcry for the operation to be discontinued, more people presently, welcome the strategy and are willing to conform to the laws if reviewed.

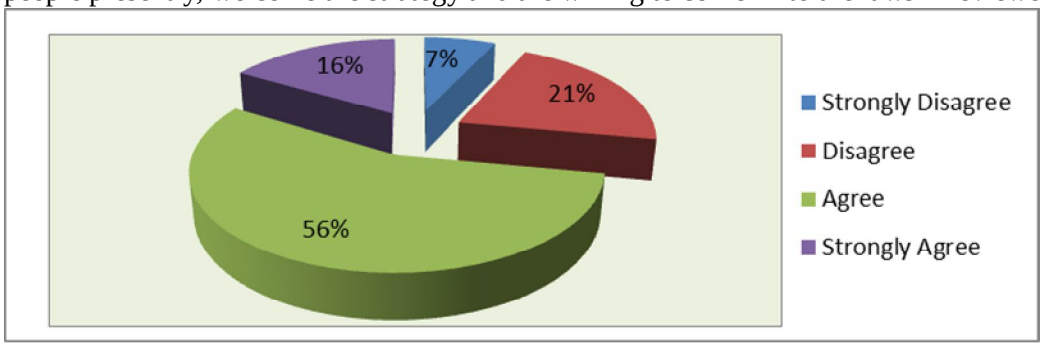

Fig10: Viability of re-adopting the on-street parking operation to manage parking.
Source: Author's Field Survey, 2015.

Within the first 30days of the implementation and enforcement of the parking management, records shows a 26% decline on the number of spontaneous sparking, subsequently 39% in the next month and afterwards there has been a progressive decline on the numbers of spontaneous parking issues. The number of spontaneous parkers apprehended also declined, thus indicating that the operation was effective in reducing spontaneous parking. The public perception on the effect of the on-street parking management compliments the findings from the transport secretariat. People experienced easier vehicular movement during the period of enforcement. While the enforcement was suspended, there was still some conscious effort to park correctly and the effect is still evident in some areas.

Conclusion and Recommendation

The Abuja on-street park-and-pay enforcement operation was an effective parking management option that should be seen beyond revenue generation. Its implementation had a multi-functional effect on urban parking management, socio-economic, environmental quality and standard of living of the residents of the FCC. The park-and-pay operation and its implementation is a public-private partnership (PPP) which relieves the government of the burden of managing parking amidst enormous responsibilities to citizens and gives opportunity to experts in the field to contribute to the urban transportation management system. The enforcement of the park-and-pay operation had reduced parking issues; thereby reducing externalities/cost on road users who have no intentions to park. Therefore, it seems pertinent that the park-and-pay operation be re-adopted for a functional Federal Capital City (FCC).

This study is intended to spur government and policy makers towards exploring more effective ways of managing urban infrastructure and challenges in the transportation sector, while reconsidering and reviewing strategies such as the park-and-pay strategy. This also calls for inclusive input from planners, academic/ research institutions and other stakeholders to develop sound planning policies. The on-street park-and-pay operations should be adopted with the required legislative backing. Parking tariff should be reviewed to meet the present urban economic realities and the parking supplies around the commercial area should be charged higher based on economic principles of the higher the price, the lower the quantity demanded. The enforcement measure of clamping and towing of cars to unknown designations due to expiration of parking tariff should be reviewed and car owners should be informed of their vehicles being towed through some form of alarm system or warning tickets as part of its operational measure. Existing parking space should be redesigned to accommodate articulated vehicles and parking facilities like lay-byes and drop- off zones. Provision of parking signs should be obvious to show areas of parking restrictions to avoid or minimize unlawful parking.

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MATERNAL MORTALITY AMONG RURAL DWELLERS IN ONDO WEST LGA NIGERIA

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Abstract
This study assessed the maternal health mortality among rural dwellers in Ondo West Local Government Area using questionnaire as a major tool for data collection. Seven (7) rural areas were identified out of which five (5) were sampled. Two sets of questionnaire were administered at the health centres; six (6) to health officials and another six (6) to women of reproductive age in the five selected rural areas. Findings from the study revealed that obstructed labour (90%), unsafe abortion (60%), and ignorance of the patient (90%), among other factors contributed to maternal mortality in the study area. On the basis of the findings, it is recommended among other things that the government at all levels should increase health education to improve knowledge of reproductive health issues among mothers especially in rural areas.
Keywords: Maternal mortality, health facilities, reproductive age, rural areas, Ondo State

Introduction

Maternal mortality has been defined as the death of a woman while pregnant or within 42 days of delivery, miscarriage or termination of pregnancy from causes related to aggravated pregnancy or its management, but not from accidental or incidental causes (WHO, 2007). Worldwide, over 500000 women of childbearing age die of complications related to pregnancy and child birth, each year over 99 percent of these deaths occur in developing countries such as Nigeria (United Nations Children's Fund,2008). Nigeria maternal mortality ratio continues at an unacceptable high rate. Rovston and Armstrong (1989) reported that maternal mortality ratio in Nigeria is 800 in 10000 live birth. With this figure, Nigeria account for 10 percent of the world's maternal death. Maternal mortality rate is twice as high in rural setting as they are in urban setting. Thus, Nigeria has one of the highest maternal mortality rates in the world, second only to India whose population is eight times larger than that of Nigeria. The trend in developing countries is much worse as studies from various countries of sub Saharan Africa indicate that maternal mortality has not only continued to be high, but is indeed increasing after the launch of the safe motherhood initiative (SMI) in Kenya in 1987 (Shah and Say, 2007). Women also die because of poor health at conception and lack of adequate care needed for the healthy outcome of the pregnancy for themselves and their babies.

The maternal health care system in Nigeria is pluralistic, characterized by orthodox, faith-based and traditional health providers. Maternal health care can also be obtained from itinerant medicine hawkers and patent medicine sellers. Some of these providers administer injections to women for a fee, sometimes in buses, markets, streets, and motor parks, with patients fully dressed. Spiritual healing, often involving the laying-on of hands, ingestion of materials that have been prayed over, holy water, oil, incantations and prayer, are prominent therapeutic options among women (Warriner and Shah;Omoruiyi, 2010; Abudulkarim and Mohammed, 2008). Spiritual or faith healing sometimes takes place during open-air rallies and religious crusades, which are often advertised in the mass media as opportunities for barren women to conceive, the bewitched to be freed, the blind to see, and the demonized to be exorcised (Fashola, 2009; Federal Ministry of Health, 2007).

The Federal Government of Nigeria is primarily responsible for tertiary-level care. It also formulates national maternal health policies and guidelines, oversees the standardization of maternal care delivery, trains health care providers, provides health-related technical assistance to states, monitors state-level implementation of national health policies and conducts disease surveillance, drug regulation and vaccine development and management (Lule, 2005). However, the current maternal health service delivery structure in Nigeria is fraught with many challenges. For instance, while primary maternal health care

(PMHC) is at the heart of the national health system, it is managed by local government authorities, which often do not have adequate resources to deliver it effectively. Unsustainable population growth also continues to exert pressure on the fragile maternal health care system at all levels of care (Myles, 2003). Low retention of skilled maternal health professionals, the poor quality of maternal healthcare coordination, weak referral and regulatory systems, and inadequate funding are other key challenges (Nigeria Partnership for Safe Motherhood-NPSM, 2003). Regional variations also exist in the distribution of formal maternal health facilities. For instance, while northern and rural areas of Nigeria host most of the public primary maternal healthcare facilities, the bulk of formal private medical facilities are located in the urban and southern parts (Faith, 2007; Graham, 2001; Halfan, 1999).

The services of private medical providers are often on a pay-before-service or cash-and-carry basis. Before treatment commences, care-seekers are often required to make cash deposits. There are regular reports of pregnant women dying at the doorsteps of private hospitals and clinics for failure to meet the deposit requirements or while their companions are still haggling over deposits (Lewis and Drife, 2001). When such deposits are exhausted, treatment is frequently withheld or women and their babies held hostage until additional payment is made (Izugbara, Wekesah and Adedini, 2016). For the public maternal health care system, Local Government Authorities, supported by the National Primary Healthcare Development Agency (NPHCDA), are responsible for the development, operation and provision of public primary healthcare (PHC) services. Local governments also oversee preventive maternal health activities, including community health education, hygiene and sanitation. While secondary care is the remit of state governments, several states also operate primary and tertiary maternal health facilities. States train health personnel and provide technical assistance in health matters to local government health programmes and facilities. States are also responsible for operationalizing national maternal health policies and enforcing guidelines for care in local governments.

In Nigeria, about 53% of the population lives in rural areas (Lissner and Wessman, 1998; Harrison, 2000). Women in rural settings are particularly at risk for poor maternal health outcomes, including maternal mortality and morbidity (Macdonal and Starrs, 2002). The maternal health challenges of rural women are heightened by the urban bias in the location of health facilities and the availability of skilled human resources for health (Ahman and Shan, 2004; Ajayi, 2004). Currently, rural Nigerian women utilize formal maternal health services much less than their urban counterparts (Omo-Aghoja, Aisien, Akuse, Bergstrom, Okonofua, 2008; Bennet and Brown, 2003; Delano, 1990; .Mojekwu, 2005). Only about 21% of rural women (compared to 29% in urban centres) have access to focused antenatal care (Parks, 2007; Rinehart, Rudy and Drennan, 1998). In 2013, while 84% of urban women sought antenatal care, only 47% of rural women did so. Rural women also use modern contraceptives less and have a higher incidence of abortion and severe complications from unsafe abortion than their urban counterparts. In 2013, only 6% of rural women in Nigeria used modern contraceptives, in comparison to 17% of urban women. In 2003, 26% of rural women compared to 22% of urban women sought care following an unsafe abortion presented with severe complications (Uzoigwe & John, 2004; Nwikpo, 1991; Rosenfied, 1999). Against this background, this paper assessed maternal health mortality among rural dwellers in Ondo West Local Government Area with a view to addressing the following questions: what is the level of accessibility of rural dwellers to healthcare in the study area? What is the major cause maternal mortality among rural dwellers in Ondo west local government? What is the nature of the relationship between maternal mortality and socio-economic attributes of rural dwellers?

The study area & methodology

Ondo is one of the major urban centres in Ondo State and the city is located on latitude 06°30[1] N and longitude 04°45[1]E. The city is bounded on the north by Oluji/Okeigbo Local Government, on the east by Idanre Local Government, on the west and south by Odigbo Local Government respectively. Ondo falls within the 'tropical wet and dry climate' with a relatively small dry season. Consequently, rainfall in

Ondo is seasonal in character with well-marked wet and dry seasons. The dry period comes between November and February, while the wet season lasts for 8 months from March to October; the mean annual rainfall is about 1615mm while the annual mean temperature is 27°C, with a maximum of 30°C.

Ondo landscape is made up of generally undulating hills of granite outcrop of igneous origin, and is marked by few dome-shaped hills. The hills are found to be developed over the basement complex of metamorphic rocks and their summits ranging between 250 and 500 metres above sea level (Akintola, 1982). The town has no major river; rather it is drained by several streams with fairly wide flood plains. Prominent among these streams are Luwa, Lisaluwa and Mode. The town falls within the moist/wet lowland forest i.e. it has thick forested vegetation, but due to human activities the original forest has been replaced with secondary re-growth. Currently, there are 12 political wards in Ondo city. The population of the town stood at 113900 persons during the 1991 population census and comprises of female population from the seven rural areas studied as shown in table 1.

Table 1: List of Villages and Population Composition in the study area

Names of rural areas in Ondo West L.G.A	Population of female
Laje	1387
Orisunmibare	1037
Litaye	339
Igbindo	1386
Babge	830
Ilunla	269
Araromi	136

Base on the population given above, it was projected to 2001 [i.e. 10 years' time] using 5% growth rate

Formula = $\left(\frac{projected\ growth\ rate+1}{100}\right)^n = \left(\frac{5}{100}+1\right)^n = (0.05+1)^n = 1.05^n$

$= 1.05^{10} = 1.6288946268$

Table 2: Female population in the study area

Locality	1991 Pop	Projected Pop
Laje	1387	2259
Orisunmbare	1037	1689
Litaye	339	552
Igbindo	1386	2257
Bagbe	830	1351
Ilunla	269	438
Araromi	136	221
Total	**5,384**	**8,767**

The Projected population of female for 2001 in the seven (7) rural areas of the local government was put at 8767 persons. Five (5) rural areas with the highest population were selected for the study and these include Laje, Orisunmibare, Litaye, Igbindo and Bagbe which together accounted for a total female population of 8108 persons. The primary source of data was the use of questionnaire. Questionnaire was administered to both the practitioner of the health centres and women of reproductive age in the rural areas to gather information on maternal mortality in the areas. Two set of questionnaires were administered at the health centres(six (6) to health officials and six (6) to the woman of reproductive age) in the five selected rural areas. Section A of the questionnaire consists of personal information of the entire respondent to elicit information of the respondent on the area of the rural area, age, education qualification and occupation while section B sought to elicit information on the causes of maternal mortality (health practitioner only), information about the way of their registration and accessibility of the health centres to their dwelling place (women of reproductive age only). Descriptive statistics and inferential statistics were utilized in the analysis of data.

Results and discussion

Socio-economic characteristics of the respondents

The findings established that age grade of 18-22 respondents was 9 in number, representing the 18% of the population as shown on the pie chart, age grade of 23-27 respondents was 7, representing 14% of the population on the pie chart; age grade of 28-32 respondents was 15, representing 30% of the population of the pie chart, age grade of 33-37 respondents was 10, representing 20 % of the population on the pie chart while the age grade of 38-42 respondents was 9, which represents 18% of the population as shown on the figure 1.

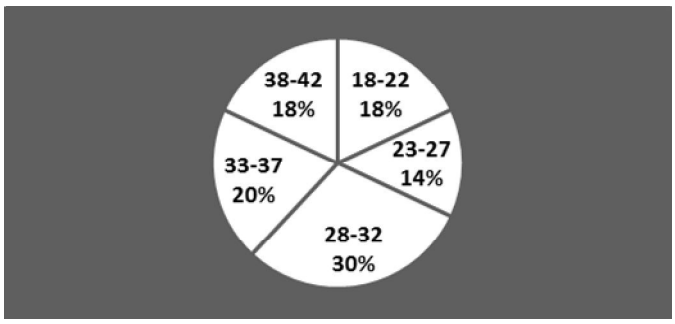

Fig. 1: Age grade of health workers

In terms of religion, the findings revealed that religion distribution of the respondents shows that Christians were 25 representing 50%, the Muslim were 22 or 44% of the respondents while the Traditionalists were 3 representing 6% of the respondents as shown in figure 2.

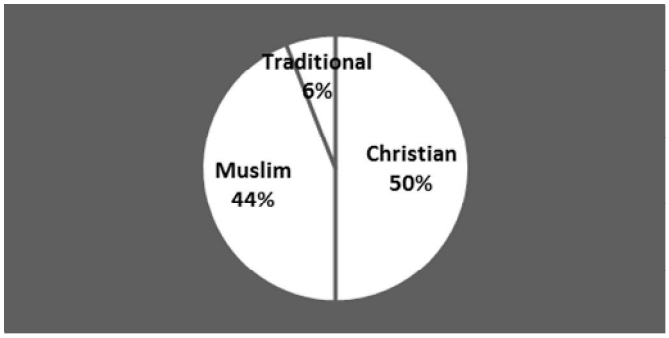

Fig. 2: Religion distribution of women of reproductive age

From fig. 3, the educational distribution of the respondents shows that primary education had 28 or 56% of the respondents while the respondents with secondary educational qualification were 22 (44%) with no respondent having the tertiary level of education.

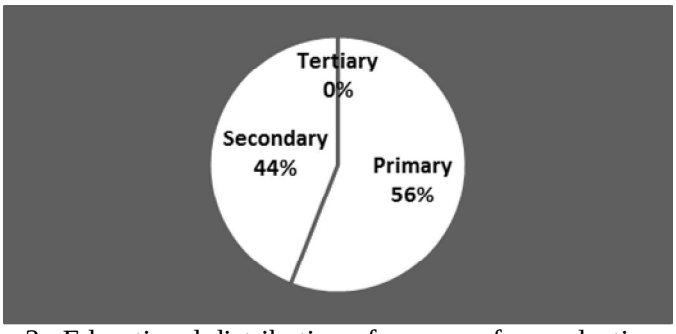

Fig. 3: Educational distribution of women of reproductive age

The occupational distribution of the respondents is displayed in figure 4 and it shows that more respondents were into trading businesses as it accounted for 32 or 62% of the women of reproductive age. The number of the respondents engaged in farming activities was 18 and this represented 35% of respondents while none of the respondent was in civil service employment.

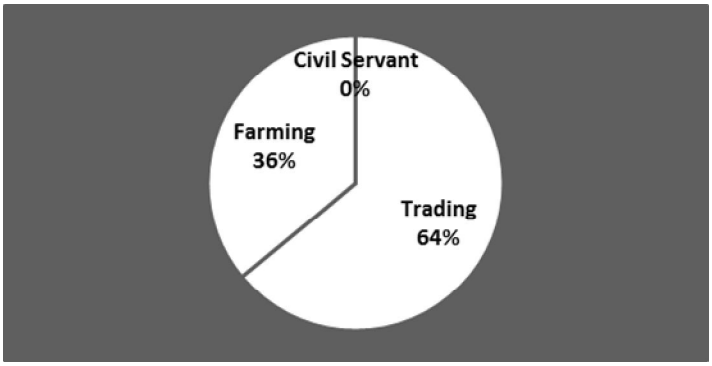

Fig. 4: Occupation Distribution of Women of Reproductive Age

Accessibility of Rural Dwellers to Health Centre

From the result as shown in Table 3, 74% of the population of women of reproductive age trek to the nearest healthcare centre while 18% do find it extremely impossible to access the health centre at any hour of the day. About 82% of the respondents find it easy to get to the nearest health centre at any hour of the day while 34% of the respondent agrees that distance is a barrier to accessing healthcare centres. About 34% of the respondents attributed poor access to healthcare centres due transportation costs while others (36%) attributed poor access to occupational activities.

Table 3: Accessibility of Rural Dwellers to Health Centre

Does rural dwellers have access to health centres (accessibility)	yes	%	no	%
Do you trek as means of transportation to the nearest health centre in your area?	37	74	13	26
Do you find it easy to get to the nearest health centre at any hour of the day?	41	82	9	18
Does distance serve as a hindrance for you to access health centre?	17	34	33	66
Does transportation serves as a barrier for you to access the health centre?	17	34	33	66
Does your occupation allow you to visit health centre frequently?	32	64	18	36

Causes of maternal mortality among rural dwellers in Ondo West LGA

From the table 4, 90% of the respondents agreed that ignorance on the parts of the pregnant women increases maternal mortality; they stated that illiteracy and ignorance are inseparable and identical twins. From the table, 80% of the respondents stated that malaria-in-pregnancy is a killer disease while 20% disagreed. This could be attributed to the poor quality of potable water supply in rural areas as well as the bushy and swampy areas characterized by stagnant water that breeds mosquitoes. This gave credence to the assertion of Rosenstock (1999) that Nigeria accounts for a quarter of malaria cases in the 45 malaria endemic countries in Africa. Another major cause of maternal mortality is obstetric hemorrhage in pregnancy; this is as a result of various infections that could lead to bleeding during pregnancy. Also, findings established that 60% of the respondents agreed that unsafe abortion can contribute to maternal mortality. Accordingly, this could be due to stress and strain on women. Pressing further 90% of the respondents agreed that obstructed labour contribute to maternal mortality while most of the respondents (70%) disagree with the fact that hypertensive disease increases the chance of maternal mortality. While 60% of the respondents said anemia and myles in pregnant women can cause maternal mortality, women that have had multiple births stand a chance of being a victim of maternal mortality. Malnutrition was also identified as a major reason for maternal death as it can lead to lack of blood which is occasioned actually by poverty. This is due to not eating the right type of food at the right time. It was discovered that

their meals were all carbohydrates (breakfast, lunch, dinner) such as yam, maize, cassava eaten in its various forms (Akpu, Garri, Tapioca) with little or no protein (egg, meat, fish, beans, milk etc). At the point of delivery such women would require blood transfusion of 1-3 pints of. Malnutrition is an effect of poverty and ignorance which leads to improper and inadequate feeding with its attendant effect on blood and low weight babies. About 30% of the respondents stated that it was evil spirit that caused maternal mortality among women while 70% disagree. Women with such ideas are mainly from the illiterate folk who tend to run from one native doctor to another and one prayer house to other in order to avert impending doom or to neutralize the effects of the enemies and the evil spirits. Also 40% of the respondent says traditional birth attendant causes maternal mortality while 60% disagreed.

Table 4: Causes of maternal mortality

SN	What are the causes of maternal mortality?	yes	%	no	%
1.	Ignorance on the parts of patient.	9	90	1	10
2.	Malaria in pregnancy	8	80	2	20
3.	Obstetric hemorrhage	7	70	3	30
4.	Unsafe abortion	6	60	4	40
5.	Obstructed labor	9	90	1	10
6.	Hypertensive disease	3	30	7	70
7.	Anemia and Myles	6	60	4	40
8.	Multiple birth	6	60	4	40
9.	Malnutrition	8	80	2	20
10	Evil spirit	3	30	7	70
11	Dependent on traditional birth attendants	4	40	6	60

Conclusion and Recommendations

The study concluded that Government should increase health education to improve knowledge of reproductive health issues among mothers. Many rural women are not even aware of the health care programme. Ignorance still persists among the rural women about their health needs and available solutions. It has been noted that malaria is a major killer of pregnant women in Nigeria. Maternal mortality is a plague that has hit the whole world. It hinders all round development of society. Maternal mortality does not only affect the immediate family of the victim but it hinders all round development of the society. To avoid this negative influence cause by maternal mortality, all hands must be on deck to reduce this natural phenomenon. Every year, more than 200 million women become pregnant, and at least 15% are likely to develop complications that will require skilled obstetric care to prevent death or serious ill-health (Rosenstock, Hochbaum,. and Kengel, 1999). Therefore, all women, whether their pregnancies are complicated or not, need good quality maternal health services during pregnancy, delivery and in the postpartum period to ensure their health and that of their infants. High quality maternal health services must be accessible, affordable, effective, appropriate for and acceptable to the women who need them. Based on the findings of this study, the following recommendations were made: Adults should be actively used in the awareness campaign programmes on maternal mortality. Health workers must be trained regularly to update their skills and knowledge for optimal practice. Government and community leaders should inform, educate and sensitize people on maternal health practices through the mass media. Increased funding of the health sector is absolutely essential. Husbands should allow their wives to attend antenatal clinic and to deliver in the hospital. Government should provide healthcare facilities with qualified health personnel and equipment in all communities. Equipping primary health centres for essential obstetric care should be of importance. Women empowerment programmes should be introduced to improve women economic and social status. This will reduce induced hypertension that most women experience during pregnancy. Local languages should be used during enlightenment campaign for the understanding of all adults, educated and un-educated in the communities. The LGs should be sensitized to show more political will and commitment to maternal health programmes in the State. The Local Government should be mandated to support maternal health care in the State.

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ENHANCED DECENTRALIZED WASTEWATER TREATMENT SCHEME FOR BUILDINGS IN CHALLENGING PERI-URBAN AREASOF NIGERIA

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Abstract
In peri-urban settlements of Nigeria, sewage management presents varied degrees of challenges, ranging from the use of pit toilets or defecation into watercourses in the rural areas, unregulated sewage disposal, high failure rates of septic tanks and soakaway pits, due to poor designs, and environmental challenges. Thus, the aim of this study is to assess and proffer solutions to the challenge of wastewater management in environmentally-challenged peri-urban areas of Nigeria. To achieve this, an experimental research was adopted; whereas, model design, operation and observation under a controlled environment, constituted the methods adopted. The modelled enhance DWTS for an environmentally-challenged setting, included an elevated toilet, a conventional septic tank, baffled septic tank or Activated Baffled Reactor (ABR), secondary settler and filter, and constructed wetland. The test, using the developed apparatus, entailed ensuring an optimal gravimetric flow of wastewater in pipes between the inspection chambers and in the treatment tanks, as expected in real-life situations. The result of this experiment is a colourless liquid that passed through activated sludge and carbon, and considered fit for watering of farms. The system can successfully serve a minimum of three 4-bedroom family units.
Keywords: Buildings; Decentralized Wastewater Treatment; Peri-urban; Septic Tanks; Soakaway Pits.

Introduction

Peri-urban areas of developing cities encompass both geographic and demographic features of the rural and urban world, and are often characterized by poor infrastructure, rapid population growth and a plethora of wastewater management challenges. Sanitation facilities in such areas include: borehole latrines that result in groundwater contamination, open channels as means of transporting wastewater to the nearest disposal point where it is sometimes used for agriculture or aquaculture – leading to food borne diseases and eutrophication (Brook & Davila, 2000). Nigeria being a developing country has so many peri-urban settlements in each of her states. Beside buildings that use pit toilets or latrines, in the peri-urban regions of Nigeria, majority of the considered urban sewage treatment units are the septic tank and soakaway pits. These basically anaerobically and anoxically treat the discharged soil and waste waters from sanitary units. However, they are not very suitable for areas with frequent flooding or with high water tables. More even, most developed countries of the world previously used the septic and soakaway pit systems before advancing into the use of the decentralized and centralized wastewater treatment systems that are very sustainable and helps to achieve the goal of resource reduction, recycling and reuse.

Considered as a remedial measure, the decentralized wastewater treatment system (DWTS) is now proliferating in some peri-urban cities of the world; yet, these systems are not suitable for challenging areas, which implies that their design must be location-specific. This position is consistent with the proposal by Tilley, Luethi, Morel, Zurbruegg, Schertenleib (2008), that *"since the tank is installed underground … it should not be installed in areas with high groundwater table or prone to flooding, as infiltration will affect the treatment efficiency and contaminate the groundwater"*. Further, United State Environmental Protection Agency (EPA) (2014) noted that *"these various types of decentralized wastewater treatment, if properly executed, can protect public health, preserve valuable water resources, and maintain economic vitality in a community"*. Hence, with good designs, this system can serve as a solution to the poor sanitation conditions of peri-urban areas. Within this context emerges the need to adopt an enhanced decentralized wastewater treatment system in peri-urban areas of Nigeria, and this study aims at filling this gap in application of the conventional DWTS technology in flood-prone areas.

The preliminary aspect of this project involves a full design of the DWTS, 3D modelling and testing of the system in the laboratory.

Review of Related Literature

Settlements are conventionally classified into rural and urban. However, a middle classification which is neither rural nor urban, but a hybrid of these settlement types, is called the peri-urban or quasi-urban settlement. To this concept, William, Steven and Eduardo (1993) considered the urban and Peri-urban as formal and informal. The authors further noted that the peri-urban or informal sector settlements constitute the squatter or marginal or illegal settlements, shantytowns, or urban slums, often characterized by poor or no infrastructure, low income, high population density, settlers building on cheap lands outside city limits, on lands within city limits that are not zoned for housing or considered dangerous or environmentally unsafe. The deprived state of these peri-urban areas unavoidably includes poor wastewater services and lack of these services in extreme cases. This inadequate human waste management poses great threat to public health and environment (William, et. al., 1993). Even as the problem of improper human waste disposal continues to plague the peri-urban dwellers, the situation is often compounded by the secondary factor of pollution from the uplands where upland settlers do not so much suffer the challenge of water logging of the environment. As inferred by Corcoran, et al. (2010), about 90% of all wastewater in underdeveloped or developing countries is discharged untreated, directly into water-bodies such as rivers, lakes or the oceans, leading to de-oxygenated dead zones in the rivers and seas. In addition, *"globally, two million tons of sewage, industrial and agricultural waste is discharged into the world's waterways and at least 1.8 million children under five years …, die every year from water related disease, or one every 20 seconds"* (Corcoran, et al., 2010, p.40). The major problem, therefore, is that most peri-urban dwellers settle around the shores of the waterways or in waterlogged areas, or other challenging environments.

Furthermore, a cognate study by Enrico, Isabel and Almud (2010, p.1) revealed that there are four major water-related challenging environments; these include: *"coastal and estuaries, rivers and riverbanks, swamps and high-water tables, and flood prone areas"*. The authors further noted that these challenging areas often have unplanned settlements with densely populated poor households that are generally beset by the absence or paucity of conventional or low-cost sanitation technologies, resulting in open defecation into water; use of polluted surface or groundwater sources for domestic activities such as cooking, bathing, washing, swimming, and others. One aftermath of this deplorable condition is the placement of higher value for clean water than proper sanitation (Enrico, et. al., 2010). In challenging peri-urban areas, there is then the major problem of achieving a functional system for a proper disposal of human waste. In such environmentally-challenged areas, conventional septic tanks and soakaway pits fail even during construction. High water table and flood, render such systems unusable in such areas. The decentralized wastewater system has worked in areas without water-related challenges, but failed in areas where the ground or surface water overwhelms the system. There is therefore the need to design a system that will adapt the features of a decentralized wastewater system and also function well in challenged areas. This entails elevating the toilet unit, conventional septic tank, baffled septic tank or Activated Baffled Reactor (ABR), secondary settler and filter, and lowering the constructed wetland(*Agence d'Aide à la Coopération Technique Et au Développement*, 2013; Decentralized Wastewater Treatment Systems, 2011; Environmental Engineering & Pollution Control Organization, 2014).

According to Tilley et al. (2008), the septic tank is a concrete watertight chamber for the storage and treatment of black and grey waters. In this chamber, solids and organics are settled and anaerobically degraded. The treatment performance at this stage (in the Activated Baffled Reactor chambers) is in the range of 65 - 90% COD removal, corresponding to about 70 - 95% of BOD (Sasse, 1998).Accordingly, the Anaerobic Baffled Reactor (ABR) is an enhanced septic tank, in that, it has series of baffles over

which the inbound wastewater is forced to flow, with an increased contact time with the active biomass (sludge) which results in improved wastewater treatment. In the Anaerobic Filter or biological reactor, as wastewater flows through the filter, particles are trapped and organic substances are broken down by the biomass that attach to the filter material. As noted by Tilley et al. (2008, p.71), in this chamber, *"suspended solids and BOD removal can be as high as 85% to 90% but is typically between 50% and 80%"*. The authors further noted that a constructed wetland or facultative pond is a series of flooded channels that aims to reproduce the naturally occurring processes of a natural wetland, swamp or marsh. The top layer of the pond receives oxygen from the atmosphere; whereas, the lower layer is deprived of oxygen and becomes anoxic and anaerobic. In this pond, the aerobic and anaerobic organisms work together to achieve BOD reductions of circa 75%. The pond should be constructed to a depth of 1 – 2.5m and have a retention time between 5 to 30 days (Tilley et al., 2008). Water from the pond is considered fit for watering gardens (Sasse, 1998). The better the treatment effect of the enhanced decentralized treatment system, the lower the fertilizing value of the effluent. It is noteworthy that as the treated wastewater can never be labelled*"guaranteed free of pathogens"*, irrigation of crops should stop two weeks prior to harvesting; even more, it is best practice not to irrigate vegetables and fruits using this partially-treated water, as vegetables and fruits are usually consumed raw (Sasse, 1998).

Research Methodology

The experimental research chosen for this study helped to understand the existing setbacks associated with using a conventional decentralized wastewater treatment system and the projected benefits of adopting an enhance DWTS in an environmentally-challenged setting. Thus, the paradigm of this research is positivism, being a quantitative research; whereas, the methods used to achieve the aim of this research were participant design, development and observation under a controlled environment.

Laboratory Modelling of the Enhanced Decentralized Wastewater Treatment Scheme

The first phase of the project is the two-dimensional (2D) design of the enhanced decentralized wastewater treatment scheme (EDWTS); this was achieved using AutoCAD software that is a Building Information Modelling (BIM) program (Figures 2, 3 and 4). The 2D design helped in detailing to precision, the requisite dimensions of specific components of the EDWTS for the three-dimensional (3D) modelling. The project components considered in this project include: an elevated toilet, a conventional septic tank, baffled septic tank or Activated Baffled Reactor (ABR), secondary settler and filter, and constructed wetland. The three-dimensional modelling of the project was heralded by a careful selection of specific materials for each component. These materials were then scaled, cut and joined. The product of the modelling exercise is revealed in Figure 1 below.

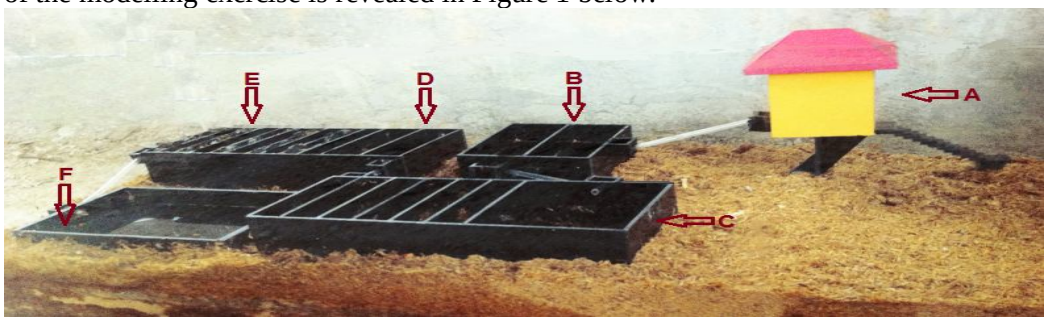

Figure 1: Laboratory Model of the Enhanced Decentralized Wastewater Treatment Scheme

In the figure above, "A" is the elevated toilet system; "B" is the conventional septic tank with a baffle wall separating the chambers, to inhibit the flow of scum, which is capable of blocking the sanitary pipe connecting the next treatment tank. "C" is the primary settler and baffled walls. Several baffle walls were introduced into the series of chambers after the primary settler, in order to achieve greater biological treatment of the wastewater. The next treatment tank is the secondary settler (denoted as "D"), which is contained in same unit with the activated carbon compartments. In this project, instead of the normal three

chambers for the activated carbon or filter unit, five were modelled. This helped to provide further purification of the wastewater, before passing it into the constructed wetland. The five filter chambers are denoted as "E" in the diagram above. Lastly, the constructed wetland is revealed in the above diagram as "F". In the constructed (horizontal) wetland, partially treated wastewater is exposed to oxygen and the UV rays of the sun, for facultative treatment.

Testing of the Enhanced DWTS in the Laboratory

Similar to the conventional DWTS, the enhanced DWTS comprised four components: Septic tank, Anaerobic Baffled Reactor, Anaerobic filter and Horizontal filter.

Figure 2 is the conventional and baffled septic tank or activated baffled reactor. The first component is the conventional septic tank (Primary Settler). Though this chamber mainly serves as the only wastewater treatment scheme in most peri-urban areas, it is often undersized and poorly maintained (Shivendra&Ramaraju, 2013). Thus, contrary to its use as a treatment chamber, in this proposed enhanced DWTS, it is utilized for sedimentation and biological degradation of settleable solids. In the laboratory, the wastewater introduced into the septic tank was separated into three layers after the first 24 hours of introduction. The first layer contained materials lighter than water, in terms of density. These are known as scum. The scum floated. The second layer was a discoloured liquid free from heavy suspensions. Microbes and biodegradable organics occupied this second layer. The third (last) layer contained settled dark coloured liquid. The lowest part of this layer is the sewage sludge. The primary settler is followed by five series of up-flow chambers known as Activated Baffled Reactor (ABR). Biological treatment process is increased as wastewater is forced to flow through the active sludge under the chambers separated by baffles. Testing of this chamber required the introduction of the first batch of wastewater on the first day to ensure that an active sludge is built up within the 24 hours of retention, before introducing the second batch of the wastewater.

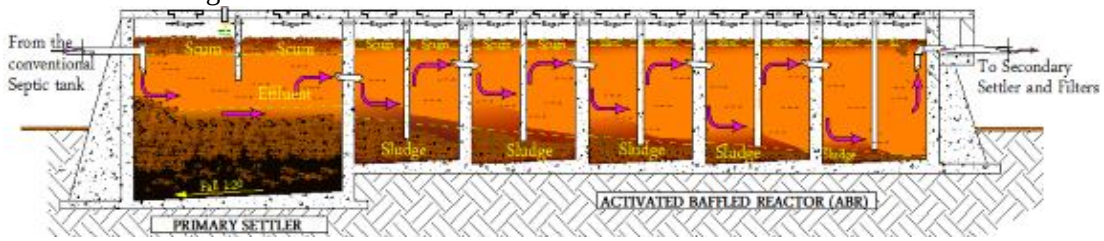

Figure 2: Conventional and Baffled septic tank

The third anaerobic treatment process is revealed as Figure 3 below. Following the initial treatment stages, at this stage, there was lower concentration of suspended solids in the wastewater. As wastewater then passed from one chamber to the other, it came in full contact with the activated carbon; the microbial action in the dense sludge then resulted in an effective digestion of dissolved organics. The activated carbon helped to purify the water, making it colourless.

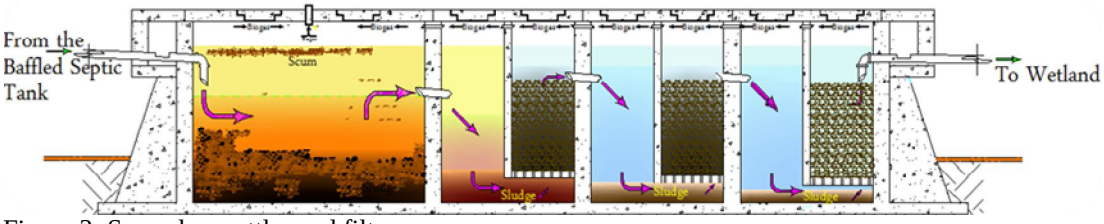

Figure 3: Secondary settler and filter

The treated water was then passed into a horizontal wetland where it was exposed to Ultraviolet (UV) rays of the sun and oxygen for facultative treatment and filtration (see Figure 4).In practice, water-loving plants are allowed to grow on the pond surface. This is aimed at further reducing the volume of nutrients in the water. The settled water is then collected from the middle of the pond. The very fine particles built below the pond constitute additional sludge for more possible digestion of any retained organics and

reduction of the load of microbes. Water collected from this treatment is colourless, odourless and fit for watering of farms or fields, as established by numerous literatures(Sasse, 1998; Tilley et al., 2008; DEWATS, 2011; EEPCO, 2014).

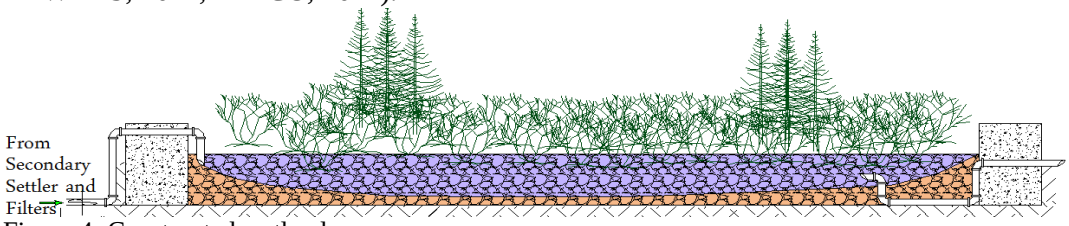

Figure 4: Constructed wetland

Conclusion and Recommendations

Considered as a panacea to the challenge of submerged decentralized wastewater treatment systems in peri-urban areas, the EDWTS incorporates two main strategies that are absent in the conventional DWTS. The strategies include raising the toilet and treatment tanks above the flood levels of the marshy region and ensuring that the chambers are constructed of rich mix impermeable in-situ concrete with the application of wastewater-specific structural waterproofing materials to the joints, manholes, pipe penetration points and service ducts. This treatment to the tanks will help inhibit any form of fluid flow from the internal wall face or infiltration from the external wall face, due to flood or high ground water table. The 3D model of the EDWTS is to serve as an archetype of the physical facility for realization in Nigeria. The EDWTS model will help support any publicity or sensitization programme aimed at promoting the development of the facility in flood prone areas of peri-urban cities, with particular focus on developing countries. From the foregoing, key benefits of this strategy include the provision of an excellent wastewater treatment facility with an elevated toilet system, reduction of the teeming excavation of septic tanks and soakaway pits found near most buildings in the peri-urban areas of developing countries and elimination or at least, minimization of water contamination / epidemic outbreaks. Considering that this facility is often capital-intensive, it is difficult for the average and low-income inhabitants expected to dwell within a Peri-urban to personally finance the EDWTS. Construction of this facility should be funded by Government, non-governmental organizations or contribution of about three and above separate families. It must not be massive; the substance is the functionality, which means that even small EDWTS would be capable of serving a smaller population with proper operation and regular maintenance. Thus, people and government should be sensitized on the need to adopt this system, especially in environmentally-challenged areas such as the communities settled within the riverine areas of the South-South states of Nigeria.

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DAYLIGHT FOR VISUAL COMFORT AND LEARNING IN ARCHITECTURAL STUDIOS IN MODIBBO ADAMA UNIVERSITY OF TECHNOLOGY, YOLA

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Abstract
The study sought to ascertain the level of daylight, visual comfort and learning in architectural studios in Modibbo Adama University of Technology, Yola. Two studios having different orientations, fenestrations, and other architectural features that influence quality and quantity of daylight, were the subject spaces. Fifty students selected on availability in each of the studios were the respondents to 12 hypothetical statements on the quality of daylight for drawing, receiving lectures, and reading and writing, on a 5-point Likert ordinal scale questionnaire. The quantity of daylight (measured in lux) in the studios were evaluated using Ecotect 2017 simulation software; the studios having been modelled using Autodesk Revit. Descriptive statistics including means, standard deviations and range were employed to analyze both the qualitative and quantitative data. Daylight levels ranged from 36 to 438 lux with mean value of 237.8 lux (SD=141.79 lux) in the studio oriented east-west; and ranged from 188 to 632 lux with mean value of 448 lux (SD = 161.79lux) in the studio oriented north-south. While light levels in both studios were perceived generally comfortable by majority of the respondents, lighting in the east-west-oriented studio was perceived partly as poorly distributed and causing deep shadow and partly hindering work due to glare and brightness from direct sunlight. The study concluded that visual comfort for learning in the studios would be enhanced through daylight retrofit by introducing evenly distributed north-south space fenestrations with light shelves and interior finishes or materials of higher reflectivity.
Keywords: Architectural education; Architectural studios; Daylight level; Learning activities; Visual comfort.

Introduction

In architecture, day lighting is concerned with the natural light as the primary source of daytime illumination, which if employed intrinsically, creates a visually comfortable space connected to outdoor (Wymelemberg, 2014). Ander (2014) opined that day lighting is the controlled admission of natural light which is renewable, free and clean, thereby reducing the demand, cost and negative consequences of artificial lighting. The generation of artificial light from sources powered by fossil fuel is not sustainable because the fuel is costly, not renewable, and emits environment degrading by-products (Ander, 2014). The European Commission Directorate-General for Energy, ECDGE (1994) revealed that visual comfort is the main determinant of lighting requirement. The quality of lighting affects an individual's well-being, visibility, activity, social interaction and communication, mood and comfort, health and safety, and aesthetic judgment (Samani and Samani, 2012). The preferences of people for lighting are reported (ECDGE, 1994) to be subjective, relative and contextual, varying with age, gender, intricacy of the task and the time of the day or year. The more intricate the task and the older the individual, the higher the level of light (illumination) required (see table 1). Where the source of light is natural rather than artificial, a wider range of illumination is said to be accepted (ECDGE, 1994).

Table 1: Some typical recommended illuminances

Corridors/Toilets*	100-150 lux	General office*	500 lux
Restaurant/Canteen*	200 lux	Workbench*	500 lux
Library/Classroom*	300 lux	Drawing office*	500-750 lux
Classroom**	300-500 lux	High-precision tasks*	1500 lux

Sources: *ECDGE, 1994; ** Korkut, 2016.

Mohammed, Nur & Azizah (2017) canvassed that studies should not be limited to how to provide enough daylight to an occupied space, but how to do so without any undesirable side effects which cause discomfort of varying degrees. It involves more than just adding windows or skylight to a space. It is the careful balancing of heat gain and loss, glare control and variation in availability of daylight. For example

successful day lighting design would invariably pay close attention to the use of shading device to reduce glare and excess contrast in the workspace. Additionally, window size and spacing glass, selection the reflectance of interior finishes, and the location of any interior partition must all be evaluated.

Daylight has numerous benefits that go beyond just lighting up a space in daytime. Dubois (2011) attested to attributes of daylight in a space which include creating good condition for seeing, supporting task performance or sets of appropriate behaviors, fostering desirable interaction and communication, and contributing to situational-appropriate mood. Daylight also provides good conditions for health, avoids ill-effects and contributes to the aesthetic appreciation of the space. The use of daylight or 'full spectrum lighting' in schools has been associated with healthier students demonstrating better work habits, more attendance, improved academic performance, resistance to fatigue, and more positive attitudes (Heschong, 2009; Healthy Schools Network, 2012). Studies revealed that in architectural education, the studio is the most important space where students acquire theoretical knowledge, and develop their vocational skills. Lectures and interaction between students and instructors, and among students on design projects and assignments as part of learning process often largely occur in studios. The highest credit units are assigned to design projects in the curriculum, and architecture students often spend most of their academic period in the studio (Husain, 2015). Apart from the general problems associated with daylight in buildings, Jahun (2017) reported some peculiarities in studios, due to their multi-purpose requirements.

Natural light sources and daylight designs are interconnected and ought to be integrated to engender quality architectural spaces. Marenne and Semidor (2010) opined that for a good design for daylight studios, the natural light sources must be combined with the daylight strategies in such a way that it creates a good distribution of the light inside the building and facilitates its penetration in a given direction. The design must also consider the protection against solar radiation or glaring light which can produce a negative consequence on the spatial activities, such as reflected sunshine glaring on the desk, chalkboard and walls. Day lighting may cause glare when there is excessive or unwanted brightness that is present in the visual field of view of an observer. Heschong (2002) submitted that students' learning and performance are negatively associated with glare and direct sun penetration through windows in classrooms. Heerwagen (2004) however, expressed glare as subjective since the extent to which a glary condition is experienced is fundamentally dependent upon how each person's visual system operates. Hence, conditions that cause discomfort will not necessarily reduce visual acuity or the ability to see but these conditions will produce a situation where an occupant's visual performance will suffer. Nevertheless, controlling of natural daylight is expedient, and must manage the quantity and distribution of the light, in order that a given space meets the visual needs of its users (Mohammed *et al*, 2017).

The daylight of a space, according to Samani and Samani (2012), is governed by the space architecture viz. its form (shape and size), composition, style, orientation, apertures on facades and/or roofs. Daylight design features include roof monitors, clerestories, light shelves, blinds and blind controls and external shades. According to Pulay (2010), an effective strategy in day-lighting a room is to deploy exterior light shelves which eliminate direct lighting into the space by reflecting the light into the room, soften the light and reduce glare as well as solar heat build-up. However, Axarli and Tsikalaudaki (2007) found that a combination of façade and roof apertures performs better than advanced façade systems like light shelves; and skylights, clerestories and double side openings more effective than unilateral façade windows.

Studies (Heschong, 2002; Healthy Schools Network, 2012) revealed that the use of daylight or 'full spectrum lighting' in schools is associated with healthier students demonstrating better work habits, more attendance, improved academic performance, resistance to fatigue, and more positive attitudes. Heschong (2002) additionally submitted that students' learning and performance are negatively associated with glare and direct sun penetration through windows in classrooms. Even though lighting requirements by people

are reported (ECDGE, 1994) to depend on the intricacy of task among other variables, divergent figures have been reported for some tasks. For drawing offices, daylight levels ranging from 300 to 400 lux were considered adequate by Musa, Abdullah, Che-Ani, Tawil & Tahir (2002). ECDGE (op cit) on the other hand indicated that between 500 and 750 lux was adequate for drawing office spaces. Lighting level of 300 lux was considered sufficient for library/classroom by ECDGE (op cit) while Korkut (2016) considered 300 to 500 lux adequate for classroom. Apart from the apparent contradictions and discordance from these reports they may be limited in application to architectural studios where students' vocational training and academic learning activities occur. This study, aimed at enhancing productivity in architectural education, sought to ascertain the level of daylight, visual comfort and learning in architectural studios in Modibbo Adama University of Technology, Yola. The research is premised on two objectives of evaluating the design and level of daylight in design studios of the building under study; and ascertaining the extent to which daylight affect visual comfort for learning among students using the studios under study.

Methodology

The study is a combination of Survey and 'Ex-post facto' research designs involving a quantitative evaluation and students' perception of daylight levels in three design studios(designated for 200L, 300L and 500L) in the Department of Architecture of Modibbo Adama University of Technology, Yola (on latitude 9^o 12'North and longitude 12^o 29' East), Adamawa, Nigeria. One of the study studios (200L) has orientations, fenestrations and other architectural features that may influence quality and quantity of daylight different from those of the other two studios (300L and 500L). Whereas 300L and 500L studios have each twelve windows of 1.2m x 1.8m (0.9m above floor level) six on each side of the wall (representing 19% of floor area), are orientated North-South but occupy different levels (500L on the first floor directly above 300L). The 200L studio, on the other has eight windows of 1.2m x 1.8m (0.9m above floor level) five on one side and three on the other side of the walls (about 16% of floor area) bounded by corridors about 1.5m wide and orientated west and east respectively. Fifty students selected on availability in each of two (200L and 500L) of the studios were the respondents to 12 hypothetical statements on the quality of daylight for drawing, receiving lectures, and reading and writing, on a 5-point Likert ordinal scale questionnaire. The quantity of daylight (measured in lux) in two (200L and 300L) of the studios were evaluated using a simulation software, *Ecotect 2011*(which was limited to ground floors only); the studios having been modelled using *Autodesk Revit.* The basic assumption was that the 300L and 500L studios would have same or almost same daylight character since their daylight architectural features are almost the same. Qualitative data (respondent responses) were coded and reduced to numbers for statistical analysis: Strongly agree = 5; agreed = 4; undecided= 3; disagreed = 2; and strongly disagreed = 1. Total response weight for each statement was computed as summation of the product of the code and frequency of responses; and weighted mean as total response weight divided by the number of all respondents. Descriptive statistics including means and standard deviations were employed to analyze both the qualitative and quantitative data.

Results and Discussion

Table 2 indicates the daylight (lux) levels of 25 work-plane positions in each of the studio (200L and 300L) spaces under study and their distances from windows on the two external fenestrated walls. The distribution patterns of these daylight levels are graphically shown in Figures 3 and 4. Column 1 (C1) in 200L studio is 6.6m from the fenestrated west-wall and 0.6m from the fenestrated east-wall; while column 5 (C5) is 0.6m from west-wall and 6.6m from east-wall. Columns 2, 3 and 4 are intermediates of distances varying from 5.1m and 2.1m from the west- and east-walls respectively. There is a progressive increase in daylight level from C1 to C5 as revealed in Figure 2. Daylight levels vary from 62 lux to 36 lux along C1 and 438 to 412 lux along C5. Mean daylight levels across rows vary from 360.7 lux in Row 1 (R1) to 225.2 lux in Row 5 (R5); while the grand mean daylight level in the 200L studio is 237.8 lux (with Standard deviation, SD of 141.30 lux). In the 300L studio, work-planes on column 6 (C6) are 8.1m

from the south-wall and 0.9m from the north-wall; while those on column 10 (C10) are 0.9m from the south-wall and 8.1m from the north-wall. Work-planes on columns 7, 8 and 9 are intermediates at distances varying from 6.3m and 2.7m from the south- and north-walls respectively. Daylight levels dip from work-planes on columns close to the south- and north-wall (C6 and C10) to those on the middle column (C8); they vary from 188 lux on C8 to 608 lux on both C6 and C10 (Table 2 and Figure 3). Mean daylight levels among the rows vary progressive from 476 lux in R10 to 500 lux in R6; the grand mean daylight level in the 300L studio being 448 lux (with standard deviation, SD of 161.79 lux).

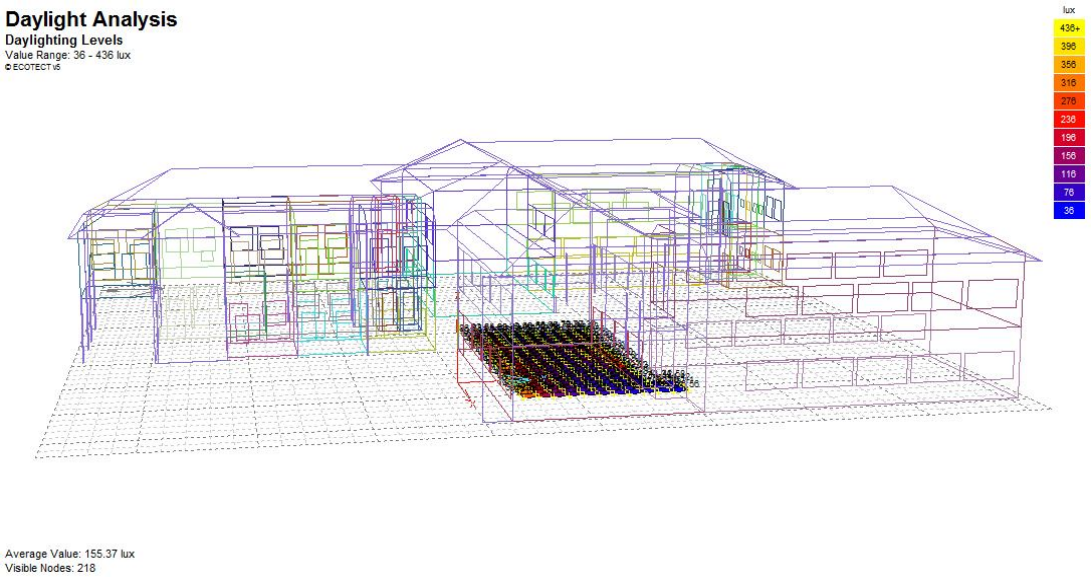

Figure 1: Model of the sample area in the studio

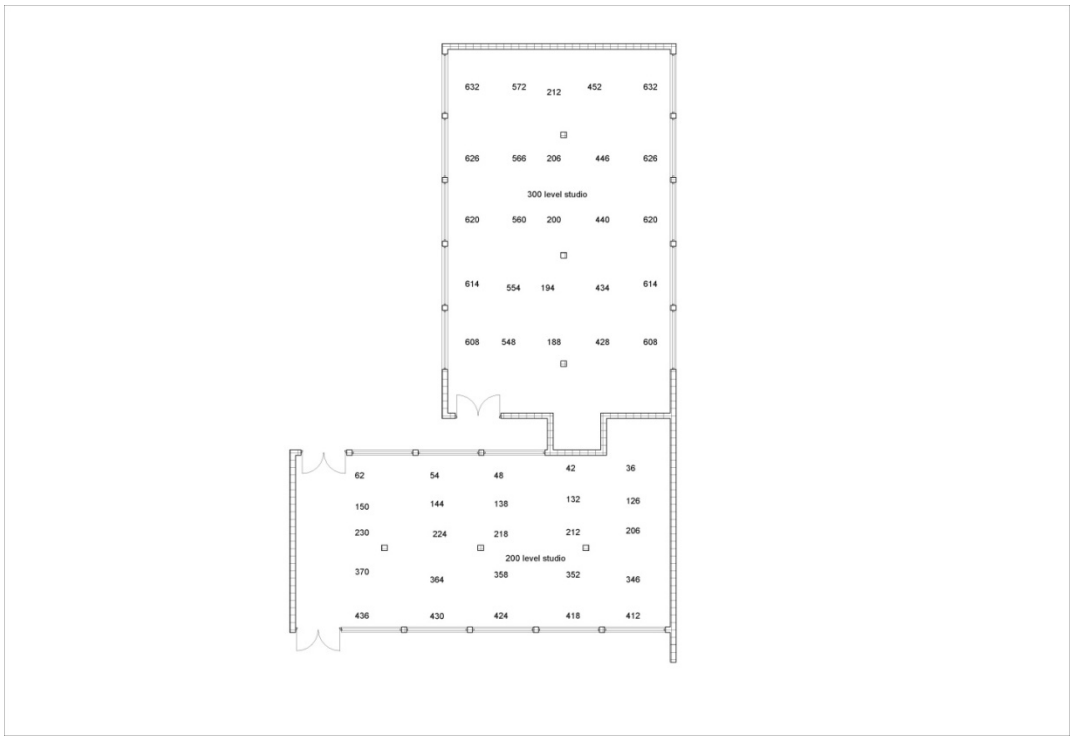

Figure 2: Daylight distribution on work-planes in the studios under study

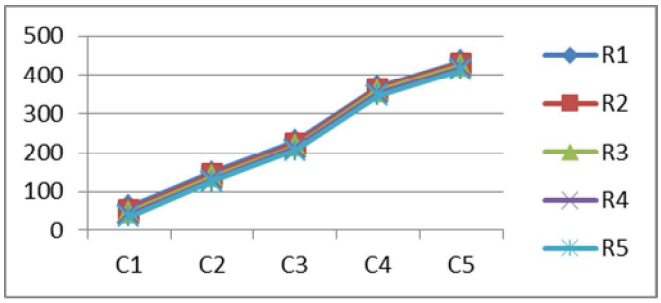

Fig.3: Daylight levels in 200L studio

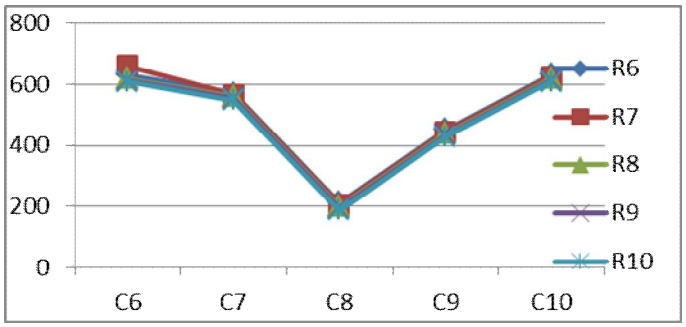

Fig.4: Daylight levels in 300L studio

Table 2: Daylight (lux) levels in the study spaces

Distance from windows(DFW)(m)		200L Studio					Mean	300L /(500L)Studio						Mean
		C1	C2	C3	C4	C5		DFW (m)	C6	C7	C8	C9	C10	
		6.6/0.6	5.1/2.1	3.6/3.6	2.1/5.1	0.6/6.6			8.1/0.9	6.3/2.7	4.5/4.5	2.7/6.3	0.9/8.1	
1	R1	62	150	230	370	438	360.7	R6	632	572	212	452	632	500
2	R2	54	144	234	364	430	245.2	R7	626	566	206	446	626	494
3	R3	48	138	218	358	424	237.2	R8	620	560	200	440	620	488
4	R4	42	132	212	352	418	231.2	R9	614	554	194	434	614	482
5	R5	36	126	206	346	412	225.2	R10	608	548	188	428	608	476
		Grand Mean/SD				237.8/141.30			Grand Mean/SD					448/161.79

The perceptions of daylight level for receiving lecture, drawing and reading by 200L students are indicated in Table 3, while those of 500L students are shown in Table 4. The 200L students majorly (80%) agreed that the lighting in the studio is generally comfortable; that direct glare from unprotected windows and brightness from direct sunlight hinder their works. The respondents disagreed with the statement that lighting is uncomfortably bright for reading and writing. However the respondents were majorly undecided with the other eight statements. Twenty one (42%) of the respondents strongly agreed or agreed that the lighting is uncomfortably bright for drawing, while 26 (52%) of them strongly disagreed or disagreed. Twenty eight (56%) of the respondents also strongly disagreed or disagreed that the lighting is uncomfortably bright for lectures. Majority of the respondents either strongly disagreed or disagreed that the lighting is uncomfortably dim for drawing (52%), for lectures (62%) and for reading and writing (62%). Majority of the respondents also strongly agreed or agreed that the lighting is poorly distributed (58%) and that it causes deep shadow (50%) in the studio. Twenty five (50%) of the respondents strongly disagreed or disagreed that reflections from windows hinder their works.

It was also majorly at least agreed (88%) among the 500L respondents that the lighting in their studio is generally comfortable. Six other statements were however disagreed with viz: that the lighting is uncomfortably bright for lectures, for reading and writing; uncomfortably dim for drawing and receiving lectures, reading and writing; that the lighting causes deep shadow while reflections from windows hinder their works. The respondents were undecided with the remaining four statements: That the lighting is uncomfortably bright for drawing; that the lighting is poorly distributed in the studio; direct glare from unprotected windows hinder works; and that brightness from direct sunlight hinders work. However, majority (66%) of the respondents strongly disagreed or disagreed that the lighting is uncomfortably bright for drawing; 62% strongly disagreed or disagreed that the lighting is poorly distributed; 64% also strongly disagreed or disagreed that direct glare from unprotected windows hinder their works; and 60% strongly disagreed or disagreed that brightness from direct sunlight hinder their works.

Table 3: 200 Level studio daylight perceptions

Statement	Response frequencies					W'ted mean	R
	SA (5)	A (4)	U (3)	D (2)	SD (1)		
Generally the lighting is comfortable	22 (44%)	18(36%)	0(0%)	8(16%)	2(4%)	4.0	A
The lighting is uncomfortably bright for drawing	2(4%)	19(38%)	3(6%)	25(50%)	1(2%)	2.9	U
The lighting is uncomfortably bright for lectures	0(0%)	15(30%)	7(14%)	21(42%)	7(14%)	2.6	U
Lighting is uncomfortably bright for reading and writing	0(0%)	7(14%)	5(10%)	33(66%)	5(10%)	2.3	D
The lighting is uncomfortably dim for drawing	1(2%)	16(32%)	7(14%)	19(38%)	7(14%)	2.7	U
The lighting is uncomfortably dim for lectures	2(4%)	12(24%)	5(10%)	25(50%)	6(12%)	2.5	U
Lighting is uncomfortably dim in reading and writing	5(10%)	13(26%)	1(2%)	26(52%)	5(10%)	2.7	U
The lighting is poorly distributed here	7(14%)	22(44%)	3(6%)	18(36%)	0(0%)	3.3	U
The lighting causes deep shadow	4(8%)	21(42%)	4(8%)	16(32%)	5(10%)	3.0	U
Reflections from windows hinder my work	3(6%)	13(26%)	9(18%)	23(46%)	2(4%)	2.8	U
Direct glare from unprotected window hinder my work	7(14%)	24(48%)	10(20%)	9(18%)	0(0%)	3.5	A
Brightness from direct sunlight hinders my work	9(18%)	22(44%)	4(8%)	15(30%)	0(0%)	3.5	A
TOTAL	62(10.3%)	202(33.7%)	58(9.7%)	238(39.7%)	40(6.7%)	3.0	U

R=Remark; A= Agreed; U= Undecided; D= Disagreed

Table 4: 500 Level Studio Daylight perceptions

Statement	Response frequencies					W'ted mean	R
	SA(5)	A (4)	U (3)	D (2)	SD (1)		
Generally the lighting is comfortable	18(36%)	28(52%)	1(2%)	3(6%)	0(0%)	4.2	A
The lighting is uncomfortably bright for drawing	3(6%)	11(22%)	3(6%)	24(48%)	9(18%)	2.5	U
The lighting is uncomfortably bright for lectures	1(2%)	11(22%)	3(6%)	27(54%)	8(16%)	2.4	D
The lighting is uncomfortably bright for reading and writing	0(0%)	8(16%)	3(6%)	26(52%)	13(26%)	2.1	D
The lighting is uncomfortably dim for drawing	2(4%)	2(4%)	3(6%)	30(60%)	13(26%)	2.0	D
The lighting is uncomfortably dim for lectures	1(2%)	3(6%)	4(8%)	29(58%)	13(26%)	2.0	D
The lighting is uncomfortably dim in reading and writing	1(2%)	2(4%)	6(12%)	31(62%)	10(20%)	2.0	D
The lighting is poorly distributed here	4(8%)	11(22%)	4(8%)	20(40%)	11(22%)	2.5	U
The lighting causes deep shadow	2(4%)	9(18%)	4(8%)	27(54%)	8(16%)	2.4	D
Reflections from windows hinder my work	1(2%)	6(12%)	4(8%)	31(62%)	8(16%)	2.2	D
Direct glare from unprotected window hinder my work	2(4%)	9(18%)	7(14%)	30(60%)	2(4%)	2.5	U
Brightness from direct sunlight hinders my work	8(16%)	9(18%)	3(6%)	23(46%)	7(14%)	2.7	U
TOTAL	43(7.2%)	109(18.2%)	45(7.5%)	301(50.2%)	102(17.0%)	2.5	U

R=Remark; A= Agreed; U= Undecided; D= Disagreed

The architectural attributes of 500L and 300L studios are similar in most respect except for height differences which may not significantly affect daylight. It is therefore safe to assume that the lux level observed in 300L would not be significantly different from what may be obtained in 500L; if any difference at all, the lux level at the upper floor (500L studio) is more likely to be lower. The mean daylight level of 448 lux in 300L studio may therefore be applicable to the 500L studio. The study found that the levels of daylight as perceived by the occupying respondents in the two studio (200L and 500L) spaces under study are generally comfortable for learning. This suggest that mean daylight levels of 238 lux is comfortable in a space exposed to east-west sunlight, and mean daylight levels of 448 lux is comfortable in a space exposed to north-south sunlight. The study also suggest that the lighting is neither uncomfortably bright nor uncomfortably dim for drawing, receiving lectures, reading and writing in both studios. The respondents in the two spaces also seem to disagree with the notion that reflections from windows hinder their works. In the light of previous studies (Dean, 2004; Hasiciri, 2011) the illumination

in both studios may be considered adequate. It however revealed some variation in the quality of daylight distribution in the spaces under study. The study suggests that lighting is poorly distributed and causes deep shadow only in the 200L studio, and not in the 500L. This could be attributed to the differences in the area, distribution and exposure/obstruction of windows between the two studios. The 500L studio has larger, unobstructed and more evenly distributed window area compared with those of the 200L which are smaller, less evenly distributed and partly obstructed especially on the eastern side. An implication of this variation in daylight quality is a likely lower patronage or utilization of the 200L studios as users may avoid areas with deep shadow and poor light; as Othman and Mazli (2012) revealed that studio users prefer the seats near day-lit areas. Mandatory use of the poor-lit areas during lectures may hamper learning and result in poor student performance as reported in Saxena (2008). In the 200L studio respondents agreed that direct glare from unprotected windows and brightness from direct sunlight hinders their works, whereas those in 500L studio seem to disagree. The lower altitude of the sun in the east and west (as in the 200L studio) compared with the north and south (as in the 500L studio) positions may be attributable to these divergent perceptions (Robertson, 2005; Molinski, 2009).

Conclusion

The study sought to determine the level of daylight required for visual comfort and learning in architectural studios in the Modibbo Adama University of Technology, Yola. The perceptions of fifty Architecture students about the level of visual comfort or discomfort for drawing, receiving lectures, and reading and writing in each of two studios of the Department of Architecture were elicited. Quantitative evaluation of daylight levels (in lux) was accomplished by simulation using *Ecotect 2017Daylight software* on the *Autodesk Revit*- modelled study studios. Daylight levels ranged from 36 to 438 lux with mean value of 237.8 lux (SD=141.79 lux) in the studio oriented east-west; and ranged from 188 to 632 lux with mean value of 448 lux (SD = 161.79lux) in the studio oriented north-south. While light levels in both studios were perceived generally comfortable by majority of the respondents, lighting in the east-west-oriented studio was perceived partly as poorly distributed and causing deep shadows and partly hindering work due to glare and brightness from direct sunlight. The study concluded that learning in architectural studios would be enhanced by evenly distributed north-south space fenestrations that scale up the quantity and quality of the interior daylight. This could be achieved through retrofit of windows with light shelves, introducing finishes or materials of higher reflectivity on interior surfaces etc.

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HOUSING AFFORDABILITY FOR THE LOW INCOME GROUP IN THE NIGER DELTA REGION OF NIGERIA

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Abstract
The Niger-Delta region accounts for 50% of Nigeria's GDP, 95% of her foreign exchange earnings, and 80% of all budgetary revenues that amount to 7 trillion naira billion annually. However, in spite of the oil wealth and contribution of the area to the monetary prosperity of Nigeria, the area is still largely under-developed as the level of infrastructural development and provision of social amenities such as housing, electricity, health care provision and education remain at an abysmal sorry state. This paper therefore examined the state of housing delivery for the low income group in the Niger Delta. Anchored on explorative and quantitative cross-section research design, the research uses quantitative structured questionnaire to generate data from low income residents in three strategies cities of Uyo, Calabar and Port Harcourt in Nigeria's Niger Delta. 216 copies of questionnaire out of 324 used for the study were returned to give a response rate of 66.7%. Data collected were analysed using descriptive, one way ANOVA, and Kruskal Wallis. It was discovered that housing affordability across the three cities was significantly below the internationally accepted thresholds. Besides, the level of effectiveness of strategies for affordable housing in the cities was insignificant as they have not made the required impact. However, the use of private developers was rated the most effective strategy. Meanwhile, high cost of land, high cost of building materials, and high cost of living were identified as the major barriers to affordable housing in the region. It is recommended that government at both federal and state levels should step up measures to reduce the high housing deficit prevalent in the Niger Delta and Nigeria as a whole; while stakeholders should embrace innovative, sustainable and cheap technology for housing construction to bring down the high cost of building houses.
Key words: housing affordability, strategies, effectiveness, barriers, low income group

Introduction

Housing is regarded as one of the most essential needs of man. It is in recognition of this that many countries and international bodies accord it very high importance. For instance, Nigeria's 1999 Constitution as amended under the fundamental objectives of state policy, specifically compels the Nigerian State "to provide suitable and adequate shelter for all citizens". It also formed part of the highlights at various UN fora such as the United Nations Habitat I conference held in Vancouver in 1976, the international year of shelter for the homeless in 1987, the Habitat II Conference held in Istanbul in 1996, and UN-Habitat conference on financing urban shelter held in 2005. Despite these, housing shortages still persist in most parts of the world especially in developing nations such as Nigeria. According to a report by UN Habitat, over 2 billion people will add to the growing demand for housing, water supply, sanitation and other urban infrastructure services by the year 2030 (UN-HABITAT, 2005). The report also disclosed that about 3 billion people, or about 40% of the world's population by 2030, will need to have housing and basic infrastructure services. This translates into completing 96,150 housing units per day or 4000 per hour (United Nation, 2008).In Nigeria, it is reported that the country as at the year 2017 has an estimated housing deficit of 17 million units and an estimated increase of 900,000 per year up from 7 million units in 1991, an increase of over 250% (The Nation, 2017). The World Bank estimates the cost of bridging Nigeria's 17 million housing deficit at ₦59.5 trillion. This is not too far from the estimation of the Federal Mortgage Bank of Nigeria which had put it at about N56 trillion to be able to adequately meet the housing needs of Nigerians. With an average housing production of 100,000 units per year, it is considered grossly inadequate given the rising deficit and a population of 180 million (National Population Commission, 2017).

Over the past two decades, Nigeria has struggled to contain the uncontrollable growth of the urban population occasioned by lack of basic infrastructure and poor economic planning. The country stands as the most populous country in Africa with an estimated pollution of 180 million based on 2006 projection of 2.3% annual growth rate (National Population Commission, 2006), while over 40% of this figure live

in urban cities. This phenomenal and unprecedented increase in urban population has put every effort for affordable housing under pressure and led to acute shortage of dwelling units particularly for the low income group who are majorly civil servants and self-employed. The Nigerian National Housing Policy (FGN, 2004) defined the low-income group as all employees and self-employed persons whose annual income is ₦100, 000:00 and below (i.e. the equivalent of salary grade level of 01-06 within the civil service). While the current minimum wage of ₦18,000 per month is under review, one argues that 70% of Nigerians who fall into category (Adedeji and Olotuah, 2017) stand no chance of qualifying for a mortgage to own a house.

Although successive governments in Nigeria have developed policy initiatives and intervention programmes to boost housing delivery and improve on housing affordability among the citizens, these have largely been insufficient as the problems have remained unabated. Niger Delta region has borne most of the housing crisis as the area has continued to bear the brunt of oil spillage and pollution that have destroyed most of their means of livelihood. Besides, the area has been largely under-developed in terms of provision of social amenities such as housing, electricity, health care provision and education remaining which are all at an abysmal sorry state (Ikediashi, 2014). This is despite accounting for 50% of Nigeria's GDP, 95% of her foreign exchange earnings, and 80% of all budgetary revenues that amount to over 7 trillion naira annually. The consequences of this neglect have been manifesting as overcrowding suburbs, inadequate infrastructure and service, poor and unhygienic living conditions, destitution, high rental costs, youth restiveness, agitations and militancy. Unfortunately, this has given the impression that all seem to be well in that region given the amount of oil wealth from the area. Although many studies have highlighted the various degrees of housing crisis in Nigeria (Arigbibola, 2008; Okedele et al., 2009; Opaluwa, 2010; Abimaje et al., 2014), none has investigated it from the point of view of Niger-Delta. Although Ewa et al. (2013) assessed housing affordability in Calabar, this study argues that it cannot be used to generalise the state of housing affordability in Niger Delta especially when viewed from the fact that the most populous city in Niger Delta (Port Harcourt) was excluded from the study. The intent of the study is to fill that knowledge gap.

Given the background above, the study aims to empirically examine the state of housing delivery for the low income group in the Niger Delta using data from three strategic Niger Delta cities of Calabar, Uyo and Port Harcourt. The specific objectives are to assess the level of affordability of housing; examine the level of effectiveness of strategies for sustainable housing delivery; and assess the barriers to affordable housing for the low income group in the region. It is hoped that the outcome will create much needed awareness about the true state of housing delivery in the area and provide workable strategies to bolster improved housing delivery thereby instilling confidence in the sector.

Housing development and delivery strategies in Nigeria

Housing represents the most basic of human needs and has profound impact on the health, welfare, and productivity of the citizenry. Over the years, the ever-increasing population in the nation's cities has put tremendous pressure on land and housing, giving rise to an unsatisfactory balance between residential quality and the ability of households to afford that quality (Ikediashi et al., 2010). In effect, housing poverty has manifested in the quality of houses which are of hugely substandard architecture and construction and which are occupied by the vulnerable urban low income group (Olotuah and Taiwo, 2015).

Government interventions to address housing crisis in Nigeria started as far back as pre-independence era. During the colonial period, official government intervention in housing focused mainly on provision of quarters for expatriates and indigenous staff of specialised government agencies such as Railway Corporation, Police, Electricity Company etc. (Jiboye, 2011). Since independence, the federal government has invested in housing sector through massive budgetary allocations in the various National

Development Plans. The First National Development Plan (1962-1968) housing policy principally focused on providing 61,000 units for Lagos, the then capital city of Nigeria but ended up building only 500 units (Onibokun, 1990). The second National Development Plan (1970-1974) targeted 59,000 units across the federation. The third National Development Plan (1975-1980) made further improvements on housing programmes, policies and delivery in Nigeria. The document pledged to provide housing for all income groups especially the vulnerable low income groups and set a target of 202,000 units. It could only achieve 14%. The fourth National Development Plan (1981-1985) which was anchored on affordability and citizenship planned to provide 160,000 units, 80% of which was earmarked for the low-income group. Only 20% was achieved (FGN, 2004, Olotuah, 2000) while majority of the units meant for the low income group were hijacked by government officials and politicians.

Having failed to meet any of the housing targets in the National Development Plans, government changed from direct provision of houses to creating enabling environment for private investors to thrive. This included provision of access roads and other social amenities around the housing sites in what was called "site and services". Part of this also included the enactment of laws that gave birth to the National Housing Fund, the Federal Mortgage Bank of Nigeria, the Federal Housing Authority, and the Housing and Urban development policy of 2002 among others. Other strategies adopted for mass housing delivery included easing of land purchase and allocation, building and selling at subsidised rates by federal and some state governments (Abimaje et al., 2014). It is instructive to argue that most of these policies have not yielded the right result as most of the housing units built by the private developers are beyond the reach of the low income group. As Adajumo (2008) succinctly pointed out, these houses are usually not for rent but for sale because the private developers needed to recoup their investments and at the same pay back the loans taken from banks. It therefore remains to be seen if these interventions have made the necessary impact on housing delivery in Nigeria.

Housing affordability

Housing affordability refers to the standard of housing (or different standard) at a price or a rent which does not impose, in the eyes of some third party (usually Government), an unreasonable burden on household incomes (Lau and Li, 2006). In other words, households should be able to occupy housing that meets well-established norms of adequacy at a net rent which leaves them enough income to live without falling below the poverty standard (Kgobetsi, 2017).According to the United State Department of Housing and Urban Development (HUD), a housing scheme is affordable when a family or household does not have to spend more than 30% of its total income on rent and utilities. Housing is thus affordable only if it does not exceed the 30% threshold. In the same vein, Andrew (1998) had argued that any family that spends more than 30% of their income on housing is considered cost burden and may find it difficult to take care of other physiological needs such as food, transport and medical care. Cox and Parteclich (2010) also argued that house rent should not exceed 3 times the gross annual household income. Apparently, this clearly indicates that there is unanimity among researchers that housing affordability can be measured using ratios. The two common methods of measuring the concept are ratio approach and residual income approach. The residual income approach measures the difference between housing cost and residual income. In other words, it takes care of whether a household's income is sufficient to cover non-housing needs after deducting the standard housing consumption (Stones 2006, Chen et al., 2010). However, its limitation is the difficulty in establishing the minimum standard of adequacy for non-housing expenditure (Stone, 2006). On the other hand, ratio approach defines the ratio of housing cost or rent to household income and any household that exceeds this ratio is considered having housing affordability problem (Kutty, 2005). The widely acknowledged threshold is 30%. The ratio approach has gained wide popularity on account of its simplicity in application and ability to appropriately fit into people's common sense (Stone, 2006) which is why it was adopted for this study.

Barriers to affordable housing

Despite the various international attentions given to the housing crisis globally, many countries including Nigeria have not been able to solve the problem. Many studies have examined the barriers inhibiting

affordable housing. Abimaje et al., 2014 identified cost of land and building materials, high interest rates on mortgages, poorly developed mortgage finance system, administrative bottlenecks, and corruption in the allocation of land within the framework of Land Use Act of 1978 as hindrances affecting housing affordability in Nigeria. Akeju (2007) listed government legislation such as the Land Use Act of 1978, bureaucracy in the registration of property, absence of a national credit data base, unstable macroeconomic environment, multiple and complex tax laws, high cost of building materials, lack of primary infrastructure as challenges to providing affordable housing. Kgobetsi (2017) however grouped barriers affecting housing affordability into demand and supply factors. Demand factors include among others, occupational mobility, gross national income, cost of living and location; while supply factors include corruption, construction cost, geographical constraints on land, complex planning processes, and availability of service land. While the intrinsic factors hindering housing affordability have been clearly identified in the highlighted studies above, one argues that most of them relied on anecdotal evidence and literature review. Besides, none of them was carried out in the Niger Delta. This research intends to close the knowledge gap by conducting an empirical diagnosis of housing affordability in the Niger Delta region using three strategic cities of Calabar, Port Harcourt, and Uyo as case studies.

Study Area & Methodology

The study was carried out in three strategic cities of Uyo, Calabar, and Port Harcourt in the Niger Delta. Uyo became the capital of the Akwa Ibom state on September 23, 1987 following the creation of Akwa Ibom State from erstwhile Cross River State. It has a population of 386, 643 according to the 2006 census and is largely a civil service state. Calabar is the capital of Cross River State, and has often been described as the tourism capital of Nigeria. Administratively, the city is divided into Calabar Municipal and Calabar South local government areas. It has a population of 371,022 at the 2006 census. Port Harcourt is the capital of Rivers State and has an estimated population of 1,865,000 persons in 2006. It is the largest city in the Niger Delta and oil capital of Nigeria as major international oil services and exploration companies are located in the city. In spite of the strategic nature of these cities to Nigeria's economic wellbeing, Ewa et al. (2013) argued that the inadequacy in housing delivery to cater for the explosive urban population of these cities, coupled with the increasing gap between supply and demand has led to an extensive development of squatter or unplanned settlements in these areas. Besides, cases of youth restiveness have defied all measures on account of massive unemployment and rising cost of living.

The research question posed for this study was to examine the state of housing delivery for the low income group in the Niger Delta using data from three strategic Niger Delta cities of Calabar, Uyo and Port Harcourt. In line with quantitative survey and exploratory approach adopted for the study, the questionnaire constructs grouped into three sets of variables were derived from the literature. The questionnaire was then fine-tuned through group discussions with key stakeholders, including property and facilities managers, planners, house owners and tenants. For instance, the average earnings per annum for low income group, % of income paid as rent per annum and housing types in the three cities were derived from the focus group discussions. It was then pilot-tested to verify the validity of questions and gauge the likely feedback from respondents. The population of this study comprised all tenants who can be described as low income group in the three cities. The Nigerian National Housing Policy (FGN, 2004) defines the low-income group as all employees and self-employed persons whose annual income is ₦100, 000.00 and below (i.e. the equivalent of salary grade level of 01-06 within the Nigerian civil service). The national minimum wage is currently ₦ 216, 000. 00 per annum (₦18,000 per month) while about fifty-seven percent (57%) of the Nigerian population falls below the poverty line, which is on the average of US$1 per day (Wahab, 2006). In reality, most employees who work outside the public sector or outside the organised private sector, as well as many self-employed Nigerians earn well below the national minimum wage.

In order to ensure proportional representation, two estates were selected from each of the three cities to serve as population frame while a pilot study was conducted to purposively select civil servants and private sector workers in the estates who earn wages of between ₦50,000 and ₦250,000 per annum. In line with census sampling, a full scale survey was then conducted covering all the tenants who formed the sample units. The breakdown is given in Table 1. The result indicates 216 out of 324 used for the survey returned valid responses giving a response rate of 66.7%.

Table 1: Response rate computation

City	Sample units	Returned	Response rate
Uyo	118	94	79.7%
Calabar	80	51	63.8%
Port Harcourt	126	71	56.3%
Total	324	216	66.7%

Data for the study was collected through a structured questionnaire. The questionnaire was divided into four sections. Section A captured the respondents' demographic data (sex, age, educational qualification, occupation and location); section B contained structured questions on housing affordability such as types of houses, range of annual income, and percentage of annual income paid as rent per annum; section C contained structured questions on five strategies for housing delivery in which respondents were asked to rate the strategies' levels of effectiveness using a 5 point Likert scale that ranged from the lowest of 1 = poor, 2 = fair, 3=moderate, 4=good, 5=excellent; while section D was on barriers to affordable housing for low income tenants in which respondents were asked to rate their levels of agreement with the 15 barriers using a scale of 1=strongly disagree, 2=disagree, 3=fairly agree, 4=agree and 5=strongly agree. Data collected were analysed using basic descriptive while one way analysis of variance (ANOVA) and Kruskal Wallis were used to test the four hypotheses postulated for the study

Results and Findings

In order to get a proper perspective on respondents who participated in the survey, their demographics were analysed using descriptive statistics. The result is presented in table 2.

Table 2: General characteristics of respondents

Descriptive	Frequency	Percentage (%)
Sex		
Male	133	62
Female	83	38
Total	216	100
Age		
18-28	35	16
29-39	108	50
40-50	59	27
Over 50	14	7
Total	216	100
Qualification		
No qualification	1	0.5
Certificate	46	21
Diploma/BSc	133	62
MSc	35	16
PhD	1	0.5
Total	216	100
Occupation		
Unemployed	13	6
Self-employed	59	28
Government employed	100	46

Private employed	44	20
Total	216	100
City of residence		
Uyo	94	44
Calabar	51	24
Port Harcourt	71	32
Total	216	100

Result shows that majority of respondents were male (60%) while in terms of age, more than 60% were in the age bracket of 18 to 39 years. In terms of qualification, 21% had certificate, 62% have either diploma or Bachelor degree. Only 16% however had Master's degree. In terms of occupation, over 90% were gainfully employed while only 6% were unemployed. It is however important to quickly point out that those who are unemployed among the respondents had their rents paid by third party. The results therefore indicate that most of the respondents used for the survey were gainfully employed as at the time of the survey. Besides, virtually all respondents were educated to at least certificate level.

Table 3: Cross-tabulation of Age versus Occupation of residents

		Occupation				
	Age	unemployed	self employed	government employed	private employed	Total
age	18-28	8	10	11	6	35
	29-39	4	34	45	25	108
	40-50	1	11	36	11	59
	over 50	0	4	8	2	14
	Total	13	59	100	44	216

A cross-tabulation of age against occupation (see table 3) shows that most of the respondents within the age bracket of 18 and 39 were either self, government or privately employed. This is an indication that majority of respondents who are employed were of the youthful age bracket. Besides, a cross-tabulation of qualification against occupation shown in table 4 indicates that more than 80% of respondents who are employed possess certificate, diploma or Bachelor's degree, an indication that majority of them were educated.

Table 4: Cross-tabulation of Qualification versus occupation of residents

	Occupation				
Qualification	Unemployed	Self employed	Government employed	Private employed	Total
No qualification	0	0	1	0	1
Certificate	5	26	7	8	46
diploma/BSc	8	30	66	29	133
MSc	0	3	25	7	35
PhD	0	0	1	0	1
Total	13	59	100	44	216

Level of housing affordability

The first objective evaluated the level of housing affordability among the low income groups in the study area. To achieve this, respondents were asked to tick type of housing they currently occupy, the range of income they currently earn, and percentage of this income paid as rent. The result of the analyses is presented in tables 5 to 7.

Table 5: Results of analysis for housing type occupied by residents

	Uyo		Calabar		Port Harcourt		ANOVA	
Housing type	N	%	N	%	N	%	F	Sig.
Single room	23	25	6	12	6	9	5.800	0.004
Self-contained flat	23	25	30	59	27	38		
Two bedroom flat	38	40	14	28	31	44		
Three bedroom flat	3	3	1	2	7	10		
Duplex	7	7	-	-	-	-		
Total	94	100	51	100	71	100		

Results from table 5 indicates that, out of 94 households used for the survey in Uyo, 23 households live in single room apartments, another 23 live in self-contained flats, 38 live in two bedroom flats, 3 in three bedroom flats and 7 in duplexes. For Calabar, 6 households live in single room apartments, 30 live in self-contained flats, 14 live in two bedroom flats, while only one respondent live in three bedroom flats. For Port Harcourt, 6 of the 71 households live in single rooms, 27 live in self-contained flats, 31live in two bedroom flats, and 7 in three bedroom flats. This finding suggests that over 90% of respondents across the three cities live in single room, self-contain one bedroom, or two bed room apartments. It was earlier observed during the pilot study that most of these households had very large families relative to the type of house they occupy. This is supported by Abimaje et al. (2014) who noted that majority of these households barely have any option as they are low income earners and could not afford accommodation that can be described a comfortable.

Table 6: Results of analysis for range of annual income earned by residents

	Uyo		Calabar		Port Harcourt		ANOVA	
Range of income (₦)	N	%	N	%	N	%	F	Sig.
50,000-75,000	24	26	16	31	8	11	4.398	0.013
75,000-100,000	19	20	9	18	14	20		
101,000-150,000	36	38	16	31	33	47		
151,000-200,000	8	9	9	18	14	20		
201,000-250,000	7	7	1	2	2	3		
Total	94	100	51	100	71	100		

Results from table 6 indicate that in Uyo, 38% of respondents earn between ₦101,000 and ₦150,000, 26% earn between ₦50,000 and ₦75,000, while 20% earn between ₦75,000 and ₦100,000. Meanwhile, only 9% and 7% earn between ₦151,000 and 200,000 and between ₦201,000 and ₦250,000 respectively. In Calabar, 31% of respondents earn between ₦50,000 and ₦75,000 as well as between ₦101,000 and ₦150,000. Also, 18% earn between ₦75,000 and ₦100,000 as well as ₦151,000 and ₦200,000. However, only 2% earn between ₦201,000 and ₦250,000.In Port Harcourt, 47% of respondents earn between ₦101,000 and ₦150,000, while 20% earn between ₦75,000 and ₦100,000 as well as ₦151,000 and ₦200,000. However, only 3% earn between ₦201,000 and ₦250,000.This finding on annual income of

respondents suggests that over 80% of respondents earn between ₦50,000 and ₦150,000 per annum. This can be described as grossly inadequate for an average family to cope with the cost of living including paying of house rent and other essential needs of the family. According to Ewa et al. (2013), these have often time led to landlord-tenant squabbles in which tenants are ejected from their homes by landlords.

Table 7: Results of analysis for % of income earned paid as rent by residents

	Uyo		Calabar		Port Harcourt		ANOVA	
% paid as rent	N	%	N	%	N	%	F	Sig.
0-10	7	7	3	6	4	6	6.090	0.003
11-20	9	10	7	14	13	18		
21-30	10	10	10	20	15	21		
31-40	40	43	5	10	19	27		
41-50	28	30	26	51	20	28		
Total	94	100	51	100	71	100		

Table 7 indicates that in Uyo, 27% of respondents spend 30% and below of their annual income as rent while 73% spend above 30%. In Calabar, 40% of respondents spend 30% and below of their annual income on rent while 60% spend more than 30%. In Port Harcourt, 45% of respondents surveyed spend 30% and below of their annual income on rent. This suggests that over 70% of respondents in Uyo spend more than 30% of their annual income for rent, 60% of the respondents in Calabar spend more than 30% of their annual income for rent, while 55% of respondents in Port Harcourt spend more than 30% of their annual income for rent. It is not out of place to argue that housing affordability has been compromised by this outcome. This is because researchers have opined that when households in the bottom 40% of income distribution spend more than 30% of their annual income on housing, they are deemed to be spending more than is necessary as rent (Cox and Pavletich, 2010; Ewa et al. 2013; Abimaje et al., 2013). The consequence is that households are left with little or nothing to spend on other essentials for the family such as food, clothing, transportation and Medicare.

Testing of hypothesis

Three hypotheses were postulated to ascertain if the variations observed in housing type, annual income range, and % paid as rent across the three cities were statically significant. The first hypothesis stated that there is no significant variation in housing type among respondents in the three cities. The second hypothesis stated that there is no significant variation in annual income among respondents in the three cities. The third stated that there is no significant variation in % of annual income paid as rent by respondents in the three cities. The hypotheses were tested with one way analysis of variance (ANOVA). Based on F distribution, the decision rule is that the hypothesis is accepted if the p-value is greater than 0.05, otherwise the hypothesis is rejected. The results of analysis are presented in tables 5, 6 and 7.

Table 5 shows that the p-value is 0.04 which is less than the significance level of 0.05. The first hypothesis is therefore rejected which means that housing types of respondents in the three cities are not the same. Table 6 shows that the p-value is 0.013 which is less than the 0.05 threshold indicating that the second hypothesis is equally rejected. This means that there is significant variation in the range of annual income of respondents in the three cities. Table 7 shows that the p-value is 0.003 and less that the significant level of 0.05. The third hypothesis is therefore rejected meaning that there is significant variation in the % of respondents' income paid as rents in the three cities. This finding implies that the housing type of respondents is significant different across the three cities. What is however not clear, is the nature of the difference. The possible explanation could be that the standard of living in these cities

varies. For instance, Port Harcourt is Nigeria's oil and gas capital and has the highest per capita income than the other two cities (Owei and Ikpoki, 2006). Therefore there could be more money in the hands of respondents in Port Harcourt to maintain their houses than those of the other two cities. This is further supported by the outcome of the other two hypotheses in which there was significant variation in the range of annual income and % of that income paid as rent.

Level of effectiveness of strategies for housing delivery

To examine the level of effectiveness of strategies in place for sustainable housing delivery, a pilot study was undertaken to find out strategies for housing provision currently in place in the three cities. Five of them were found to be in place. They were then subjected to views of respondents who were asked to rate the level of effectiveness of the strategies using a five-point scale of 1 = poor, 2 = fair, 3=moderate, 4=good, 5=excellent. A benchmark of the mean score was determined by summing the weightings and dividing by the number of weights (1+2+3+4+5/5=3). Therefore strategies that have mean scores greater than 3 are deemed effective, while those with means less that 3 are deemed not effective. The result of analysis showing the mean scores and rankings of the mean scores is presented in Table 8.

Table 8: Results of analysis for level of effectiveness of strategies for housing delivery

Strategies	Uyo (N=94)		Calabar (N=51)		Port Harcourt (N=71)		Average	
	M	R	M	R	M	R	M	R
Provision of mass housing	2.14	5	1.76	5	1.80	4	1.90	5
Use of private developers	2.20	3	2.39	1	2.31	1	2.30	1
Granting of mortgage loans	2.15	4	2.20	3	1.93	3	2.09	3
Easing of Land purchase and allocation	2.21	2	2.27	2	2.23	2	2.24	2
Build & sell at subsidised rates	2.28	1	2.04	4	1.65	5	1.99	4

Key: M = mean score; R = rank; N=number of respondents

Results indicates that the top three effective strategies in Uyo are "build and sell at subsidised rates" at first, "easing of land purchase" at second, and "use of private developers" at third. In Calabar, "use of private developers" was rated as the most effective, followed by "easing of land purchase" at second, and granting of mortgage loans" at third. In Port Harcourt, "use of private developers" was rated the most effective, followed by "easing of land purchase" at second, and "granting of mortgage loans" at third. "Provision of mass housing" was least rated across the three cities. The result also shows that none of the strategies had mean score of above 3, indicating that they have not been effective. This finding suggests that respondents were dissatisfied with all strategies in place for affordable housing in the three cities. This is supported by the work of Olotuah and Taiwo(2015) which observed that despite huge financial allocations to housing sector in Nigeria, very little has been achieved in meeting specific targets of housing delivery. The authors blamed the debacle on poor focus on the housing needs of the poor and lack of political will to take government housing schemes to logical conclusions. It is worth pointing out that this outcome has further substantiated the argument that the Niger Delta which sustains the nation's economy through oil has not felt the impact of housing schemes in the country. However, in terms of level of effectiveness of the strategies, findings indicate that there are divergent opinions on the level of effectiveness of the strategies in each of the cities used for the survey. For instance, Uyo residents were of the view that building and selling homes at subsidised rates is the most effective, those of Calabar and Pot Harcourt rated the use of private developers as the most effective. However, on the average, the use of private developers was the top rated strategy while provision of mass housing was the least rated. The use of private developers has however been largely ineffective because most of the houses delivered using

this model are usually beyond the reach of the low income group who in most cases do not have access to mortgage. This is made worse by the inability of mortgage institutions to offer good measure of financial intermediation in housing delivery because of what Olotuah (2001) described as inadequate capitalisation, weak management practices among other factors. The finding that provision of mass housing is the least effective strategy is supported by many studies such as Adedeji (2006), Adajumo (2008), and Olotuah and Taiwo (2015). The general conclusion from these studies has been that the provision of mass housing by government at both federal and state levels has not only been inadequate but failed to meet the expectations of the masses especially the low and middle income brackets.

Barriers to affordable housing for low income group in Niger-Delta

The third objective assessed the barriers hindering housing affordability for low income groups in the study area. The study identified 15 barriers from past studies such as Akeju (2007), Ugonaho and Emoh (2013), and Kgobetsi (2017). They were scrutinised by a focus group and subjected to the views of respondents. The result of analysis of their views is shown in table 9.

Table 9: Result of analysis for barriers to sustainable housing delivery

Barriers	Uyo (N=94)		Calabar (N=51)		P/Harcourt (N=71)		Average	
	M	R	M	R	M	R	M	R
High cost of building materials	3.72	1	3.91	3	4.32	1	3.98	2
Unstable macro-economic environment	3.64	5	3.90	4	4.31	2	3.95	4
Government legislation	3.55	7	3.22	9	3.17	14	3.31	12
Difficulty in acquiring land	3.29	10	3.67	6	3.59	9	3.52	7
High cost of land	3.51	9	4.24	1	4.22	3	3.99	1
Lack of primary infrastructure	3.71	2	3.49	7	3.76	7	3.65	6
Weak regulation policies	3.13	14	3.08	10	4.04	6	3.42	9
Difficulty in accessing loans from banks	3.14	13	3.73	5	4.17	4	3.68	5
Absence of a national credit data base	3.53	8	3.43	8	3.52	10	3.49	8
Shortage of skilled manpower in mortgage industry	3.26	11	2.92	15	3.15	15	3.11	15
Bribery & corruption	3.12	15	3.04	12	3.48	12	3.21	14
High community and youth charges	3.63	6	3.06	11	3.42	13	3.37	11
High urbanisation	3.69	3	2.98	13	3.49	11	3.39	10
Youth restiveness	3.19	12	2.96	14	3.61	8	3.25	13
Cost of living	3.65	4	4.08	2	4.15	5	3.96	3

The result shows that the top three rated barriers by Uyo respondents were “high cost of building materials”, “lack of primary infrastructure”, and “high urbanisation”, while the three least rated barriers were “difficulty in accessing loans from banks” at 13th, “weak regulation policies” at 14th, and “bribery and corruption”. Meanwhile, all the 15 barriers were significant. For Calabar, the top three barriers were “high cost of land”, “cost of living”, and “high cost of building materials”. The three least rated barriers

from Calabar were "high urbanisation" at 13th, "youth restiveness" at 14th, and "shortage of skilled manpower in the mortgage industry" at 15th. However, 12 of the 15 barriers were significant as their mean scores were more than 3. For Port Harcourt respondents, the top three barriers were "high cost of building materials", "unstable macro-economic environment", and "high cost of land". The three least rated barriers were "high community and youth charges", "government regulation", and "shortage of skilled manpower in the mortgage industry". Taking an average of the respondents' ratings in the three cities, the three top rated barriers were "high cost of land", "high cost of building materials", and "cost of living"; while the three least rated were "youth restiveness", "bribery and corruption", and "shortage of skilled manpower in the mortgage industry". The finding that high cost of land is the most rated barrier to affordable housing for the low income group is consistent with the findings of Akeju (2007), Ugonaho and Emoh (2013) and Ewa et al. (2013). The exorbitant cost of acquiring land in the Niger Delta region has made it almost impossible for the not too rich residents to build houses for their household. An average plot of land in this region costs between $3,000 and $5,000 and has continued to rise. This is clearly unaffordable for an average civil servant who earns about $500 a year. Findings also show that high cost of building materials and cost of living were the other top rated factors. The high cost of building materials recently orchestrated by government's monetary and fiscal policy changes has led to high cost of construction. The implication is that many people became very scared of embarking on building houses while both private developers and government contractors have had to increase their cost of building production. This extra cost is unfortunately transferred to the consumers who are made to paid more in order to live comfortably.

Kruskal–Wallis was used to determine whether the mean of significance of the 15 barriers to affordable housing was equal across the respondents (city of residence, qualification and occupation).Based on chi-square distribution, the decision rule for Kruskal–Wallis test statistic is that the null hypothesis is accepted if the significant level presented as asymptotic significance is greater than 0.05, otherwise the null hypothesis is rejected and alternate hypothesis is accepted. The hypothesis postulated states that there is no significant difference in the perception of respondents on the listed barriers to affordable housing for the low income group. The result is presented in table 10.

Table 10: Results of Kruskal Wallis test for barriers to housing delivery

Barriers to housing delivery	City of residence		Qualification		Occupation	
	Chi-square	p-value	Chi-square	p-value	Chi-square	p-value
High cost of building materials	13.591	0.001*	4.232	0.375	10.056	0.018*
Unstable macro-economic environment	21.543	0.000*	2.309	0.679	1.883	0.597
Government legislation	0.005	0.997	7.746	0.101	0.400	0.940
Difficulty in acquiring land	1.679	0.432	1.081	0.897	0.305	0.959
High cost of land	10.769	0.005*	3.106	0.540	0.800	0.850
Lack of primary infrastructure	13.331	0.001*	2.660	0.616	1.947	0.584
Weak regulation policies	30.509	0.000*	0.873	0.928	3.294	0.348
Difficulty in accessing loans from banks	11.261	0.004*	9.985	0.041*	1.360	0.715
Absence of a national credit data base	2.687	0.261	6.047	0.196	5.975	0.113
Shortage of skilled manpower in mortgage industry	1.629	0.443	0.248	0.993	2.475	0.480
Bribery & corruption	7.347	0.025*	2.948	0.567	5.716	0.126
High community and youth charges	7.488	0.024*	2.130	0.712	2.480	0.479
High urbanisation	7.531	0.023*	5.262	0.261	0.585	0.900
Youth restiveness	11.774	0.003*	3.523	0.474	3.304	0.347
Cost of living	11.929	0.003*	5.961	0.202	1.385	0.709

Note: *p is significant at p > 0.05; * = p < 0.05*

The result indicates that in terms of city of residence, the hypothesis was rejected for 11 of the 15 barriers as their p-values were less than 0.05. The hypothesis was however accepted for 4 barriers namely

"government legislation", "difficulty in acquiring land", "absence of national credit base" and shortage of skilled manpower in the mortgage industry. However, in terms of qualification and occupation, the hypothesis is accepted for virtually all the 15 barriers. This means that when respondents are stratified based on qualification and occupation, their opinions expressed through ranking of the barriers were unanimous with no dissenting voice. This finding therefore generally suggests that there is unanimity of opinion among respondents on the ranking of the barriers to affordable housing. The possible explanation for dissenting opinion in the 4 barriers for which the hypothesis was rejected may be because respondents are not keen about these barriers as findings show that they are not among the top rated.

Conclusion and Recommendations

To recall, this study examined the state of housing delivery for the low income group in the Niger Delta using data from three strategic Niger Delta cities of Calabar, Uyo and Port Harcourt. Housing affordability across the three strategic cities of Niger Delta is significantly below the internationally accepted thresholds. As a result, majority of households are spending more than is necessary from their income to foot the rent bills leaving little or nothing for other basic necessities of life. This has often time led to overcrowding. However, there is significant variation in the housing type, range of annual income, and % of income paid as rent across the three cities. This could have been attributed to varying standard of living. Besides, the level of effectiveness of strategies for affordable housing in the cities has been insignificant as they have not made the required impact. However, the use of private developers was rated the most effective strategy. Meanwhile, high cost of land, high cost of building materials, and high cost of living are identified as the major barriers to affordable housing in Niger Delta.

The study has added to housing literature by providing insights into the state of housing crisis in the Niger Delta region of Nigeria with regards to housing affordability and strategies for affordable housing. Besides, the outcome of this study has provided the needed feedback from the region that sustains the nation's economy to enable government and other stakeholders step up measures to ameliorate the housing crisis in the region. Based on findings of the study, it is recommended that (1) government at both federal and state levels should step up measures to reduce the high housing deficit prevalent in the Niger Delta and Nigeria as a whole; (2) stakeholders should embrace innovative, sustainable and economical building technology for housing construction to bring down the high cost of constructing homes. This way, the low income group can own houses at an affordable cost; (3) the country's mortgage institutions should increase its responsibility of granting credit facilities with low interest rates to civil servants who mostly fall into the low and middle income brackets to enable them build their homes; and (4) government should as a matter of urgency review and increase the current minimum wage as the current take-home salary of an average worker can no longer take them home. This way, many can pay their rents with ease.

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COMPRESSIVE STRENGTH AND MICROSTRUCTURE OF TERNARY BLENDED CEMENT MORTAR CONTAINING PALM OIL FUEL ASH AND METAKAOLIN

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Abstract
The combining effect of palm oil fuel ash (POFA) and metakaolin (MK) as cement replacement materials on the compressive strength and microstructures of blended cement mortar was investigated in this study. Cement mortars of binder to sand ratio of 1: 2.75 and binder to water ratio of 0.55 were produced and cured in water for 7, 28 and 90 days. The cement was partially substituted with both POFA and MK at 20% levels.The X-Ray Diffraction (XRD) and Thermogravimetry Analysis (TGA) techniques were used for the microstructure analysis.The results show that, at early age (7 days), the compressive strengths of the cement mortar specimens blended with POFA alone (20PF), MK only (20MK), and combination of POFA and MK (10PF10MK) were 84%, 115% and 103% of the unblended (OPC) specimen (37 MPa) respectively. However, at later age (90 days), the compressive strengths of OPC, 20PF, 20MK and 10PF10MK increased to 50.52 MPa, 52.90 MPa, 52.44 MPa and 53.31 MPa respectively. Impliedly,the simultaneous use of POFA and MK is not only beneficial in compensating for the low compressive strength of binary POFA at early age but also improve the long term strength development of the binary blend of MK. Therefore, the ternary blend of POFA and MK can be used as cement replacement material especially where early and later strength development is important.
Keywords: Compressive strength; Metakaolin; Microstructures; Palm oil fuel ash; Ternary blend

Introduction

Partial substitution of Portland cement with pozzolanic materials has been a sustainable way of improving the performance of concrete or mortar and of curtailing the environmental issues related to Portland cement (PC) production. During cement production, about one ton of CO_2 is emitted to atmosphere for every one ton PC produced. In fact, 5-8% of the total global anthropogenic CO_2 emission emanates from cement production (Rashad, 2013). Furthermore, since most of the pozzolanic materials are industrial wastes, their use has also been beneficial in reducing environmental problems related to their disposal. Pozzolanic materials are siliceous or siliceous and aluminous materials that react with calcium hydroxide liberated during cement hydration to produce secondary cementitious compounds that improve strength and durability (ASTMC125, 2013). The commonly used pozzolanic materials include; fly ash, silica fume, rice husk ash, and metakaolin (MK). However, each of these materials has a different physical characteristics as well as distinctive chemical reaction behavior with calcium hydroxide. Consequently, the influence of each of these materials on the properties of concrete varies. Whilst some materials are deficient others exhibit contrasting influences on the properties of concrete or mortar. However, the simultaneous use of two pozzolanic materials to replace cement as a ternary blend has the potential of not only minimizing the deficiencies but also optimizing the benefits of these materials on the properties of concrete or mortar.

Palm oil fuel ash (POFA), an agro-waste ash obtained from burning palm oil residues as biomass for energy production in palm oil mills has recently been established to be a good pozzolanic material(Jaturapitakkul, et al., 2007).POFA improves long-term strength(Kroehong, Sinsiri, and Jaturapitakkul,2011), moderates heat of hydration(Awal & Hussin, 2011), minimizes expansion due to alkali-silica reaction and improves other durability properties of concrete(Awal & Hussin, 1997; Tangchirapat, et al., 2012). However, due to its low pozzolanic activity, it delays early strength development of concrete (Jaturapitakkul, et al., 2011). This may limit the use of POFA as cement replacement material where early strength development is paramount such as, in precast industry. However, the low strength development of POFA may be enhanced with the addition of high pozzolanic

material such as silica fume or metakaolin that improves strength development at early ages. MK, a calcined product of kaolinite clay or paper sludge produced at the temperature range of 600 to 850 ^{o}C, has also been used as pozzolanic material long ago(Rashad, 2013). MK, due to its high pozzolanicactivitywas shown to improve both early and long term strength development of concrete (Ramezanianpour and Bahrami Jovein, 2012). In addition, the permeability, resistance to expansion due to alkali-silica reaction and other durability properties of concrete were also improved with the use of MK (Shekarchi, et al., 2010; Khatib andWild,1998).Despite the potential benefits of combining POFA and MK in enhancing the properties of mortar, there are no much studies reported. Therefore, in this paper the effect of combining POFA and MK on the compressive strength and microstructure of cement mortar is investigated.

Materials and Methods

The materials and the methods used to achieve the objective of this paper are described in this section. Portland cement (ASTM Type I), POFA and MK were used as binders in this study. The POFA was obtained from a palm oil mill located in KilangSawit PPNJ, Kahang, Malaysia. Before used, the as-received POFA was oven-dried at 105 ^{o}C temperatures for 24 hours to remove moisture, and then sieved using 300µm sieve to remove larger particles. To improve its pozzolanicity, the POFA passing 300µm sieve was ground for 2.5 hours by using a modified Los Angeles abrasion test machine having 8 stainless steel bars (16mm diameter and 900mm long) as a substitute for steel balls. However, the metakaolin was produced by thermal treatment of an industrially-processed kaolin (KM 40) obtained from Kaolin (Malaysia) SdnBhd, Malaysia. The kaolin was thermally treated at 650^{o}C temperatures for 1 hour (Usman, et al., 2013) in a laboratory furnace under controlled conditions. The chemical compositions and physical properties of the binders are presented in Tables 1 and 2 respectively. As shown in Table 1, the summations of the major oxides (SiO_2+Al_2O_3+Fe_2O_3) for both POFA and MK are greater than 70%. In addition, the strength activity index (Table 2) which indicates the reactivity level of the two materials are above the minimum value of 75% recommended by the standard requirements (ASTM C 618, 2012). Hence, the MK and POFA used in this study can be classified as Class N and Class F pozzolans respectively. Sand of 1.18mm maximum size and specific gravity of 2.60 was used as fine aggregate. The sand was supplied by the Plenitude Capital Sdn. Bhd, Malaysia. The fineness modulus and absorption capacity of the sand were 2.57% and 2.4%, respectively. A polycarboxylic ether based superplasticizer (GLENIUM ACE 388) was used to achieve the required flow at the fixed free water content.

Mortar mixtures of constant binder to aggregate ratio of 1:2.75 and water to binder ratio of 0.55 were produced in accordance with ASTM C 109(2011). OPC was partially substituted with POFA andMK at 20% levels by weight to produce binary and ternary blended mixes.The mix with 100% OPC was used as control with which binary and ternary mixtures were compared. The mixture formulations are shown in Table 3. After mixing and molding, the mortar specimen (cubes of 50 × 50× 50 mm size) were covered with plastic sheets and kept in the laboratory for 24 hours. The specimens were then demolded and immersed in water for 7, 28 and 90 days. However, for the microstructure test, the specimens were prepared by grinding the remnants of the crushed mortar specimens for compressive strength test to powder passing 45 µm sieves. Before grinding, the specimens were immersed in acetone to stop hydration. This method was successfully used in the previous study (Luz and Pandolfelli, 2011).

Compressive strength test on the specimens at the end of the curing ages was carried out based on the ASTM C 109(2011) procedure. Five specimens per mixture were used for the compressive strength test at each point. However, the development of microstructure of the specimens by monitoring the formation of hydration products due to cement hydration and pozzolanic reaction was examined using the thermogravimetry Analysis and X- ray diffraction techniques. The thermogravimetric analysis was conducted on the specimens by monitoring the weight while heating up from 25 to 1000 ^{o}C at 10 ^{o}C min^{-1} and purging with nitrogen gas at a flow rate of 50 ml min^{-1} in a Mettler-Toledo (TGA/DSC 1 Star system). The amount of calcium hydroxide (CH) expressed as the % of ignited weight of sample was

calculated using Equation 1 (Sumadi, 1993). This equation allows for adjusting the content of calcium hydroxide that reacted with atmospheric CO_2 to form calcite (CC).

$CH\ (\%) = (4.111 \times W_{CH}) + (1.6818 \times W_{CC})$ ----------Equation 1

Where, W_{CH} = weight loss due to decomposition of calcium hydroxide at between 400 to 500°C; and W_{CC} = weight loss due to decarbonation of calcite at between 500 to 800°C. The precise weight losses were read from the thermogravimetric curves. The XRD test on the specimens was conducted using D8 advance, Bruker X-ray diffractometer with Cu K_α radiation (λ= 1.54 ´). The specimens were scanned over the range of 10 to 60° (2θ) with a step of 2θ= 0.020° and time per step of 15.4s.

Table 1 Chemical composition of binders

Chemical composition %	OPC	POFA	Metakaolin
Silicon dioxide (SiO_2)	19.78	63.70	54.70
Aluminium oxide (Al_2O_3)	3.898	3.68	39.90
Iron oxide (Fe_2O_3)	2.995	6.27	1.43
Calcium oxide (CaO)	63.38	5.97	-
Magnesium oxide (MgO)	2.001	4.11	0.34
Sulfur trioxide (SO_3)	2.851	1.59	-
Sodium oxide (Na_2O)	0.75	-	-
Phosphorus pentoxide (P_2O_5)	0.1248	4.26	-
Chloride (Cl)	0.0005	0.50	-
Potassium oxide (K_2O)	0.180	9.15	2.58
Titanium Oxide (TiO_2)	-	0.30	0.70
Loss on Ignition (LOI)	1.90	7.95	1.5
$SiO_2 + Fe_2O_3 + Al_2O_3$	-	*73.65*	*96.03*

Table 2 Physical properties of binders

Properties	OPC	POFA	Metakaolin
Specific gravity	3.15	2.42	2.19
Median particle size, D_{50}(μm)	15.90	10.89	6.67
Strength Activity Index (28 days)	-	98	111

Table 3 Mix formulation of plain and blended cement mortar

Mortar type	Binder content (% by weight)			Superplasticizer dosage to achieve mortar flow of 136 ± 10 mm	
	OPC	MK	POFA	Superplasticizer content (%)	Flow achieved (mm)
Plain (OPC)	100	0	0	0.00	136
Binary POFA (20PF)	80	0	20	0.00	148
Binary MK (20MK)	80	20	0	0.50	134
Ternary (10PF10MK)	80	10	10	0.00	138

Binder to Aggregate to ratio, 1:2.75; water to binder ratio, 0.55

Results and Discussion

The compressive strength of plain and blended mortars at different curing ages is shown in Figure 1. It is clear that the compressive strengths for all the mortars increased with increasing hydration age but the rate of strength increase varies with curing age and the type of pozzolanic material used. The 20MK mortar exhibited superior strength at all ages while 20PF mortar exhibited inferior strength at early age (7 days), comparable at 28 days, and higher at later age (90 days) than the corresponding plain OPC mortar (control). Interestingly, the ternary blended mortar also showed higher compressive strength than the plain OPC mortar at all ages. Furthermore, in comparison to the binary blends, the ternary blend showed better strength performance than the binary blend of POFA at early age. At later age, however; the strength improvement of ternary blend was not only better than that of binary blend of POFA but also the binary blend of MK. The compressive strengths of OPC, 20PF, 20MK and 10PF10MK were 36.61 MPa,

30.77 MPa, 42.05 MPa and 37.86 MPa at 7 day and eventually increased to 50.52 MPa, 52.90 MPa, 52.44 MPa and 53.31 MPa at 90 days respectively. Therefore, the simultaneous use of POFA and MK is not only beneficial in compensating for the low compressive strength development of binary POFA at early age but also improves the long term strength development of binary MK. Similar benefits were also observed by combining MK and fly ash(Vance, et al 2013), and MK and rice husk ash(Shatat, 2013).

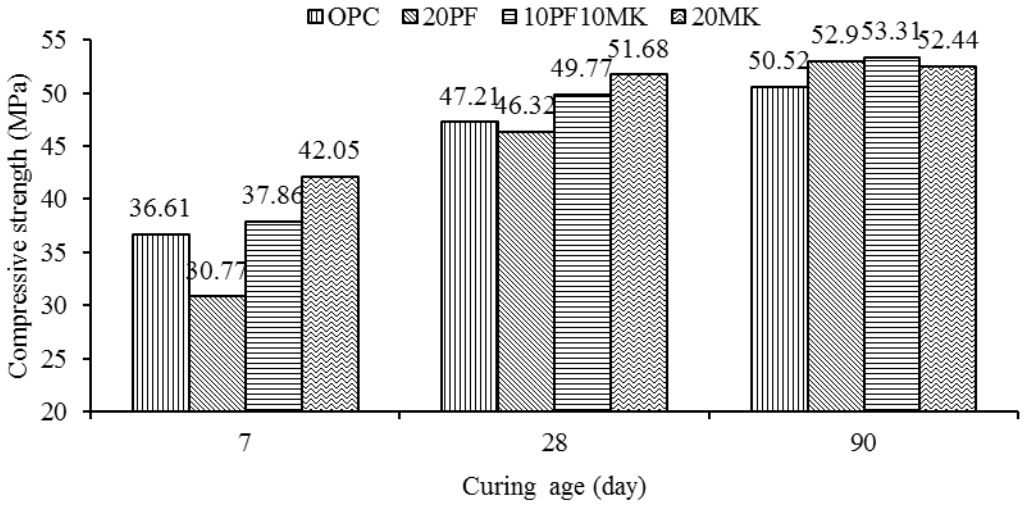

Figure 1: Compressive strengths of mortars

The thermogravimetric analysis and derivative thermogravimetric (TG/DTG) curve for the plain OPC mortar specimen at 7 is presented in Figure 2. The curves for the other mixes are not presented since they show trend quite similar. Mass loss transitions in three distinct stages can be observed. The first stage at the temperature range of 23 to 400^{o}C indicates the mass loss associated with the absorbed water molecules as well as dehydration of C-S-H, ettringite and other hydrated silicate-aluminate phases (Chindaprasirt, et al., 2013). The second stage at 400 to 500^{o}C is due to the decomposition of calcium hydroxide(Rostami, et al., 2012) while the third stage at 500 to 800^{o}C shows the mass loss related to decarbonation of calcite(De Weerdt, et al., 2011).The calcite present is attributed to the secondary reaction of calcium hydroxide with atmospheric CO_2 since no limestone was used.However, only the mass losses related to calcium hydroxide and calcite were considered to monitor the progress of pozzolanic reaction by quantifying the calcium hydroxide content.

The calcium hydroxide content of plain and blended mixes at 7, 28 and 90 days are presented in Figure 3. It is clear that the calcium hydroxide content of the plain mix increased with time, and remains nearly constant after 28 days. However, the blended mixes showed reduction in calcium hydroxide content compared to plain mix at all ages. The reduction increased with the curing age at different rate depending on the type of blend. The 20MK mortar exhibited significant reduction in calcium hydroxide content compared to plain mortar at all ages. At 7 days, the hydroxide content was about 39.7% lesser than that of the plain mortar (20.86%). At 28 and 90 days however; the hydroxide content was 55% and 52% that of the plain mortar, respectively. However, for the 20PF mortar, the calcium hydroxide content was slightly lower than that of the plain at 7 days but progressively reduced with age. At 7, 28 and 90 days, the calcium hydroxide content was 9%, 21% and 42% lesser than that of plain mortar respectively. The high content of calcium hydroxide in the 20PF mortar compared to 20MK mortar at 7 days despite the reduction of cement by 20% suggests that POFA accelerates hydration reaction but contributes little to pozzolanic reaction at early age. The acceleration is due to the smaller particle size of POFA that provides nucleation site for C-S-H gel. Furthermore, the portlandite content for the ternary blended mortar was reduced at all ages compared to plain mortar but the rate of decrease varied with the curing ages. At 7

days, the portlandite content was 15.35% of the ignited weight which is equivalent to about 74% of the corresponding value for the plain mortar (20.86%). At 28 days, the calcium hydroxide content was not only lesser than that of plain mortar but also lesser than that of 20PF mortar. Moreover, at 90 days, the ternary blend was more effective in reducing calcium hydroxide than the corresponding binary blends of POFA and MK. In fact, at 90 days, the calcium hydroxide content of the ternary mix was about 3% lesser than that of MK.

As the reduction of calcium hydroxide is a measure for material pozzolanicity(De Weerdt, et al., 2011), the high rate of reduction corresponds to rapid pozzolanic activity which in turn would result in high pozzolanic material contribution to strength. Therefore, the high strength of binary blend of MK and the ternary blend at both early and later age can be explained by the high pozzolanicity of MK while the low strength development of binary blend of POFA at early can be attributed to low pozzolanicity of POFA.

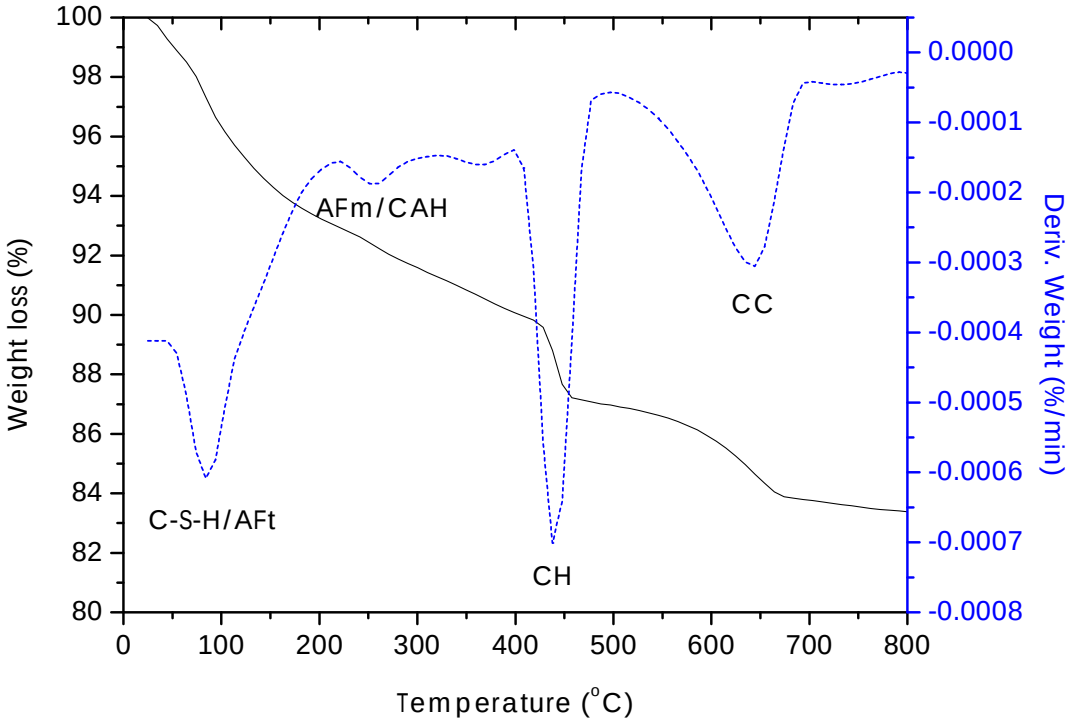

Figure 2: TG/DTG curves for plain mortar at 7 days

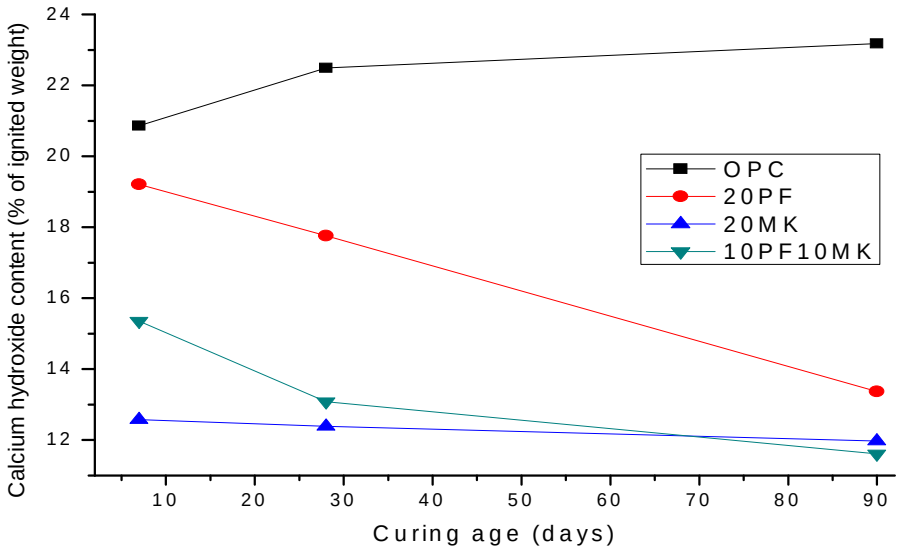

Figure 3: Calcium hydroxide content of mortars

The XRD patterns of plain and blended mortars at 7, 28 and 90 days are shown in Figures 4, 5 and 6, respectively. Calcium hydroxide (Portlandite), calcite, quartz and unreacted alite and belite can be seen as the crystalline phases in all the mortars. However, the focal point of interest is the portlandite content (indicated by its peak intensity) since it indicates the progress of cement hydration and pozzolanic reactions. At early age (7 days), as shown in Figure 4, the portlandite content is; remarkably reduced in 20MK mix, almost similar in the 20PF mix but slightly reduced in the ternary mix compared to plain OPC mix. At later ages (28 and 90 days) as shown in Figures 5 and 6 respectively, the amount of portlandite and unreacted alite and belite in all the blended mixes progressively and significantly reduced, marking the progress of hydration and pozzolanic reactions in all the blended mixes. These results corroborate the TGA results.

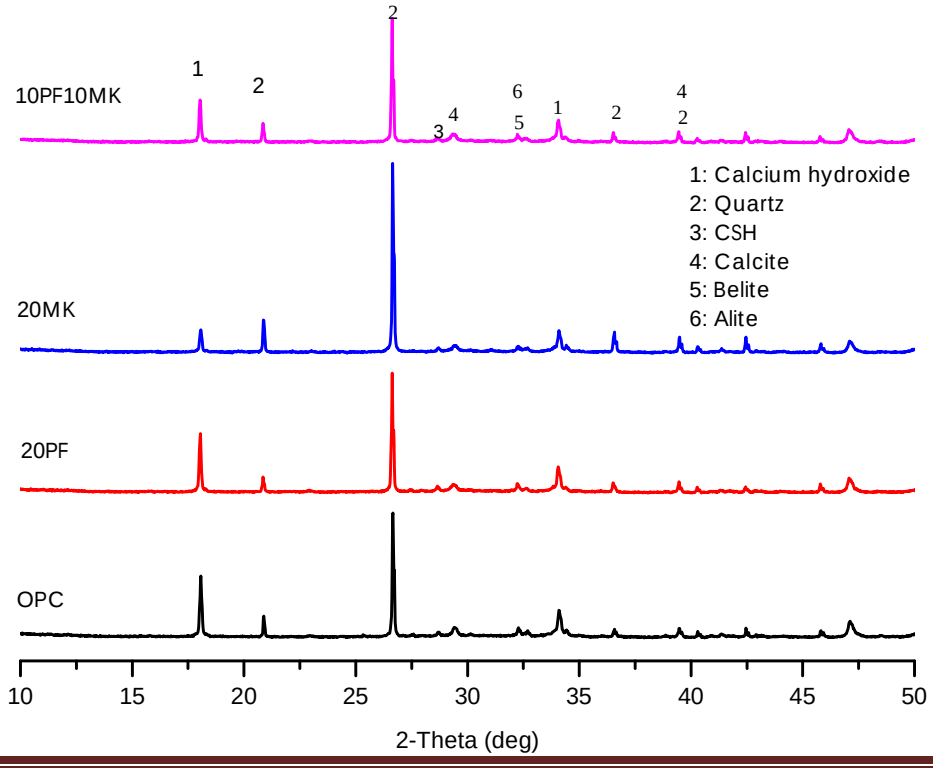

Figure 4: XRD patterns of mortars at 7 days

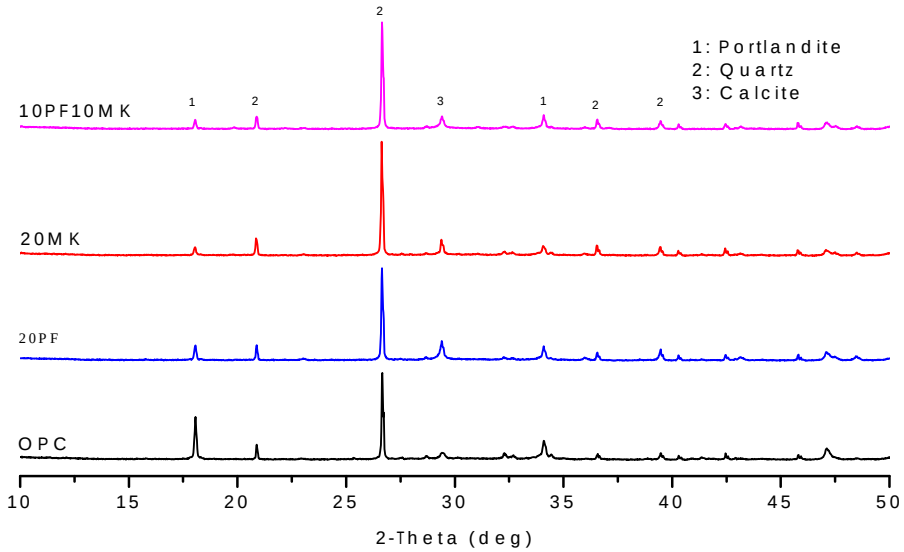

Figure 5: XRD patterns of mortars at 28 days

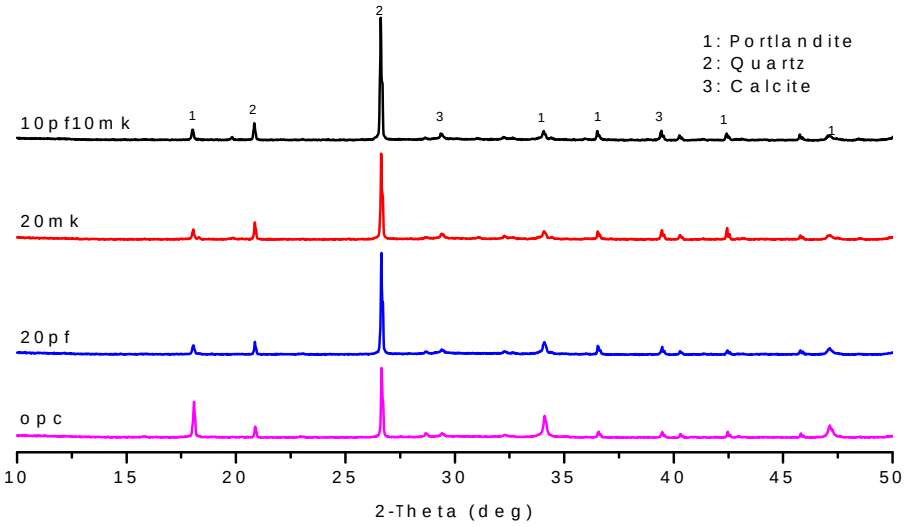

Figure 6: XRD patterns of mortars at 90 days

Conclusion and Recommendation

Based on the results obtained from this study, it is concluded that the simultaneous use of POFA and MK is not only beneficial in compensating for the low compressive strength development of binary POFA at early age but also improve the long term strength development of binary MK. Interestingly, the TGA and XRD results confirmed that the strength improvement of binary blend of MK and the ternary blend at both early and later age is due to high pozzolanicity of MK while the low strength development of binary blend of POFA at early is attributed to the low pozzolanicity of POFA. Cement mortar made with the combination 10% POFA and 10% MK as cement replacement can be used where early and long term strength development may be required.

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GBXMLAS BIM INTEROPERABILITY SCHEMA FOR BUILDING ENERGY ASSESSMENT

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Abstract
Whereas, Building Information Modelling (BIM) enables smart integration, collaboration, precision, quality and efficiency in project delivery, its application does not come without challenges such as high cost of BIM software and training, resistance to change, legal barriers, interoperability problems, among others. Thus, this study aimed at proffering solutions to problems associated with BIM interoperability. To achieve this, Revit Architecture BIM software was used to generate an academic building's 3D architectural model which was subsequently exported using the Industry Foundation Classes (IFC)and Green Building eXtensible Markup Language GBXML schemas, into the Integrated Environment Solution <Virtual Environment> (IES VE) software, assessment of components and geometry. Results of interoperating the model established that the IFC model was not consistent with the architectural form of the building, whereas, the GBXML model produced an architype of the architectural model. Hence, the GBXML model was used for the energy assessment. Further, from the findings of the assessment, the building under consideration has a total energy consumption of 106.32 kWh/m^2; this is well in excess of the indicative target of 64.62 kWh/m^2. Accordingly, the building's CO_2 emission rate of 39.2 $KgCO_2/m^2$ exceeds the target emission value of 21.3 $KgCO_2/m^2$ for a building in its class (notional). These high energy rates are due to the dependence on fossil energy sources and the absence of renewable energy sources such as photovoltaic systems, wind turbines, solar thermal systems, etc., that serve as CO_2 sinks and means of supplementing the fossil sources of energy generation. Finally, the overall performance of the building is rated as "C".
Keywords: BIM; GBXML; Interoperability Schema; IFC; Simulation*.*

Introduction

In contemporary times, the construction industry has faced great challenges of embracing the rapidly emerging technology known as Building Information Modelling or Product Data Modelling or Integrated Design Systems or Building Product Modelling (Penttilä, 2006). The technology requires good understanding of how to model the digital life of a building in order to manage the entire lifecycle of the physical building. Thus, for both existing and projected buildings, BIM requires modelling the complete geometry of such buildings, before any assessment or simulation would be carried out on the model. However, most separate discipline 'BIM' tools do not have the required capability for a complete modelling of the architectural, mechanical, structural, and electrical forms or components of the building. The construction industry is therefore faced with the problem of modelling a building form or component in the appropriate tool of the concerned discipline and making same available for other disciplines to use for assessments. This requires that the model is interoperable, that is, could be shared in different schemas. This study aimed at proffering solutions to problems associated with BIM interoperability. To achieve this aim, the study concentrated on four objectives of developing the Architectural, IFC and GBMXL Models of building under consideration; determining the suitability of the IFC and GBMXL Models for energy performance simulation; simulating the building's energy performance; and to produce the building's energy label.

The Building Information Modelling Concept

The first description of the BIM concept was given by Eastman (1975) in his explanation of the 3D modelling capabilities of a computer, where any alteration(s) of arrangement would have to be made only once for all future drawings to be updated. Thus, all other drawings derived from the same arrangement of the elements would automatically be consistent. Further, Penttilä (2006) suggested that Building Information Modelling (BIM) is a methodology to manage the essential building design and project data in digital format throughout the building's life cycle. When viewed from the perspective of the construction stakeholders, Egbu and Sidawi (2012) considers that BIM provides the means for stakeholders to query, simulate and estimate activities and their effects on the building process as a

lifecycle; hence, leading to the required value judgment for creating a more sustainable infrastructure. The Architecture, Engineering and Construction (AEC) industry has also experienced great advancements in the different disciplines. Below are the different levels of BIM developments.
Level 0: Drafting in 2D hardcopy or CAD or electronic (pdf, jpeg …) formats – Unmanaged;
Level 1: Managed geometrical shapes in 2D or 3D formats with collaborative capabilities;
Level 2: A managed 3D environment of separate discipline 'BIM' tools and data;
Level 3: (4D modelling) Level 2 + Integrated and collaborated processes enabled by web services. This level of BIM will utilize 4D construction sequencing, 5Dcost information and 6Dproject lifecycle management information (Pinsent, 2012).
Level n: nDModelling (3D + Cost information + Sequencing + lifecycle management + ...)
Based on the levels of BIM development, it is construed that *level 0* which is unmanaged, clearly does not constitute BIM application; more so, the 3D Model element of the *level 1*, technically makes it only a 'component' of BIM, and not BIM in itself. The *level 2* BIM development which entails holding separate BIM tools and data in a 3D environment is relatively considered as BIM. However, the aim of creating a standalone manageable BIM model with collaborative features as required in the *level 3* BIM, remains unachieved (part of the requirements of *level 3* BIM is illustrated below in Figure1). This explains where we are in the BIM technology *level 2*. Moving from *level 0* to *level3* BIM can be likened to the transition from paper drafting to CAD; and there seem to be more possibilities of separate disciplines maintaining their BIM models and sharing their digital data / knowledge using interoperable platforms, than attaining the *level 3* BIM soon.

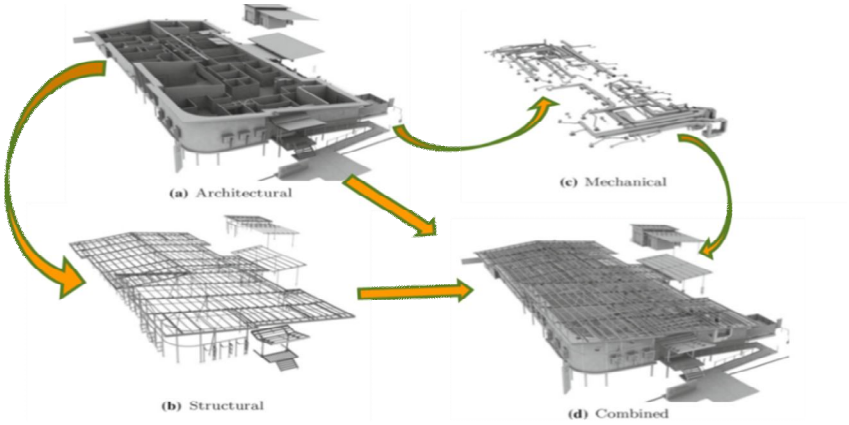

Figure 1: A standalone manageable BIM model with collaborative features
(Steel, Drogemuller and Toth, 2012)

Major Issues Associated with BIM Application
Several problems have been identified as key barriers to a functional application of the BIM technology. Research by Osello, et al. (2011) revealed the problems associated with application of BIM to include: resistance to change; lack of requisite BIM education/training; shortage of skilled trainers; lack of personal incentives; legal barriers; security of ICT processes; technology barriers; incompatibility / interoperability problems; difficulties in using new technology; high training and hardware/software costs; among others. Of these challenges, BIM model interoperability constitutes a major barrier to full BIM adoption because it is neither best practice to always carry out a fresh model of complex structures for BIM assessments, nor is it possible for the plug-ins of various BIM software vendors to fully decode and translate exchange files into complete models. It therefore remains difficult to easily find a solution to BIM interoperability issues because it requires an in-depth understanding of a specific model by several software vendors, and development of exchange files that are capable of containing the design

information after importing such files into BIM software for analysis or simulations. The problem of BIM interoperability is further discussed in the succeeding sections of this study.

The problem of BIM Interoperability

BIM interoperability is a major requirement of any BIM software, as it enables the accurate exchange of data, information, models, *et cetera* among ICT platforms or software. BIM interoperability may be defined as *"the ability of two or more systems or components to exchange information and to use the exchanged information"* (Osello, et al., 2011) or *"the ability to exchange data between applications, which smoothes workflows and sometimes facilitates their automation"* (Eastman, Teicholz, Sacks and Liston, 2011). Model interoperability remains an indispensable means of sharing data in file-based formats. This may be limited to geometry, typical of DXF (Drawing eXchange Format) and IGES (Initial Graphic Exchange Specification) or in both graphic and data-embedded formats, such as the eXtensible Markup Language (XML) and the Industry Foundation Classes (IFC) (Zhyzhneuski, 2011). The Industry Foundation Classes (IFC) is an industry-developed standard for the design and full life cycle of buildings; whereas, the Green Building XML is a scheme developed to transfer information needed for energy analysis of building envelopes, thermal zones, components and locations, and other HVAC simulations (Osello, et al., 2011). As highlighted by Osello, et al. (2011), traditional two-dimensional drawings (2D CAD) in the AEC industry create communication gaps among architects, owners, contractors, and other stakeholders, and this exists in all project phases. According to the authors, to solve this problem, a BIM model is created to include all geometry, physical characteristics and other data needed to fully describe the building; then all drawings, schedules, simulations, and services required during the building life cycle can be hypothetically extracted from the model. The study by Osello, et al. (2011), established that even as there are exchange standards for data export between software, there is often great information loss from the original native parametric model, since they reduce the model to static geometry and attributes – solid, surface, or wireframe. It is therefore important to ensure that the greatest amount of data or information is captured in the exchange file in an interoperable way, since any BIM analysis or simulation result can only be as accurate as the input data for the simulation or assessment (Osello, et al., 2011).

Another prevailing barrier to BIM application is professionals' inability to carryout BIM assessments using unknown software. This challenge has raised the need for interoperability or sharability of models produced using already known software for BIM applications (Jack & Eric, 2013). For instance, it would amount to waste of time and other resources, engaging a Building Services Engineer in a process of modelling the Architectural form of a complex building before undertaking an energy performance assessment on the building model using energy assessment software such as the Integrated Environment Solutions (IES). Most times, even existing architectural model cannot be transferred into the IES software. To this Osello, et al. (2011), clearly noted that manual data input or repetition of avoidable modelling for any assessment wastes time and resources that would have been used for productive simulation runs. To this, the authors considered that incompatibility/interoperability problems and the lack of standardization constitute a primary BIM technology barrier, and suggested that utilizing BIM as a data source and interoperability as format exchange for any analysis would enable greater efficiency in adopting BIM and making existing data more reusable.

Interoperability challenges fall under the File and syntax, and visualization and semantic (Steel *et al.*, 2012). Very large files such as mechanical and electrical services models are often difficult to load or render in other BIM tools; similarly, poor coordination of building geometry such as gap between a wall and an upper floor is capable of leading to syntax error in the file exchange format. These problems constitute the file and syntax interoperability challenges. Also, imported models often assume different colours that end up communicating different meanings when viewed. This may be seen where two structural members (Beam and Column for instance) appear in different colours even as they are made up

of same composite material (concrete); hence, this is seen as an interoperability challenge at visualization level. Lastly, semantic interoperability problems are encountered as the industry moves deeper into BIM which requires more digital information to be precisely interpreted by file exchange platforms. Even as the Industry Foundation Classes (IFC) is the accepted standard for design models, its data schema does not hold information covering all disciplines. This makes it semantically difficult to decode information not earlier encoded in its data schema (Steel e*t al.,* 2012).

Research Methodology

The building under assessment is a three-floor University building with mixed usage including discussion spaces for academic sessions, the students' association office, the 24/7 Radio broadcast and entertainment unit, the indoor games hall, 24 hours computer laboratory, kitchen, Toilets and Baths, among others. Data used for the analyses were from secondary sources, specifically from the energy readings of the Building Management System that monitored the buildings energy processes. CAD software (AutoCAD) and two *level 2* BIM software programs (Revit and IES VE) were used to model and conduct the Simplified Building Energy Model (SBEM) and Dynamic Simulation Modelling (DSM). The building's external wall is covered with aluminium cladding, a100mm facing brickwork,75mm ventilated mineral wool filled cavity and 100mm concrete blocks, internally finished with a lightweight plaster. The internal walls are made up of plasterboard partitions fixed to studs mostly used between the open offices, debate and large shared spaces; and 125mm sandcrete block work used in areas such as the severy, cellular offices, plant room, etc. Suffice it that this study used data from an academic complex, with detailed records of its energy processes. These data were collected on a note of utmost confidentiality and anonymity; thus, the name of the University is excluded, as this research is purely for academic purposes.

Analysis and Discussion of Findings

This section reveals the analyses of the collected data and a detailed presentation of the results. These analyses heralded a carefully interpretation of the findings, and discussion of the results.

Architectural and BIM Models (IFC and GBMXL)

It is pertinent to note that BIM software programs are of two kinds: Authoring software – such as Autodesk Revit Architecture, Sketch-up, Bentley systems, etc., and Coordination software – including Bentley Projectwise, IES VE and Autodesk Navisorks etc (Pinsent, 2006). The authoring software programs are majorly architectural design specific, whereas, the coordination software takes the architectural model created in the authoring software and adds cost, time, energy or scheduling information for assessment purposes. It is believed that as BIM matures, these two elements will be integrated in subsequent BIM tools (Pinsent, 2006). For the purposes of this study, REVIT Architecture software was used to generate the building's 3D model from the CAD format. Subsequently, the building model was exported in the Industry Foundation Classes (IFC) and Green Building eXtensible Markup Language (GBXML) formats, for energy performance analysis in the Integrated Environment Solution <Virtual Environment> (IES VE) software. Figure 2 reveals the Architectural, IFC and GBMXL Models of the building under investigation. The basis of first using the Revit Architecture to model the building is to ensure that the building is completely produced as built. This contrasts with directly using the BIM simulation software to model the building and also carry out the assessment, as the use of architectural software to model the building ensures that the architectural forms required for any energy assessment are in place, before the operation. The 3D model of the ground, first and second floors of the building shows the external and internal components of the building. The Revit application enables the selection of the exact materials as existing, considering their thicknesses, U-value (the rate of heat transfer or loss) and R-value (the measure of thermal resistance). The complete 3D perspective is the integration of the three floor levels.

After modelling the building, the next process is the Model Room Check. This process ensures that all sides of each room are properly bound and no two units are fused together because of missing surfaces.

Further, the Model Room Check constitutes the calculation of the volume, floor area, ceiling area, external walls, internal walls, total glazing, ratio or volume to Area (m), ceiling holes / ceiling, floor holes / floor, area ratios of floor / ceiling, total / wall floor, eternal wall / floor, window / wall and missing surface area (m^2). These were deduced and the result of this exercise is contained in the appendix section (Table 4). A total of 86 rooms were assessed – 31 rooms on the ground floor, 30 rooms on the first floor and 25 rooms on the second floor. Once the Model Room Check is complete and there is no missing surface, then the model is exported to an operable format.

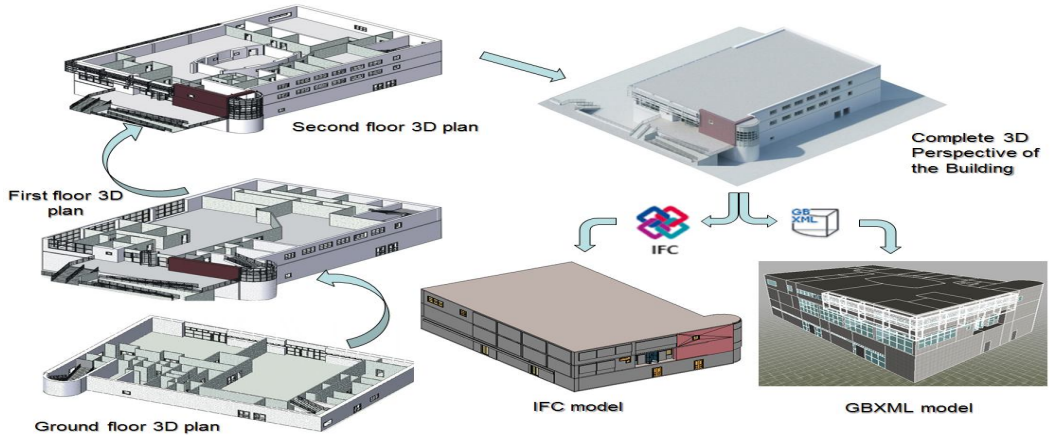

Figure 2: The Architectural, IFC and GBMXL Models

For this exercise, the model was exported to the Industry Foundation Classes (IFC) and Green Building eXtensible Markup Language (GBXML) formats, before finally importing the interoperable file into Integrated Environment Solution Virtual Environment software for energy performance. As seen in Figure 2, the model imported using the IFC schema was not consistent with the architectural model. The windows are erroneously converted to walls and the shades were completely deleted. For any energy assessment, the external and internal materials must be fully retained. Also, the fenestrations (doors and windows openings, etc.) were wrongly replaced with extruded walls. This will introduce errors in the results of the simulation, because according to Integrated Environmental Solutions (2012), the U_a – Limit (Limiting area-weighted average U-values) of walls is 0.27 W/(m^2K); floor, 0.22 W/(m^2K); Roof, 0.2 W/(m^2K); windows, roof windows, and roof lights, 2 W/(m^2K); personal doors, 2 W/(m^2K); vehicle access & similar large doors, 1.5 W/(m^2K), etc. This means that based on the deformation of the IFC model, the U_a– value of 2 W/(m^2K) for windows and doors (personal) will be replaced with the 0.27 W/(m^2K) of walls. Based on this outcome, the IFC model is discarded and the GBXML file is imported into the IES-VE software. After importing the GBXML model file into the IES-VE software, the model generated was checked for consistency of design. As shown in Figure 6.1, the GBXML model clearly replicates the architectural model. The windows, doors, wall types and solar facades are well retained. With this, the GBXML model is used to carry out the energy simulation.

Energy performance assessment results

With detailed operational data of the building's individual units fed into the design model, and the energy templates and Apache systems of the simulation software, the energy performance simulation was conducted. After the simulation using the IES VE BIM software, the succeeding results were gotten.

Table 1: Energy Production by Technology (kWh/m^2)

	Actual	Notional
Photovoltaic systems	0	0
Wind turbines	0	0
Solar thermal systems	0	0

During the simulation, the BIM software (IES VE) assessed all fossil and renewable energy sources, deduced the entire building's energy consumption (in kWh/m^2)and compared same with a notional building. As the building has no photovoltaic system or wind turbine or solar thermal system that would have augmented the provision of its energy need (Table 1), the total energy consumption by end use of the building is $106.32kWh/m^2$; this is well in excess of the indicative target of $64.62kWh/m^2$, as depicted in Table 2.

Table 2: Energy consumption summary

	Actual	Indicative Target
Total Energy consumption [kWh/m^2]	106.32	64.62

Table 3: CO_2 emission from the existing and notional building

1	Target CO_2 Emission Rate (TER)	21.3 $KgCO_2/m^2$.annum
2	Building CO_2 Emission Rate (BER)	39.2 $KgCO_2/m^2$.annum
3	Are emissions from building less than or equal to the target?	BER > TER NO

From the building's energy assessment, the CO_2 emission rate of the building is deduced. It is seen from Table 3 that the building's CO_2 emission rate of 39.2 $KgCO_2/m^2$ exceeds the target emission rate of 21.3 $KgCO_2/m^2$ for a building in its class (notional). The key reason for the high CO_2 emission is that the building majorly depends on fossil fuel sources of energy generation, without renewable energy sources such as photovoltaic systems, wind turbines, solar thermal systems that serve as CO_2 sinks (see Table 1).

Building's Energy Performance Certification

Based on the technical assessment, the building is labelled in order to reveal its overall energy performance. IES-VE was used to carry out the energy labelling of the building under consideration. The building's Energy Performance Certificate (EPC) is presented as Figure 3. The certificate reveals that the energy performance of the building is graded "C". However, as shown on the certificate, *"a building of this type built to building regulations standards current at the date of issue of this certificate would have a rating: B"* (Integrated Environmental Solutions, 2012). This shows that there are potential energy conservation measures that can be harnessed to improve the building's energy performance. From the assessment, it is inferred that adopting renewable alternatives will help in abating the buildings energy use level.

Conclusion and Recommendations

This study highlighted the problems associated practical application of BIM for energy simulations and dwelt mainly on the problem of BIM interoperability. The aim is to underscore the need to use the right interoperable schema for generation of models to be used for energy performance assessment. Results of interoperating the model establish that the IFC model was not consistent with the architectural form of the building; thus, the IFC model was not used for the simulation. The GBXML model was checked for model consistency and it was confirmed that the model was a prototype of the architectural model. Hence, the GBXML model was used for the energy assessment. This result supports the previous finding Osello, et al. (2011), that the Industry Foundation Classes (IFC) is a standard for the design and full life cycle of buildings; whereas, the Green Building XML is a scheme developed to transfer information needed for energy analysis of building envelopes, thermal zones, components and location, and other HVAC simulations. From the findings of this assessment, the building's energy consumption and CO_2 emission are in excess of the indicative targets. Major reasons for this are the chief dependence on fossil sources for generation of electricity and the absence of renewable energy sources such as photovoltaic systems, wind turbines, solar thermal systems that serve as CO_2 sinks and means of supplementing the fossil sources of energy generation. Based on the results of the energy consumption, CO_2 emission rate and non-use of major renewable energy sources overall performance of the building is rated as "C". Consequent

on the foregoing, it is recommended that for energy assessments, the architectural form of a building to be assessed should be modelled using suitable BIM application, and the right interoperable schema to be used should be the Green Building eXtensible Markup Language (GBMXL), not the Industry Foundation Classes (IFC). In addition, it is recommended that renewable energy sources such as photovoltaic systems, wind turbines, solar thermal systems, *etcetera*, should be used to augment the building's energy supplies and reduce the high CO_2 emission rate.

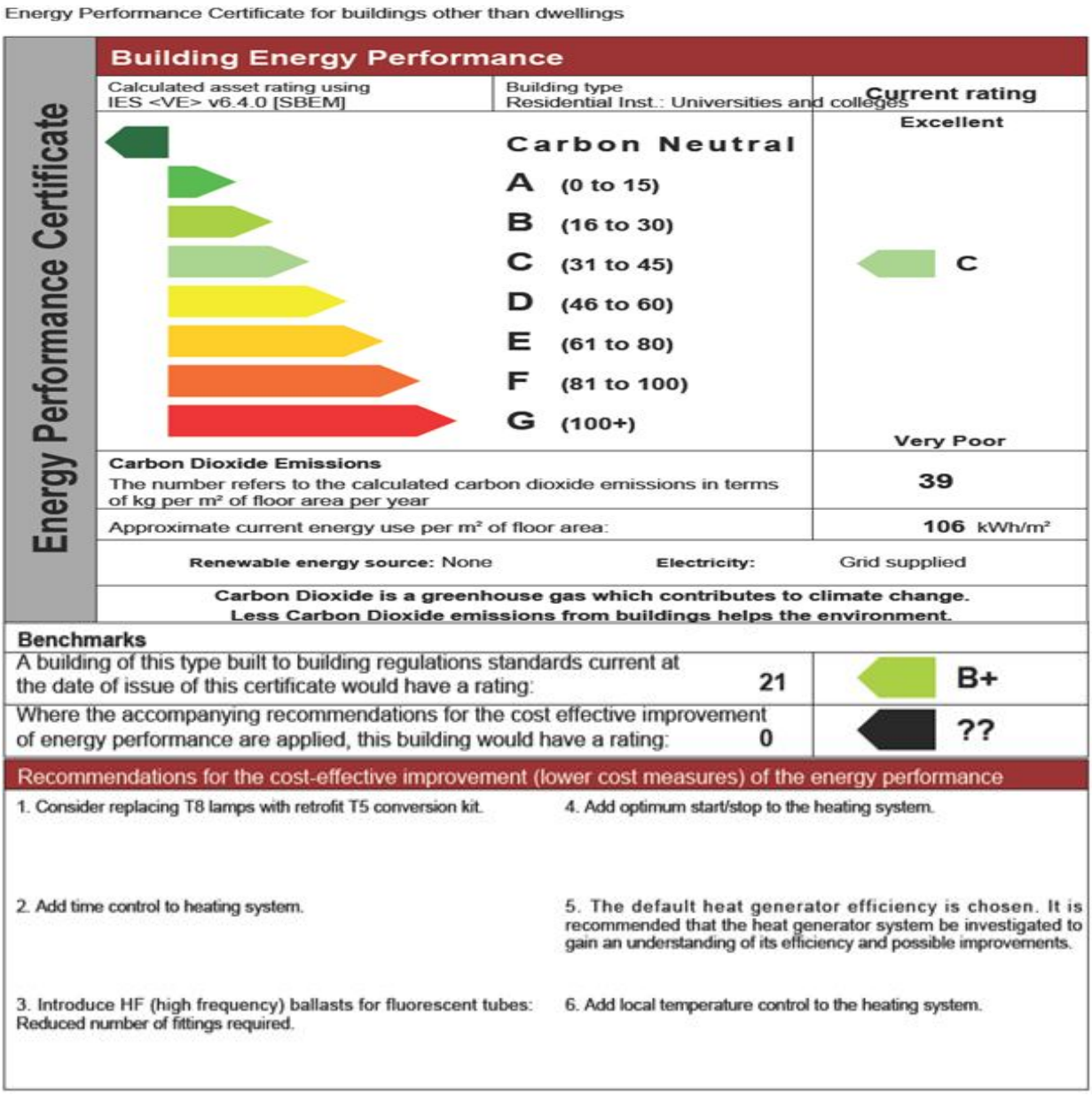

Figure 3: Energy Performance Certificate of the Building (Energy labelling)

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APPENDIX

Table 4: Model Room Check

Model Room Check

Notes:

- Values which are outside expected bounds are **highlighted**, we would recommend that these rooms are inspected carefully.
- To allow for sloping ceilings, the **Floor / Ceiling** ratio is calculated from the area of the floor and the area of the projection to the horizontal of the ceiling.
- All internal areas are calculated from the inner volume of a room (using wall thicknesses) where that exists.
- A **Missing Surfaces Area** value greater than zero may indicate that the surfaces of a room do not join cleanly, or overlap, or are missing. Using the model viewer will help identify these gaps.
- A **Ceiling holes / Ceiling** or **Floor holes / Floor** ratio greater than zero indicates any room ceiling or floor surfaces that contain an air gap. This can occur in Revit 2010 when a room does not have a Ceiling, Roof or Floor element bounding it. In this case the value is 1 and the cell is highlighted so that rooms may be inspected before continuing to analysis.

Room			Area (m²)					Ratio	Area ratios							
Name	ID	Volume (m³)	Floor	Ceiling	External Walls	Internal Walls	Total Glazing	Volume to Area (m)	Ceiling holes / Ceiling	Floor holes / Floor	Floor / Ceiling	Total Wall / Floor	External Wall / Floor	Window / Wall	Missing Surfaces Area (m²)
sp-0001-secure_Store	00205818	24.7	6.2	6.2	28.2	45.7	2.5	4.000	0.000	0.000	1.000	7.410	4.578	0.054	0.000
sp-0002-Cellar	00205821	133.6	33.4	33.4	32.3	92.5	0.0	4.000	0.000	0.000	1.000	2.769	0.968	0.000	0.000
sp-0003-Store	00205823	23.0	5.7	5.7	8.3	39.2	0.0	4.000	0.000	0.000	1.000	6.817	1.445	0.000	0.000
sp-0004-Office	00205825	47.1	11.8	11.8	16.5	55.6	2.2	4.000	0.000	0.000	1.000	4.717	1.401	0.039	0.000
sp-0005-Good_In	00206878	95.5	23.9	23.9	22.3	131.7	0.0	4.000	0.000	0.000	1.000	5.515	0.933	0.000	0.000
sp-0006-Store	00206904	21.7	5.4	5.4	4.9	43.6	0.0	4.000	0.000	0.000	1.000	8.026	0.893	0.000	0.000
sp-0007-Store	00206909	20.3	5.1	5.1	4.5	41.5	0.0	4.000	0.000	0.000	1.000	8.162	0.894	0.000	0.000
sp-0008-Lift_B	00206914	16.9	5.9	5.9	6.9	27.9	0.0	2.850	0.000	0.000	1.000	4.701	1.158	0.000	0.000
sp-0009-Stair_B	00206919	87.9	30.9	30.9	39.0	73.8	2.2	2.848	0.000	0.000	1.000	2.392	1.263	0.030	0.000
sp-0010-Computer_Room	00206921	735.5	256.9	256.9	46.3	205.5	15.5	2.863	0.000	0.000	1.000	0.800	0.180	0.076	0.000
sp-0011-Plant_Room	00206923	99.4	24.9	24.8	49.8	93.4	0.0	4.000	0.000	0.000	1.000	3.759	2.003	0.000	0.000
sp-0012-Common_Room	00206925	462.3	162.2	162.2	79.4	164.5	14.9	2.850	0.000	0.000	1.000	1.014	0.489	0.093	0.000
sp-0013-Chair_Store	00206927	63.0	15.8	15.8	13.7	63.7	0.0	4.000	0.000	0.000	1.000	4.045	0.870	0.000	0.000
sp-0014-Corridor	00206929	225.0	56.3	56.3	50.8	197.9	0.7	4.000	0.000	0.000	1.000	3.519	0.904	0.004	0.000
sp-0015-Room	00206931	43.0	10.8	10.8	5.7	56.5	0.0	4.000	0.000	0.000	1.000	5.257	0.526	0.000	0.000
sp-0016-Ventilated_Lobby	00206933	37.0	9.2	9.2	0.0	68.6	0.0	4.000	0.000	0.000	1.000	7.416	0.000	0.000	0.000
sp-0017-Male_Changing	00206935	40.8	10.2	10.2	13.5	55.8	0.0	4.000	0.000	0.000	1.000	5.481	1.321	0.000	0.000
sp-0018-Store	00206937	19.3	4.8	4.8	0.0	35.3	0.0	4.000	0.000	0.000	1.000	7.308	0.000	0.000	0.000
sp-0019-Male_WC	00206939	9.7	2.4	2.4	0.0	26.5	0.0	4.000	0.000	0.000	1.000	10.889	0.000	0.000	0.000
sp-0020-Female_WC	00206941	9.7	2.4	2.4	0.0	26.5	0.0	4.000	0.000	0.000	1.000	10.889	0.000	0.000	0.000
sp-0021-Female_Changing	00206943	40.7	10.2	10.2	12.0	55.8	0.0	4.000	0.000	0.000	1.000	5.488	1.180	0.000	0.000
sp-0022-Store	00206945	9.5	2.4	2.4	0.0	24.6	0.0	4.000	0.000	0.000	1.000	10.416	0.000	0.000	0.000
sp-0023-Ventilated_Lobby	00206951	4.9	1.2	1.2	0.0	17.8	0.0	4.000	0.000	0.000	1.000	14.398	0.000	0.000	0.000
sp-0024-Female_Toilet	00206953	108.4	27.1	27.1	15.1	99.5	0.8	4.000	0.000	0.000	1.000	3.670	0.557	0.008	0.000
sp-0025-Disabled_WC	00206955	14.3	3.6	3.6	0.0	30.4	0.0	4.000	0.000	0.000	1.000	8.515	0.000	0.000	0.000
sp-0026-Ventilated_Lobby	00206957	5.1	1.3	1.3	0.0	18.1	0.0	4.000	0.000	0.000	1.000	14.179	0.000	0.000	0.000
sp-0027-Male_Toilet	00206959	93.6	23.4	23.4	28.8	91.1	0.0	4.000	0.000	0.000	1.000	3.895	1.230	0.000	0.000
sp-0028-Room	00206961	12.7	3.2	3.2	1.1	28.6	0.0	4.000	0.000	0.000	1.000	8.995	0.346	0.000	0.000
sp-0030-Lift_A	00207543	13.0	4.6	4.6	12.0	24.3	0.0	2.843	0.000	0.000	1.000	5.323	2.624	0.000	0.000
sp-0031-Stair_A	00207545	94.5	33.0	33.0	49.5	69.3	0.0	2.868	0.000	0.000	1.000	2.102	1.501	0.000	0.000
sp-0101-Store	00207625	45.7	16.0	16.0	26.5	45.8	0.0	2.850	0.000	0.000	1.000	2.852	1.651	0.000	0.000
sp-0102-Fr	00207628	13.5	4.7	4.7	5.5	25.5	0.0	2.850	0.000	0.000	1.000	5.381	1.172	0.000	0.000
sp-0103-Ch	00207630	13.4	4.7	4.7	5.5	25.4	0.0	2.850	0.000	0.000	1.000	5.405	1.173	0.000	0.000
sp-0104-KitchenOffice	00207632	31.4	11.0	11.0	12.4	38.5	0.0	2.850	0.000	0.000	1.000	3.497	1.127	0.000	0.000
sp-0105-Service_Riser	00207964	33.5	11.8	11.8	12.5	40.0	0.0	2.844	0.000	0.000	1.000	3.400	1.066	0.000	0.000
sp-0106-Lift_B	00207966	17.2	6.0	6.0	6.9	28.2	0.0	2.851	0.000	0.000	1.000	4.667	1.142	0.000	0.000
sp-0107-Stair_B	00207968	105.6	35.9	35.9	40.7	75.2	1.2	2.943	0.000	0.000	1.000	2.094	1.135	0.016	0.000
sp-0108-Store	00207980	26.6	9.3	9.3	0.0	48.0	0.0	2.850	0.000	0.000	1.000	5.144	0.000	0.000	0.000
sp-0109-Store	00207984	10.2	3.6	3.6	0.0	23.1	0.0	2.850	0.000	0.000	1.000	6.423	0.000	0.000	0.000
sp-0110-Cleaners_Store	00207986	15.0	5.3	5.3	0.0	30.3	0.0	2.850	0.000	0.000	1.000	5.764	0.000	0.000	0.000
sp-0111-Protected_Lobby	00207978	50.8	17.8	17.8	0.4	62.0	0.0	2.850	0.000	0.000	1.000	3.481	0.023	0.000	0.000
sp-0112-Kitchen	00207982	95.1	33.4	33.4	16.2	78.3	0.0	2.850	0.000	0.000	1.000	2.346	0.484	0.000	0.000
sp-0113-Games	00207988	453.7	159.2	159.2	47.9	171.2	12.6	2.850	0.000	0.000	1.000	1.075	0.301	0.074	0.000
sp-0114-Servery	00207990	814.3	286.1	286.1	65.6	276.5	37.7	2.847	0.000	0.000	1.000	0.966	0.229	0.136	0.000
sp-0115-Rec_Office	00207992	45.3	15.9	15.9	19.4	48.9	13.0	2.850	0.000	0.000	1.000	3.075	1.223	0.265	0.000
sp-0116-First_AidSecurity	00207994	37.4	13.1	13.1	0.0	41.8	0.0	2.842	0.000	0.000	1.000	3.178	0.001	0.000	0.000
sp-0117-Store	00207996	34.3	12.0	12.0	2.3	40.4	0.0	2.850	0.000	0.000	1.000	3.360	0.194	0.000	0.000
sp-0118-Lobby	00207998	10.7	3.7	3.7	0.5	23.7	0.0	2.850	0.000	0.000	1.000	6.342	0.133	0.000	0.000
sp-0119-Female_Toilet	00208000	58.1	20.4	20.4	12.1	53.6	2.0	2.850	0.000	0.000	1.000	2.629	0.593	0.037	0.000
sp-0120-Disabled_WC	00208002	10.2	3.6	3.6	0.3	21.7	0.0	2.850	0.000	0.000	1.000	6.067	0.082	0.000	0.000
sp-0121-Lobby	00208004	10.1	3.5	3.5	0.5	22.9	0.0	2.850	0.000	0.000	1.000	6.454	0.133	0.000	0.000
sp-0122-Office	00208008	44.2	15.5	15.5	28.7	48.1	17.1	2.846	0.000	0.000	1.000	3.093	1.847	0.356	0.000
sp-0123-Office	00208175	43.3	15.3	15.3	8.7	49.3	4.4	2.840	0.000	0.000	1.000	3.228	0.570	0.090	0.000
sp-0124-Cloaks	00208177	24.4	8.6	8.6	1.5	33.4	0.0	2.850	0.000	0.000	1.000	3.897	0.170	0.000	0.000
sp-0125-Sec_Room	00208179	22.8	8.0	8.0	12.7	32.3	1.4	2.850	0.000	0.000	1.000	4.035	1.584	0.042	0.000
sp-0126-Male_Toilet	00208006	55.6	19.5	19.5	12.3	52.7	0.0	2.850	0.000	0.000	1.000	2.702	0.632	0.000	0.000
sp-0127-Protected_Lobby	00208181	9.3	3.2	3.2	0.9	20.5	0.0	2.850	0.000	0.000	1.000	6.328	0.278	0.000	0.000
sp-0128-Stair_A	00208185	94.2	33.0	33.0	43.5	69.1	6.5	2.859	0.000	0.000	1.000	2.095	1.320	0.091	0.000
sp-0129-Lift_A	00208183	13.0	4.6	4.6	9.0	24.3	0.0	2.843	0.000	0.000	1.000	5.323	1.979	0.000	0.000
sp-0130-Lobby	00207976	36.0	12.6	12.6	0.0	59.3	0.0	2.850	0.000	0.000	1.000	4.704	0.000	0.000	0.000
sp-0201-Plant_Room	00208360	379.2	126.4	126.4	94.9	144.5	6.5	3.000	0.000	0.000	1.000	1.144	0.751	0.045	0.000
sp-0202-Lift_B	00208404	20.1	6.7	6.7	8.4	31.1	0.0	3.000	0.000	0.000	1.000	4.634	1.255	0.000	0.000
sp-0203-Protected_Lobby	00208406	34.9	11.6	11.6	6.5	43.0	0.0	3.000	0.000	0.000	1.000	3.693	0.558	0.000	0.000
sp-0204-Lift_B	00208408	96.9	32.3	32.3	39.4	70.8	3.4	3.000	0.000	0.000	1.000	2.195	1.221	0.047	0.000
sp-0205-Office	00208410	39.7	13.2	13.2	25.1	44.3	1.6	3.000	0.000	0.000	1.000	3.344	1.896	0.037	0.000
sp-0206-Store	00208412	39.4	13.1	13.1	13.9	44.1	0.0	3.000	0.000	0.000	1.000	3.355	1.054	0.000	0.000
sp-0207-Print	00208414	46.8	15.6	15.6	26.7	48.9	0.0	3.000	0.000	0.000	1.000	3.133	1.708	0.000	0.000
sp-0208-Marketting_and_Communication	00208420	147.6	49.2	49.2	45.8	83.0	5.4	3.000	0.000	0.000	1.000	1.687	0.931	0.065	0.000
sp-0210-MeetingDebating_room	00208418	225.9	75.3	75.3	108.3	100.5	0.0	2.998	0.000	0.000	1.000	1.334	1.437	0.000	0.000
sp-0211-Job_Spot	00208422	50.6	16.9	16.9	19.2	53.0	2.8	3.000	0.000	0.000	1.000	3.144	1.141	0.053	0.000
sp-0212-Welfare_Advisor	00208424	41.3	13.8	13.8	17.1	47.8	2.8	3.000	0.000	0.000	1.000	3.468	1.238	0.058	0.000
sp-0213-Vice_President_Student_Affairs	00208426	46.1	15.4	15.4	28.1	49.5	2.8	3.000	0.000	0.000	1.000	3.224	1.829	0.056	0.000
sp-0214-Cleaners_Store	00208430	4.8	1.6	1.6	8.9	16.3	0.0	3.000	0.000	0.000	1.000	10.261	5.587	0.000	0.000
sp-0215-Disabled_WC	00208436	11.9	4.0	4.0	5.7	24.1	0.0	3.000	0.000	0.000	1.000	6.110	1.454	0.000	0.000
sp-0216-Staff	00208589	37.0	12.3	12.3	15.0	43.5	0.0	3.000	0.000	0.000	1.000	3.528	1.220	0.000	0.000
sp-0217-Male_WC	00208432	6.9	2.3	2.3	7.0	18.5	0.0	3.000	0.000	0.000	1.000	8.066	3.069	0.000	0.000
sp-0218-Female_WC	00208434	6.6	2.2	2.2	0.0	18.6	0.0	3.000	0.000	0.000	1.000	8.455	0.000	0.000	0.000
sp-0219-Ventilated_Lobby	00208587	21.5	7.2	7.2	5.2	38.4	0.0	3.000	0.000	0.000	1.000	5.357	0.725	0.000	0.000
sp-0220-General_Manager	00208695	46.6	15.5	15.5	45.9	50.7	8.6	3.000	0.000	0.000	1.000	3.262	2.955	0.170	0.000
sp-0221-Financial_Accountant	00208697	32.1	11.3	11.3	17.0	38.7	3.0	2.837	0.000	0.000	1.000	3.415	1.504	0.078	0.000
sp-0222-Finances	00208699	51.1	17.0	17.0	46.1	52.5	2.6	3.000	0.000	0.000	1.000	3.081	2.705	0.051	0.000
sp-0223-Stair_A	00208591	109.3	36.4	36.4	54.2	83.8	7.9	2.999	0.000	0.000	1.000	2.302	1.489	0.092	0.000
sp-0224-Lift_A	00208593	13.7	4.6	4.6	14.9	25.7	0.0	3.000	0.000	0.000	1.000	5.616	3.260	0.000	0.000
sp-0225-Int	00208428	23.7	7.9	7.9	19.5	33.7	2.0	3.000	0.000	0.000	1.000	4.271	2.461	0.059	0.000

CONCEPTUAL MODEL OF LEADERSHIP INFLUENCE ON CONSTRUCTION SITE WORKERS' HEALTH AND SAFETY BEHAVIOUR

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Abstract
Causes of construction site accidents and at-risk work practices have not been exhaustively examined alongside with the critical health and safety (H&S) leadership roles and ethical behaviour of key projects leaders. In fact, survey results have shown that the root causes of unsafe behaviour and unsafe acts of workers could be traced to leadership failure of key project leaders, particularly during the early projects formulation stage. This study examines the relationship between key project leaders' H&S leadership roles and construction site workers' H&S behaviour. The empirical results revealed that H&S leadership roles and ethical behaviour of key project leaders particularly during the early projects design stage have positive impacts on construction site workers' H&S behaviour. Client H&S visible leadership manifesting through appointment of competent design team and allocation of adequate financial recourse for H&S, designing H&S into construction projects by designers. Coordinating and integrating H&S into the projects work plans by project managers and facilitation of financial provisions for H&S into the contract documents by quantity surveyors were all found to have positive impacts on workers' H&S behaviour. The study concludes that the key project leaders should demonstrate visible leadership and commitment towards workers' H&S during the early projects planning stage. The study therefore recommends that construction clients, consultants and contractors should acquire leadership and interpersonal skill for effective H&S management. The conceptual model developed illustrates the relationship between key project leaders' H&S leadership and improved worker H&S behaviour.
Keywords: Construction site worker, behaviour, health and safety, leadership, Nigeria

Introduction

Concern about poor construction site H&S performance has tended to focus attention exclusively on unsafe behaviours and unsafe acts of workers (mistakes, omissions, and rules violations) on the detriment of poor H&S leadership and unethical behaviour of key project participants or leaders(Krause, 1997; Lees and Austin, 2011). Nonetheless, Geller (2008) asserts that at-risk work practices or unsafe behaviour may be connected as site workers are always in the front line of physical on-site activities. Perhaps, workers' activities at operational levels exposed them to the proximal cause of adverse events. Nonetheless, mistakes, omissions and rules violations of site workers may be connected to early decisions made by the distant causal factors such as clients, project managers, designers and quantity surveyors during projects formulation phase (Okorie, 2014). The H&S leadership roles and behaviours of these upstream leaders are critical in shaping and promoting construction site H&S culture (Krause, 2003). Decisions made at the early projects formation stages have dire consequences on projects success or failure. At the site levels, according to Krause (1997) a great deal of exposure to risk and hazard to worker health and safety has already occurred before any given injury or accident occurs. On that premise, poor leadership and unethical behaviour exhibited by each of the distant key project leaders at different stages precipitate or give birth to unsafe behaviours or unsafe acts of workers on construction on sites. Krause (1997); Gambtese et al. (2008) put it in this manner, that it is the latent conditions or leaders' behaviours at the upstream that create the workplace H&S culture. Thus, the collective leadership and ethical behaviour of each distant key project leaders are required for further improving construction site workers' health, safety and wellbeing.

Leadership of site managers or the contractor's H&S management systems according to Lees and Austin (2011) on their own cannot bring about the desired construction site workers' H&S performance improvement in the industry. Relating the criticality of H&S leadership roles of key project participants to workers H&S behaviour, Krause (1997 cited in Okorie, 2014) noted that much emphasis on workers'

unsafe behaviours were at the expense of good designs and clients involvement and attitude towards projects H&S. Krause (2003) and Geller (2008) maintained that unsafe behaviour and unsafe acts of workers on construction site could be improved through visible leadership and ethical behaviour demonstrated at the upstream by the key project leaders. In support of the importance of leadership for effective H&S management by the key project leaders, Hopkins (2007) argues that focusing solely on unsafe acts of workers as the only cause of site accidents and incidents without considering the critical related H&S behaviour of these key projects leaders and contractors, may not led to significant H&S performance improvement in the industry. Thus, it could be argued that H&S performance improvement is dependent on leadership qualities and behaviour exhibited by the key project leaders at the project designing stages. Similarly, Wu and Fang (2012) maintain that improvement of workers' H&S behaviour in the industry are likely to have greater impact if directed upwards, since it is the H&S leadership roles and behaviour of the upstream factors that are most critical in creating and sustaining a positive workplace H&S culture.

Project leaders have responsibility for establishing the best standards to which organisation must adhere to. Okorie (2014) postulates that it is the leadership qualities exhibited by the client as the project owner and financer that determines/influences the behaviour of the appointed consultants (project manager, designers and quantity surveyor) towards worker safety and wellbeing on construction sites. The desired improved worksites H&S culture should begin from the upstream leaders and trickled down to construction worksites. Flin and Yule (2003) assert that there is a great relationship between organisational success and its commitment to leadership practices. The paradigm shift from management to leadership is dictated by today's global economy. Leadership in both public and private organisations have significant outcomes related to productivity, profit and workers' H&S (Flin and Yule, 2003; Hopkins, 2007; Geller, 2008). Thus, the underlying theme to improving workers' H&S performance in construction is the leadership qualities, which must cascade or permeate across all the key project leaders in all stages of construction projects delivery chain. The International Labour Organisation (ILO, (2010) observes that occupational accidents can be prevented and it is everyone's responsibility to help prevent them, and that an H&S management system approach and culture at work is not only an ethical imperative, but it makes "dollars and sense." Therefore, it is believed that with visible leadership and active commitment to projects H&S by the key project leaders a healthier and safer construction industry would be achieved. Given that leadership is the single most important factor that determines success or failure of an organisation, this paper seeks to examine H&S leadership roles and behaviours of key project leaders/participants at the early stage of construction projects formulation in the developing countries. Therefore, the research seeks to develop a conceptual model for possible applications in workers' H&S behaviour.

Leadership influence on H&S Management

Accidents do not occur without a reason as they are caused by failure of leadership and unethical behaviour or both (Sunindijo and Zou (2011). Failure of leadership manifests in many forms: clients' lack of commitment in the appointment of competent professionals (Okorie, 2014), lack of supervisions by clients' agents (Behm, 2005), poor designs (Gibb and Bust, 2008), and unethical behaviour existing in forms of unfair practices and compromise among public office holders (cidb, 2011). Arguably, achieving sustainable improvement in workers' H&S behaviour in the industry could be achieved through commitment and behavioural change of the key project leaders. A number of studies have linked leadership as the single most important factor that determines success or failure of an organisation. Hopkins (2007) asserts that there is widespread agreement that organisational effectiveness is proportional to the strength of leadership. Krause (2003) maintains that the success and failure of any organisation is dependent upon the strength of the leaders. However, leadership in the context of workers' H&S behaviour are not common. A few of these studies according to Cooper (2010); Lees and Austin (2011) have focused on direct investigation of the roles of site managers as leaders of their team and the

range of managerial styles they adopted in managing site operations. Leadership of site managers on its own cannot bring about significant improvement in construction site workers' H&S behaviour (Krause, 2003). It is the collective leadership of the key project leaders at early the stage according to Krause (2003), Cooper (2010) and Lees and Austin (2011) that can impact positively on the workers' H&S behaviour. Oloke (2010) argues that there are fundamental differences between leadership in construction process and contractor's site H&S management.

Research Methodology

This research undertakes an extensive literature review to provide the required background information on the influence of leadership on construction site worker's health and safety behaviour with the overall aim of developing a conceptual model. Quantitative research approach was adopted for this study. The information gathered from literature review was used to develop a structured questionnaire which was administered to contractors and project managers. IBM SPSS and Microsoft Excel were used for data analysis while Microsoft Visio was used do design the conceptual model. A total of 200 questionnaires were administered and 129 (contractors = 54; and project managers = 75) were retrieved. Mann-Whitney U Test was used to test for differences between two independent groups on continuous measure. The test of non-parametric is an alternative to t-test for independent samples. The Mann-Whitney U Test compared medians score as against means scores of the two groups in the T-test (Pallant, 2013). It transferred the scores on the continuous variable to ranks across the two groups. It then measures if the ranking of the two groups have significantly difference. However, the outcome of Mann-Whitney U Test also checked the effectiveness of each statistically significant difference variable using (Pallant 2013) and Cohen (1988) criteria .1=small effect, .3=medium effect, .5=large effect. However, the test has been adopted by past researcher, take for example Adewuyi and Otali (2013); Famakin and Fawehinmi (2012).

Analysis of Results

H&S Leadership Roles and Influence of Key Project Leaders on Safety Performance

Table 1 shows the results of Mann-Whitney U Test carried out on H &S leadership roles and influence of key project leaders on safety performance ranking from contractors and project managers' perspectives. Out of twenty one (21) safety performance indicators gotten from literature review, eight (8) were not significant while the rest were significant at .05 level. Under Client's H&S leadership, there was no significant difference on "Failure to ensure that contractor has made adequate financial provision for H&S" between contractors (n = 54) and project managers (n = 75), U = 1693.500, z = -1.702, p = .089, r =.150 and this would general have small effect. There was significant difference on "lack of prequalification of contractors on H&S" between contractors (n = 54) and project managers (n = 75), U = 1422.500, z = -3.040, p = .002, r = .268 and this would generally have small effect. There was significant difference on "lack of transparency in project procurement process" between contractors (n = 54) and project managers (n = 75), U = 1495.500, z = -2.683, p = .007, r = .236 and this would generally have small effect. There was significant difference on "poor project brief to the design team" between contractors (n = 54) and project managers (n = 75), U = 1333.000, z = -3.473, p = .001, r =.306 and this would generally have medium effect.

Under project manager's H&S leadership, there was significant difference on "poor monitoring to ensure that contractors comply with project H&S plan" between contractors (n = 54) and project managers (n = 75), U = 1236.500, z = -3.949, p = .000, r =.348 and this would have medium effect. There was significant difference on "lack of prequalification of contractors on H&S" between contractors (n = 54) and project managers (n = 75), U = 572.000, z = -7.205, p = .000, r =.634 and this would have greater effect. There was significant difference on "inadequate attention to H&S during project progress meetings" between contractors (n = 54) and project managers (n = 75), U = 1238.000, z = -3.913, p = .000, r =.344 and this would have medium effect. There was significant difference on "poor coordination of design team" between contractors (n = 54) and project managers (n = 75), U = 1555.000, z = -2.401, p = .016, r =.211 and this would have small effect. There was significant difference on "inadequate

provision of H&S information to the design team" between contractors (n = 54) and project managers (n = 75), U = 700.000, z = -6.545, p = .000, r =.576 and this would have greater effect. Under designer's H&S leadership, there was significant difference on "Design hazards identification & risk assessment not conducted" between contractors (n = 54) and project managers (n = 75), U = 963.000, z = -5.275, p = .000, r =.464 and this would have medium effect. There was significant difference on "specification & hazardous materials" between contractors (n = 54) and project managers (n = 75), U = 859.000, z = -5.786, p = .000, r =.509 and this would have greater effect. There was an insignificant difference on "H&S information not incorporated into design" between contractors (n = 54) and project managers (n = 75), U = 1964.500, z = -.308, p = .758, r =.027 and this would have very small effect. There was significant difference on "complex design" between contractors (n = 54) and project managers (n = 75), U = 1217.500, z = -3.996, p = .000, r =.352 and this would have medium effect.

Under quantity Surveyor's H&S leadership, there was an insignificant difference on "Failure to ensure that contractor has not made adequate financial provision in the tender" between contractors (n = 54) and project managers (n = 75), U = 1980.500, z = -.227, p = .820, r =.020 and this would have very small effect. There was an insignificant difference on "Non-inclusion of an H&S section in BoQs" between contractors (n = 54) and project managers (n = 75), U = 1921.000, z = -.561, p = .575, r =.049 and this would have very small effect. There was significant difference on "Inadequate facilitation of financial resources H&S" between contractors (n = 54) and project managers (n = 75), U = 1388.000, z = -3.227, p = .001, r =.284 and this would have small effect on workers' H & S behaviour. Under contractors' H&S leadership, there was an insignificant difference on "Lack of top management commitment to project H&S" between contractors (n = 54) and project managers (n = 75), U = 1651.000, z = -1.884, p = .060, r =.166 and this would have small effect. There was significant difference on "inadequate financial provision for H&S" between professionals (n =54) and site operatives (n = 75), U = 1053.500, z = -4.921, p = .000, r =.433 and this would have medium effect. There was an insignificant difference on "Inadequate H&S training to workers" between professionals (n =54) and site operatives (n = 75), U = 1747.000, z = -1.393, p = .164, r =.123 and this would have small effect. There was an insignificant difference on "Irregular site H&S meetings" between professionals (n =54) and site operatives (n = 75), U = 1728.000, z = -1.503, p = .133, r =.132 and this would have small effect. There was an insignificant difference on "poor involvement of workers in H&S decision making" between professionals (n =54) and site operatives (n = 75), U = 1685.000, z = -1.686, p = .092, r =.148 and this would have small effect.

Table 1: Mann-Whitney U Test on H &S leadership roles and influence of key project leaders on safety performance ranking

Roles and Influence	Mann-Whitney U	Wilcoxon W	Z	R	Sig. (2-tailed)
Client's H&S leadership					
Failure to ensure that contractor has made adequate financial provision for H&S	1693.500	3178.500	-1.702	0.150	.089
Lack of prequalification of contractors on H&S	1422.500	2907.500	-3.040	0.268	.002
Lack of transparency in project procurement process	1495.500	2980.500	-2.683	0.236	.007
Poor project brief to the design team	1333.000	2818.000	-3.473	0.306	.001
Project manager's H&S leadership					
Poor monitoring to ensure that contractors comply with project H&S plan	1236.500	2721.500	-3.949	0.348	.000
Lack of prequalification of contractors on H&S	572.000	2057.000	-7.205	0.634	.000
Inadequate attention to H&S during project progress meetings	1238.000	4088.000	-3.913	0.344	.000
Poor coordination of design team	1555.000	3040.000	-2.401	0.211	.016
Inadequate provision of H&S information to the design team	700.000	2185.000	-6.545	0.576	.000
Designer's H&S leadership					
Design hazards identification & risk assessment not conducted	963.000	2448.000	-5.275	0.464	.000
Specification & hazardous materials	859.000	2344.000	-5.786	0.509	.000
H&S information not incorporated into design	1964.500	4814.500	-.308	0.027	.758
Complex design	1217.500	4067.500	-3.996	0.352	.000
Quantity Surveyor's H&S leadership					
Failure to ensure that contractor has not made adequate financial provision in the tender	1980.500	3465.500	-.227	0.020	.820
Non-inclusion of an H&S section in BoQs	1921.000	4771.000	-.561	0.049	.575
Inadequate facilitation of financial resources H&S	1388.000	4238.000	-3.227	0.284	.001
Contractors' H&S leadership					
Lack of top management commitment to project H&S	1651.000	3136.000	-1.884	0.166	.060
Inadequate financial provision for H&S	1053.500	2538.500	-4.921	0.433	.000

Inadequate H&S training to workers	1747.000	3232.000	-1.393	0.123	.164
Irregular site H&S meetings	1728.000	4578.000	-1.503	0.132	.133
Poor involvement of workers in H&S decision making	1685.000	3170.000	-1.686	0.148	.092

Model of Leadership Influence on Construction Site Workers' H&S Behaviour

One of the objectives of this paper is to develop a leadership model that can bring about improvement in site workers' H&S behaviour in the Nigerian construction industry. The developed model is a pictorial overview of the collective H&S leadership roles of the identified key project leaders' contributions that could bring about significant improvement in workers' H&S behaviour in the industry. At-risk work practices, unsafe conditions and unsafe behaviour emanating from construction sites activities are preventable (Hinze, 2006; ILO, 2010). Researchers and scholars such as Lees and Austin (2011) and Wu and Fang (2012) argue that most of the causes of unsafe conditions and unsafe behaviour emanating from construction sites could be traced to clients, designers, project managers, quantity surveyors, and contractors. In fact, literature surveys indicated that the root causes of construction site accidents, injuries and fatalities could be traced to leadership failure of leadership. Given emphasis to the criticality of H&S leadership roles of key projects leaders, Hopkins (2007) stated that attention should be directed to the upstream leaders who are the creator of the work environment. Therefore, understanding the H&S leadership roles and behaviour of the key project leaders will lead to a positive workplace H&S culture, which will result in improved workers' H&S behaviour. Figure 1 below illustrates how the collective H&S leadership roles and behaviour of key project leaders identified in this study could result in safe or unsafe behaviour of construction site workers. The key project leaders identified in Figure 1 below play important H&S leadership roles at different stages of construction project process. The assumption is that unsafe conditions or unsafe behaviour of workers arise from a failure in leadership between the clients, designers (architects/engineers), project managers, quantity surveyors, and contractors at different stages. In other words, their poor leadership and unethical behaviour at different stages of construction processes allow the potential incident to become a reality at the construction sites (Krause, 1997, Krause, 2003; Geller, 2008).

Behm (2006) identifies clients' poor H&S leadership in terms of appointment of incompetent design team and inadequate allocation of financial resources for project H&S. H&S not been designed into project and faulty designs by designers contribute to unsafe behaviour of workers on site (Hinze, 2006), project managers' poor H&S leadership relative to poor coordination and lack of integration of H&S information into the project (Smallwood and Venter, 2002), quantity surveyors' poor H&S leadership in terms of inadequate provision of financial resources for project H&S in the contract documents (Olatunji et al 2011), and lack of visible leadership and commitment towards workers' H&S management in contracting organisations at all levels of management (Hopkins, 2007; Sunindijo and Zou, 2012). It has been noted that addressing workers' H&S behaviour during the projects planning and at the construction phases can have positive impacts on site workers' H&S behaviour in the followings: workers are most aware of the necessity of safe behaviour; workers are more alert and respond to unsafe conditions and practices; workers maintain a better safety culture and ethic; workers respond more positively to H&S guidance and compliance, and workers aim for H&S achievement and awards.

Conclusions and Recommendations

The importance of leadership and leaders' behaviour in the area of construction H&S management has drawn great attention from scholars in various fields in the recent years.H&S leadership of the key project leaders are central to improvement of workplace H&S culture and workers' H&S behaviour. The study discovered there is a significant relationship between key project H&S leadership and improved worker H&S behaviour such as: workers are most aware of the necessity of safe behaviour; workers are more alert and respond to unsafe conditions and practices; workers maintain a better safety culture and ethic; workers respond more positively to H&S guidance and compliance, and workers aim for H&S achievement and awards. In addition, the developed model can be useful in improving safety on

construction sites.On this premise, conclusion can be drawn that with visible leadership, commitment and ethical behaviour demonstrated by the key project leaders during the early project planning stage, at-risk work practices can be significantly improved.

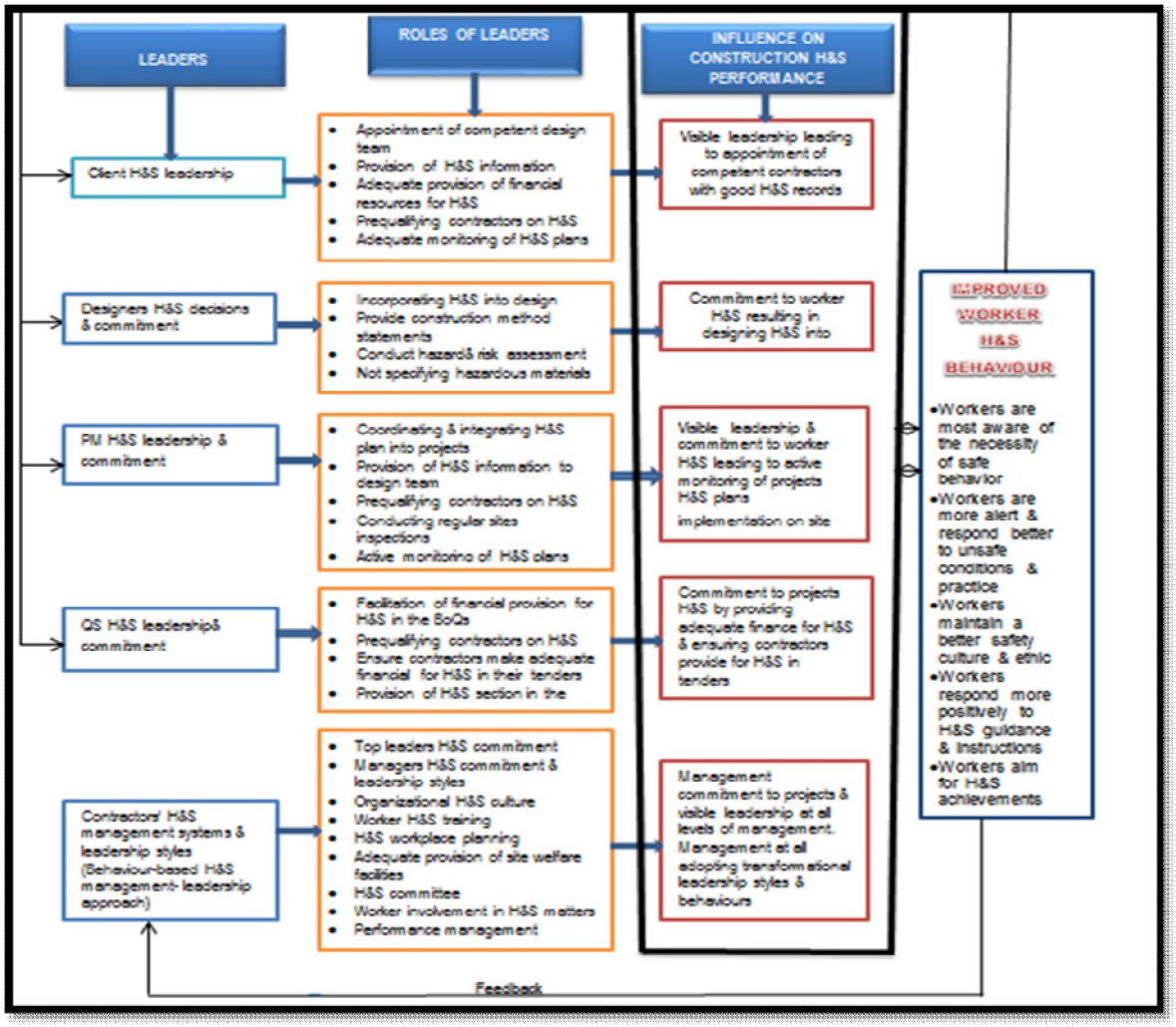

Figure 1: Model of Leadership influence on worker H&S behaviour

Against the background of the result, it is recommended that construction clients, consultants and contractors need to develop their leadership and interpersonal skills for the improvement and sustainability of workplace H&S culture. The concerned professional bodies should equally advocate for an inclusion of construction H&S course module into the curriculum of construction-related programmes in all tertiary institutions in Nigeria. Various professional bodies concerned with the Built Environment should regularly organise leadership training programmes to their members.

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PROPERTIES OF CONCRETE CONTAINING BROKEN CLAY POT AS PARTIAL REPLACEMENT OF COARSE AGGREGATES IN CHEMICAL ENVIRONMENT

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Abstract
Concrete is regarded as the most utilized construction material all over the world. This has led to excessive consumption of the constituents used in the production of concrete, to the extent that it is predicted that these essential ingredients, most especially aggregate, will not be available in sufficient quantity for major construction work in future. This study assessed the properties of concrete produced with broken pot as partial replacement of coarse aggregate. First, a preliminary investigation of the various properties of the materials used for the production of concrete samples was carried out. Concrete samples were, then prepared using 10%, 20%, 30%, 50%, and 100% replacement of broken clay pot aggregate and cured in water for: 7, 14, 21, and 28 days hydration periods. Durability property of the hardened concrete was also investigated by exposing the samples to H_2SO_4.It was observed that, the control samples with 0% replacement of broken pot aggregate achieved maximum strength of 19.50 N/mm^{2}at 28 days of curing, while for 10%, 20%, 30% and 50% replacements, the compressive strengths are: 17.3 N/mm^2, 22.50 N/mm^2, 23.20 N/mm^{2}and 14 N/mm^{2}respectively. Besides that, 50% reduction in compressive strength was recorded when 100% replacement was used. Furthermore, when the concrete samples were exposed to H_2SO_4, the compressive strength for the 30% replacement was 18.10 N/mm^2, after 28 curing days, as against 17,20 N/mm for the control sample. Also, 53% reduction in compressive strength was recorded when 100% replacement was used. It was concluded that concrete samples made with broken pot aggregate at 30% replacement level, have more resistance to aggressive environment than the conventional concrete samples. It is recommended that 30% replacement levels broken clay pot aggregate should be used for concrete production most especially in an aggressive environment.
Keywords: Broken clay pot, coarse aggregates, concrete, chemically aggressive environment

Introduction

The importance of concrete cannot be over emphasized. This is because of the significant role it plays in the provision of buildings and other infrastructural facilities. It is undoubtedly, the most widely used material in building and civil engineering construction. According to United Nation Centre for Settlement Survey (2016), approximately 25 billion tons of concrete are mass-produced worldwide every year, thus amounting to over 1.7 billion truck loads each year, or about 6.4 million truck loads a day, or over 3.8tons per person in the world each year. Okekere (2007) noted that concrete constitutes between 50% - 70% of the total cost of materials used in the construction of buildings. Thus the quality of concrete in any building project determines, to a large extent, the quality of building production in terms of the performance of such structures, production cost and delivery time.

The high demand and usage of concrete require more and more usage of its natural constituents. In view of the fact that aggregates occupy 70-80% of the volume of concrete, they are one of the most important constituents of concrete. Aggregate plays a major role in giving the concrete its body. Neville and Brooks (2010) noted that aggregate properties not only affect the durability and structural performance, but may limit the strength of concrete. This perhaps explain the reason why Shetty (2010) said that, to know more about concrete, it is very essential that one should know more about aggregates; it was further observed that without an in-depth research on aggregate, the study of the concrete is incomplete. Clinkenbeard, (2012) and AbdulKadir (2018) asserted that the building and paving industries consume large quantities of aggregate and future demand for this commodity is expected to increase throughout the world. According to Behera, Bhattacharyya, Minocha, Deoliya&Maiti, (2014) Concrete industry demands more than 20 billion tons of coarse aggregates every single year and the demand will be doubled in the next 20

– 30 years. Projections suggest that vast quantities of crushed stone, sand and gravel will be needed in the future and that much of it will have to come from resources yet to be delineated or defined.

These aggregates are obtained through extracting natural resources and operating quarries as this requires a more mining process, vas aggregates quarries and equipment challenges develop due to depletion and scarcity of the sources which will not be available forever (Akinkurolere 2013) That is why, Jonathan, Medhat& Philip (2016) observed that the reduction of virgin aggregates sources has become a general issue as such, it brought into view, a need for other aggregate source, conservation of natural resources and protection of environment, it is necessary that alternate sources of aggregates be searched which is necessary for any developing/developed country. This is particularly important when the statement made by Akinkurolere (2013) and Shetty (2010) that report shows that these materials will no longer be available in sufficient quantities for concrete production. Considering the disproportionate consumption of the conventional concrete constituents, high cost and environmental degradation connected to cement and aggregate, in concrete production, there is the dire need to find alternative materials that will fully or partially replace these key materials used in concrete production. That is why many researchers have focused their attention on the development of materials that can completely or partially, replace the traditional constituents used in the production of concrete. For instance, according to Gambhir (2006) and Dahiru, Dangaura and Opoola (2014) recent advances has led to the development of modern crushers specially designed for producing cubical, relatively smooth textured and well graded fine aggregates; thus, the crushed fine aggregate is fast replacing natural fine aggregate .In addition, new technologies are used for producing both course and fine aggregates. Besides that, researchers are now investigating the use of waste materials as aggregates in concrete production. There are numerous studies on the use of waste industrial by-product. An example of such studies is one undertaken by Chavan &Kulkarni (2013), they evaluated the effects of using copper slag waste material as a replacement of fine aggregate on the strength properties of concrete. In that study, M25 grade concrete was used and tests were carried out for various replacement levels of sand with copper slag from 0 to 100% in concrete. The results obtained compares with that of normal concrete. Recycled demolished concrete and masonry units, are yet another key areas where researchers focus their attention. For instance there are studies on recycling of broken sandcrete blocks as aggregate.

Abdur Rashid,Hossain and Ariful Islam(2009) conducted a research on the use of crushed brick as coarse aggregate for the production of high strength concrete. It was found that higher strength concrete made with bricks aggregate is achievable. It was also observed that the compressive strength of brick aggregate concrete can be increased by decreasing water-cement ratio and using admixture. Dey & Pal (2013) assessed the performance of concrete produced with brick aggregate, exposed to elevated temperature. It was noted that concrete with very good heat resistance of up to a temperature of 600^0c can be achieved. The use of municipal wastes and incinerator residues as likely sources of concrete aggregate were investigated. Glass, paper, metals and organic materials were the main constituents of municipal waste considered. Result of study shows that the presence of crushed glass in aggregate tends to produce unworkable concrete mixtures and there is high alkali content which affects the long term durability and strength of concrete. Additionally, metals such as aluminum react with alkaline solutions and cause excessive expansion while paper and organic wastes, with or without incineration, cause setting and hardening problems in Portland cement concrete. Thus it was concluded that municipal wastes are not suitable for making aggregate for use in structural concrete (Mehta & Montero, 2007). Also, there are researches on sea shell wastes, such as Olivia, Mifshella and Darmayanti (2015) in which the mechanical properties of seashell concrete were assessed. The mechanical properties investigated are compressive strength, splitting tensile strength and modulus of elasticity. It was found that a maximum compressive strength was achieved when cement was substituted with 4% of grinded seashell. A related study was undertaken by Kumar and Jain (2015) in that research, the use of sea shells as aggregate in concrete production was examined. Result of that study, shows that the compressive strength of

concrete containing sea shells, is relatively lower than that of normal concrete. Lately, Mo, Alengaram, Jumaat and Yuen (2018) studied the application of seashell waste as a partial replacement for conventional materials in concrete and other based product. Study on the various Properties of seashells waste and its influence on fresh and hardened concrete were investigated. Outcome of the study shows that there is reduction in workability and strength of concrete produced with seashell waste as partial replacement of cement. Agricultural wastes are also studied with a view to establishing their suitability for use as coarse aggregates. For example Kunya *et al* (2007) investigated the compressive strength of *cinerariumschweinfurthii* seedling (Atile Seed) as light weight aggregate. Result of the study showed that the compressive strength increase with increase in *cinerarium schmeinfurthii* seedling content. However, such concrete cannot be used on structures that may be exposed to loads beyond 52,5kN. An important point worth noting is, much as there is the need for the sourcing /development of new materials as fine aggregate, such material must satisfy the minimum technical requirement that can be used in concrete production. Thus knowledge of the quality or properties of materials and availability are not only vital but necessary components for the use of material in construction. This is particularly true in the case of aggregate; Neville (2007) noted that no specific rock or mineralogical type in itself is required for aggregate. What is required is that rock or any other material to be used must attain specified desired properties. Kaman (2018) noted that with all the numerous advantages, associated with use of concrete, it is still under research for improving their properties to suit recent requirements in the construction field. Advancement in concrete technology has been on the strength of concrete. It is now recognized that strength of concrete alone is not sufficient, the degree of harshness of the environmental condition to which the concrete is exposed over it is entire life is equally important.

Clay is used in the production of cooking utensils in Nigeria. The clay is sourced, prepared, and molded to the desired shape and size. It is then exposed to elevated temperature. In view of the fact that it is locally made, the producers do not set or control the temperature. The only use the colour, surface hardness and experience as a guide. Usually, it is expected that, if the required temperature is attained, the pots will be reddish in colour, hard and gives certain sound. A lot of wastes of clay pot are usually generated either during production or after use. This paper present a research on an evaluation of the properties of concrete containing broken clay pot as coarse aggregate.

Materials and Methods

The materials used in this research project for the production of cubes specimens were; cement, fine aggregate, coarse aggregate (crushed granite and broken pot), water and sulphuric acid. Details of the materials used, are as follows: Cement used is the limestone blended cement manufactured by Dangote Cement Company in Nigeria. It was obtained from local dealers in Zaria and used throughout the production of the specimens. The OPC used complies with the requirements of BS 12 (1996). The fine aggregate used was river sand obtained within Zaria and was saturated surface dried under fan in the laboratory of the department of building, Ahmadu Bello University Zaria. The sand was sieved to remove organic impurities and bigger aggregate sizes. The coarse aggregates samples were broken pots and crushed granite which was sourced from Giwa Local Government Area of Kaduna State and Samaru, Zaria respectively. The aggregates were manually crushed, washed and sieved in accordance with BS 933 part 1 (1997). The water used for mixing the concrete was potable water, free from injurious oils, chemicals and impurities obtained directly from tap in the Department of Building, Ahmadu Bello University Zaria. The acid used for this research was sulphuric acid (H_2SO_4) and it was sourced from Sabon Gari market, Zaria.

The tools and apparatus used for the experiment tests were Weight scale, Mixing board, Hand scoop, Tapping rod, Trowel, Head pan, Measuring cylinder, Revolving drum type concrete mixer and 100 x

100mm cubes mold. The physical properties of the broken pots were determined based on the saturated surface dried condition (S.S.D) and the mechanical properties were based on the oven dry sample base.

Physical Properties

a. Sieve Analysis: The particle size distribution for both the coarse and fine aggregate were determined by sieve analysis as described in accordance with BS 812-103.1 [1985].

b. Bulk Density*:* The bulk density test for the broken port samples was carried out in accordance with BS 812.2 [1995]. The bulk density was determined based on saturated surfaced dry.

$$\text{Bulk Density (SSD)} = \frac{W_1 - W}{V} \quad \text{---------- (1)}$$

Where: W_1 = Weight of container + sample; W = Weight of empty container; V = Volume of container

c. Moisture Content and Absorption Capacity*:* A sample, A of the aggregate was weighed, W1 was recorded. Sample A was dried in an oven at 100 for 24 hours. The weight W2 after 24 hours was measured. Another sample, B of the same weight soaked in water for 24 hours. The weighed after 24 hours W3 was also measured. A third portion, C of same weight was weighed and soaked for 24 hours and weighed again. The moisture content and absorption capacity of the aggregates were computed using the relationship below:

$$\text{Moisture content} = \frac{\text{Air weigt} - \text{Oven dry weight}}{\text{Oven dry weight}} \times 100 \text{---------- (2)}$$

d. Specific Gravity: The specific gravity (Gs) of both the coarse and fine aggregates were determined by using the pycnometer method in accordance to BS 812-2 (1995).The relationship below was then used to find the relative densities of the fine and coarse aggregates for the experiment.

$$\text{Specific gravity } (S.G_{SSD}) = \frac{B}{B + C - D} \text{ ---------- (3)}$$

Where: B = Mass of saturated surface dry sample in air; C = Mass of jar or vessel file with water; D = Mass of vessel with Pumice and water to the calibration

Mechanical Properties of Aggregates

i. Aggregate Impact Value Test*:* The test was carried out to determine the impact value of given aggregates and hence its suitability for making concrete.This test was performed in accordance with BS 812: part3: 1975

ii. Aggregate Crushing Value Test*:* The test was carried out to determine the crushing value of a given aggregate sample and its suitability for making concrete.

Concrete Production

Mixed Design: A nominal mix of 1:2:4 with w/c of 0.60 was used and the quantities were determined using the absolute volume method. The method involves the following steps:

a) Computing the total volume of concrete require.

b) Adding waste (normally 10-15%)

c) Computing absolute volume

$$\text{Absolute volume of material (a.v)} = \frac{\text{ratio of material in mix} \times \text{density of material}}{\text{specific gravity of material} \times 100} \text{ - - (4)}$$

d) Computing total absolute volume

e) Determining the quantities in kilograms per cubic meter of concrete.

$$\text{Quantity of material (kg/m3)} = \frac{\text{ratio of material in mix} \times \text{density of material}}{\text{total absolute volume}} \text{ - - (5)}$$

f) Determining the quantities of materials in kilogram for the total volume of concrete required.

Preparation of Concrete: The concrete was produced using steel cubes of 100mm x 100mm x 100mm. The fresh mix is scooped into the cube using hand scoop in three equal layers. Each layer is tamped 25

times using a tamping rod. The cube is leveled off using a hand trowel. The mixing was done with concrete mixing machine to minimize segregation of mixes so as not to lose plasticity.

Curing of Concrete

The concrete samples were cured by completely immersing into the curing media. 0.0% concentration of sulphuric acid (H_2SO_4) and 1.0% concentration of H_2SO_4 in 50 litres of water. The curing continued for 28 days

Testing of Hardened Concrete

Test carried out on the hardened concrete were the determination of the density of the hardened concrete and compressive strength.

Density of Concrete: The density in kg/m^3 was determined by firstly air-drying the cured cubes, weighing and computing the density using the relationship;

$$\text{Density of concrete} = \frac{Mass\ of\ cube\ in\ kg}{Volume\ of\ cube\ in\ m^3} \quad - \quad - \quad - \quad - \quad (6)$$

Compressive Strength

Test for compressive strength was carried out by crushing the cubes in a crushing machine at the age of 7, 14, 21 and 28 days of curing respectively. The test was undertaken in accordance with the provisions of BS 1881: 116 (1983).

$$\text{Compressive Strength} = \frac{Maximum\ load\ (KN)}{Cross\text{-}sectional\ area\ (m\,m^2)\pi} \text{ X } 1000 \text{ - --- -- -- --- } \quad (7)$$

Results, Analysis and Discussion

Presentation of Results of Preliminary Test: The results for preliminary tests conducted for this research work were; specific gravity, bulk density, moisture content, water absorption, and sieve analysis of the aggregates.

Table 1: Summary of the physical properties of the aggregates

Properties	Broken Pot Aggregates	Natural Gravel Aggregate
Specific Gravity (SSD)	1.80	2.50
Bulk Density (kg/m^3)	1050	1500
Moisture Content (%)	0.81	0.40
Water Absorption (%)	16.0	0.60

Specific gravity: Table 1 presents the specific gravity, bulk density, moisture Content and Water Absorption capacity of broken pot aggregates and natural gravel aggregates. The specific gravity of broken pot and gravel were determined as 1.80 and 2.50 respectively. Therefore the specific gravity of the broken pot and the gravel are below the specified value as enunciated by Gupta and Gupta (2012) which is between 2.60 to 2.80.The specific gravity is one of the important physical properties of aggregates that give an idea of quantity of materials needed in producing concrete. This means that more of clay pot aggregate is required in a mix than gravel; if they are to be used in the same mix.

Bulk density of the coarse aggregates: The result obtained in Table 1 shows that broken pot and gravel aggregates have bulk densities of 1050kg/m^3 and 1500kg/m^3 respectively. The bulk density of broken pot aggregate indicate that the material is within the range of lightweight aggregate (the values according to BS 882: Part 2: (1973) are from 300 to 1200kg/m^3). Aggregate that has relatively low bulk density means that there is no dense packing. Thus when the two physical properties are considered, it can be said that the gravel is denser than broken clay pot aggregate.

Moisture content and absorption capacity: From the result in Table 1, it can be observed that the coarse aggregates have moisture content of 0.81%, and 0.40% with absorption capacities of 16.0% and 0.30% respectively. The higher the moisture content of an aggregate the lower the water content to be added to

the concrete mix and the weaker the aggregate. It can be concluded that the coarse aggregate with 16% absorption capacity is not a strong aggregate but cannot be regarded as weak aggregate as described by BS EN 1097-6; 2000. But the percentage capacity of the aggregate may be said to be good for low strength concrete.

Table 2: Results for sieve analysis of broken clay pot (20mm)

Sieve Size (mm)	Weight Retained (g)	Weight Passing(g)	Percentage Passing (%)
20.00	290	710	95.85
10.00	6070	40	9.14
5.00	480	160	2.28
2.36	80	80	1.14
Pan	040	0	0

Table 3: Results for sieve analysis of crushed granite (20mm)

Sieve Size (mm)	Weight Retained(g)	Weight Passing(g)	Percentage Passing (%)	Percentage Retained (%)
20.00	13	2987	99.53	0.43
10.00	2061	936	30.87	68.70
5.00	786	140	4.67	26.20
2.36	79	61	2.04	2.63
1.18	8	53	1.77	0.27
600	5	48	1.60	0.17
300	10	38	1.27	0.33
150	15	23	0.17	0.50
Pan	23	0	0	0.77

Table 4: Results for sieve analysis of fine aggregate (10mm)

Sieve Size (mm)	Weight Retained(g)	Weight Passing(g)	Percentage Passing (%)	Percentage Retained (%)
10.00	0	500	100.0	00.00
5.00	3	497	99.40	0.60
2.36	90	407	81.40	18.00
1.18	154	253	50.60	30.80
600	172	81	16.60	34.40
300	62	19	3.80	12.40
150	12	7	1.40	2.40
Pan	7	0	0	1.40

Tables 2, 3, and 4 show the results of the sieve analysis of broken pot, crushed granite and fine aggregate respectively. The results shows that the aggregates fall in the grading zone II indicated that the aggregates are neither too fine nor too coarse.

Table .5: Summary of the mechanical properties of the aggregates

Properties	Broken pot Aggregate	Natural Gravel Aggregate
Impact Values	20.88%	17.00%
Crushing Values	25.33%	22.60%

Table 5 presents results of impact value and crushing value of aggregates used. The percentage of aggregates impact value for broken pot and natural gravel was found to be 20.88% and 17.00% respectively which indicates that both the aggregates are resistant to impact and the values obtained were below the maximum 45% specified by Gupta and Gupta (2012). Similarly, the crushing value for broken pot aggregate was found to be 25.33% while that of natural gravel was 22.60%. The natural gravel was found to have higher ability to resist crushing than the broken pot aggregate. However, it can still be used

on a structure that will be exposed to According to Gupta and Gupta (2012) the ratio of the fraction passing should not be more than 45% which shows that the aggregate used has conformed to standard specified.

Presentation of results on hardened concrete

Density of hardened concrete samples

Table 6 present the average density of concrete made with broken pot and cured in water (H_2O) and weighed at 7, 14, 21, and 28 curing days. The density of concrete cubes varies from 2163.33kg/m^3 to 2466.66kg/m^3 and is increasing with increase in curing periods. However, there was lost in density as the percentage replacement of broken pot increases from 10 to 100%.

Table6: Density of concrete samples cured in water (H_2O) (Density of Cubes in *kg/m*^{3})

(%) Replacement	7 Days	14 Days	21 Days	28 Days
0	2233.33	2306.67	2466.66	2440.00
10	2326.67	2460.00	2346.67	2346.67
20	2300.00	2233.33	2340.00	2433.33
30	2200.00	2233.33	2366.67	2306.67
50	2200.00	2186.67	2233.33	2246.67
100	2163.33	2186.67	2200.00	2206.67

Table 7: Density of concrete samples exposed to Acid (H_2SO_4) (Density of Cubes in kg/m^3)

(%)Replacement	7 Days	14 Days	21 Days	28 Days
0	2360.00	2366.67	2466.67	2373.33
10	2286.67	2340.00	2306.67	2420.00
20	2320.00	2366.67	2233.33	2373.33
30	2340.00	2273.33	2206.67	2353.33
50	2300.00	2220.00	2100.00	2380.00
100	2246.67	2073.33	2226.67	2080.00

Compressive strength of hardened concrete samples

Table .8: Average compressive strength of broken pot concretes exposed to H_2O and H_2SO_4

Percentage replacement (%)	Curing periods (*Days*)				Curing periods (*Days*)			
	7	14	21	28	7	14	21	28
	Compressive strength (*N/mm*^{2})							
	Sample cured in H_2O (Control)				Sample cured in H_2SO_4			
0	12. 66	12.70	18.00	19.50	11.90	12.50	13.93	17.20
10	12.47	13.90	16.90	17.30	8.33	12.93	14.20	14.10
20	10.93	16.10	20.96	22.50	9.70	15.30	17.40	15.08
30	16.33	19.46	21.93	23.20	14.80	17.47	17.13	18.10
50	8.50	11.47	12,00	14.00	7.50	8.00	11.50	12.00
100	8.50	10.47	10.7	13.00	7.90	8. 60	10.80	11.23

Table 8 shows the compressive strength of concrete made with varying percentages of broken pot aggregate 0%, 10%, 20%, 40%, 50% and 100% replacement cured in both H_2O and H_2SO_4 and crushed at 7, 14, 21 and 28 hydration period. There was relative reduction in compressive strength as the percentage replacement increases throughout the curing periods. The minimum compressive strength of 8.50N/mm^2 was observed.

Durability properties of hardened concrete samples

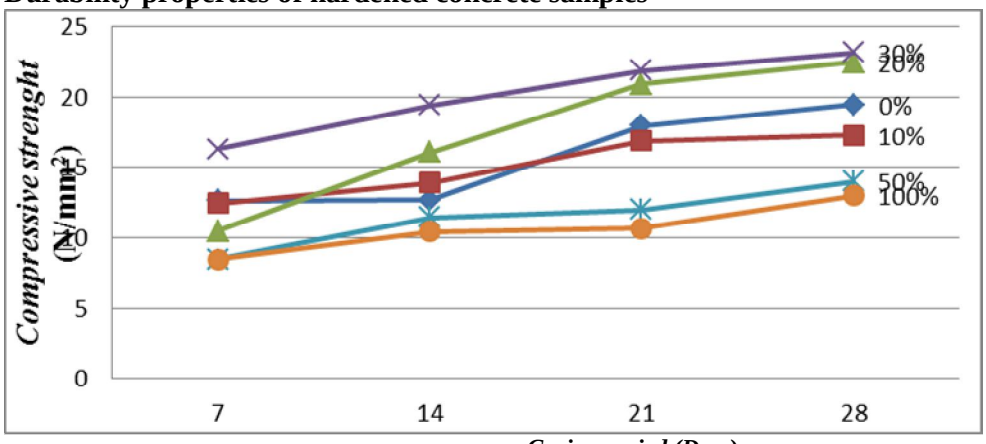

Figure 1: Compressive strength of concrete cured in water

Figure 1 represents the compressive strength of concrete made with 0%, 10%, 20%, 30%, 50%, and 100% replacement of broken pot aggregate cured in H_2O and crushed at 7, 14, 21 and 28 hydration period. The concrete samples with 0% replacement of broken pot achieved maximum strength of 19.50 N/mm^2. However, concrete with 20% and 30% partial replacement of clay pot aggregate, have compressive strength of 22.50 N/mm^2 and 23.20 N/mm^2 respectively. This shows that when clay pot aggregates is incorporated into the concrete mix, within the range of 20% to 30%, it enhances the compressive strength of concrete; beyond that range, it decrease the strength of concrete. This can be seen from Table 9 and Figure 1 that there was 18.97% increase in compressive strength when 30% replacement was used while 50% reduction in compressive strength was recorded when 100% replacement was used

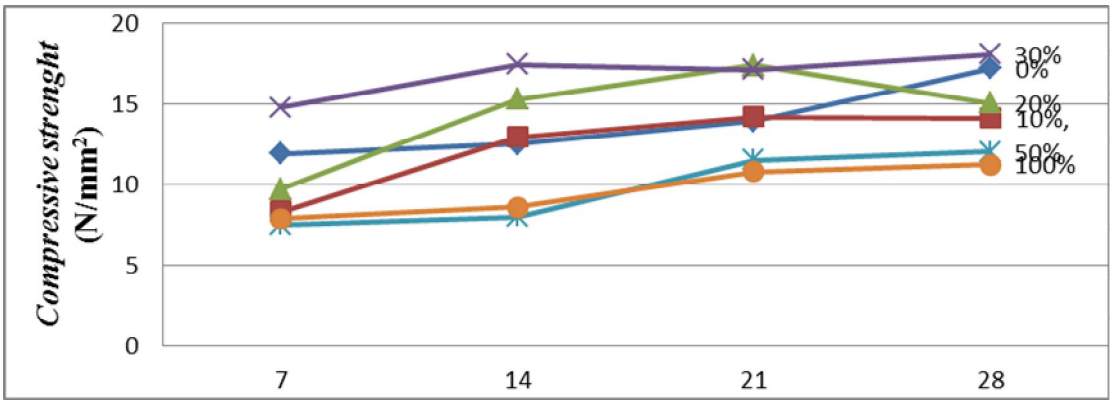

Figure .2: Compressive strength of concrete exposed to acid curing media

Figure 2 represents the compressive strength of concrete made with 0%, 10%, 20%, 30%, 50%, and 100% replacement of broken pot aggregate exposed to chemically aggressive media and crushed at 7, 14, 21 and 28 hydration period. The concrete samples with 0% replacement of broken pot achieved maximum strength of 17.20 N/mm^2. Other hand, concrete containing 30% of clay pot aggregates, has compressive strength of 18.10N/mm^2 .This represent 5.23% increase in compressive strength, over and above the control sample. When 30% replacement was used while 53% reduction in compressive strength was recorded when 100% replacement was used. This implies that concrete containing up to 30% of clay pot aggregate is more durable in chemically aggressive environment. Thus such concrete can be employed in

the construction of structures such as sewer; that will be exposed to harsh and hostile chemical environment.

Conclusion and Recommendations

Against the background of the findings, it can be concluded that the broken pot aggregate granite has specific gravity of 1.80 and 2.50 with bulk density of 1050kg/m^3 and 1500kg/m^3 respectively. The impact value of broken pot aggregate is 20.88% and crushing value was found to be 25.33 while natural granite has impact value of 17.0% and crushing value of 22.60%. The density of concrete cubes cured in water varies from 2163.33kg/m^3 to 2466.66kg/m^3 and is increasing with increase in curing periods. However, there was lost in density as the percentage replacement of broken pot increases from 10 to 100%. Similarly, the density of concrete cubes cured in Acid varies from 2073.33kg/m^3 to 2466.67kg/m^3 and is increasing with increase in curing periods from 0% to 50% replacement. Hence, this shows that the acid influences the density by 14.10% when 100% replacement was used. The compressive strength of the concrete samples was observed to increase with age. There was relative reduction in compressive strength as the percentage replacement increases throughout the curing periods with a minimum strength of 8.50N/mm^2 at 7 days curing with 100% replacement

Thus, the physical properties of broken pot aggregate such as specific gravity, moisture content and bulk density were found to fall below the required range as specified. Besides that, concrete samples produced with broken clay pot as partial replacement, have higher strength than control samples in both normal and chemical environment, at 20% and 30% replacement levels. However, when full replacement was carried out, there is inverse relationship between the compressive strength and the amount of aggregate used produced in the preparation of concrete. Additionally, concrete samples made with broken pot aggregate have more resistance to aggressive environment than the conventional concrete when the replacement level is within the range of 20% - 30% replacement level. It is recommended that 30% partial replacement of conventional aggregate with clay pot aggregate should be used for concrete production. Also, clay pot aggregates should be subjected to an elevated temperature above 1200^0C and test its suitability when used as aggregate should be undertaken. Other durability properties of concretes made with broken pot aggregates should be carried out such as fire resistance, shrinkage, and thermal and sound insulation properties.

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ASSESSMENT OF HOUSING CHARACTERISTICS IN PERI-URBAN SETTLEMENTS OF IBEJU-LEKKI, LAGOS

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Abstract
Housing developments in Lagos State peri-urban settlements have contributed immensely to alleviation of the challenges of housing deficits in central Lagos. This research aims at examining the characteristics of housing development in the peri-urban settlements of Lagos State, Nigeria. Using a case study approach, housing developments in peri-urban settlements in Ibeju-Lekki Local Government Areas were selected to represent the rapidly urbanizing metropolitan peripheral areas in Lagos State. Data was collected through survey questionnaire and direct observations. Using two stage sampling techniques, questionnaire was distributed to households in purposively selected 16 peri-urban settlements in Ibeju-Lekki. Data collected through field survey was analysed using descriptive statistics such as frequencies, percentages, and cross tabulations. The findings revealed that different housing initiatives in the peri-urban settlements performed differently in typology and resident's perception. Socio-economic attributes revealed a multi-cultural households composition and reasonable literacy level. It is recommended that improved quality and user performance peri-urban housing development can be achieved through residents' participation in housing policy design and also by timely regional policy response to the pace of housing development in Lagos peri-urban settlements.
Keywords: Peri-urban, housing characteristics; typology; building materials; residential segregation.

Introduction

Housing development in Lagos peri-urban settlements is dynamic because of the different perception of stakeholders to the potential of the interface. Shaped by activities of many actors and often unfavourable urban policy, there exists a dichotomy in the governance and policy response to the sustainability of different housing initiatives in the interface. The characteristics of the emerging housing development is a function of many factors, some of which are government policy toward peri-urban settlements, the housing development management, socio-economic attributes of the residents, government perception of the economic viability of the location and the building materials used in construction. Housing development in Lagos peri-urban settlements and other developing countries is in a response to the challenge of housing in the city centre due to limited land supply in the metropolitan regions and continuous population growth in cities (Dutta, 2012; Acheampong & Anokye, 2013).This study will assess the characteristics of housing development in Lagos peri-urban settlements.

Housing development in Lagos peri-urban usually exists under three initiatives; government-led housing development, private company-led development and self-help housing development. Each housing initiative varies in building typologies, mode of construction, target users and conformity to standard (Wu *et al*, 2013; Salem, 2015). Socio-cultural diversity and the socio-economic characteristics of the residents greatly affect the physical characteristics of housing development in the peri-urban. Housing development in the peri-urban calls for consideration of the socio-economic attributes of the different income groups of the migrants but this is not the situation in most peri-urban housing developments (Shen & Wu, 2013).

There is disparity in Lagos peri-urban infrastructural development. The government-led housing settlements and private-led housing settlements are better developed in terms of infrastructure than settlements constituting self-help housing by the low-income group. Armed with inadequate knowledge of the socio-economic composition of the migrants, most housing initiatives led by institutional and

corporate bodies are not meeting the needs of the majority of low-income and middle income group due to affordability issues. Therefore, most exclusive gated housing developments in the peri-urban are not occupied. Although the peri-urban housing developments are generally known to be poor in term of quality, there exists good housing development led by government initiatives and private developers' initiatives. Borne out of the varying socio-economic composition of the residents and poor institutional responses, most self-help housing developments in Lagos peri-urban are total deviation from acceptable housing quality standard. There is an institutional failure which translates to additional challenges in Lagos peri-urban housing developments and ultimately impairs the characteristics of housing in Lagos peri-urban settlements. Contributing also to the chaotic development pattern is the lack of adequate monitoring of the continuous development by the building regulation authority and lack of proper documentation of the pattern of growth as seen in most peri-urban developments in developing countries (Puttal & Ravadi, 2014). The urban transformation taking place in terms of housing in Lagos peri-urban has not been captured adequately. An assessment of the characteristics of housing development in Lagos peri-urban settlements is vital because the peripheral locations in Lagos accommodate a large share of the urban population. Though there have been prior works on peri-urban study in Nigeria, none has adequately addressed the characteristics of housing development in Lagos as it should. Prior works on peri-urban developments in Nigeria were on land use changes, agricultural land conversion, rural-urban linkages and housing quality (Binns *et al*, 2003; Olotuah, 2006; Dung-Gwom, 2008; Nwokoro & Dekolo, 2012; Lawanson *et al*, 2012; Emankhu & Ubangari, 2015). Therefore, this study is imperative owing to scanty attention paid to peri-urban housing development in Nigeria.

Literature Review

Housing typologies is based on classification of existing building types and urban forms in term of social function and spatial efficiency (Keyes, 2010). Housing characteristics has evolved with technological advances like the rise in the use of automobile, introduction of industrial building components and also changed according to the needs of the developers. The patterns of housing investment, housing form, community services, settlement density and morphology are relevant to the growth and pattern of peri-urban development. Housing classification is determined by society, affordability and legality in form of government-led, private development-led and self-help housing. Housing in the peri-urban exists under three types of initiative and governance: self-built housing development, private developer - led housing and state-led housing development (Shen & Wu, 2013).

Self-help housing grew as a result of aggravated housing demand increased preference for single family houses (Gough & Yankson, 2000) and it is the most predominant housing initiative in peri-urban development zones. Under this initiative, individual household takes responsibility for the construction of their housing units. Generic attributes of most self-help housing development in developing countries are poor construction, unavailability of standardized designs and limited infrastructure connectivity (Bangdome-Dery et al, 2014). State-led housing development is aimed at driving the growth of the metropolitan fringe. It is accompanied with land acquisition and meagre compensation to the original landowners. Private developer-led housing development is formally regulated and predominantly occupied by middle class and higher income migrants from the city centres (Simon, 2008).

Housing typologies in the peri-urban are classified based on household size, the floor space per person for living, circulation and land intensity (Ravetz et al, 2013). Typologies are also influenced by the socio-economic attributes of the end users. Each type of housing is dominated by different types of neighbourhood. Types of housing in the metropolitan fringe are commodity housing, single family house, middle rise buildings, apartment buildings, detached house, compound houses and blocks of flats (Binns et al, 2003). Commodity housing has co-renting as its unique attributes and it serves the poor migrants. It is also called rooming apartment and characterized by one apartment sub- divided into numerous bedrooms (Olotuah, 2006). Rooming house is adopted because of ease of design, low cost on construction

and high return from rental. Housing characteristics in Lagos peri-urban settlements include clusters of settlements and the urban morphology follow the trend of construction of housing estates on acquired large tracks of land (Lawanson et al, 2012).There is also an emergence of mixed-use housing development in Lagos peri-urban settlements. It has both negative and positive impact on housing development in the peri-urban. It is used to promote infrastructural development and provision of services. The concept of mixed-used development is utilized to address the multi-dimensional needs in the peri-urban (Tavares et al, 2012; Tan & Li, 2013).The adverse impact of mixed-use development comes in term of environmental pollution created by discharge of toxic wastes which affect both dwelling and environmental quality in the peri-urban.

Residential segregation in the peri-urban emerges as a consequence of people tendency to live in a residential community with some characteristics like language, race and social class. There exists a segregation of land uses into distinct zones in the peri-urban due to self-sorting of the population based on socio-economic status. Residential segregation can be seen as an isolation of a certain community in a certain residential area usually separated from mainstream community owing to several reasons like policy and solid residential gate. Residential segregation induces spatial fragmentation and social segregation. It hinders balanced developments (Firman, 2004). There are different levels of residential segregation, residential segregation by education level and income, segregation by housing typology, existence of solid gate segregation by internal kinship and segregation by social class (Pradoto, 2012).

Socio economic status of residents has significant influence on the housing typology in the peri-urban. The types of housing development are a function of the socio-economic composition of the residents. Residents with lower socio-economic status occupy different spatial form of settlements; these are often characterized by squatter settlements. Socio-cultural composition of peri-urban residents' constitutes migrants from other places, residents from the inner city and local natives. Poverty contributes to the environmental quality in the interface. Differentiating factors between the peri-urban resident groups could be through either socio-economic factors, personal motivation for housing, housing choices preference or the resulting spatial differentiation. In the peri-urban, using socio-economic attributes, the most significant differentiating factor that distinguishes migrants from other resident groups is housing tenure. Non migrant groups are mostly home owners regardless of socio-economic status. Rural migrants constitute the root of rental housing in the peri-urban. This class of people eventually settles in low cost private rental houses in the peri-urban (Shen & Wu, 2013).

The Study Area, Materials and Methods

The study area is Ibeju-Lekki peri-urban settlement; a Local Government Area of Lagos State and is approximately 75 kilometers long and about 20 kilometers wide. Ibeju- Lekki Local Government Area is about 646 kilometers square. This equals one quarter of the total land mass of Lagos state. According to the National population Commission (2006) census, Ibeju-Lekki had a population of 117481 persons out of Lagos State's total population of 9113605 persons. The sample frame constitutes the existing housing units in the study area. This study employs a case study design. The case study approach was applied by conducting field research covering the three tiers of housing; that is, self-help housing, private developer-led housing development and government-led housing development. Primary data for this study was extracted from the questionnaire instrument and the observation schedule. Data was obtained through a questionnaire survey of purposively selected 16 settlements in Ibeju-Lekki and the survey was carried out between August and October 2016. A total of 366 completed copies of questionnaire were retrieved and used for analysis. The questionnaire was administered during the weekend to ensure a high response rate. Two-stage sampling was adopted to randomly select 370 housing units in Ibeju-Lekki and the heads of households were the respondents. Descriptive analysis was conducted on the data to generate percentages and frequencies of respondents' socio-economic characteristics and housing initiatives, housing typologies and characteristics in the study area.

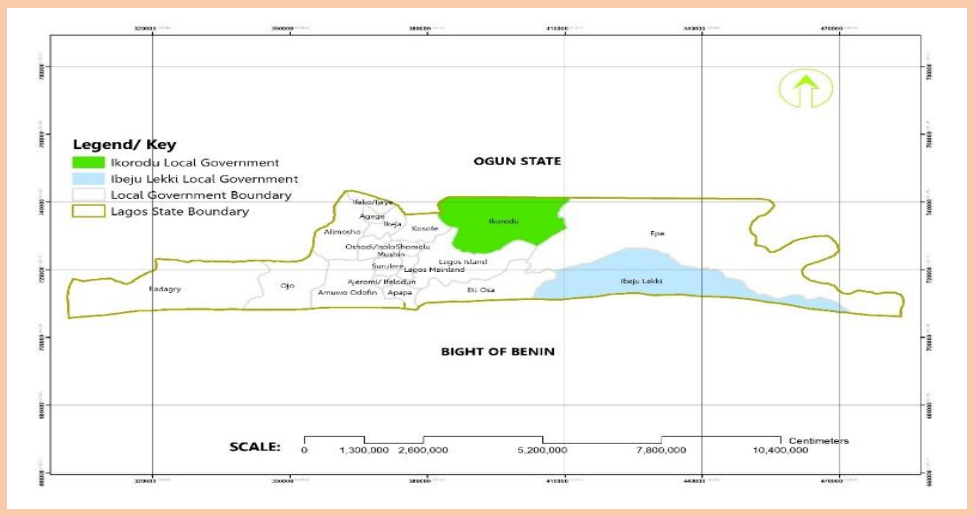

Figure 1: Map of Lagos State showing Ibeju-Lekki (study area highlighted in blue).
Source: Field Survey, 2016.

Results and Discussion

Characteristics of Housing developments in the study area

Characteristics of housing in this study will be discussed based on housing typologies, units of household per building and the number of rooms per household. Analysis of the field survey presented in Table 1 show ten housing typologies was identified and one uncategorized in the study area. The three commonest housing types in the peri-urban are the single family bungalow unit which constitutes about 76.2%. The single storey family unit (11.5%) and two family detached storey building (4.9%) were also observed. Other less prominent housing types are two family semidetached bungalow (2.2%), semidetached duplex (1.6%), multiple units traditional housing (1.1%), multiple unit bungalow row housing(1.1%), storey block of flats, single unit traditional housing(0.3%) and tenement storey building (0.3%).

Housing Typologies in the study area

Single family bungalow unit is the most prevalent in Ibeju-Lekki peri-urban settlements. It is mainly owner occupied and not part rented. The single storey family units are wholly owner occupier especially among the polygamous families in the study area. The two families semidetached bungalow housing in the peri-urban is partly owner occupied and partly rented out. Part of the building is usually rented out for investment purpose and also often for security purpose in areas of the peri-urban that are a long way from the active areas. Two families semidetached storey housing unit is like the two families semidetached but different in that it is storey. The owners usually occupy one unit of the whole housing while the other wing is rented out. The semidetached duplex housing unit is a two winged duplex buildings in which one is owner occupied and the other rented out. It is widespread in developer-led housing and also among the middle income earners. Block of flats housing is a multi-family housing built mostly and purposely for profit and mostly not occupied by the owners. Tenement unit bungalow and storey buildings are for rental housing, sharing communal sanitary facilities and built purposely for low income and the poor. The single unit and multiple traditional housing are the regular housing unit among the natives, built to be lived in by all extended families and usually with poor quality building materials. It is more of inheritance housing in the peri-urban of Ibeju-Lekki. Finally, multiple unit row housing consists of many households units on the same parcel of larger lands built for rental purpose and not for the owner occupier.

Table 1: Housing typologies in the study area.

Housing Typology	N=366	%
Single family unit (bungalow)	279	76.2
Single family unit (storey)	42	11.5
Two family semidetached bungalow	8	2.2
Two family semidetached (storey)	18	4.9
Semi-detached duplex	6	1.6
Block of flats(storey)	2	0.5
Single unit traditional housing	1	0.3
Multiple units traditional housing	4	1.1
Multiple unit row housing (bungalow)	4	1.1
Tenement unit bungalow(face to face)	0	0
Tenement storey building (face to face)	1	0.3
Missing	1	0.3

Source: Field survey, 2016.

Internal characteristics of housing units in the study area

Analysis of the internal characteristics of the housing units is presented in Table 2. The commonest household units per building in the study area are 7-8 units having 28.1% of the total households. Other types are 3-4 units (22.1%), 8-above units (20.7%), 5-6 units (18%) and less than 2 units (10.9%). The prominence of multiple units of household per building could be attributed to the preference for storey building and investment-driven growth in Ibeju-Lekki peri-urban settlements. The commonest is 6-9 rooms' household having 25.7%. Others are 0-2 rooms (11.2%), 3-5rooms (24.9%), 10-12 rooms (19.9%) and more than 13 rooms (15%). Most of the residents in the study area were home owners, to 74.6%, while 22.7% and 2.5% were tenants and enterprise owners respectively. There are two types of occupancy in the study area, full family occupation and part rented house occupation. The full family occupation is more prevalent in Ibeju-Lekki peri-urban settlements having 56% while part rented housing units are 44%. However, different levels of house ownership exist in peri-urban settlements of Ibeju-Lekki. Self-built and owned houses constitute about 58.7% of housing, family owned housing covers about 21%, family built but not owned housing(0.8%), employer built and owned housing (0.5 %), employer built but not owned (0.3 %), tenant self-paying (16.4%), and tenant not paying(2.2 %) were found in the study area.

Table 2: Characteristics of housing units in the study area

Variable	No of household units/building	N=366	%
Household units per building	0-2 units	40	10.9
	3-4 units	81	22.1
	5-6 units	66	18.0
	7-8 units	103	28.1
	8-Above	76	20.7
Rooms per household	0-2	41	11.2
	3-5 room	91	24.9
	6-9 room	94	25.7
	10-12 room	73	19.9
	13 and above	55	15.0
	Others	12	03.3
Occupancy	Full family occupation	205	56.0
	Part family occupation/part rented	161	44.0
	Others	0	00.0
Ownership status	Self-built house (owned)	215	58.7
	Family built house (owned)	77	21.0
	Family built house(not owned)	3	00.8
	Employer built house(owned)	2	00.5
	Employer built house (not owned)	1	00.3
	Government built house (owned)	0	00.0
	Tenant (self-paying)	60	16.4
	Tenant (non-paying)	8	02.2

Source: Field survey, 2016.

Analysis of building materials used in the study area

Through observation schedule and the analysis of field survey provided in table 3, there were diverse building materials used in the study area. Wall materials were mostly block wall and contributed about 97.8% of the total stock of buildings. Thatch wall was only fairly used in areas belonging to the local natives whose primary occupations were fishing and coconut farming. They interspersed their walls with wood and mud blocks. Such settlements are Eleko and Ibeju. Though there were some unidentified roofing materials constituting about 12.6% of the analysis, aluminium roofing was approximately 76%, thatch and the concrete slab were 5.5% and 6.3% respectively. Windows were composed of aluminium (68.7%), wooden windows (12.8%), louvre windows (10.1%) and casement windows (8.5%). Wooden flush and panel doors were the commonest in the peri-urban settlements. These constituted about 62.6% of the analysis. Steel and iron doors were also used on the scale of 35.5%. Other sparingly utilized door types were glass doors and some unknown materials. Apart from the highway; that is, the urban corridor of Ibeju-lekki that is tarred, almost all secondary roads in the peri-urban settlements are either graded earth or ungraded earth roads. The state of these roads makes an important contribution to the high commuting time during the peak period in the peri-urban settlements.

Table 3: Analysis of building construction materials in the study area

Building materials used	Type	N=366	%
Wall	Block wall	358	97.8
	Mud wall	3	00.8
	Thatch/others	1	00.3
	Missing System	4	01.1
	Total	366	100
Roof	Aluminium	277	75.7
	Thatch	20	05.5
	Concrete slab	23	06.3
	Other	46	12.6
	Missing system	0	00.0
	Total	366	100
Window	Aluminium	251	68.6
	Louvre	37	10.1
	Wooden	47	12.8
	Casement	31	08.5
	Missing system	0	00.0
	Total	366	100
Door	Steels/iron	130	35.5
	Flush/panel/wooden	229	62.6
	Glass	2	00.5
	Others	5	01.4
	Missing System	0	00.0
	Total	366	100
Road	Earth	243	66.4
	Tarred	71	19.4
	Graded mud	5	01.4
	poorly tarred	47	12.8
	Missing system	0	00.0

Source: Field survey, 2016.

Socio-economic characteristics of the household heads

Through the field survey presented in Table 4, there are five recognised household sizes in the study area. Household size of 1-2 persons constituted 13.1% of the total households, more than 13 persons (3.3%) and 10-12 persons (2.2%). Household sizes of 3-5 persons were the commonest, having 55.2% of the respondents' population. Trading and commercial enterprises are the commonest occupation of the peri-urban residents. About 36.6% of the population is engaged in this category of occupation while 19.1% of the population is in civil service because of the location of many government parastatals in the study area.

Professional practices and artisan work constituted 16.7% and 15.3% respectively. Students comprised 5.7% and retirees 3.6%. Unemployed (0.5%) and farmers (0.3%) have almost insignificant contribution in the occupational capacity in the study area. Illiteracy level in Ibeju-Lekki is very low as only about 2.2% of the respondents were illiterate. People with secondary school education were about 30.1% and constituted the highest among the respondents. Highest level of literacy is the postgraduate level, first degree, and diploma certificates having 15.3%, 28.7% and 16.9% respectively. Predominant monthly income of household heads as captured by the survey instrument is the monthly earnings above N150, 000 monthly, this constituted high income group forming about 44.6% of the entire population. The low income group with monthly earnings of N50, 000 and below was 36.3% and the middle income earning N50, 000-N150, 000 constituted 19.1% of the population. Tenure analysis revealed that 37.1% of the respondents have been living in the study area for more than ten years. The Yoruba ethnic group makes up the largest portion of the population in Ibeju-Lekki peri-urban settlements forming about 71.9% of the population. Housing initiatives were primarily of three types in the study area. Self-help housing is the commonest and constituted about 84.4% of the housing development. Private developers' initiatives formed about 14.5% of the housing development in the peri-urban while government housing initiative was 1.1%.

Table 4: Socio-economic characteristics of the household heads

Variable		N=366	%
Household size	1-2 persons	48	13.1
	3-5persons	202	55.2
	6-9persons	96	26.2
	10-12persons	8	2.2
	More than 13 persons	12	3.3
Occupation	Civil service	70	19.1
	Trading/business	134	36.6
	Professional practice	61	16.7
	Unemployed	2	0.5
	Retired/pensioner	13	3.6
	Artisan	56	15.3
	Student	21	5.7
	Farming	1	0.3
	others	8	2.1
Literacy level of the household head	Postgraduate	56	15.3
	First degree/HND	105	28.7
	National diploma	62	16.9
	Secondary	110	30.1
	Primary	25	6.8
	None	8	2.2
Monthly Income of household head(Naira)	Low income N25,000-N50,000	133	36.3
	Middle income N50,001-N150,000	70	19.1
	High income N150,001-Above	163	44.6
Respondents' Ethnic group	Yoruba	263	71.9
	Hausa	6	1.6
	Ibo	70	19.1
	Others	27	7.4
	Total	366	100
Tenure	Less than 5 years	114	31.1
	5-10years	116	31.7
	More than 10 years	134	36.6
	Others	2	0.5
Housing Initiative	Self-help housing	309	84.4
	Private developer/Cooperative	53	14.5
	Government housing	4	1.1

Source: Field survey, 2016.

Conclusion and Recommendations

Characteristics of housing are affected by the socio-economic attributes of the residents and the housing initiatives. There were ten different housing typologies were identified in Ibeju-Lekki peri-urban settlements. Among these, commonest housing type in Ibeju-Lekki was the single family bungalow housing and single family storey building constituting 76.2% and 11.5% respectively. The commonest type of households units per building were the 7-8 units, 0-2 grouping was the least. The commonest rooms per household in Ibeju-Lekki housing were 3-5 rooms. Housing Occupancy in Ibeju-Lekki shows that full family occupation was 56% while part family and part rented occupancy were 44%. Self-owned housing units were 58.7%, family built housing was 21% and tenant housing was 16.4%. The majority of the housing developments were constructed with conventional building materials like cement sandcrete blocks, aluminium burglary proof windows, mostly wooden panel internal doors and steel external doors. Most secondary roads are either graded earth road, ungraded earth road. Only few secondary roads in both locations are tarred. Findings show no trace of alternative building materials for the mentioned housing initiatives in the peri-urban.

Residential development in the study area can be enhanced by balancing infrastructure development which can be achieved by a policy review. In order to ascertain the infrastructure needs and distribution in the peri-urban, effort should be made to update data on the pattern and extent of development. A policy framework to standardize design to serve the various income groups and household sizes should be set up. This can be achieved by creating a portfolio of the socio-economic characteristics of the residents. Also there should be an inclusion of the end users in the design stage, especially projects targeting low income group and middle income group, to help in achieving appropriate housing delivery strategy by housing providers in terms of the provision of an efficient and user responsive housing units. Post occupancy study should be carried out in government and private housing development to determine their efficiency and suitability for the peri-urban settlements. This will enhance performance standard in other housing projects to be implemented. Advocacy for housing policy that encourages the use of alternative building materials by the government and private developers will aid housing affordability in the peri-urban.

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EMPIRICAL EVALUATION OF ECONOMIC PERFORMANCE OF LOCAL AND FOREIGN OWNED CONSTRUCTION FIRMS IN NIGER- DELTA, NIGERIA

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Abstract
The aim of the study is to assess the economic performance of locally owned and foreign owned construction firms in Niger Delta, Nigeria. Survey design approach was adopted in this study. Data were obtained using 1179 copies of structured questionnaire, administered by the researcher and research assistants. The Data were collected on a five-point scale of 1, 2, 3, 4 and 5 and were assigned to the options of very low growth, low growth, moderate growth, high growth and very high growth respectively. Methods of data analysis were simple percentage, mean score, and Mann- U - Whitney test. The result revealed that the overall level of employment growth among construction firms in the Niger Delta was moderate. However, the level of employment growth among foreign owned construction firms was higher than the level of employment growth among locally owned construction firms in the Niger Delta. In terms of financial turnover growth among foreign owned construction firms in Niger Delta, the result showed significant differentials between foreign and locally owned construction firms in Niger Delta. The evaluation of the net income growth of construction firms also yielded moderate level of net income growth among the construction firms; however, the level of net income growth of foreign owned construction firms was higher than the net income growth of locally owned construction firms in Niger Delta.
Keywords: Empirical Evaluation; Economic Performance; Construction Firms; Niger-Delta, Nigeria

Introduction

The Niger Delta which is located in the southern part of Nigeria has some peculiar characteristics ranging from the climate, terrain, vegetation, culture, economic activities and value system. The Niger Delta Region of Nigeria produces a significant portion of the aggregate oil wealth of Nigeria. Since 1956 when oil was first discovered in Oloibiri in Southern Nigeria, the Niger Delta region has accounted for over 90 per cent of Nigeria's oil income (Ujene, 2014). However, the region has perennially suffered from environmental neglect, crumbling infrastructures and services, high unemployment, social deprivation, abject poverty and endemic conflict. This has led to calls for firms operating in the Niger Delta to demonstrate the value of their investments to Nigeria by undertaking increased community development initiatives that provide direct social benefits such as local employment, new infrastructure, schools, and improved health care delivery (Ijaiya, 2014). According to Chambers (1993), sustainability is defined as "that which is capable of being sustained; in ecology, the amount or degree to which the earth's resources may be exploited without deleterious effects. Sustainability at the firm level refers to meeting social and environmental needs in addition to the firm's profitability (Porter, 2008).

Tam (2008) stated that in the construction industry, sustainability is generally interpreted as environment oriented or focused. This assertion was supported by Lilja (2009). In contrast, Shen, Tam, Leona and Ji (2010) stated that a greater concern is given to economic and social issues. According to Ekundayo, Perera, Udeaja and Zhou (2011), the construction industry has often explored the economic dimension which explains why most of the times projects are awarded to the contractor with the lowest tender (Fotwe and Price, 2009). According to Baumgartner and Ebner (2010), economic dimension of corporate sustainability is often discussed as the generic dimension. The study stated that the economic dimension of sustainability in organizations embraces general issues of an organization that have to be respected next to environmental and social aspects in order to remain in the market for long time. Baumgartner and Ebner (2010) noted that organizational executives need to place serious emphasis on these issues since good results in these issues are likely to lead to good financial and sustainability results.

Several studies that were conducted to determine key performance indicators were project specific. They emphasized on the performance measurement at the project level. It was revealed that existing research, which has been conducted for performance evaluation and comparison at the company level, is limited in the literature (Ali, Al-Sulaihi and Al-Gahtani, 2012). Firm's growth can be measured by several attributes such as turnover/sales, annual employment, return on assets, return on investment, market shares, annual financial turnover, profits and net income. However, in the context of this study, employment growth, financial turnover and net income were used as indicators of firm performance. This is because employment has been considered as an alternative measure for performance and with the public interest in new employment, there are arguments that employment growth is an important dimension to capture (Wiklund, 1999). The choice of annual financial turnover is also significant because it reveals the volume of work done by the firms within the period under study. It also reveals the level of survival and competitiveness of the firms in the study area. Superior financial performance is a way to satisfy investors (Chakravarthy, 1986) and can be represented by profitability, growth and market value (Venkatraman and Ramanujam, 1986; Cho and Pucik, 2005). These three aspects complement each other. Profitability measures a firm's past ability to generate returns (Glick, Washburn and Miller, 2005). Growth demonstrates a firm's past ability to increase its size (Whetten, 1987).
There is a suggestion that local firms are more sensitive to their national, institutional and cultural context and may be more able to implement these practices. Studies in East Asian companies showed that sustainability practices introduced by locally owned firms fared better in terms of reducing organizational-level staff turnover than foreign-owned firms (Yalabik, Chen, Lawler, and Kim, 2008). However, Dania, Larsen, and Yao (2013), concluded that multinational firms have higher capability, capacity to adopt, organization, awareness and knowledge base of sustainability than indigenous construction firms.

The objective of this study is to evaluate the economic performance of locally owned and foreign owned construction firms in Niger- Delta, Nigeria. In order to achieve the objective of the study, three hypotheses to be tested were formulated: There is no significant difference in the level of annual employment growth among locally owned and foreign owned construction firms in Niger- Delta, Nigeria; There is no significant difference in the level of annual financial turnover growth among locally owned and foreign owned construction firms in Niger- Delta, Nigeria; and there is no significant difference in the level of net income growth among locally owned and foreign owned construction firms in Niger-Delta, Nigeria

Research Methodology
Survey design approach was adopted in this study. Data was obtained using 1179 copies of structured questionnaire, administered by the researcher and research assistants. The Data was collected on a five-point scale of 1, 2, 3, 4 and 5 and assigned to the options of very low growth, low growth, moderate growth, high growth and very high growth respectively. This is in consonance with Santos and Britos (2012). Methods of data analysis were simple percentage, mean score, and Mann- U - Whitney test.

Table 1 shows the sample frame and sample size of this study. The Sample size was determined using the yamene (1967) equation as shown below
$n = N/1+N(e)^2$ ---------- equation 1
where n = Sample size; N = Finite population; e = Level of significance (0.05); and 1 = Unity
This study adopted Yamene (1967) equation for determining sample size because of its simplicity, reliability and validity. These have encouraged its wider acceptance and usage among researchers over a long period of time.

Table 1: Sample Frame and Sample Size of Construction Firms in Niger Delta

State	Sample Frame	Sample Size
Abia	165	117
Akwa Ibom	214	139
Bayelsa	128	97
Cross River	223	143
Delta	200	133
Edo	237	149
Imo	143	105
Ondo	221	142
Rivers	250	154
Total	1781	1179

Data Presentation and Discussion of Results

This section contains the results of the analysis of data collected for the study. It contains the descriptive results of the response rate of questionnaire, and firm characteristics. This section also contains the result of evaluation of level of economic performance of locally owned and foreign owned construction firms in Niger- Delta, Nigeria and the result of the hypothesis.

Questionnaire Distribution and Response in the Study

One of the research instrument used in this study was structured questionnaire. The questionnaire was administered among the construction firms operating in Niger Delta, Nigeria. The results of analysis were presented in Table 2. Table 2 showed that the number of questionnaire administered to the construction firms in Niger Delta were 117, 139, 97, 143, 133, 149, 105, 142, and 154 in Abia, Akwa Ibom, Bayelsa, Cross River, Delta, Edo, Imo, and Rivers state respectively. From the questionnaire distributed, the response rate ranges between 76.1% and 94.7%. Delta state received the highest response rate of 94.7% while Abia State got the least rate of 76.1 %. In all, an overall response rate of 83.2% was achieved. Groves (2006) noted that a response rate of at least 50 percent is considered adequate for analysis and reporting, a response of 60 percent is good and a response rate of 70 percent is very good. As a guide, researchers typically seek response rates of at least 70% to feel confident that their sample is representative of the sample frame. Hence, the overall response rate of 83.2% in this study is considered very good and adequate.

Table 2: Questionnaire Distribution and Response Rate

S/N	States	Number of questionnaire administered on construction firms	Number of questionnaire returned	Percentage of questionnaire returned (%)	Average of the Response Rate (%)
1	Abia	117	89	76.1	
2	Akwa Ibom	139	113	81.3	
3	Bayelsa	97	85	87.6	
4	Cross River	143	112	78.3	
5	Delta	133	126	94.7	
6	Edo	149	114	76.5	
7	Imo	105	92	87.6	
8	Ondo	142	109	76.8	
9	Rivers	154	140	90.1	
10	TOTAL	1179	980		83.2

Firm Characteristics

Firms' characteristics comprised of location of construction firms and ownership of construction firms. Table 3 shows the distribution of construction firms in each state in Niger Delta, Nigeria. The percentage of firms in Abia, Akwa Ibom, Bayelsa and Cross river states are 9.1%, 11.5%, 8.7% and 11.4%. Others

are Delta, Edo, Imo, Ondo and Rivers with their percents of 12.9%, 11.6%, and 9.4%, 11.1% and 14.3% respectively. Table 3 shows a good distribution of the construction firms among the states in Niger Delta. This implies that the results from this study represents the situation in Niger Delta and can be relied on.

Table 3: Location of Construction Firms

States	Frequency	Valid Percent	Cumulative Percent
Abia state	89	9.1	9.1
Akwa Ibom state	113	11.5	20.6
Bayelsa state	85	8.7	29.3
Crossriver state	112	11.4	40.7
Delta state	126	12.9	53.6
Edo state	114	11.6	65.2
Imo state	92	9.4	74.6
Ondo state	109	11.1	85.7
Rivers state	140	14.3	100.0
Total	980	100.0	

In terms of ownership of Construction Firms, the result of analysis on Table 4 shows that the locally owned construction firms accounted for 96.4% of the total number of firms considered in this study while the foreign owned firms accounted for 3.6% of the total number construction under consideration in this study. This clearly shows that majority of the construction firms operating in Niger Delta are predominantly locally owned firms.

Table 4: Ownership of Construction Firms

Ownership of Firms	Frequency	Valid Percent	Cumulative Percent
Locally owned	945	96.4	96.4
Foreign owned	35	3.6	100.0
Total	980	100.0	

Economic Performance of Locally Owned and Foreign Owned Firms in Niger Delta, Nigeria

The economic performance of locally owned and foreign owned firms in this study comprise of annual employment growth, annual turnover growth and net income growth. Table 5 shows the annual employment growth of locally and foreign owned construction firms in Niger Delta. The decision rule is that any employment growth whose mean falls between 1.0 – 1.8 is of very low growth, 1.8 – 2.6 is of low growth, 2.6 – 3.4 is of moderate growth, 3.4 – 4.2 is having high growth and 4.2 – 5.0 is regarded as having very high growth. The result showed that locally owned construction firms experienced low employment growth in 2007 and 2008. The mean scores range of between 2.61 and 3.28 showed that the locally owned construction firms experienced moderate employment growth from 2009 to 2015. It was also revealed that the employment growth among locally owned construction firms declined from moderate level to low level in 2016 as indicated by the mean score of 2.51. The average mean score of 2.83 showed that the overall level of employment growth among locally owned construction firms in Niger Delta was moderate.

The mean scores ranging between 2.91 and 3.31 revealed that the employment growth of the foreign construction firms was moderate in 2007, 2008, 2009, 2010 and 2011. There was an improvement on the employment growth of foreign owned construction firms in 2012 and 2013 as the firms recorded high employment growth. However, the employment growth declined from high growth level in 2013 to moderate growth level in 2014, 2015 and 2016. The mean score of 3.23 showed that the level of employment growth among large construction firms in Niger Delta is moderate. The average mean score of 3.23 showed that the overall level of employment growth among the foreign owned construction firms was moderate.

Table 5: Annual Employment Growth of Locally Owned and Foreign Owned Construction Firms in Niger Delta, Nigeria

Size of Firms /Year	Locally owned Firms N=945		Foreign Owned Firms N=35		Combined N=980	
	M.S	Remark	M.S	Remark	M.S	Remark
2007	2.27	LG	2.91	MG	2.29	LG
2008	2.54	LG	3.11	MG	2.56	LG
2009	2.61	MG	3.20	MG	2.63	MG
2010	2.84	MG	3.34	MG	2.86	MG
2011	2.97	MG	3.31	MG	2.99	MG
2012	3.17	MG	3.40	HG	3.18	MG
2013	3.28	MG	3.49	HG	3.29	MG
2014	3.12	MG	3.34	MG	3.13	MG
2015	2.97	MG	3.23	MG	2.98	MG
2016	2.51	LG	2.97	MG	2.53	L.G
Overall Level of Employment Growth in Niger Delta	2.83	MG	3.23	MG	2.84	MG

LG = Low Growth, MG = Moderate Growth, HG = High Growth

Mann Whitney U Test for Comparing Level of Employment Growth among Locally Owned and Foreign Owned Construction Firms in Niger Delta was carried out and the result in Table 6 shows that the P-value is 0.003. This value is less than the 0.05 significant level set for the test. This implies that there is significant difference in the level of employment growth among locally owned construction firms and foreign owned construction firms in Niger Delta. The result in Table 6 indicates that foreign owned construction firms have higher level of employment growth because it is the group with the highest mean rank. From these data, it can be concluded that the level of employment growth among foreign owned construction firms is significantly higher than the level of employment growth among locally owned construction firms (U = 15.000, p = .003).

Table 6: Mann Whitney U Test for Comparing Level of Employment Growth

	Mean Rank	Sum of Rank	Decision @ 0.05 Sig level
Locally Owned Firms	7.36	81.00	
Foreign Owned Firms	15.64	172.00	
Mann Whitney U	15.000		
Wilcoxon W	81.000		
Z	-2.993		
P- Value	.003		Reject null hypothesis

Annual Financial Turnover Growth of Local and Foreign Owned Construction Firms in Niger Delta

Table 7 shows the annual financial turnover growth of construction firms operating in Niger Delta based on firms' ownership. The decision rule is that any financial turnover growth whose mean falls between 1.0 – 1.8 is of very low growth, 1.8 – 2.6 is of low growth, 2.6 – 3.4 is of moderate growth, 3.4 – 4.2 is having high growth and 4.2 – 5.0 is regarded as having very high growth. The mean scores ranging between 2.62 and 3.30 indicated that locally owned construction firms experienced moderate financial turnover growth from 2007 to 2015. However, there was a decline in the financial turnover growth from moderate level of financial turnover growth to low level of financial growth among locally owned firms in 2016 as revealed by the mean score of 2.45. The average mean score of 2.89 implied that overall level of financial turnover growth among locally owned construction firms in Niger Delta was moderate within the period under study.

The mean scores of 3.31, 3.31 and 3.34 showed that foreign owned construction firms in Niger Delta experienced moderate financial turnover growth in 2007, 2008 and 2009 respectively. The mean scores of 3.46, 3.51, 3.57 and 3.63 indicated that foreign owned construction firms in Niger Delta experienced high

financial turnover growth in 2010, 2011, 2012 and 2013 respectively. However, in 2014, the firms experienced moderate financial turnover growth and the moderate level of financial turnover growth continued till 2016.The average mean score of 3.34 showed that the overall level of financial turnover growth among foreign owned construction firms in Niger Delta was moderate within the period under this study.

Table 7: Annual Financial Turnover Growth of Locally Owned and Foreign Owned Construction Firms in Niger Delta

Ownership of Firms /Year	Locally owned Firms N=945		Foreign Owned Firms N=35		Combined N=980	
	M.S	Remark	M.S	Remark	M.S	Remark
2007	2.64	MG	3.31	MG	2.66	MG
2008	2.62	MG	3.29	MG	2.65	MG
2009	2.71	MG	3.34	MG	2.74	MG
2010	2.96	MG	3.46	HG	2.98	MG
2011	3.09	MG	3.51	HG	3.11	MG
2012	3.22	MG	3.57	HG	3.23	MG
2013	3.30	MG	3.63	HG	3.31	MG
2014	2.98	MG	3.29	MG	2.99	MG
2015	2.94	MG	3.14	MG	2.95	MG
2016	2.45	LG	2.86	MG	2.47	LG
Level of Annual Financial Turnover Growth in Niger Delta	2.89	MG	3.34	MG	2.91	MG

LG = Low Growth, MG = Moderate Growth, HG = High Growth

Mann Whitney U Test on level of annual financial turnover growth among locally owned and foreign owned construction firms in the study area was carried out to compare their performance and the result in Table 8 shows that the P- value is 0.001. This value is less than the 0.05 significant level set for the test and implies that there is significant difference in the level of annual financial turnover growth among locally owned construction firms and foreign owned construction firms in Niger Delta. The result in Table 8 indicates that foreign owned construction firms have higher level of annual financial turnover growth because it is the group with the highest mean rank. From this result, it can be concluded that the level of annual financial turnover growth among foreign owned construction firms is statistically significantly higher than the level of annual financial turnover growth among locally owned construction firms (U = 11.000, p = .001).

Table 8: Mann Whitney U Test for Comparing Level of Annual Financial Turnover Growth

	Mean Rank	Sum of Rank	Decision @ 0.05 Sig level
Locally Owned Firms	7.00	77.00	
Foreign Owned Firms	16.00	176.00	
Mann Whitney U	11.000		
Wilcoxon W	77.000		
Z	-3.251		
P- Value	.001		Reject null hypothesis

Net Income Growth of Locally Owned and Foreign Owned Construction Firms in Niger Delta

Table 9 shows the net income growth of construction firms based on ownership of firms. The decision rule is that any net income growth whose mean falls between 1.0 – 1.8 is of very low growth, 1.8 – 2.6 is of low growth, 2.6 – 3.4 is of moderate growth, 3.4 – 4.2 is having high growth and 4.2 – 5.0 is regarded as having very high growth. The mean scores ranging between 2.66 and 3.31 showed that the net income growth of locally owned construction firms in Niger Delta from 2007 to 2016 was moderate. The average mean score of 2.92 implied that the overall level of net income growth of locally owned firms was moderate within the period of this study. Furthermore, the mean scores of 3.14, 3.17, 3.11, 3.14 and 3.29 showed that the net income growth of foreign owned construction firms was moderate in the years 2007, 2008, 2009, 2010 and 2011 respectively. It was also revealed that foreign owned construction firms

experienced high net income growth in the years 2012, 2013 and 2014. However, the high income growth dropped to moderate level in 2015 and this condition continued in the year 2016. The average mean score of 3.25 also showed that the overall level of net income growth among foreign owned construction firms was moderate within the period of this study. The average mean score of 2.94 indicates that the overall level of net income of construction firms operating in Niger Delta was moderate within the period of this study.

Table 9: Net Income Growth of Construction Firms based on Ownership of Firms

Ownership of Firms /Year	Locally owned Firms N=945		Foreign Owned Firms N=35		Combined N=980	
	M.S	Remark	M.S	Remark	M.S	Remark
2007	2.66	MG	3.14	MG	2.68	MG
2008	2.66	MG	3.17	MG	2.70	MG
2009	2.67	MG	3.11	MG	2.68	MG
2010	2.81	MG	3.14	MG	2.84	MG
2011	3.00	MG	3.29	MG	3.01	MG
2012	3.16	MG	3.40	HG	3.17	MG
2013	3.31	MG	3.43	HG	3.31	MG
2014	3.26	MG	3.40	HG	3.26	MG
2015	2.96	MG	3.23	MG	2.97	MG
2016	2.72	MG	3.17	MG	2.74	MG
Level of Net income Growth of Construction Firms in Niger Delta	2.92	MG	3.25	MG	2.94	MG

LG = Low Growth, MG = Moderate Growth, HG = High Growth

The result of Mann- Whitney U test in Table 10 shows that the P- value is 0.005. This value is less than the 0.05 significant level set for the test and implies that there is significant difference in the level of net income growth among locally owned construction firms and foreign owned construction firms in Niger Delta. The result in Table 10 indicates that foreign owned construction firms have higher level of net income growth because it is the group with the highest mean rank. From these data, it can be concluded that the level of net income growth among foreign owned construction firms is statistically significantly higher than the level of income growth among locally owned construction firms (U = 18.000, p = .005).

Table 10: Mann Whitney U Test for Comparing Level of Net income Growth

	Mean Rank	Sum of Rank	Decision @ 0.05 Sig level
Locally Owned Firms	7.64	84.00	
Foreign Owned Firms	15.36	169.00	
Mann Whitney U	18.000		
Wilcoxon W	84.000		
Z	-2.793		
P- Value	.005		Reject null hypothesis

The result of hypothesis shows that there is significant difference in the level of employment growth among locally owned construction firms and foreign owned construction firms in Niger Delta. The result indicates that foreign owned construction firms have higher level of employment growth than the locally owned firms. It can be concluded that the level of employment growth among foreign owned construction firms is significantly higher than the level of employment growth among locally owned construction firms. This study concurs with Dania, Larsen, and Yao (2013), who concluded that multinational firms have higher capability, organization, and capacity than indigenous construction firms. The result reveals that overall level of financial turnover growth among locally owned and foreign owned construction firms

in Niger Delta was moderate within the period under study. The result of Mann-Whitney U test indicates that there is significant difference in the level of annual financial turnover growth among locally owned construction firms and foreign owned construction firms in Niger Delta. The result indicates that foreign owned construction firms have higher level of annual financial turnover growth. It can be concluded that the level of annual financial turnover growth among foreign owned construction firms is significantly higher than the level of annual financial turnover growth among locally owned construction firms. This connotes that the volume of work done by foreign owned construction firms is more than the volume of work done by locally owned construction firms within the period of this study in Niger Delta, Nigeria. This can be attributed to their level of financial resources, technical abilities, managerial capability, innovativeness, diversification and their flexibility in the construction market. This study concurs with Dania, Larsen and Yao (2013) who opined that the construction market is largely dominated by large multinational firms in terms of project size and value. The multinational firms display higher capabilities than their indigenous counterparts. The result revealed the overall level of net income of construction firms operating in Niger Delta, Nigeria was moderate within the period of this study.

The result also shows that the overall level of net income growth of locally owned firms was moderate within the period of this study. Furthermore, it was revealed that the net income growth of foreign owned construction firms was moderate in 2007, 2008, 2009, 2010 and 2011 respectively. It was also revealed that foreign owned construction firms experienced high net income growth in 2012, 2013 and 2014. However, the high income growth dropped to moderate level in 2015 and this condition continued in 2016. The result showed that the overall level of net income growth among foreign owned construction firms was moderate within the period of this study. The result of Mann- Whitney U test shows that there is significant difference in the level of net income growth among locally owned construction firms and foreign owned construction firms in Niger Delta. The result indicates that foreign owned construction firms have higher level of net income growth. It can be concluded that the level of net income growth among foreign owned construction firms is significantly higher than the level of income growth among locally owned construction firms in Niger Delta, Nigeria. This can be attributed to working capital management, the ability of large and foreign owned firms to employ more qualified managers to control their resources. This study is in consonance with Babalola (2013) who argued that the larger a firm is, the more the influence it has on its stakeholders and so foreign firms which are also large firms tend to outperform small firms. It is also in agreement with Mohamad, Ibrahim, and Massoud (2013) who revealed that working capital management has implications on the value, risk and profitability of firms. Other factors that might determine the financial performance of a firm include: leverage, level of economic activity in the country, firm growth, operating cash flow, firm size, nature of industry and firm's operating cycle.

Conclusion

This study concluded that the overall level of employment growth among construction firms in Niger Delta is moderate. However, the level of employment growth among foreign owned construction firms was higher than the level of employment growth among locally owned construction firms in Niger Delta. In terms of the overall level of financial turnover growth of construction firms in Niger Delta, the result was found to be moderate. However, the level of financial turnover growth among foreign owned construction firms in Niger Delta is higher than the level of financial turnover among locally owned construction firms in Niger Delta. The net income growth of construction firms in Niger Delta was also evaluated and a moderate level of net income growth among the construction firms in Niger Delta was established, however, the level of net income growth of foreign owned construction firms was higher than the net income growth of locally owned construction firms in Niger Delta.

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FACTORS CONTRIBUTING TO FAILURE OF PUBLIC-PRIVATE PARTNERSHIP IN INFRASTRUCTURAL DEVELOPMENT IN BENIN CITY, EDO STATE, NIGERIA

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Abstract
The overall assessment of infrastructural development using Public-Private Partnership (PPP) has shown that it has not succeeded in Nigeria due to certain factors. This study aimed to examine the factors contributing to failure of public-private partnership in infrastructural development. The study adopted a quantitative research approach by eliciting primary data through semi-structured questionnaire. One hundred and eighty (180) copies of questionnaire were administered and 164 were retrieved and considered for further analysis. The data obtained were analysed using severity index (SI), Mean item score (MIS), and content analysis. The findings revealed three major factors contributing to the failure of PPP projects as: corruption (SI = 87%), inadequate funding and finance (SI = 85%), and lack of risk sharing and management (SI = 82%). The study also revealed funding project adequately without any delay as the most effective strategy to minimize occurrence of failure in PPP projects. This study however recommends that; Government should enact stringent policies that will reduce corruption; accountability and transparency should be encouraged in both private and public sector; financial institutions should be setup to improve finance and funding of PPP construction projects.
Keywords: Construction industry, public- private partnership, infrastructural development, Nigeria economy

Introduction

Infrastructural development through Public-Private Partnership has become one of the most adopted methods of executing projects in both developed and developing countries (Alfen *et al*., 2009). All over the world, Governments face challenges of providing infrastructure for its citizens (Ibrahim *et al*., 2007). Regardless of the economic resources at the disposal of a country, it is a social responsibility to provide basic services to the citizens (Isa, 2010). Infrastructure is the basic physical and organizational structure needed for the operation of a society (Oyedele, 2012; New Oxford American Dictionary, 2013). Oyedele(2013) defines Public-Private Partnership as a means of providing the public with infrastructure through collaboration of the public sector and private sectors with the aim of providing services to benefit the general public. The backbone of any nation is the status of its infrastructure facilities. Developing nations across the globe have a great need for expanded infrastructure as their economies undergo rapid development and urbanization. Physical infrastructure, such as roads and bridges; power generation plants; power transmission and distribution; water and sanitation networks; ports; airports; and transportation systems like railways have to be put in place for the benefit of her citizens.

These infrastructure projects are highly capital-intensive in nature and exert a strain on the public purse. Developing nations generally, have limited resources to carry out the required infrastructure facilities due to the large investment requirements of infrastructure projects and the scarcity of available resources in terms of huge financial outlay and human to provide the adequate infrastructural facilities essential for development (Oyedele, 2012). Thus, the Governments and the public sector authorities in developing countries are constantly on the lookout for alternative sources of funds (Infrastructure Concession Regularoty Commission (ICRC), 2017). Public-Private Partnership scheme in the area of development of infrastructure is not a new notion and this strategy has been used in providing basic infrastructure in most developing countries (Alonso, 2015). Lately PPP has been used by governments of many developing countries, and as a result, there is increasing number of problems associated with the implementation of

PPP projects (Cheung et *al*., 2010). The overall assessment of infrastructural development using PPP has shown that it has not succeeded in Nigeria due to certain factors (Oyedele, 2013). PPP is primarily aimed at providing basic infrastructure for the public in order to ensure that developing countries achieves their infrastructural development target (Ndonye *et al*., 2014). Nigerian infrastructure has been in a state of deterioration for decades without proper maintenance. However, infrastructure is a capital intensive process that imposes constraints on government budget. Thus, PPP is meant to relieve some of these constraints, and Nigeria has benefited and is still benefitting from the PPP implementation to deliver majority of the basic infrastructure. However, this study seeks to examine the factors contributing to failure of public-private partnership in infrastructural development with a view to suggesting strategies that will minimize the occurrence of failure in PPP projects.

Literature Review

General Concept of Public-Private Partnership

Private sector involvement in the delivery of public services is not a new concept: PPPs have been used for over three decades, since 1970s. Initially, it focuses on economic infrastructure, but today PPPs have evolved to include the procurement of social infrastructure assets and associated non-core services. PPPs are used in housing, health, corrective facilities, energy, water, and waste treatment projects. PPP policy has also evolved globally as public sectors budgetary challenges limit potential options. One method of tapping into alternative sources of capital is the public-private partnership (Agyemang, 2011; Tiwary, 2017).

Public Private Partnership Practice in Nigeria

Public-Private Partnership in the provision, maintenance, and management of social services and building of infrastructure has been in practice in developed countries like USA, as far back as 1676, a century before the American Revolution (Ugwu, 2012). In Africa, it is a relatively new initiative or concept. The post 1999 reform project, initiated by the Obasanjo Presidency, represents a fundamental economic ideological shift from the socialist character of the Nigerian economy to a full-blown free market economy with neo-liberal policies such as deregulation, privatization, monetization, and right-sizing of public bureaucracy featuring prominently on the policy agenda of the government (Adekunle, 2011; Ugwu, 2012). Prior to the inception of the 1999 civil rule and the institution of the market reforms, several state utilities were organizationally crippled by corruption and inefficiency and constituted a drain pipe to the national treasury (Adekunle, 2011; Ugwu, 2012). It was in attempt by the Obasanjo administration, to revamp and restructure Nigerian economy that the neo-liberal economic policies of the PPP, Privatization and the rest were initiated (Ugwu, 2012).

State of Nigerian Infrastructure

Infrastructure in Nigeria is in a state of decay given their levels of maintenance. All aspects of infrastructure from transportation, electricity, water supply to housing and communication have all experienced severe neglect from governments at different levels. Electricity and water supply in Nigeria was solely the responsibility of the government. In order to relieve some of the financial burden, the Nigerian government privatised some public agencies that provided some of the infrastructure. However, since the privatisation of the public services, no changes have occurred to the infrastructure in place (Udoka, 2013).

Factors Contributing to Failure of PPP Construction Projects

Public Private Partnership (PPP) has proven to be a veritable tool in the development of infrastructural facilities all over the world. Thus, in line with one of the indicative parameters of Vision 20:2020 the blueprint designed by the government to make Nigeria one of the world's best 20 economies by 2020, the Federal Government is making moves towards a massive upgrade of infrastructure across several sectors (Imbua and Ecoma, 2014; George Etomi & Partners, 2017).

However, the private sectors are wary of undertaking the projects lined up for private financing due to failure of past PPP projects. Virtually every PPP initiative of the government in the last decade has failed by disagreements, litigations and other problems (George Etomi & Partners, 2017). PPPs in Nigeria have faced a number of challenges including allegations of corruption, a lack of transparency and accountability, unsustainability due to changes in government and poor governance, poor project planning and management, poor access to funds as well as politicization of PPP contracts (George Etomi & Partners, 2017). Similarly, Dabak (2014) highlighted the challenges with PPP in Nigeria to be: financial limitations, dominance of public companies, corruption, inability of private companies to access local currency, and affordable long term loan. In addition, PPPs are faced with the problem of definition, as it is not properly defined in the law permitting the use of the finance option (Dabak, 2014). Incessant changes in relevant political office holders and the Chief Executives of Regulatory agencies is also a major problem with PPP projects (Afolabi, 2011; Dabak, 2014).

Four reasons for failure of national sewerage project in Malaysia were revealed in Abdul-Aziz (2001). These reasons are: lack of transparency (Adam *et al*. 1992); low equity-debt ratio (WIDER, 1992); over-lavish provided by government to the concessionaire for safety nets (Clifford, 1993); and inefficient and mismanagement occurred by the concessionaire (Kuan, 1996). Furthermore, Afolabi (2011) highlighted eleven factors contributing to failure of many PPP projects in Nigeria, these are: big difference between public and private parties anticipations; ambiguous objectives and obligations laid out by government; complexity in making decisions; inadequacy in defining each sector authority; poorly and insufficient legal/institutional framework; lack of risk management; lack of integrity by public sector; bad domestic market; lack of attracting private sector to involve in long term financial contract with reasonable rate; lack of transparency; and insufficient competition among private parties.

Research Method

To achieve the objectives of this study, literature survey was conducted to provide the required information on the factors contributing to failure of Public-Private Partnership in infrastructural development in Benin City and possible strategies to reduce failure rate. Quantitative research approach was adopted for this study. The information gathered from literature review was used to develop a semi – structured questionnaire which was administered to relevant professionals. A total of 180 questionnaires were administered and 164 were retrieved. Severity index (SI) was used to rank the identified factors while Mean item score (MIS) was used to rank the identified strategies. For MIS, the strategies were rated against a scale to assist in assessing the significance of each strategy. The scale was then transformed into an average otherwise known as mean item score (**MIS**) for each strategy to determine the ranks of the different strategies. It is represented mathematically below;

$$Mean\ Item\ Score = \frac{5n5 + 4n4 + 3n3 + 2n2 + n1}{(n5 + n4 + n3 + n2 + n1)}$$

Where; N= Total Number of respondents, $\mathbf{n_1}$= Number of respondents for 'strongly disagree', $\mathbf{n_2}$= Number of respondents for 'disagree', $\mathbf{n_3}$= Number of respondents for 'not sure', $\mathbf{n_4}$= Number of respondents for 'agree' and $\mathbf{n_5}$= Number of respondents for 'strongly agree'.

On the other side, severity index was determined and used to rank the factors contributing to failure of PPP projects according to their degree of severity. The severity indices were measured using the formula as follows:

$$\text{Severity index} = \sum_{1=i}^{5} (wi \times fxi) \times \frac{100}{5n}$$

Where: *wi is* weight given to *i*th response and *i* = 1, 2, 3, 4, or 5 is response frequency
fx1 = not important and *fx5* = very important, *n* = total number of responses.

Results Analysis

Respondents Demographic Statistics

Out of the 164 copies of questionnaire retrieved, 32% of the respondents were Quantity surveyors, 27% were Engineer, 20% were Architect, 13% were project managers and 8% were non – built environment professionals as shown in figure 1. This indicates that the respondents are well knowledgeable about the dynamics of built environment. Figure 2 shows the academic qualifications of the respondents. It was observed that majority of the respondents have B. Sc / B. Eng / B. Tech (59%), followed by M. Sc (25%), next were respondents with HND (7%) while only 6% have PhD. The educational qualification with the least percentage was NCE (3%). This connotes that the respondents are qualified to provide meaningful information for the research. Figure 3 shows the years of experience of respondents. 72% of the respondents have spent less than 14 years in the construction industry while 28% have spent above 14 years in the industry. Majority of respondents thus possessed considerable experience in the construction industry. This was advantageous for the study because it would improve the reliability of data and subsequent findings. Figure 4 shows the response of the respondents concerning their knowledge about Public-Private-Partnership Project (PPP) Delivery Method. It was revealed that almost all the respondents were aware about the workings of Public-Private-Partnership Project delivery method with a percentage of 93% while only 8% lack knowledge of Public-Private-Partnership Project Delivery Method. This would be of tremendous benefit to this research and hence increase it reliability.

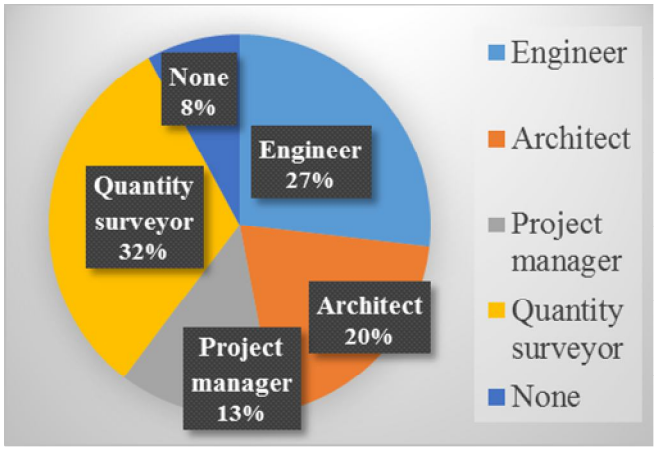

Figure 1: Profession
Source: Researcher's Analysis (2018)

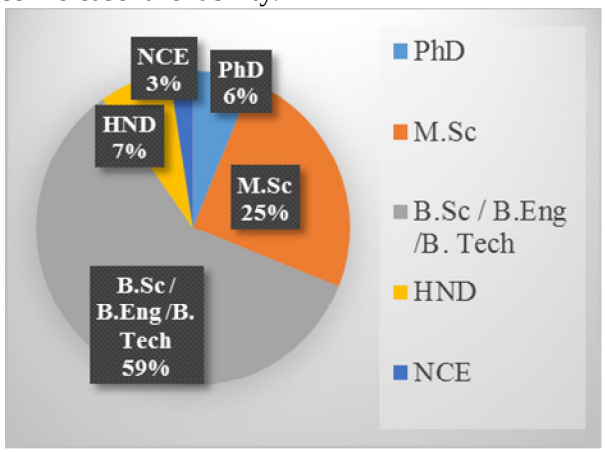

Figure 2: Educational Qualification
Source: Researcher's Analysis (2018)

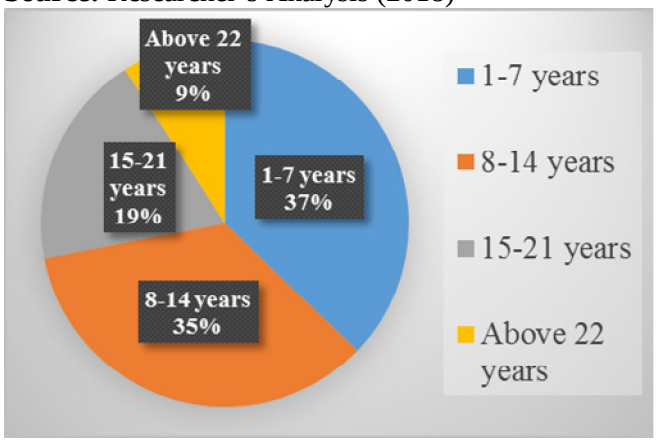

Figure 3: Years of Experience
Source: Researcher's Analysis (2018)

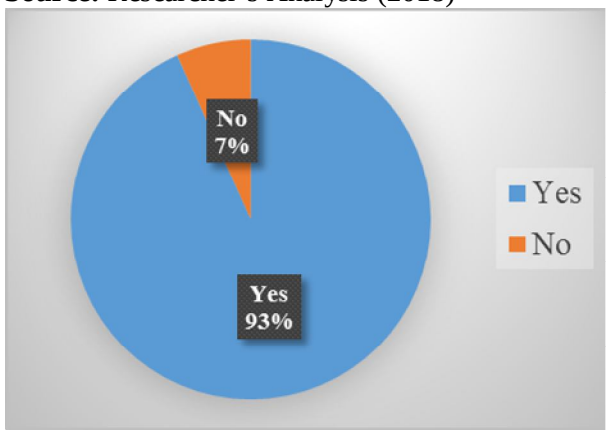

Figure 4: Knowledge About PPP
Source: Researcher's Analysis (2018)

Factors Contributing to Failure of Public-Private Partnership in Housing Delivery in Benin City, Edo State

Table 1 shows the factors contributing to failure of Public-Private Partnership in housing delivery in Benin City, Edo State. Severity index (SI) was used to rank the factors. 24 factors were identified where the severity index ranges between 47% and 87%. The greater the severity index, the higher the rank of the factor. Corruption ranked first with a severity index of 87%, followed by Inadequate funding and finance (SI = 85%), next was Lack of risk sharing and management (SI = 82%). Bad domestic market (SI = 80%) and Lack of integrity among public sector (SI = 77%) ranked 4th and 5th respectively while Unfavorable economic condition and Technical incapability both ranked 6th with same severity index of 73%. Furthermore, Poor and insufficient legal institutional framework (SI = 70%) and Unwillingness of private sector to invest in PPPs (SI = 67%) ranked 7th and 8th respectively. Poor governance (SI = 65%), Political unwillingness (SI = 64%), Absence of social support (SI = 63%) and Interest rate volatility and inflations (SI = 62%) ranked 11th, 12th and 13th respectively. Lack of experience, expertise and poor organization and Lack of understanding of PPP concepts both ranked 14th with same severity index of 60%. Impractical PPP policy and strategies (SI = 57%) ranked 16th while Complexity in making decisions and Lack of partnering skills and good relationships both ranked 17th with severity index of 56%. In same vein, Lack of awareness, Poor transparency and Incompetency of both public and private sectors all ranked 19th with same severity index of 55%. Lastly, Government's defective PPP policy and strategy (SI = 52%), Low equity debt ratio (SI = 51%) and Insufficient competition among private parties (SI = 47%) ranked 22nd, 23rd and 24th respectively.

Table 1: Factors Contributing to Failure of Public-Private Partnership

S/N	Factors	Severity Index (%)	Rank
1	Corruption	87	1
2	Inadequate funding and finance	85	2
3	Lack of risk sharing and management	82	3
4	Bad domestic market	80	4
5	Lack of integrity among public sector	77	5
6	Unfavorable economic condition	73	6
7	Technical incapability	73	6
8	Poor and insufficient legal and institutional framework	70	8
9	Unwillingness of private sector to invest in PPPs	67	9
10	Poor governance	65	10
11	Political unwillingness	64	11
12	Absence of social support	63	12
13	Interest rate volatility and inflations	62	13
14	Lack of experience, expertise and poor organization	60	14
15	Lack of understanding of PPP concepts	60	14
16	Impractical PPP policy and strategies	57	16
17	Complexity in making decisions	56	17
18	Lack of partnering skills and good relationships	56	17
19	Lack of awareness	55	19
20	Poor transparency	55	19
21	Incompetency of both public and private sectors	55	19
22	Government's defective PPP policy and strategy	52	22
23	Low equity debt ratio	51	23
24	Insufficient competition among private parties	47	24

Source: Researcher's Analysis (2018)

Strategies to Minimize Occurrence of Failure in PPP Projects

Table 2 shows the strategies to minimize occurrence of failure in PPP projects. Mean Item Score (MIS) was used to rank the factors. 10 factors were identified where the mean item score ranges between 3.11 and 4.55. Projects should be adequately funded without any delay ranked first with MIS of 4.55 while there should be sharing, allocations and mitigation of risks ranked second with MIS of 4.52. Loans should be easy to access from banks and Proper monitoring and management teams ranked third and fourth with MIS of 4.32 and 4.15 respectively. Both parties should be willing to carry out their individual assignments effectively at all stages (MIS = 3.92), Proper analysis of projects by government during the procurement stage (MIS = 3.59), Adequate political support from government to attract both foreign and local investors (MIS = 3.54), Proper planning and conceptualizing on risk sharing issues (MIS = 3.51), Public enlightenment on PPP through national training (MIS = 3.18), and Proper feasibility and viability study should be carried (MIS = 3.11) ranked fifth, sixth, seventh, eighth, ninth and tenth.

Table 2: Strategies to minimize occurrence of failure in PPP projects

Factors	MIS	Rank
Projects should be adequately funded without any delay	4.55	1
There should be sharing, allocations and mitigation of risks	4.52	2
Loans should be easy to access from banks	4.32	3
Proper monitoring and management teams	4.15	4
Both parties should be willing to carry out their individual assignments effectively at all stages	3.92	5
Proper analysis of projects by government during the procurement stage	3.59	6
Adequate political support from government to attract both foreign and local investors	3.54	7
Proper planning and conceptualizing on risk sharing issues	3.51	8
Public enlightenment on PPP through national training	3.18	9
Proper feasibility and viability study should be carried	3.11	10

Discussion of Findings

The first objective of this study was to identify and establish the factors contributing to failure of Public-Private Partnership in infrastructural in Benin City, Edo State. Surprisingly, Corruption ranked first with a very high severity index (85%) which makes it one of the main cause of failure of Public-Private Partnerships, followed by Inadequate funding and finance (SI = 85%), Lack of risk sharing and management (SI = 82%), Bad domestic market (SI = 80%) and Lack of integrity among public sector (SI = 77%). This revealed that corruption has been the major source of failure as both private and public sector of Nigeria economy lack accountability and transparency. This research further affirmed the assertions made in Stansbury (2005) where it was stated that large number of small scale sub-contractors, permits numerous approval and thus makes a project prone to corruption. This is the case of PPP construction projects which usually involve wide range of people from different sectors (private and public) of the economy; hence, it is highly prone to corruption. These findings were supported by Abdul-Aziz (2001) and Asian Business (1996). The second objective of this study was to suggest strategies to minimize the occurrence of failure of PPP. "Projects should be adequately funded without any delay" ranked first with the highest mean item score (4.55), followed by "There should be sharing, allocations and mitigation of risks" (MIS = 4.52), "Loans should be easy to access from banks" (MIS = 4.32), "Proper monitoring and management teams" (MIS = 4.15), and "Both parties should be willing to carry out their individual assignments effectively at all stages" (MIS = 3.92). As indicated in a research carried out by Bhagatkar, Jaiswa, Kulkarni, Mehta, and Lature (2015) that cash flow is critical for the success of any construction project, when a construction project is funded efficiently, it hastens the rate of project completion and thus improves the quality of Private-Public Partnerships (PPP).

Conclusion and Recommendations

Infrastructural development plays an essential role in the economic development of every nation and Public-Private Partnership (PPP) is a very useful tool in facilitating housing delivery in developed and developing countries. Based on the findings from this study, the following conclusions were drawn:
Majority of construction industry stakeholders in Benin City, Edo State are knowledgeable about Public-Private Partnership (PPP) and the rate of failure of Public-Private Partnership is very high. This means that there are excessive corrupt practices in most Public-Private Partnership (PPP) construction projects in Nigeria. Corruption, Inadequate funding and finance, Lack of risk sharing and management, Bad domestic market, and Lack of integrity among public stakeholders are the main causes of failure for most Public-Private Partnership (PPP) construction project in Nigeria. The effective strategies in minimizing the occurrence of failure in PPP in Benin City, Edo State include adequately funded projects, risks sharing and mitigation measures, easy access to bank loans for project execution, as well as proper monitoring and management team for project implementation. On the basis of the findings, this study recommends that accountability and transparency should be encouraged in both private and public sectors; financial institutions should be setup to improve finance and funding of PPP construction projects; and stakeholders to PPP construction projects should setup efficient monitoring and management teams.

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CHARACTERISTICS OF CONCRETE MADE OF CLAMSHELL AS COARSE AGGREGATES

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Abstract
Excessive utilization of aggregate across the globe and a sharp increase in prices due to high demand especially in areas where there are no deposits like the Niger-delta has forced researchers to focus attention on the development of alternative materials that can partially or fully replace aggregate in concrete production. This is a study on the properties of concrete containing clamshell as full or partial replacement of coarse aggregates with a view to establishing its suitability in concrete production. Laboratory investigations were carried out to study the quality of the clamshell as an aggregate as well as the concrete produced using the clamshell as full replacement of coarse aggregate. The findings indicated that Clamshell aggregates were found to have a better resistance to impact but poor in crushing strength with values of 8.9% and 16.6% respectively as against gravel with16.0% and 6.9%respectively. The compressive strength of concrete made with clamshell are: 89.7 N/mm^2,130N/mm^{2}176.3N/mm^2, and 186 N/mm^2 at 7, 14, 21 and 28 curing days respectively as against normal concrete with values of 132 N/mm^2, 151.3 N/mm^2, 191.3 N/mm^{2}and 210 N/mm^2 at the end of 7, 14, 21 and 28 days of curing respectively. The specific gravity of clamshell aggregates is 2.74 while the average density of concrete made with clamshell is 2450kg/m^3 as compared to 2360kg/m^3 for normal concrete made with gravel. This falls within the range of normal weight concrete. When the sample specimen was exposed to aggressive environment, loss of weight due to effect of acid was recorded as follows: 3.3%,1%,11.5% and 8.2% at 7, 14, 21 and 28days respectively for clamshell concrete and 27.3%, 20%, 4.9% and 1.9% respectively for the control sample. Thus it was concluded that concrete made with clamshell aggregates can be used in mass concrete. It is also recommended that further research should be carried out, using a partial replacement to establish whether the target strength of 30N/mm^2 can be achieved.
Keywords: Aggregates, clamshell, concrete, compressive strength, full replacement, suitability

Introduction

The entire shoreline of Nigeria is a sedimentary basin that is virtually riverine and estuarine except for a few areas in the west. The major occupation of the people is fishing. Both shell and fin fishes are caught, processed, sold or consumed by the fishing family. Among the commonest shell fishes consumed in coasts are periwinkle, *Tympanutonusfuscatus*, clam (*Chionesubrugosa*, *Geloinaerosa*) and the mangrove oyster, *Crassostreagasar* (Elijah, Sunday and Dorcas 2014). These shell fishes are typically processed for consumption by removing the inedible shells. The waste shells are thrown away, which causes environmental pollution. Fish and their products account for a large proportion of the people's diet and the intensification of fishing activities have led to the production of large quantities of these waste shells. Several dumps of sea shell are common in many cities in the coast of Nigeria including Lagos, Port Harcourt, Calabar, Warri, Yenagoa, Oron, sapelle, Uyo etc. As a way of waste management, a number of useful materials have been produced from sea shell wastes. 'Agoha (2007) produced useful biomaterials such as chitin and chitosan from waste periwinkle shells' (Elijah *et al* 2014). An evaluation in to the suitability of periwinkle shells as substitute for lime in glass manufacturing was carried out by Malu and Bassey (2003). They did a proximate analysis of periwinkle shell, which showed that the shell contained important minerals suitable for glass production such as calcium oxide, silicon iv oxide, magnesium oxide, aluminum trioxide and iron oxide (Zonji, 2011and Elijah *et al* 2014). Other promising areas where waste seashells can be put to use include the use of periwinkle for the formulation of fish feed as a source of calcium, the use of waste sea shells as calcium supplements in the food industry and in poultry feeds.

One of the promising uses of waste gastropod shells is in civil construction as substitute for aggregates (chippings) especially in the coastal areas where these materials are lacking. Accordingly, researchers have conducted exploratory studies on the partial or total substitution of waste sea shells with coarse

aggregates/chippings for the production of mortar and concrete used for civil construction' (Shanthappa *et al* 2013 and Elijah *et al* 2014). Job *et al* (2007) carried out laboratory investigation on crushed periwinkle Shells (CPS) as partial replacement for Sand in fibre concrete tiles. It was observed that 20 percent sand replacement with CPS for 1:2 and 1:3 mixes produced tiles that are suitable for roofing in riverine areas. Also an evaluation of the properties of concrete produced with Cockle shell as partial replacement of coarse aggregate was undertaken. In that study, concrete samples were produced using partial replacements of 0%, 5%, 10%, 15%, 20, 25% and 30% of sand with cockle shell. Result showed that 20% was the optimum percentage replacement level that can produce workable concrete with satisfactory performance (Muthusamy & Sabry, 2012)

The entire coastline of Nigeria is dotted by several communities, which rely closely on environmental resources particularly fisheries for survival. However, the production of shell fish waste threatens the sustainability of the local fish industry and the environment in general. Also because of the far distance of these communities away from upland areas and the sedimentary nature of the terrain, construction aggregates, chippings, gravels, etc. are unavailable in these communities. Most of these communities are remote, with only water transportation as mode of access; hence it is costly to transport construction materials to these communities. Many communities in the coasts are now converting waste crustacean shells for use in civil construction and other related activities. The aim of this study is therefore to assess how particularly, clamshells (Egeria radiate) as dumped on the beaches by ocean waves can be used as full replacement for coarse aggregates in concrete, which incidentally translates to an effective waste management practice for sea shells that were hitherto dumped into the environment.

Materials and Methods

To carry out this study, clamshell specimens were prepared into suitable coarse aggregate sizes and their physical properties determined; after which an evaluation of the properties of concrete produced with clamshell aggregates and normal concrete with gravel aggregates (control) was carried out; and finally comparison of the properties of the two sets of concrete 'sample specimen was made. The study entails laboratory investigation. Details of the materials used and methods adopted are as follows:

Materials: The materials used for the experiment includes: Ordinary Portland Cement, OPC, Coarse aggregates, Fine aggregates, 'clam shell' aggregates crushed and graded, consisting of sizes from 4.75mm-20mm.and water.

Methods: Various tests were carried out on both Clam Shell aggregates and concrete made with clam shell aggregates, these include; Crushing test, Impact value test, Absorption capacity test, Moisture content test, Voids Ratio test, Compressive strength test, Acid attack test. All tests were carried out according to the relevant British standard method of testing.

Equipment: Laboratory equipment used to aid the experiment includes a variety of small manually operated, movable tools and much larger muscle demanding fixed tools. These apparatus are as follows:

Trowels, Cubical molds (100mmx100mmx100mm), Steel tampers, Curing containers, Counter balancing weigh, Digital weigh, Impact value Drop Hammer, Manual Hydraulic Crusher, Electric Oven, Wheel barrow etc.

Properties of crushed Clamshell aggregate

Aggregate Crushing Value: This test was used to assess the mechanical property and strength of aggregates. It was carried out in accordance to BS 812: part 11 (1990).

Particle Shape and Texture: The particles shape and texture of the crushed clamshell aggregates was determined by visual observation and comparison to criteria set by BS812 part 1 1975. The aggregates contained predominantly flat flaky particles with a small percentage of fairly rounded particles. The aggregate particle texture on the other hand could be described as smooth with only areas of breakage having a rough texture similar to the texture you find on granite. Plate I gives a pictorial view of the aggregate particle shape and texture.

Bulk Density: The bulk density of a loose material can be defined as the weight of material held by a container of unit volume when filled and compacted under a defined condition. For the purpose of this research work, the bulk density was determined on the basis of air-dry condition for both compacted and uncompacted situations.

Voids Ratio: Voids ratio is a measure of voids in an aggregate sample and indicates the volume of mortar or cement paste required to fill the space between the coarse aggregate particles and also hints if an aggregate sample is well graded or not. For a well graded aggregate the voids ratio is small. The voids ratio is calculated the following relation.

$$\text{Voids Ratio} = 1 - \frac{\text{Bulk Density}}{\text{Specific Gravity x unit weight}} \quad \text{---------- (1)}$$

Aggregate Impact Value: This test is used to measure the toughness of an aggregate value. Toughness is defined as the resistance of aggregate to failure by impact. This was determined by applying impact from a standard hammer falling 15 times under its own weight upon the aggregates in a cylindrical container. The resulting fragmented aggregates were then sieve using the 2.36mm sieve to determine the percentage passing and retained. This test was performed in accordance with BS812: part3: 1975.

Moisture Content: In view of the fact that moisture content may influence the water cement ratio and workability of fresh concrete. The actual moisture content of aggregates to be used in concrete production has to evaluated and deducted (mix water correction) from the total water required for the mix to obtain the effective mixing water. As such, Determination of moisture presence in Clamshell aggregates was also carried out in accordance to BS 1377: (1990)

Preparation of Concrete Cubes

Trial Mix: A constant mix proportion of 1:2:4, with four different water-cement ratios were used for the trial mixes. Each of the four different water cement ratio mixes of 0.45, 0.5, 0.55 and 0.6 were labeled A, B, C and D respectively. They were subjected to compressive crushing strength test at 7days, 14days, 21days, and 28days of curing to determine which water cement ratio gave the highest strength. Specimen D gave the best result. For the concrete mix design, the absolute volume method was used. A fixed mix proportion by volume of 1:2:4 parts of cement sand and aggregates respectively was used. This ratio was then used for the rest of the cubes.

Concrete Mix Design: After the trial mix, the absolute volume method was used to estimate the individual constituent materials used for the production of concrete samples. A nominal mix of 1:2:4 used in the trial mix was adopted with a Water/Cement ratio of 0.55. Details of the Quantities of materials per 12 cubes are presented in Table 1.

Table 1: Concrete Materials Required to Produce 12 Cubes of Concrete

Materials	Quantity (kg)
Cement	8.832
Sand	19.626
Clamshells	33.330
Water	5.299

Workability Test: The workability test was conducted on the concrete mix made with clam shell as aggregate. The slump test method of checking the workability of concrete is found to be the simplest method and hence adopted. It was undertaken in accordance to the appropriate British Standard.

Tests on Hardened Concrete

Density of Concrete: The density of the clamshell aggregate concrete was determined under two different moisture conditions of the concrete specimens, i.e. Saturated Surface Dry and Air Dry State.

The weight of each of the concrete specimen was determined under each of the above moisture state and the densities calculated using the relationship.

Density = Mass/volume ---------- (2)

For each of the moisture conditions and was calculated from the 3 cubes.

Compressive Strength Test: Compressive Strength Test was carried out in accordance to BS 1881: 116 (1983). The ultimate crushing test is a destructive form of testing. The concrete cube specimens were subjected to an increasing load from a motorized hydraulic compression machine of 1100kN (i.e. 250000 lbs.) capacity and the failure load recorded. A total of 12 cubes were crushed, 3 each at 7, 14, 21, and 28curing days. All cubes were crushed at the air dry moisture condition. This was to ensure that all the cubes had constant water content and thus a constant water pressure. The test was carried out at the Concrete Laboratory, Department of Building, Ahmadu Bello University Zaria, Nigeria.

Chemical Resistance Test: In view of the fact that the use of concrete structures has been extended to harsh and hostile environment where concrete structures are in contact with harmful chemicals; a chemical resistance test was undertaken. This was carried out by exposing the samples to chemically aggressive environment in which the sample specimens were put in a diluted acid (H_2SO_4) of a particular concentration. Thus all cube specimens were cured immersed in the Acid matrix prepared to depict the Acid attack phenomenon. The concrete cube specimens were then subjected to compressive strength test in accordance to BS 1881: 116 (1983). As a means of ensuring that the cubes had constant water content and thus a constant water pressure, all cubes were crushed at the air dry moisture condition.

Presentation of Results, Analysis and Discussions

The results of various tests carried out in this research work are presented and discussed. These include both the tests carried out on the clamshell aggregates and concrete samples produced with it.

Clamshell Aggregates: The clamshell aggregate was subjected to a various tests. This include: aggregate crushing value test, specific gravity test, bulk density test, voids ratio test, Aggregates impact value test, and the moisture property tests such as the moisture content and absorption capacity tests. Table 2 shows the summary of the tests carried out on the clamshell aggregates.

Table 2: Result of sieve analysis of Clam shell aggregates

Sieve size Mm	Weight retained(kg)	Cumulative weight retained	Cumulative % weight retained	cumulative % passing
19.0	5.4	5.4	14.8	85.2
10	18.6	24	65.6	49.2
5	5.55	29.6	80.9	84.8
2.36	3.29	32.9	89.9	91
1.18	1.87	94.8	34.7	94.9
0.600	0.92	35.6	97.3	97.5
0.300	0.46	36.1	98.6	98.7
0.150	0.51	36.6	100	98.6

Table 3: Density of Concrete made of Clamshell aggregate and Normal Concrete (Control)

Age (Days)	Density (kg/m3)	
	Concrete made of Clamshell Aggregate	Normal Concrete (control)
7	2413	2367
14	2473	2420
21	2420	2213
28	2487	2427

Table 4: Compressive strength of Concrete made of Clamshell aggregate and Normal Concrete (Control)

Age (Days)	Compressive strength (**N/mm^2**)	
	Concrete made of Clamshell Aggregate	Normal Concrete (control)
7	13.2	9.0
14	15.1	13.0
21	19.1	18.0
28	21.0	19.0

Table 5:Compressive strength and weight of normal concrete before and after exposure to chemically aggressive environment

Age (days)	Average Compressive strength before exposure (N/mm^2)	Exposure to Acidic Attack with H_2SO_4				Average weight After exposure (kg)
		Percentage weight loss	Average Compressive strength (N/mm^2)	% decrease of compressive strength	Kg weight before exposure	
7 days	13.20	4.6	9.60	27.3	2.37	2.26
14 days	15.13	6.2	12.10	20	2.42	2.27
21 days	19.13	3.9	18.20	4.86	2.30	2.21
28 days	21.00	1.6	20.60	1.9	2.47	2.43

Table 6: Compressive strength and weight of clamshell concrete before and after exposure to chemically aggressive environment

Age (days)	Compressive strength before exposure (N/mm^2)	Exposure to Acidic Attack with H_2S0_4				Weight after exposure (kg)
		Percentage weight loss	Compressive strength (N/mm^2)	% decrease of compressive strength	Kg weight before exposure	
7 days	8.97	0.8	86.7	3.3	2.41	2.39
14 days	13.00	2	128.7	1	2.47	2.42
21 days	17.63	4.6	156	11.5	2.42	2.31
28 days	18.60	2.8	170.7	8.2	2.49	2.42

Sieve analysis of clamshell aggregate: *The result obtained for the sieve analysis of the crushed clamshell aggregates is presented in figure 1.*

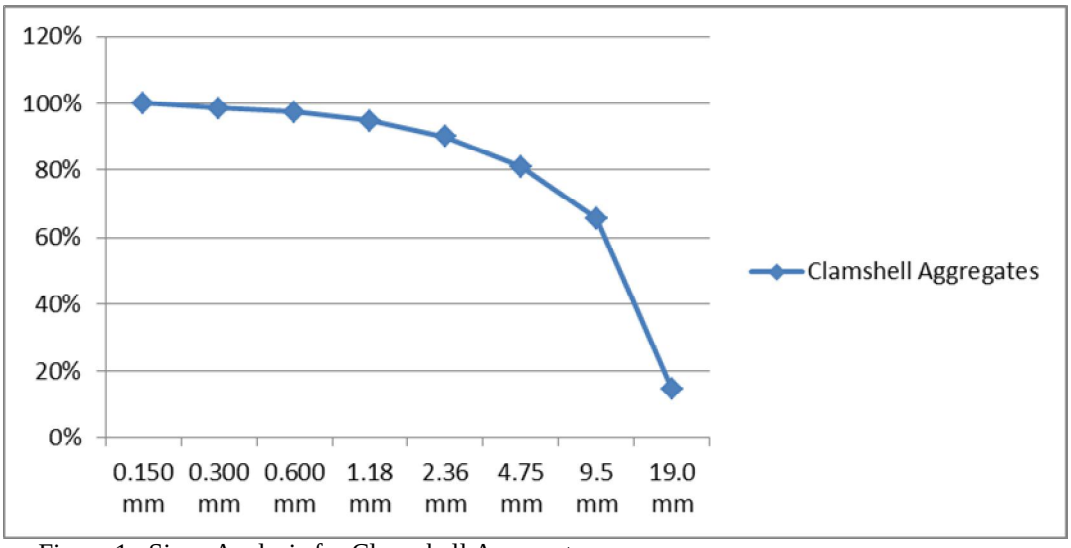

Figure 1: Sieve Analysis for Clam shell Aggregates

Table 7: Summary of the tests carried out on clamshell aggregates

SN	Property	Aggregate condition	Unit	Value/classification
1	Specific Gravity	Air Dry	X	2.74
2.	Bulk Density	Air Dry	Kg/m^3	1359
3.	Voids Ratio	Air Dry	X	0.51
4.	Moisture Content	Air Dry	%	1.5
5.	Absorption Capacity	Oven Dry	%	2.0
6.	Crushing Value	Oven Dry	%	16.63
7.	Impact Value	Oven Dry	%	8.9

Fresh Concrete: The result of slum test carried out on the fresh concrete to determine the effect of the Clamshell aggregates on the workability of concrete, is presented in Table 8

Table 8: Slum test results

Mix	W/C Ratio	Slum (mm)	Degree of workability
Clam Shell Concrete	0.6	5	Low
Gravel Concrete	.06	9	Low

Hardened Concrete: Results of the experiments on hardened concrete carried out in this research work are presented as follows: Clam shell aggregates were found to produce normal weight concrete with an approximate density of 2400 kg/m^3. The clamshell aggregate used in this research work produced concrete of an average density of 2450 kg/m^3 while the results of compressive strength test are presented in figure 2.

Looking at the various properties of Clamshell aggregates that were determined, it can be observed that Clamshell aggregates give better impact and crushing resistance as compared to gravels, a much lower absorption capacity and moisture content. Thus Clamshell aggregates generally tend to show better promise as coarse aggregate in concrete than even, the gravel (control). However, the major disadvantage associated with Clamshell, is its lack of bonding with other constituents. Bonding in concrete has direct relationship with the strength characteristics of concrete. Thus this problem will have negative effect on

the strength properties of concrete produced with clamshell aggregate. This is clearly shown in the graph in Figure 2. As it can be observed, in all the curing days, concrete produced with clamshell aggregate, is relatively lower than the normal concrete (control) – concrete produced with gravel as coarse aggregate.

Plate I: Slum test for clamshell aggregates

Result of test on workability, using slum test, shows that both the sample specimens and control samples gave a true slum of just a few millimeters less than mold height as it can be observed from Plate I. This could be due to the flat flaky nature of the clamshell aggregate which gave tough resistance to shovel movements, significantly greater than with the gravel mix. This means that more effort would be needed when concrete is produced using clamshell as aggregate. Thus more water is needed in order to produce workable concrete when and where clamshell is used as an aggregate in concrete production. In view of the fact that there is inverse relationship between the water/cement ratio and the compressive strength of concrete (Neville 2007, Shetty 2009 and Neville & Brooks 20 10); this could reduce the compressive strength, hence the quality, of such concrete. The average density of the sample specimen, that is concrete produced with clam shell and gravel (control) are 2450kg/m^{3}and 2360kg/m^{3}respectively, the clam concrete emerged with a higher density than the gravel concrete. Thus the performance of concrete made of clam shell as coarse aggregate is most likely, similar with that of normal concrete.

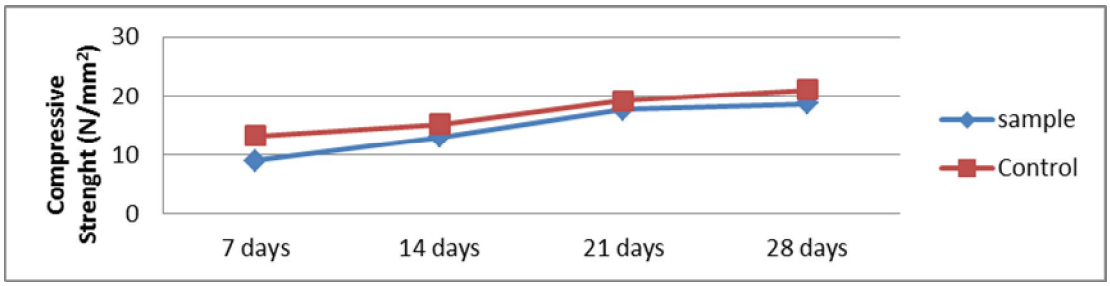

Figure2: Compressive Strength Result

A close comparison of the experimental results obtained shows that the control samples produced with gravels have relatively higher compressive strength than the concrete made with clam shell aggregates. This can be clearly seen from the graph in figure2, Close observation of the clam shell aggregates, clearly shows that the clamshell aggregates have a smooth glassy texture on over 85% of its surface area, with the rough portions, due to crushing, making the remaining 15% of its surface area. This phenomenon can greatly affect the compressive strength of concrete as the required bonding between concrete paste and coarse aggregate is reduced considerably hence failure due to sliding can easily occur. See plate II.

Plate II: Concrete cast with clam shell aggregates

In Plate II, it can be clearly observed that there is poor bonding between the clam shell aggregates and mortar.

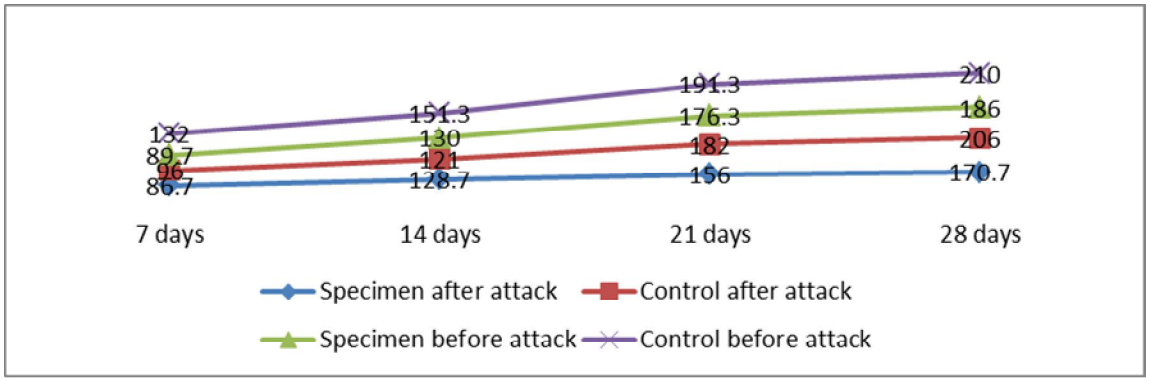

Figure3: Compressive strength of Sample specimen and normal concrete (control) before and after exposure to aggressive environment.

As observed earlier, concrete samples were exposed to chemically aggressive environment. A Solution of 300g H2SO4 and 20kg water were used to ensure total submersion of concrete cubes.

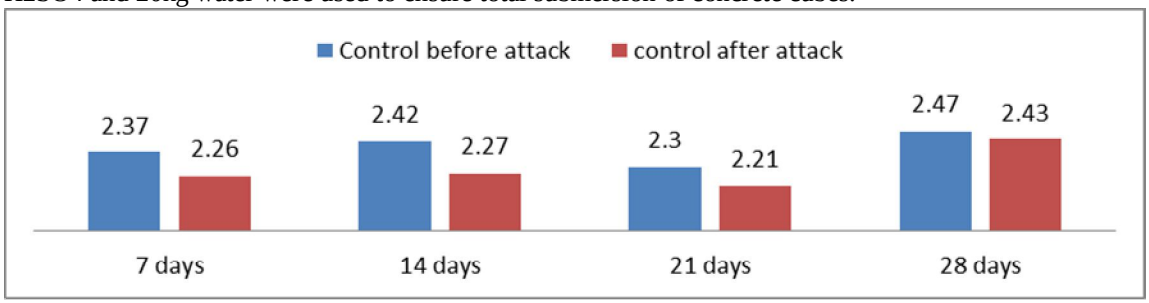

Figure 5: Change in weight of the control sample due exposure to chemically aggressive environment.

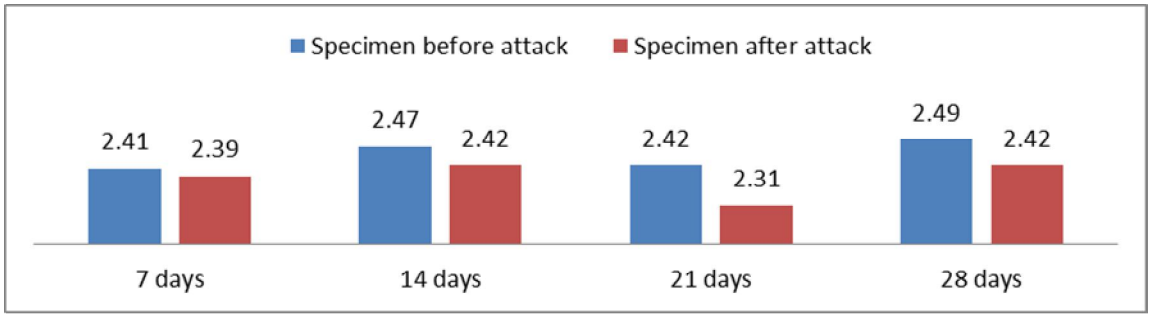

Figure 6: Change in weight of the sample specimen due exposure to chemically aggressive environment.

As it can be observed, the effect of the acid was immediate and comparatively more noticeable on the control samples. While for the sample specimen, it only becomes significant later, as the days advanced. This because when the percentage differences between samples exposed to aggressive environment and those samples that were not exposed to aggressive environment, is compared, the control samples have the following percentage differences:4.60%, 6.20%, 3.91% and 1.62% for 7, 14, 21 and 28 curing days respectively. Whereas for the sample specimen, the following percentage differences were obtained: 0.83%, 2%, 4.50%, and 2.81% for 7, 14, 21 and 28 days of curing. Thus when these values are compared with that of control specimen, it can be observed, that at the beginning the percentage difference was not much however at 28 curing days, the percentage difference for the sample specimen was much higher (2.81%) than that of control sample (1.62%). Looking at the whole curing days, it can noted that there is no defined pattern taken by the results of the two samples but if 28 curing day's is considered alone it can be observed that aggressive environment has more serious side effect on the sample specimen that the control. This could be due to the larger surface area of reaction afforded by the rough gravel surface which is much greater than that afforded by the smooth clamshell surface. So the acid goes straight into action with the gravel aggregates but in the case of the clamshell aggregates, it takes a longer time for the acid to properly act on the smooth clamshell surface which is of a lesser surface area.

Conclusion and Recommendation

This research experiment was carried out to test the suitability of clam shell aggregates as full replacement for coarse aggregate in concrete. The major findings indicated that the density of clam shell concrete was found to be within the range of normal weight concrete of about 2450kg/m^3 while clam shell aggregates were found to have a better resistance to impact but relatively poor in crushing values of 8.9% and 16.6% respectively as against gravel with 16.0% and 6.9%. The average compressive strength was found to be about 18.6 N/mm^2 at 28 days, slightly below 21.0N/mm^2 at 28 days for the control sample. There was poor bond at the aggregate and cement/mortar interface for concrete produced with the clamshell aggregates (sample specimen) due to smooth surface texture. Loss in weight due to exposure to chemically aggressive medium was more rapid for the gravel concrete during the early stages (7 & 14 days) than during the later days (21 & 28 days). The clamshell aggregates had the most significant loss in weight during the later days of (21 & 28 days). In conclusion, Clamshell concrete and gravel concrete come pretty close in terms of most of their properties and as such there will be little difference in the performance of concrete produced with clam shell as coarse aggregates in some functions such as radiation attenuation with the normal concrete made of gravel as coarse aggregates. When concrete produced with clam shell aggregate is used to construct structural components that will be exposed to high/heavy traffic, like floor slab and rigid pavement, its resistance to rough usage, is most likely, comparatively lower than the normal concrete. It is recommended that the use of Concrete produced with clam shells as coarse aggregates should be avoided in areas where such a structure is expected to be exposed to hash and hostile condition such as construction of sewers. Concrete cast with clamshell aggregates can be used in members that are not subject to high bending and flexural forces as the inferior bonding may lead to failure but can be used in mass concrete and concrete that is largely subject to mainly compressive forces within a moderate medium range like simple pavements. The target strength of 30N/mm^2 at 28 days was not reached by the clam shell specimen but it is likely that a partial replacement, instead of a full replacement as was done in this research work and alternative concrete designs could attain such target strength. Thus, a way of improving the roughness of clamshell aggregates surface be devised so that the bond between aggregates and mortar in concrete be improved to afford clamshell aggregate concrete the ability to withstand higher compressive forces.

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ENVIRONMENTAL AND SOCIAL PERFORMANCE OF LOCAL AND FOREIGN OWNED CONSTRUCTION FIRMS IN NIGER DELTA, NIGERIA

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Abstract
This study evaluated the environmental and social performance of locally owned and foreign owned construction firms in Niger Delta, Nigeria. Survey design approach was adopted in this study. Data was obtained using 1179 copies of structured questionnaire administered by the researcher and research assistants. Methods of data analysis were simple percentage, mean score, and Man U Whitney test. The findings from the study revealed that the overall level of environmental performance of local construction firms was low while that of foreign firms was moderate. In terms of social performance, the result showed that the locally owned construction firms in Niger Delta recorded low social performance while foreign owned construction firms in Niger Delta recorded moderate performance in their social responsibilities.
Keywords: Environmental, Social, Performance, Construction Firms, Niger Delta, Nigeria

Introduction

Klang, Vikman and Brattebo (2003), stated that the construction industry is an important industry for the development of every society but its activities consume lot of non-renewable resources and contribute to natural resources depletion. It is also responsible for high levels of pollution, climate change and other environmental threats. Kheni and Akoogo (2015) opined that the construction industry has a role to play in ensuring a healthy-liveable environment and equitable access to social infrastructure and sustainable development in developing countries and this will help in achieving the sustainable development goal in developing countries. Apart from the environmental degeneration suffered due to oil exploration, the fact that several construction activities which have been on to accommodate the activities and growing population, also add to the degeneration of the environment. Asad and Khalfan (2007) reported that construction has a significant effect on people's quality of life; construction outputs affect the nature, function and appearance of the towns and countryside in which people live and work.

However, the rising global campaign for sustainable construction demands that the challenges be addressed to promote environmentally friendly, social responsibility and economic support. The poor attention being paid to sustainable development agenda in the developing countries poses great danger to present and future generations. It remains unknown, the plan of actions or the current direction of the stakeholders in the construction industries of developing countries regarding sustainable construction (Oni, 2015). According to Chambers (1993), sustainability is defined as "that which is capable of being sustained; in ecology, the amount or degree to which the earth's resources may be exploited without deleterious effects. Sustainability at the firm level refers to meeting social and environmental needs in addition to the firm's profitability (Porter, 2008).

The quest to look beyond economic sustainability of construction firms cannot be overemphasized. Dania, Larsen, and Yao, (2013) stated that Nigeria is lagging behind world developments associated with sustainability within the construction sector and beyond. Singh, Murty, Gupta and Dikshit (2009) stated that there is insufficient effort to measure firms' commitment to sustainability with integral approach that encompasses environmental, economic and social aspects. To sustain the success of the construction firm, information is crucial for creating a consensus for a sustainability assessment (Gomes and Silva, 2005) and this necessitated the assessment of environmental and social performance of construction firms operating in Niger- Delta, Nigeria.

Combs, Crook and Shook (2005) stated that firm performance suffers from the problems of lack of consensus and proper consideration of its dimensionality. Financial measures are often used alone regardless the growing importance of other social and environmental aspects (Dess, 1996). Many studies represented firm performance as unidimensional even when they acknowledge its multidimensionality (Glick, washburn, and Miller, 2005). Shen, Tam, Leona and Ji (2010) stated that a greater concern is given to economic and social issues. In contrast, Tam (2008) and Lilja (2009) stated that in the construction industry, sustainability is generally interpreted as environment oriented or focused. There is a suggestion that local firms are more sensitive to their national, institutional and cultural context and may be more able to implement these practices. Studies in East Asian companies showed that sustainability practices introduced by locally owned firms fared better in terms of reducing organisational-level staff turnover than foreign-owned firms (Yalabik, Chen, Lawler, and Kim, 2008). However, Dania, Larsen, and Yao (2013), concluded that multinational firms have higher capability, capacity to adopt, organization, awareness and knowledge base of sustainability than indigenous construction firms.

The Niger Delta which is located in the southern part of Nigeria has some peculiar characteristics ranging from the climate, terrain, vegetation, culture, economic activities and value system. The Niger Delta Region of Nigeria produces a significant portion of the aggregate oil wealth of Nigeria. Since 1956 when oil was first discovered in Oloibiri in Southern Nigeria, the Niger Delta region has accounted for over 90 per cent of Nigeria's oil income (Ujene, 2014). However, the region has perennially suffered from environmental neglect, crumbling infrastructures and services, high unemployment, social deprivation, abject poverty and endemic conflict. This has led to calls for firms operating in the Niger Delta to demonstrate the value of their investments to Nigeria by undertaking increased community development initiatives that provide direct social benefits such as local employment, new infrastructure, schools, and improved health care delivery (Ijaiya, 2014). Many researches were conducted to determine key performance indicators (KPIs) but most of them were project specific. They concentrated on the performance measurement at the project level. Existing research, which has been conducted for performance evaluation and comparison at the company level, is limited in the literature and limited insight is provided into the overall performance of the firms (Ali, Al-Sulaihi and Al-Gahtani, 2012). To bridge this gap, this research evaluated the environmental and social performance of locally owned and foreign owned construction firms in Niger Delta, Nigeria. In order to achieve this objective, two hypotheses for testing were formulated: There is no significant difference in the level of environmental performance among locally owned and foreign owned construction firms in the Niger- Delta; and there is no significant difference in the level of social performance among locally owned and foreign owned construction firms in the study area.

Research Methodology

Survey design approach was adopted in this study. Data was obtained using 1179 copies of structured questionnaire administered by the researcher and research assistants. The Data was collected on a five-point scale of 1, 2, 3, 4 and 5 assigned to the options of very low performance, low performance, moderate performance, high performance and very high performance respectively. This is in consonance with Santos and Britos (2012). Methods of data analysis were simple percentage, and mean score, Kruskal Wallis test and Man- U- Whitney test. The Sample size was determined using the Yamane (1967) equation thus: $n = N/1+N(e)^2$; where n = Sample size, N = Finite population, e = Level of significance (0.05), and 1 = Unity. This study adopted Yamane (1967) equation for determining sample size because of its simplicity, reliability and validity. These have encouraged its wider acceptance and usage among researchers over a long period of time. Table 1 shows the sample frame which represents the number of construction firms in the study area. It also shows the sample size which represents the number of construction firms selected for study. Table 1 also shows the number of questionnaire administered and the response rate achieved. From the questionnaire distributed, the response rate ranges between 76.1%

and 94.7%. Delta state received the highest response rate of 94.7% while Abia State got the least rate of 76.1 %. In all, an overall response rate of 83.2% was achieved. Groves (2006) noted that a response rate of at least 50 percent is considered adequate for analysis and reporting, a response of 60 percent is good and a response rate of 70 percent is very good. As a guide, researchers typically seek response rates of at least 70% to feel confident that their sample is representative of the sample frame. Hence, the overall response rate of 83.2% in this study is considered very good and adequate.

Table 1: Sample Frame; Sample Size and Questionnaire Administration

	Sample		Questionnaire Administration			
State	Sample Frame	Sample Size	Number administered	Number returned	Percentage returned	Response Rate (%)
Abia	165	117	117	89	76.1	
Akwa Ibom	214	139	139	113	81.3	
Bayelsa	128	97	97	85	87.6	
Cross River	223	143	143	112	78.3	
Delta	200	133	133	126	94.7	
Edo	237	149	149	114	76.5	
Imo	143	105	105	92	87.6	
Ondo	221	142	142	109	76.8	
Rivers	250	154	154	140	90.1	
Total	1781	1179	1179	980		83.2

Data Presentation and Discussion of Results

The result of analysis on Table 2 shows that the locally owned construction firms, account for 96.4% of the total number of firms considered in this study while the foreign owned firms account for 3.6% of the total number construction under consideration in this study. This clearly shows that majority of the construction firms operating in Niger Delta are predominantly locally owned firms.

Table 2: Ownership of Construction Firms

Ownership of Firms	Frequency	Valid Percent	Cumulative Percent
Locally owned	945	96.4	96.4
Foreign owned	35	3.6	100.0
Total	980	100.0	

Environmental Performance of Local and Foreign Owned Construction Firms in the Niger Delta

Table 3 shows the environmental performance of firms based on the ownership of firms. The decision rule is that any environmental performance indicator whose mean falls between 1.0 – 1.8 is of very low performance, 1.8 – 2.6 is of low performance, 2.6 – 3.4 is of moderate performance, 3.4 – 4.2 is having high performance and 4.2 – 5.0 is regarded as having very high performance. The result showed that locally owned and foreign owned firms had low performance in the use of recyclable materials and recycling level and reuse of residuals. It was also revealed that locally owned firms performed moderately in building designs, construction practice and technologies that are environmentally friendly and sustainable. However, the foreign owned construction firms performed better than their local counterpart as they recorded high performance in building designs, construction practice and technologies that are environmentally friendly and sustainable.

The mean scores of 2.94 and 3.20 implied that both locally and foreign owned construction firms in Niger Delta performed moderately in effective communication of sustainability and other environmental management issues among contractors, suppliers and other professionals engaged by the organisation. The mean score of 2.49 implied that locally owned construction firms in Niger Delta recorded low performance in standardised management systems such as ISO 14001 or environmental management system in your organisation while the mean score of 2.80 implied that foreign owned construction firms recorded moderate performance in standardised management systems such as ISO 14001 or

environmental management system in your organisation. The mean score of 2.52 indicated that locally owned construction firms recorded low performance in the implementation of environmental management programmes and the use of certified professionals while the foreign owned firms recorded moderate in the implementation of environmental management programmes and the use of certified professionals as shown by the mean score of 3.09. The mean score of 2.38 showed that locally owned construction firms recorded low performance in the inclusion of sustainability and other environmental management measure in tendering requirement and the mean score of 2.89 implied that foreign owned construction performed moderately in the inclusion of sustainability and other environmental management measure in tendering requirement. The mean score of 2.14 implied that the locally owned construction firms recorded low performance in the use of innovative features and renewable energy forms such as solar panels whereas their foreign counterpart recorded moderate performance in the use of innovative features and renewable energy forms such as solar panels. Table 3 also revealed the overall level of environmental performance of the construction firms operating in Niger Delta based on ownership of the firms. The mean score of 2.38 implied that locally owned constructions in Niger Delta recorded low environmental performance while the mean score of 2.80 showed that foreign owned firms recorded moderate environmental performance.

Table 3: Environmental Performance of Local and Foreign Construction Firms in Niger Delta

Environmental Performance	Locally Owned N=945			Foreign Owned N=35			Combined N=980		
	Sum	Mean	Rmk	Sum	Mean	Rmk	Sum	Mean	Rmk
Use of recyclable materials	1729.00	1.83	LP	85.00	2.43	LP	1814.00	1.85	L.P
Recycling level and reuse of residuals	1734.00	1.83	LP	84.00	2.40	LP	1818.00	1.86	LP
Building designs, construction practices and technologies that are environmentally friendly and sustainable	3101.00	3.28	MP	127.00	3.63	HP	3228.00	3.29	MP
Effective communication of sustainability and other environmental management issues among contractors, suppliers and other professionals engaged by the organization	2774.00	2.94	MP	112.00	3.20	MP	2886.00	2.94	MP
Standardised management systems such as ISO 14001 or environmental management system in your organization	2357.00	2.49	LP	98.00	2.80	MP	2455.00	2.51	LP
Implementation of environmental management programmes and the use of certified professionals	2385.00	2.52	LP	108.00	3.09	MP	2493.00	2.54	LP
The inclusion of sustainability and other environmental management measure in tendering requirement	2251.00	2.38	LP	101.00	2.89	MP	2352.00	2.40	LP
The use of innovative features and renewable energy forms such as solar panels	2023.00	2.14	LP	95.00	2.71	MP	2118.00	2.16	LP
Level of Environmental Performance of Firms in Niger Delta		2.38	LP		2.80	MP		2.44	LP

LP = Low Performance, MP = Moderate Performance, HP = High Performance, Rmk= Remarks

The result of Mann- Whitney U test in Table 4 shows that the P- value is 0.047. This value is less than the 0.05 significant level set for the test. This implies that there is significant difference in the level of environmental performance among locally owned construction firms and foreign owned construction firms in Niger Delta. The result in Table 4 indicates that foreign owned construction firms have higher level of environmental performance because it is the group with the highest mean rank. From these data, it can be concluded that the level of environmental performance among foreign owned construction firms is statistically significantly higher than the level of environmental performance among locally owned construction firms (U = 18.000, p = .047).

Table 4: Mann Whitney U Test for Comparing the Level of Environmental Performance

Parameters	Mean Rank	Sum of Rank	Decision @ 0.05 Sig level
Locally Owned Firms	7.00	63.00	
Foreign Owned Firms	12.00	108.00	
Mann Whitney U	18.000		
Wilcoxon W	63.000		
Z	-1.987		
P- Value	.047		Reject null hypothesis

Social Performance of Locally Owned and Foreign Owned Firms in Niger Delta, Nigeria

Table 5 shows the social performance of firms based on ownership of construction firm. The decision rule is that any social performance indicator whose mean falls between 1.0 – 1.8 is of very low performance, 1.8 – 2.6 is of low performance, 2.6 – 3.4 is of moderate performance, 3.4 – 4.2 is having high performance and 4.2 – 5.0 is regarded as having very high performance. Table 5 shows that the level of employment, infrastructural development, and standard of living in locally owned and foreign owned firms in Niger Delta, Nigeria was moderate. Locally owned construction firms recorded low performance in public and private sector investment, peace and security, biodiversity and ecosystem stability, poverty reduction, pollution control and human health standard. Table 5 also showed that foreign owned construction firms in Niger Delta, Nigeria performed moderately in public and private sector investment, peace and security, biodiversity and ecosystem stability, poverty reduction, pollution control and human health standard. The average mean score of 2.56 showed that the level of social performance of the locally owned construction firms in Niger Delta was low. Also the average mean score of 2.97 indicated that the level of social performance of foreign construction firms in Niger Delta was moderate.

Table 5: Social Performance of Firms based on Ownership of Firms

Social Performance	Locally Owned N=945			Foreign Owned N=35			Combined N=980		
	Sum	Mean	Rmk	Sum	Mean	Rmk	Sum	Mean	Rmk
Employment Level	2627.00	2.78	MP	113.00	3.23	MP	2740.00	2.80	MP
Infrastructural development	2474.00	2.62	MP	101.00	2.89	MP	2575.00	2.63	MP
Standard of living	2497.00	2.64	MP	105.00	3.00	MP	2602.00	2.66	MP
Public and private sector investment	2408.00	2.55	LP	102.00	2.91	MP	2510.00	2.56	LP
Peace and security	2442.00	2.58	LP	106.00	3.03	MP	2548.00	2.60	MP
Bio-diversity and eco-system stability	2361.00	2.50	LP	105.00	3.00	MP	2466.00	2.52	LP
Poverty reduction	2329.00	2.46	LP	101.00	2.89	MP	2430.00	2.48	LP
Human health standard	2366.00	2.50	LP	101.00	2.89	MP	2467.00	2.52	LP
Pollution control	2278.00	2.41	LP	102.00	2.91	MP	2380.00	2.43	LP
Level of Social Performance of Firms		2.56	LP		2.97	MP		2.58	LP

LP = Low Performance, MP = Moderate Performance, HP = High Performance, Rmk= Remarks

The result of Mann- Whitney U test in Table 6 shows that the P- value is 0.001. This value is less than the 0.05 significant level set for the test. This implies that there is significant difference in the level of level of social performance among locally owned construction firms and foreign owned construction firms in Niger Delta. The result in Table 6 connotes that foreign owned construction firms have higher level of social performance because it is the group with the highest mean rank. From these data, it can be

concluded that the level of social performance among foreign owned construction firms is statistically significantly higher than the level of social performance among locally owned construction firms

Table 6: Mann Whitney U Test for Comparing Level of Social Performance

	Mean Rank	Sum of Rank	Decision @ 0.05 Sig level
Locally Owned Firms	5.50	55.00	
Foreign Owned Firms	15.50	155.00	
Mann Whitney U	.000		
Wilcoxon W	55.000		
Z	-3.788		
P- Value	.001		Reject null hypothesis

This study evaluated the level of performance of environmental performance of locally owned and foreign owned construction firms in Niger Delta, Nigeria. The result shows that the locally owned constructions in Niger Delta recorded low environmental performance while the foreign owned firms recorded moderate environmental performance. The result of Mann-Whitney U test shows that there is significant difference in the level of environmental performance among locally owned construction firms and foreign owned construction firms in Niger Delta. The result indicates that foreign owned construction firms have higher level of environmental performance than locally owned firms in Niger Delta, Nigeria. It can be concluded that the level of environmental performance among foreign owned construction firms is significantly higher than the level of environmental performance among locally owned construction firms. It revealed the superiority of foreign owned firms over locally owned firms, which include more capacity, more technical and human resources. It can also be attributed to consciousness of the foreign construction firms of corporate image and corporate performance. Hence, environmental investment is not a wasteful venture, but is part of corporate strategy, as well as, corporate responsibility to comply with regulations and support the environment while at the same time achieving the economic goal of the firm. This result therefore informs firms of the need to embrace environmentally friendly practices in order to restore and guarantee a conflict free corporate atmosphere needed by firms and workers for maximum productivity because money spent in settling disputes could be applied to enhance corporate liquidity and management is better able to plan and make decisions when it is not engrossed in disputes. The art of managing and production is optimal when an enabling serene atmosphere is in place. This study is in consonance with Ngwakwe (2008) who stated that environmental regulation, and pressure group activity is weak in developing countries, though some corporations in these countries are becoming conscious of their international market and are making appreciable effort as regards sustainable business practices.

This study showed that the level of social performance of the locally owned construction firms in Niger Delta was low while the level of social performance of foreign construction firms in Niger Delta was moderate. The result of Mann- Whitney U test revealed that there is significant difference in the level of social performance among locally owned construction firms and foreign owned construction firms in Niger Delta. The result connotes that foreign owned construction firms have higher level of social performance than their local counterpart. It can be concluded that the level of social performance among foreign owned construction firms is significantly higher than the level of social performance among locally owned construction firms. This study is in agreement with Madueno, Jorge, Conesa, Martínez-Martínez (2015) which stated that the real development that corporate social responsibility (CSR) has experienced in small and medium firms is different from large firms.

Conclusion

This study concluded that the overall level of environmental performance of construction firms in Niger Delta is low. The level of environmental performance of locally owned firms is low while the level of environmental performance of foreign owned firms is moderate. The result Man Whitney test indicates

that foreign owned construction firms have higher level of environmental performance than locally owned firms.

This study evaluated that the level of social performance of construction firms in Niger Delta and concluded that the overall level of social performance of construction firms in Niger Delta is low. The result of Man Whitney test connotes that foreign owned construction firms have higher level of social performance because it is the group with the highest mean rank. From these data, it can be concluded that the level of social performance among foreign owned construction firms is significantly higher than the level of social performance among locally owned construction firms in Niger Delta, Nigeria.

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