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EDITORIAL COMMENTS

Welcome to yet another volume of the Journal of Environmental Design. Volume 16 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 16th 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.

The views expressed in the articles published in this Journal (JED) are those of the authors and Journal of Environmental Design (JED) does not hold itself accountable for such.

Professor Best Ochigbo

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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 date 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.

TABLE OF CONTENTS

AN APPRAISAL OF COVER MANAGEMENT FACTOR (C) DERIVED FROM DIFFERENT PERSPECTIVES

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Abstract
Cover management factor C is one of the parameters used in the Revised Universal Soil Loss Equation to model soil erosion and estimate soil loss in a region. It is used to express the ratio of soil loss in relation to a given crop and management system to that of bare soil. There are basically two approaches to derive C factor which are Land use land cover classification and normalised difference vegetation index (NDVI). This work assessed the result of cover management factor derived from the two methods. Landsat 8 satellite (OLI) image of 2016 was processed to derive the C factor using the two methods. Five classes were determined from land use land cover classification. C factor values ranged from 0 to 1 with thick forests and heavy vegetation having zero values, and built up areas and other non-vegetated surfaces having values of one and above zero. C factors derived from NDVI ranged from 0.28 to 0.64 with forests and vegetations indicating the minimum value of 0.28, and built u areas showed the value 0.64. This difference is attributed to the processing functions in the two methods. NDVI gives pixel-based analyses and with this, attention is paid to every detail on the satellite imagery. LULC carries out object-based processing which may have some levels of generalization in the classification process. The result of C factor can affect the final result of estimated soil loss hence caution must be exercised during image classification when using LULC method.
Keywords: cover management factor, soil loss equation, normalized difference, vegetation index, soil erosion model

Introduction

Land use land cover is one of the major factors considered in soil erosion modelling. It is one crucial component that impact on soil erosion in any given location. Land use is described as the specific application of land for a specific purpose. It is the purpose for which man has used the land, while land cover describes the surface coverage of the land. Land cover explains how much of a region is covered by forests, wetlands, impervious surfaces, agriculture, and other land and water types (*National Oceanic and Atmospheric Administration*). Land use/land cover factor also known as cover management factor and sometimes represented as C factor is one of the parameters used in most soil erosion models to assess the rate and extent of soil erosion and to quantify soil loss. In the popular Revised Universal Soil Loss equation (RUSLE), cover management factor is one of the six parameters that are applied in running the model. Apart from being one of the important factors in erosion modelling, it is the factor that is most influenced by man. Tadesse *et al*. (2017) stressed that the C factor is the most important factor with regard to planning and land use management as it represents the condition that can be most easily managed to reduce erosion. The RUSLE model is very effective in modelling soil erosion and estimating soil loss in a region. It has been applied widely in many regions of the world and it has global acceptability. However, care must be taken when deriving the parameters of the model because each component of the model has the tendency to generate some errors which if not controlled can accumulate to cause greater amount of error in the final soil loss result. There are basically two methods in deriving the cover management factor C, which are Land Use/Land Cover classification and the Normalised Difference Vegetation Index (NDVI). NDVI is an analytical tool in remote sensing that is used to assess vegetation health. The land use land cover classification method is an object-based method but NDVI is a pixel-based method. Remote sensing and GIS offers capabilities in studying LULC from various perspectives including NDVI and to derive the cover management factor C for soil loss estimation. The aim of this research is to examine the cover management factor derived from land use land cover classification and from NDVI for the RUSLE model.

Overview of Soil Erosion Modelling

Soil erosion is a global challenge that has impacted the whole world today and calls for global concern. Erosion involves the breaking down of soil particles, detachment and deposition of detached particles at another location. (wikipedia). Factors affecting soil erosion includes climate, soil, land use land cover and topography. In order to effectively represent the scenario and effects of soil erosion and estimate soil loss in a place, there is need to employ soil erosion models. Several soil erosion models are available and their application depends on the type of erosion, location or environment and factors being considered. A commonly used erosion model is the Revised Universal Soil Loss Equation (RUSLE). The RUSLE is an empirical model that can assess soil erosion and quantitatively estimate soil loss. It comprises of six

parameters including rainfall, soil, land use land cover and topographic factors which is further broken down into two parameters of slope length and slope steepness (LS). The RUSLE model is expressed as $A = R \times K \times LS \times C \times P$ ***Where A = Average Annual Soil Loss Rate (t ha-1 year-1); R = Rainfall Erosivity Factor (MJ mm ha-1 h-1 year-1); K = Soil Erodibility Factor (t ha h ha-1 MJ-1mm-1); LS = Slope Length and Steepness Factor (dimensionless); C = Cover and Management Factor (dimensionless); and P = Support Practice Factor (dimensionless)***

Overview of RUSLE model parameters

The average annual soil loss A denotes the potential long-term average annual soil loss in tonnes per hectare (tons per acre) per year ($t/ha^{-1}/yr^{-1}$). The estimate is usually compared to the tolerable amount of soil loss. Rainfall erosivity R is the the intensity of rainfall and its effect on soil erosion. It is the kinetic energy of the impact of raindrop and the rate of associated runoff. The erosivity index of rainfall for a rainfall event (energy-intensity values – EI30) is calculated using the total kinetic energy and maximum 30 min intensity of individual events (Yin et al. 2015, Kusimi et al. 2015). Soil Erodibility factor (K) is used to represent soil susceptibility to erosion, transport tendency of the sediment and the measure of surface runoff given a particular rainfall input, as measured under a standard condition. K is the ability and capacity of the soil particles to be detached and transported on exposure to agents of erosion. Factors affecting soil erodibility include soil structure, organic matter content and permeability. When K values are high, the soil susceptibility to erosive forces will also be high.

Slope Length and Slope Steepness (LS): Slope length (L) is the distance from the point where overland flow begins to the point where concentrated flow or deposition occurs. Slope steepness (S) is the ratio of soil loss from the slope found in the field to that from a 9% slope believed to be under the same conditions. The LS factor represents a ratio of soil loss under given conditions to that at a site with the "standard" slope steepness of 9% and slope length of 22.13 m (72.6 ft). The steeper and longer the slope, the higher the risk for erosion. In RUSLE and its computer program, complex slopes can be readily represented to provide a better approximation of the topographic effect (McCool et al. 1995).

Land use Land cover or Cover Management Factor (C) reflects the effect of surface cover on soil erosion. It is a ratio that compares the soil loss from an area under a specific cropping system and management practices to the corresponding loss from continuously fallow and tilled land. The C factor is an index applied in the RUSLE model to examine the relative impacts of copping system and management practices. The C factor reflects the way conservation plan will affect the average annual soil loss and how that soil-loss potential will be managed in time during other activities like construction, crop rotations, or other management schemes (Yoder et al. 1997).

Support Practice (P) in RUSLE represents control structure and practices aimed at controlling erosion. The P factor defines the control practices that minimize the erosion potential of the runoff by their impact on drainage patterns, concentration of runoff, runoff velocity, and hydraulic forces exerted by runoff on soil. (Kim 2006). The result of such practices will lower the proportion and rate of surface runoff and thus reduce the magnitude of soil erosion. Such may include terracing, contouring, ridging and strip cropping etc. The P factor represents the effect of surface condition on flow path and flow hydraulics.

Overview of Normalised Difference Vegetation Index (NDVI)

The Normalised Difference Vegetation Index (NDVI) is a numerical indicator that uses the red and near infra red bands of the spectrum and is adopted in remote sensing to assess plant health. NDVI indicates the amount of green vegetation by determining spectral reflectance difference between near infrared (NIR) and red band of electromagnetic spectrum (Perovic et al. 2013). When plants are healthy, they absorb most of the visible red light and reflect a large amount of the near infra red light. Unhealthy plants or sparse vegetation absorb more of visible light and reflect less of the near infra red light. Healthy vegetations show high NDVI values whereas near zeros and negative values of NDVI show surfaces or features that are non- vegetated such as rock, soils, water and ice. The NDVI have been applied extensively in assessing the relationship between Spectral differences and the changes in the rate of vegetation growth. It is also helpful in determining the production of green vegetation as well as detects vegetation health. Vegetation indices allow the delineation of the spread of vegetation and soil based on the characteristic reflectance patterns of green vegetation. The NDVI is used as a simple numerical pointer to analyze vegetation parameters in remote sensing measurements. It is used in remote sensing to assess whether the target or object being observed

contains live green vegetation or not. (Meera et al. 2015). NDVI is derived from the red and near-infrared reflectance measurements of the spectrum as;

NDVI = $\frac{rNIR-rRed}{rNIR+rRED}$ ***Where*; *NIR is the near-infrared band response andRED is the red band response for a given pixel***

Methodology

Landuse Land Cover Mapping: In erosion studies, land use land cover is used to derive the cover management C factor for erosion models. C factor can also be determined from the Normalised Difference Vegetation Index (NDVI). The C factor represents the effect of surface cover and roughness on soil erosion. It is defined as the ratio of soil loss under a given crop and management system to that of bare soil. Generally the C-factor will range between 1 and almost 0. Whereby C=1 means no cover effect. C=0 means a very strong cover effect resulting in no erosion. In easy accessible areas, the *C* factor can be calculated from vegetation data obtained during field work. Another method is to assign predefined C factor values to an existing vegetation map (Annemieke de Kort, 2013). In this research, Cover management factor (C factor) was derived from both the NDVI and land use land cover classification scheme. Landsat 8 satellite image of the Operational Land Imager having path 188 and row 056 and 057 was used for extracting land use land cover classes. Band combination was done to derive the classified image. The adopted bands were bands 543 due to good contrast between water courses, land and vegetation. The metadata file that came with the 2016 Landsat 8 data showed that cloud cover was less than 1% (0.05), so it was assumed, as could be appreciated by visual inspection that the atmospheric disturbance on the imagery was highly negligible. To enhance the spectral quality of the image, the data was subjected to pan-sharpening to improve the original resolution of the imagery from 30m to 15m. Subsetting was done to delineate the scene covered in the study. With the above, the data was set for feature extraction for C factor analysis. Different land use land cover classes within the study area were determined.

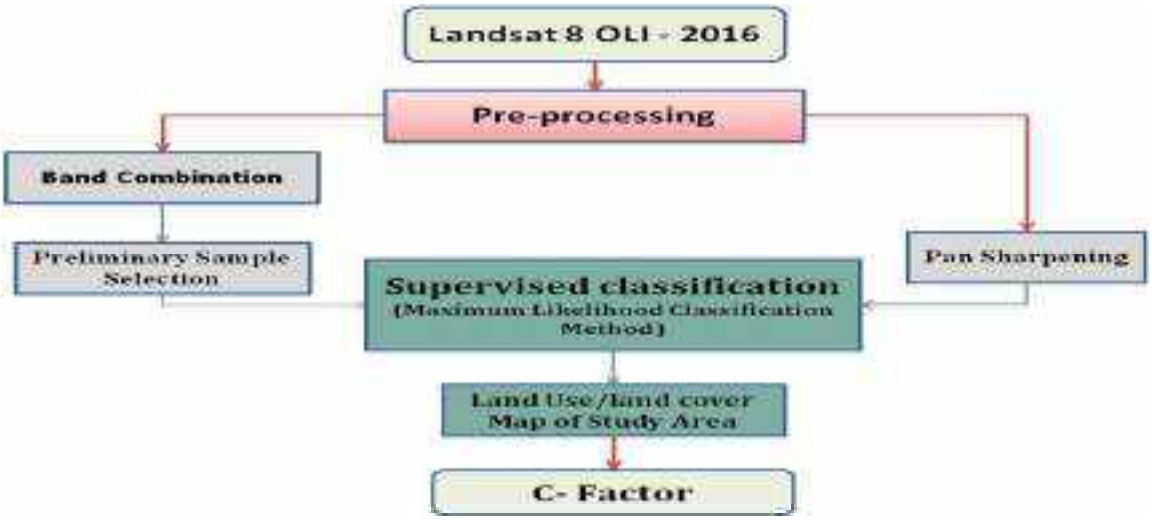

Figure 1: Flow chart for deriving C factor from LULC

Deriving Cover management C factor: The study area image was subset from the entire image using the clip data management tool in ArcGIS toolbox. The study area was then exported to ERDAS for classification. Supervised Classification method was used to obtain the land use land cover classes. For the image classification 42 training points obtained from Google earth imagery were used to classify the image. The signature files were used to train the software in the selected algorithm used. In the classification process, the Maximum Likelihood Classification algorithm of ERDAS Imagine was implemented to derive the landuse and land cover classification result. In the image classification process, 6 classes were considered including built up, forest, shrub, water body, bare-land and cultivated land. The Maximum Likelihood Algorithm considers both the variance and covariance of the class signatures when assigning cell to any of the class represented in the signatures. The statistical probability was computed for each class to determine the membership of the cells to the class. When the default equal option for A priori probability weighting is specified, each cell is assigned to the class to which it has the highest probability of being a member. The

land use land cover result was exported to ArcGIS and was then reclassified into C factor using the Reclassify tool in spatial analyst tool in ArcToolbox. The C Factor value used to reclassify the landuse land cover classes was the C factor value implemented by Sulistyo (2016).

Table 1: Land use land cover classes and their C factor

S/N	LULC Classes	C Factor Values
1	Water body	0
2	Cultivated land	0.3
3	Bare land	0.9
4	Built up	1
5	Forestland	0.03
6	Shrub	0.5

Table 2: Land use land cover classes, total area and counts

S/N	Class	Area (Km)	Counts
1	Water body	11.331	12590
2	Farm land	319,6107	355123
3	Forest	1243,8063	1382007
4	Shrub	55,9818	62202
5	Bare land	36,1278	40142
6	Built up	163,656	181840

Accuracy Assessment for Land Use/Land Cover Classification

In context of remote sensing, accuracy assessment is the evaluation of the agreement between a standard assumed to be correct and a classified image of unknown quality (Campbell, 2016). Accuracy assessment provides information on where errors occurs and determine if the classification is useable or not. In this case the landuse land cover classification accuracy was determined by comparing text pixels gotten from google earth image with the corresponding location in the classified image. Reference points were visually identified from google earth image. The selected test pixels were evenly distributed across the image and were distinct pixels from the training area used for the supervised classification. A confusion matrix is a very effective tool to measure accuracy assessment because it compares two sources of information: pixels or polygons from a classification map developed from remotely sensed data and, ground reference test information (Jensen, 2005). Confusion matrix is a widely accepted method for accuracy assessment and it was implemented for this work. In implementing this task the test pixels were converted to pixel using the Arcgis point to raster tool and the text pixel was align with the classification pixel to compute the confusion matrix in Arcgis 10.5.

Deriving C Factor from NDVI

In order to derive the C factor using the NDVI, The NDVI was first derived using the formula NDVI = (NIR – R) / (NIR + R) Where; NIR and R indicate channel or band of Landsat 8 which are near infrared and visible red respectively. The band 5 (Near Infra red) and Band 4 (red) of the study area were imported and the formula was implemented in Map algebra in ARCGIS 10.5 using the raster calculator tool. The result from the NDVI was used to compute for the C factor using the equation $C = 0.6 – 0.77$ NDVI developed by Sulistyo (2016).

Result and Discussion

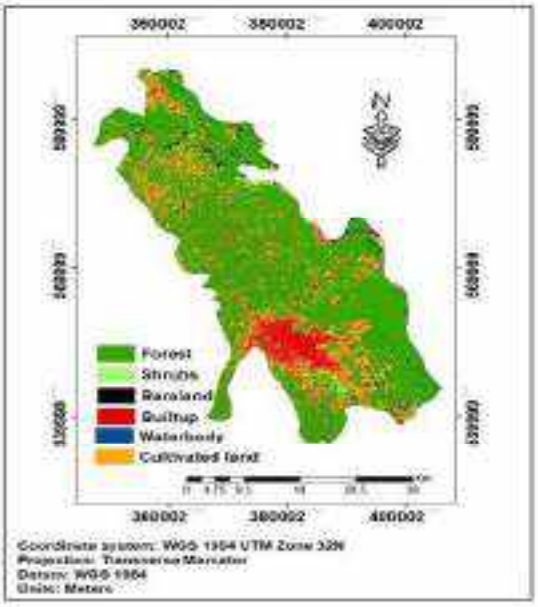

Fig 2: Land Use Land Cover map of the study area

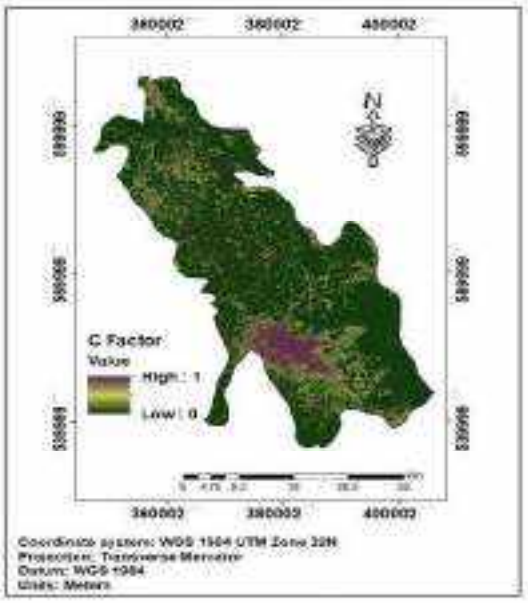

Fig 3: Cover management factor C derived from LULC classification

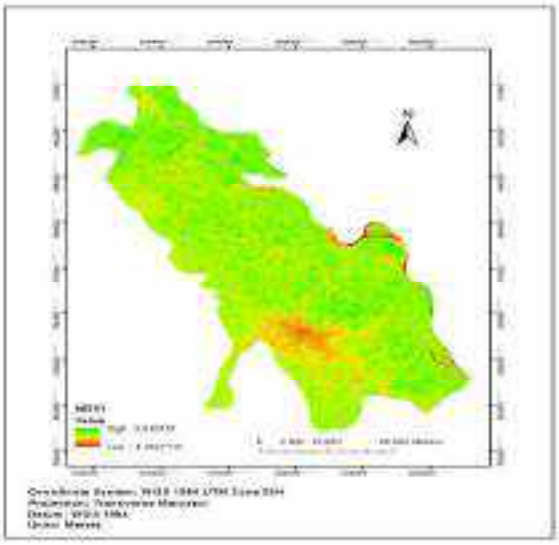

Fig 4: Normalized Difference Vegetation Index Map

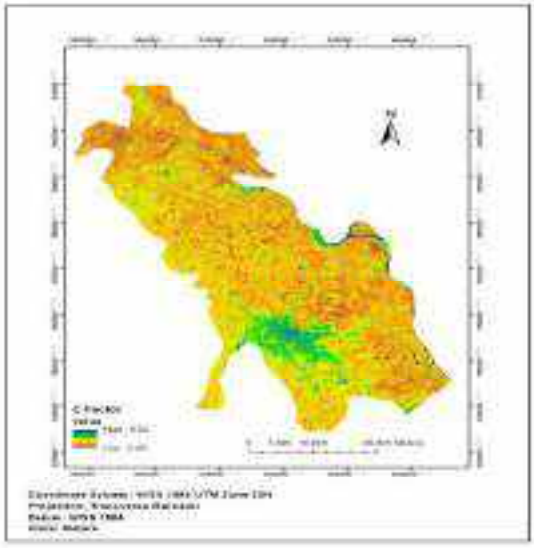

Fig 5: Cover management C factor-derived from NDVI

From the study, it was observed that C factor values derived from land use land cover classification ranged from 0 to 1. Thick forests and heavy vegetation had zero values while the value of one was mainly in the built up areas. Other non vegetated surfaces like farmland, shrubs and bare surfaces had values above zero but less than one. High C factor values are indicative of poor or no vegetative cover and such areas are usually prone to erosion as the ground surfaces are highly exposed to erosive forces hence erosion vulnerability is high in those areas. It is important to mention that the values of C factor derived from land use land cover classification showed some variation with that of NDVI. This is based on the fact that land use land cover classification is an object-based classification. With object-based classification, there are some forms of generalization of features on the image.

Result from NDVI ranged from 0.28 (low) to 0.64 (high). Low C factor values occurred in forested areas, vegetation, and cultivated lands. High values occurred in built up areas. By comparing the C factor values from land use land cover classification and Normalised difference vegetation index, the highest values were 1 and 0.64 respectively, whereas the lowest values were 0 and 0.28 respectively. The difference in the values may also result from the classification algorithm in the two methods. Land use land cover classification uses

object-based classification where features are grouped into feature classes and the processing is on object-based. The Normalised Difference Vegetation Index carries out pixel-based processing such that features are analysed at pixel level. NDVI has higher sensitivity corresponding with crown density change. The differences in the values though not large, may also show wide variation in the quantitative estimates of soil loss results of the two methods. This gap may be caused also by the multiplying effect of the other parameters (rainfall erosivity, soil erodibility, slope length and slope steepness) of the RUSLE model.

Conclusion

The study assesses the two methods in deriving cover management factor C for the Revised Universal Soil Loss Equation (RUSLE). The land use land cover method and the Normalised Difference Vegetation Index (NDVI) were considered. Land use land cover method does an object-based modelling where the classification process addresses features on an image at object level. NDVI processing analyses the features on an image at the pixel level. Here every pixel is considered in the process of deriving C factor. In this study, result from LULC ranged from 0 to 1, while NDVI ranged from 0.28 to 0.64. The method would yield varying quantitative estimates when applied in RUSLE model to estimate soil loss in the same region. Caution must taken when deriving this parameter from any of the two methods such that the final estimated result of soil loss may show minimal variances.

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COST PRICING AND REVENUE IMPERATIVES OF UYO URBAN WATER SUPPLY, NIGERIA

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Abstract
Persistent inadequate water supply is a major challenge in most urban centres in Nigeria such as Uyo, the capital city of Akwa Ibom State. This work hinged on the demand-supply concept to examined the relationship between cost and revenue generation imperatives in water supply management in Uyo capital city. Historical survey design method was used. Collated data was compiled with SPSS software. Pearson Product Moment correlation (PPMC) was applied to test the formulated hypothesis. The PPMC result showed correlation coefficient of .477 which indicated that 22.75% of the revenue outcome from water supply is associated with cost of water production. It is inferred from the outcome that other factors such as inadequate funding, poor pricing regime, inadequate infrastructure, and poor bill collection ratio also affect water supply in the study area. Based on the findings, it is recommended that in order to achieve sustainable water supply in the study area, a staggered/targeted volumetric billing method leveraging on the high income communities in the study area should be introduced.
Keywords: Urban Water, Demand, Supply, Cost, Pricing, Revenue

Introduction

Water has since been described as one of the three basic needs of man. Other needs are food and shelter. Water is a natural resource, very precious and ubiquitous. It is essential to a country's social, economic and environmental security. Thus, without any exaggeration, water can be described as the most helpful servant of mankind, and consequently the most important resource of a society (Gray, 2005). Successive governments over the years in Nigeria have made considerable investments in water supply yet a large number of the populace still does not have access to water in adequate quantity and right quality. It is estimated that only 48% of the inhabitants of the urban and semi-urban areas of Nigeria and 39% of rural areas have access to potable water supply. In addition to these low figures the average delivery to the urban population was only 32 litres per capita per day (lpcd) (FMWR, 2000). This figure which is perceived to remain unimproved today is a far cry from the over 120 lpcd minimum recommended by the World Health Organization. Sustainable water systems should provide adequate water in quantity and appropriate quality for a given need, without compromising the future ability to provide similar capacity and quality.

In studying an urban water supply scheme, two basic considerations are imperative. Firstly, it is important to consider the demand, and secondly, to find sources to fulfill that demand, that is, the source areas for water supply. Demand for water can be domestic or residential water demand, industrial, institutional, commercial and agricultural water demands, to mention but a few (Suntra, 2005). Although, water is generally regarded as a natural gift, public good, and a free gift to man, it attracts some cost to supply it both in acceptable quantity and quality. However, economic, social and political forces are perceived to influence its availability through market failure and incorrect policies, excessive public sector control and poor management. Generally, there is a lack of awareness that water is a finite resource with supply constraints. Also, water has a scarcity value and there is a cost for using it. Consequently, water is regarded as a social good and often its supply is under-priced, particularly in developing economies (Sharma *et al.*, 1996). Therefore, the efficiency of water management for the sustenance of a country's population and economic growth are interwoven and must be comprehensively planned. Understandably, management and sustainability in water supply require multi disciplinary approach. The obstacles to sustainable water supply include low cost recovery, lack of good pricing system and sustainable financing for reticulation expansion (Jideonwo, 2014). In Nigeria, water supply is highly centralized, and the public sector plays a dominant role in its management mostly through public water boards or corporations. Studies have revealed that in many states of the Federation, the institutional and implementation capacities of these Water Boards or Corporations are weak and ineffective.

In most states, public water use is highly subsidized as water tariffs are set below the supply costs and often below the operation and maintenance costs (Nnodu *et al.*, 2009). Water supply over the last five years showed that average incremental costs (the appropriate basis for efficiency prices) and actual average prices in most urban centres have been low (Nnodu *et al.*, 2009). This implies that urban water supply schemes

require high levels of subsidies in the face of increasing cost in order to stay afloat. According to Eugene (2005) the level of subsidy would be higher if the marginal production costs included environmental cost or opportunity cost of access to water resources, reflecting the full economic costs. Pricing decisions are generally influenced by political considerations, preferred priority users, and equity reasons (Nnodu, *et al.*, 2009). The benefits of subsidies by government do not necessarily go to the low-income groups. Ironically, it is usually the low-income groups and high density areas that are not patronized by constant water supply. The low-density areas with mostly high income residents (well-to-do) enjoy more and constant patronage of pipe borne water supply, and by implication capture a high proportion of the subsidies; thus, the higher the consumption by an individual user, the higher the subsidy (Nnodu, *et al.*, 2009). On the other hand, those not reached by formal services often spend so much of their income yet consume more often than not unwholesome quality of water. Furthermore, the absence of revenue undermines sustenance of supply and investments for expansion of services to those who need it most. The situation is such that the higher the level of subsidy, the fewer the resources available to extend services to the previously not served population.

As a result of population increase, Uyo capital city has experienced increase in water demand, without a commensurate improvement in water infrastructure facility over the years. In addition to this, rising water production costs and inadequate distribution network to various communities; residential and institutional areas, have led to diminishing and deteriorating supplies. Due to the poor service delivery, water has become a commodity of strategic importance in the city. The situation is one in which those living in low-density and high brow areas of Uyo urban area like Ewet Housing Estate, Shelter Afrique, Abak Road Housing and Ebiye Estates are benefiting greatly from the under-pricing of water while the low income groups of high-density areas like parts of Nwaniba Road, Aka Road, Oron Road, Urua Ekpa, Ekpiri Nsukara with formal water services get much lower unit subsidies. Most people within the capital city have resorted to private boreholes to augment public water supply or in some occasions completely replace public water supply. The aim of the study therefore, is to appraise the economics of public water supply in Uyo capital city. This study looks at the cost of water supply, existing tariffs for residential buildings, per capita water usage in Uyo capital city vis-à-vis the revenue generation by Akwa Ibom State Water Company Limited (AKSWCL) with a view to recommending sustainable water supply management that will enable the water company function efficiently.

Scarcity and irregular water supply have plagued Uyo urban for a long time. The Akwa Ibom State Water Company Limited (AKSWCL), an agency responsible for potable water supply in the city complains of inadequate funds to maintain constant water supply and a better coverage. Yet residents of the capital city pay high for vended water from alternative sources. This has been corroborated by Jiburum (2010) that vended water is 700 times the cost of water supplied by State Water Corporations in Nigeria. In addition to this, Rogers, *et al*. (2015) established that there are a greater number of people patronizing the private water boreholes than the public water distribution system. They also observed that the cost of water from the private boreholes is more than the cost of water from the public water system. As such, proper management by the public water distribution company should be carried out by the responsible government agencies. If residents are willing to pay so much for vended water, it then follows that Water Corporations should be ready to charge tariffs that will enable them generate revenue to maintain and develop their infrastructure. Adequate and sustainable public water supply will reduce disease situations associated with poor hygiene. Thus, in this study, it is hypothesized that: there is no significant relationship between cost and revenue generated from water production by Akwa Ibom Water Company Limited.

Water Production Cost and Revenue Generation

Water pricing is important for water demand management to achieve sustainable use of water. More often than not, urban water supply in Nigeria is a state subject. The provision, its management and systems of pricing including price structures vary across the various states in Nigeria. Price discrimination has been the common feature of water pricing structure to tailor the objectives of efficiency and equity (Padwal, 2003). Pricing water appropriately is important for water providers and consumers to get the right market signals. The price of potable water service is rarely equal to marginal cost (i.e. the cost to the system of producing an additional unit of water), and is often below the average cost per unit of water service. Brookshire and Whittington (1993) opined that switching to a pricing approach that recovers the full cost of water service could address the infrastructure funding gap. Full-cost pricing would increase revenue however, moving to full-cost pricing may require changes in accounting and management to ensure the rate covers the cost of future investment needs as well as current operations. With these changes in place, the revenue generated

through full-cost pricing can provide management with much of the funding necessary to finance infrastructure investment. According to Billings and Agthe (1980) the correct definition of 'water price' should be the charge or market price that would affect a rational water users' decisions concerning their pattern of water use, including qualities of water and inter-related investments. This is the behaviourally relevant price, i.e. the cost that a rational water user will compare with its marginal benefits in deciding on a water use technology and water quantities. Theoretically, demand for any normal good is inversely related with the price, and positively related with individual income all things being equal (Reddy, 2009). Pricing of water on cost basis is essential because it not only helps in revenue generation but also results in the efficient usage of water and discourages water wastage. It is often observed that decision makers at a time of scarcity of a resource such as water prefer to allow the scarcity and allocate water by non-price means when the existing capacities are on the verge of full utilization (Reddy, 2009). According to Reddy (1999), it is often erroneously believed that users are unwilling to pay higher prices for improved water supply, however, contrary to the norm, users have shown willingness to pay higher prices for improved services but unfortunately, most policies in developing countries have been carved to reflect this. On the other hand, Reddy (1999) also opined that, users spend more than the actual cost of water under a flat rate pricing mechanism. Therefore, willingness to pay is not a bottleneck for charging higher prices (Reddy, 2009). In fact, it is the willingness to charge that is the main obstacle (Reddy, 1999). While pricing could be an effective tool for demand management, getting the prices right to the level that results in efficient allocation of water is never easy, more often than not to strike this balance, implementation cost associated with volumetric pricing is often ignored or under stated (Reddy, 2009).

In volumetric pricing, implementation costs could be very substantial especially where metering and monitoring costs are quite high (Howe, 1994). Efficient allocation takes place as long as prices affect demand. Most of the pricing mechanisms appear to fulfill this condition (Tsur and Dinar, 1997). When implementation cost and value of water is not a factor, the most efficient pricing method will be volumetric pricing tied to marginal cost, whereas making implementation cost and value of water key factors, other tariff mechanisms fare better relative to volumetric pricing(Reddy, 2009). However, in order to realise sustainability in efficient allocation and revenue generation, pricing on cost basis may not be viable (Reddy, 2009). Building, expanding, providing new as well as replacing dilapidated water infrastructure is a continuous process and also capital intensive. Carrying out such a continuous project requires huge capital outlay. Funding such projects require financing and pricing strategies that cover the cost of providing the right quantity and quality and also maintain the facilities while managing long-term debt and ensuring that services remain affordable (EPA, 2017). Price in this case serves as a means of revenue generation for the public water company. We must be able to price water services to reflect all of the costs of treatment and delivery taking into cognizance that price elasticity which refers to changes in revenue as price changes depends on the responsiveness of users to price (Brookshire and Whittington, 1993).

The problems militating against effective performance among public water supply institutions in Nigeria, causes and root factors are synonymous with reports from other developing countries. From the literature review, a cocktail of factors militate against urban public water supply such as poor finance, poor data collection, poor management of water supply facilities, inappropriate system design, poorly implemented polices, corruption and political interference. These have been widely cited as the bane of the situation in Nigeria (WHO, 1994) and in other developing countries (World Bank, 2004). Whittington (1990) supported the assertion that water supply sector challenges in Nigeria can be categorized as inadequate quantity of water, inadequate distribution network and low quality of water supplies. He suggested that inadequate quantity, inequitable distribution and incessant shortage of potable water supplied by water schemes carried out by governments in Nigeria failed because there are wide gaps between their design capacities and ultimate urban water demand.

In addition, Oyebande (1977) highlighted shortage of skilled manpower, inadequate funds for capital and recurrent expenditures, lack of feasibility study of hydrological systems, reduction in government efforts and poor management of water resources as the causes of supply problems in Nigeria. Also, rapid urbanization coupled with high rate of population growth in Nigeria urban centres and high rate of illegal connection to the existing water distribution mains are also of the factors responsible for inadequate water supply to Nigerian populace.

Conceptual Framework

The demand supply concept depicted as the three rings (Figure 3) represents price, demand and supply of water. By price we are referring to all economic factors that explain affordability such as income, in demand we are looking at requirement levels and social water needs while supply looks at accessibility of water by the local populace. At the intercept P is the sustainability in water services which is when per capita standards is achieved at a price consumers can afford which will also provide commensurate revenue to continue production. This is also the equilibrium price where demand meets supply. The sustainable development of water resources is a multi-dimensional way of thinking about the connections or interdependencies among standard water requirement, affordability and accessibility in the use of water. It strikes out in new directions, taking advantages of opportunities to marry price, demand and supply to achieve sustainability.

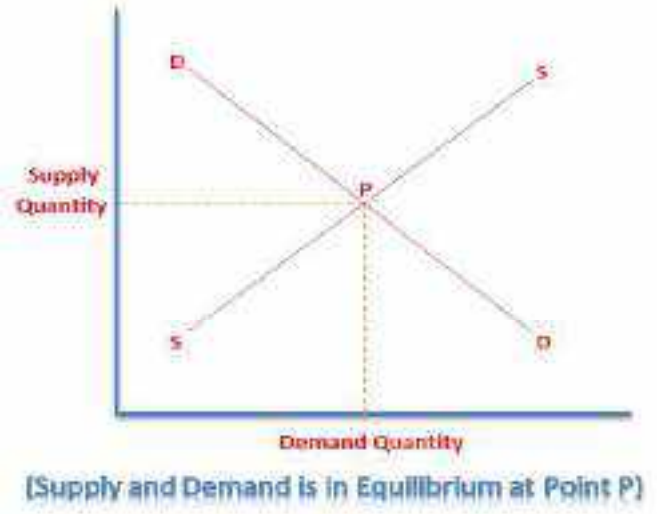

Figure 3 Conceptual model of sustainable development, demand, supply, and equilibrium price.
Source: Goodland and Daly (2006)

Research Method and the Study Area

Historical survey design method that depends majorly on documentary and interview analysis was used. Collated secondary data from AKWSCL were compiled with SPSS software. Pearson Product Moment correlation (PPMC) was applied to test the formulated hypothesis. Uyo the capital city of Akwa Ibom State and the headquarters of Uyo Local Government Area (LGA) is located in the coastal South-eastern part of Nigeria. It lies between latitudes 04° 52' and 05° 07' North and longitudes 07°47' and 08° 03' East (Figure 1). It was delineated by Uyo Capital City Development Authority edit as an area within a 10 kilometre radius with epicentre at the Ibom connection (AKSG, 2003). Over the years, Uyo capital city has experienced a steady increase in population mainly through rural-urban migration. The population of Uyo capital city according to NPC (2006) was 554,906. The 2019 projected population of the city at a 3.4 % Akwa Ibom State growth rate, is put at 875,219. With increased population and slow replacement or maintenance of the aging water infrastructure, a greater proportion of the populace is left to depend on alternative poor or unwholesome water supply sources. Based on the projected population and in accordance with National Water and Sanitation Policy (FMWR, 2000) standard of 120litres per capita per day, the water needs of the people is 1,030,262,800 litres per capita per day in 2019.

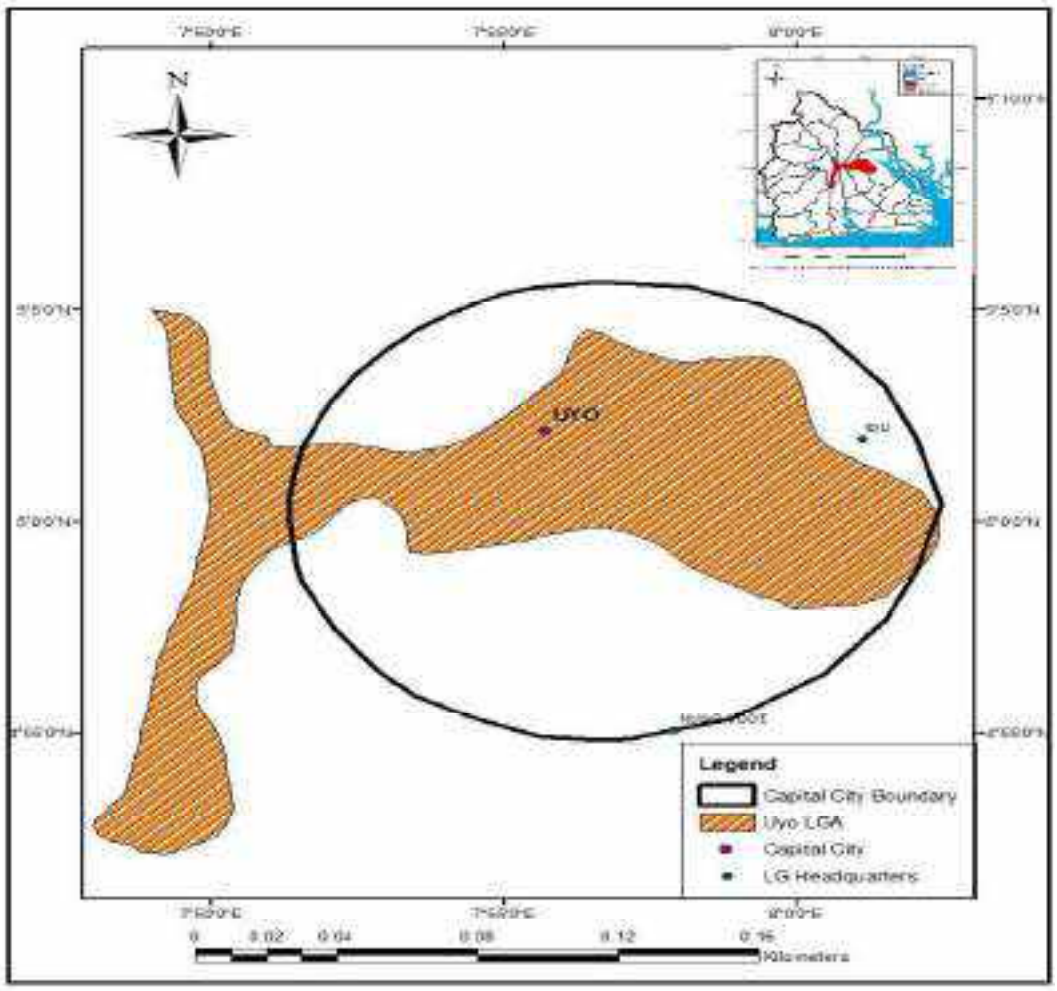

Figure 1: Limit of Uyo capital city on the map of Uyo LGA

According to Udom (2008) Uyo capital city has 3.8% of the population linked to public water supply. This seemingly uneven distribution of (water) infrastructure in Uyo capital city was also identified by Ofem and Udida (2014) who concluded that infrastructural development reduces in quality and quantity as distance from the city centre increases. Infrastructure such as pipe lines layout cover about 50% of Uyo capital city mostly in areas such as the housing estates, Abak Road, Oron Road, Nwaniba Road and Ikot Ekpene Road (Figure 2). Uyo capital city straddles two water areas as delineated by the AKSWCL. The water areas are Uyo and Ekit Itam areas. A water area consists of more than one water works station. Each water works station consists of several boreholes, a treatment plant and a raised/elevated water tank. The Uyo water area has four water works stations located at Idu, Ifa, Ewet Housing and Ekpenyong Street. They all have elevated tanks with storage capacity of $720m^3$ except the Ewet Housing water works station with $25m^3$ storage capacity. On the other hand, Ekit Itam water area consists of the following water works stations: Itam, State secretariat and Obio Etoi.

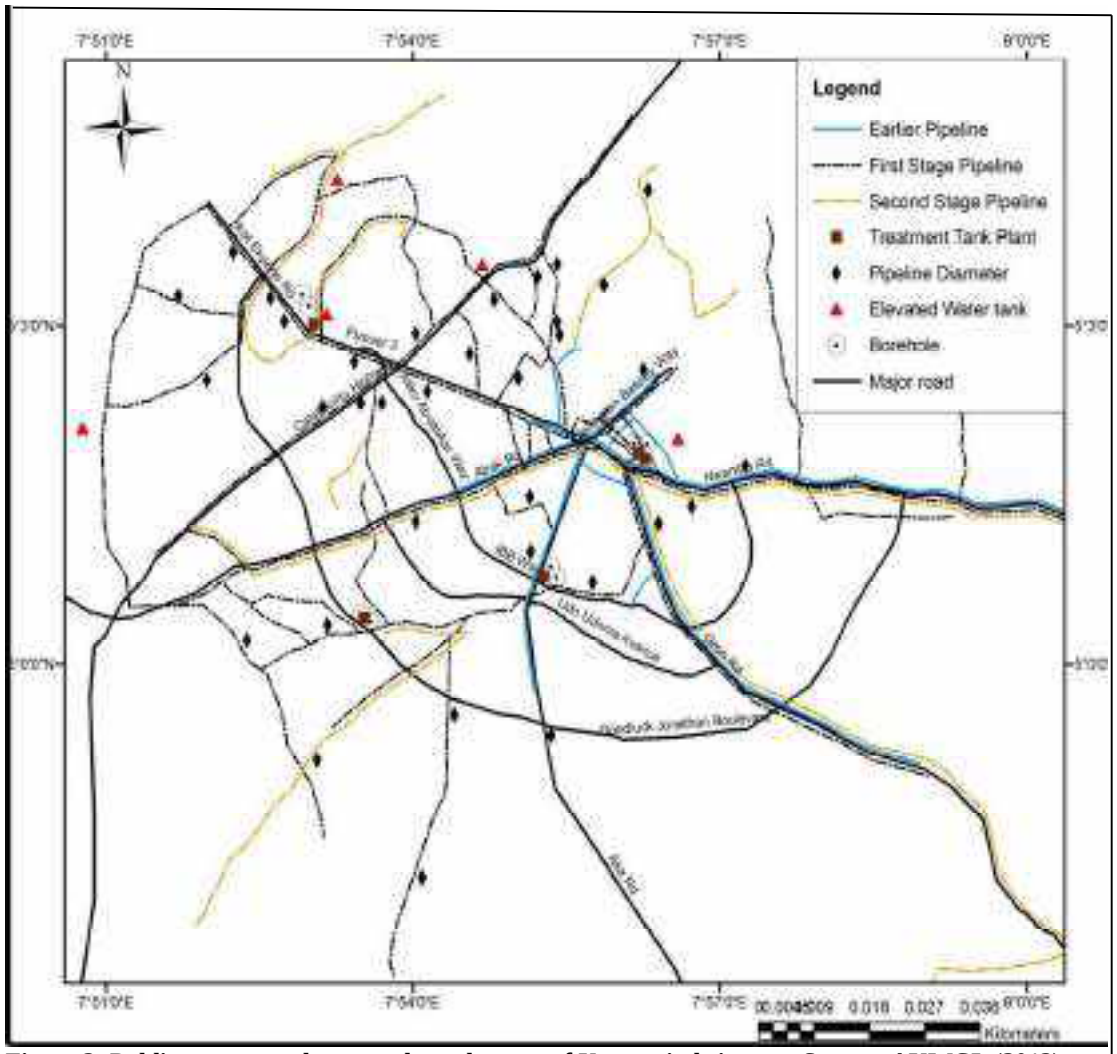

Figure 2: Public water supply network on the map of Uyo capital city. Source: AKWCL (2012)

Data Analysis and Findings

Table 1: Tariff for reticulated water in Uyo capital city

Structure type	High density areas	Low density areas
Single room(face me)	#200	#500
2 or less bedroom	#650	#1,350
3 or more bedroom flat	#800	#1,650
Duplexes	#850	#2,775- #5,550

Source: AKWCL (2012)

According to AKWCL (2012), water tariff charged to homes in high-density areas is ₦200.00 per month. In the case of buildings let out as flats with separated bath and cistern toilet per flat, for two or less bedroom flat/bungalow the charge is ₦650.00, while the charge for three or more bedroom flat/bungalow is ₦800.00 per month in each case. Duplexes in the high density area are charged ₦1, 850.00. Flats and bungalows in low-density areas also pay according to house types, which vary according to the number of rooms. These charges are fixed irrespective of the number of persons in a household or the actual quantity of water consumed. A two or less bedroom flat with or without boy quarters (BQ) is charged ₦1, 350.00, while a three or more bedroom flat with similar facilities is charged ₦1, 650.00. Two or less bedroom bungalow and three or more bedroom bungalow are charged ₦2, 250.00 and ₦2, 775.00 respectively. Duplex and detached single family dwelling of one block only is charged ₦2, 775.00, whereas detached single family building of more than one block is charged ₦5, 550.00 as shown in Table 1

The Cost Structure of Water Production

Between the months of January and December 2016, AKWCL distributed/reticulated 2.2m^3 (two million two hundred cubic metres) of water within Uyo Capital City and spent N82m within the same time frame as the total operating cost (including cost incurred in revenue collection, salaries, maintenance of equipment). Table 2 revealed the relationship between cost and estimated returns on water supplied while the cost is not worsening; revenue generation is not showing any significant improvement. On the other hand, Figure 4 shows that the firm has been running at a loss for all twelve months of 2016. AKWCL collected only about 34% of estimated billed distributed in 2016. The manager believed they issue was not just the amount billed but that lots of household were not connected while those connected did not have adequate supply. He also believed with adequate supply and connection of more homes, that revenue will improve to at least a break even rate.

Table 2: Twelve month cost of water reticulation and revenue in study area in 2016

Month/Year	Total Operating Cost	Estimated Bill Distributed	Revenue/Water Bill Collected
January	8,874,455.66	3,227,700.50	1,290,700.00
February	8,950,905.69	3,252,900.00	1,197,500.00
March	8,505,826.28	3,252,900.00	1,513,680.00
April	5,997,375.34	3,252,900.00	1,552,040.00
May	8,782,410.57	3,525,900.00	1,307,590.00
June	6,449,627.54	3,538,500.00	1,614,510.00
July	6,901,385.88	3,628,800.00	936,650.00
August	5,830,355.85	3,647,700.00	1,015,200.00
September	5,606,216.34	3,662,400.00	921,775.00
October	7,254,142.73	3,687,600.00	1,148,100.00
November	4,502,482.40	3,725,400.00	682,150.00
December	4,396,282.40	3,733,200.00	993,500.00
Total	82,051,466.68	42,135,900.50	14,173,395.00

Source: AKWCL (2016)

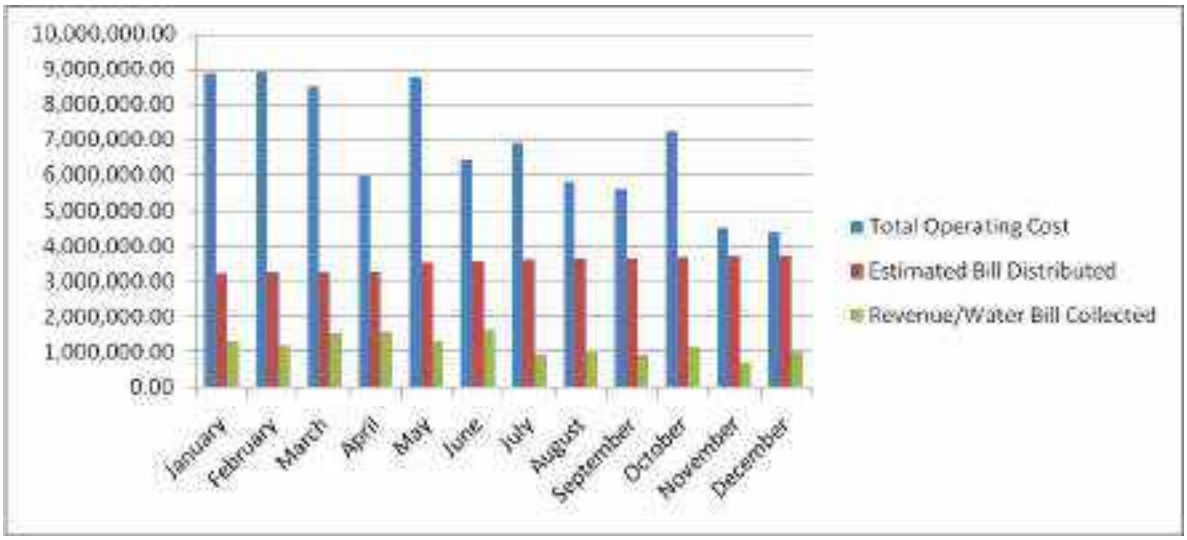

Figure 4: Water company cost and revenue returns for 2016 ; Source: AKWCL (2016)

The Pearson correlation coefficient, r, shows the strength and direction of the association between the two variables of cost and revenue. As the sign of the Pearson correlation coefficient is positive, we can conclude that there is a positive correlation between cost of water production (cost) and revenue generated from water reticulation (Revenue). On the other hand, the magnitude of the Pearson correlation coefficient determines the strength of the correlation such that a Pearson correlation coefficient (r = 0.477) as shown in Table 3 suggests a weak to medium strength correlation. This also implies that cost is responsible for 22 % of the revenue outcome.

Table 3: Correlation coefficient of operating cost and water bills in Uyo

		Total water bill collected
Total operating cost	Pearson Correlation	.477
	Sig. (2-tailed)	.117
	Sum of Squares and Cross-products	2.674E12
	Covariance	2.431E11
	N	12

In order to test the hypothesis that there is no significant relationship between cost and revenue generated from water production by Akwa Ibom Water Company Limited, the level of statistical significance (p-value) of the correlation coefficient (.117) implies that there is an insignificant relationship between the two variables. On the basis of the result, the null hypothesis which states that there is no significant relationship between cost and revenue from water in Uyo capital city is hereby accepted. This means that there are other factors with greater aggregate impact on revenue collected other than the cost of production. The level of revenue generation in relationship to cost of production, bearing in mind the conceptual framework of demand and supply, it can be deduced that water supply cannot be sustainable since the supply company cannot break even.

Conclusion and Recommendations

The need for proper pricing and management of improved water services and supply cannot be over emphasized. To achieve sustainable water management, managers need to properly harness the water resources within neighborhoods, imbibe the demand supply concept, and create an even distribution/reticulation network constantly maintained with room for expansion to meet anticipated increase in population. The poor water supply in the study area has giving rise to most households relying on other sources of water supply such as streams, hand dug wells and boreholes in order to meet their water and sanitation needs. To this end, the astronomical rise in drilling of boreholes in the study area has become a great concern. For a proper water supply mechanism in Uyo Capital City, the following recommendations should be considered:

i. Volumetric pricing has more advantages over other pricing structures. Its probability of inducing economic efficiency is higher than that of public pricing. The charge is based on the amount of water delivered. Volumetric pricing has simple and expedient way for government/ Water Company to generate revenue which will help in providing sustainable infrastructure. It also makes users not to misuse or waste water as billing is done according to quantity of water consumed.

ii. From the research findings, the water company spent N82million to generate a total supplied water of 2.2million cubic metres. This implies that cost of generating, supply and collection of revenue for a cubic metre of water supplied is about N40.00. Therefore at a cost of N40/m^3 -N50/m^3 of water reticulated, the water company will be able to recover their cost of production, break even and move towards sustainability.

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PROBLEMS OF KNOWLEDGE MANAGEMENT PRACTICES AT THE PROJECT LEVEL IN BUILDING CONSTRUCTING FIRMS

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Abstract
This study examined the problems of knowledge management practices (KMP) at the project level in building construction firms with a view to enhancing best practices. Despite the abundance and proliferation of various knowledge management tools and techniques, a thorough investigation of the knowledge management system (KMS) users' behaviours revealed that the low usage and effectiveness of the current system were mainly due to the problems of current KMS. However, the assessment and rationale for the application of informal and unsystematic approach are not known. The study utilized a descriptive survey research design. Study population of the building managers was 2533 and out of which a sample of 330 construction managers in Lagos State were identified and utilized. Data for the analysis were collected through self-administered questionnaires using random sampling method and were analysed using descriptive statistics. The study revealed that knowledge management tools used were at low level(Mean = 2.34). the major barrier militating against knowledge management was lack of effective communication (Mean = 3.29). It is recommended that building construction firms should encourage teamwork building among building managers in order to capture, retain and transfer knowledge successfully.
Keywords: Building Firms, Knowledge Management, Practices, Problems

Introduction

Today's economy is characterized by a rapid rate of change, globalization and knowledge –based products (Daud and Yusuf, 2008). Furthermore, the survival and performance of an organization is influenced by its ability and speed in developing knowledge-based competences. To achieve these objectives, Obasan (2011) opined that the establishment and continuous existence of organization requires the continuous and effective functioning of its materials input with the human element being indispensable in the day-to-day running of the organisation. Knowledge, a justified true belief, is seen as one of the most important resources in any organization (Dave, and Koskela, 2009). The success or even the survival of any organization depends on how effectively it manages the knowledge present internally and externally (Switzer, 2008). Effective management of this knowledge provides the capacity to reuse the existing organizational knowledge gained in the past via experience and can greatly reduce the time spent on problem solving and increase the quality of work. Ineffectiveness in managing knowledge makes the knowledge irrelevant and not useful for organizations (Yusof and Abubakar, 2012). For these reasons, there is an emerging need in the construction sector to effectively implement knowledge management systems with the aim of transcending boundaries for an organization. According to Daud and Yusuf (2008), knowledge acquisition deals with the processes of creating, developing, building and constructing knowledge internally so as to derive new and useful insights and ideals. Decentralized knowledge management, which relies on network of individual, is being used to manage knowledge in most of the building construction firms. Despite the abundance and proliferation of various knowledge management tools and techniques, a thorough investigation of the knowledge management system users' behaviour by Moonseo, Changbum, Hyun-soo and Seungjun (2007) revealed that the low usage and effectiveness of the current system were mainly due to the challenges of current knowledge management system. Zuofa, Burns, and Ocheieng (2015) rightly supported the view when the study revealed that the pool of knowledge is lost because there are no effective ways of managing it. With the application of adequate knowledge management, knowledge would hopefully be securely managed and loss of project knowledge will be prevented.

Knowledge management, according to (Kanagasabapathy, Radhakrishnan, and Balasubramanian, 2012), is a managerial activity which develops, transfers, transmits, stores and applies knowledge, in other to provide the members of the organization with real information to react and make the right decisions to be able to attain the organization's goals. Uriarte (2008) described knowledge management as simply the conversion of tacit knowledge into explicit knowledge and the sharing of it within the organization. Chang & Lee (2008) defined it as useful processes that have effect on the performance of an organization in distinct ways.
The fact that achievement of the overall goals and objectives of construction project revolves around the ability to manage knowledge effectively, a major aspect of this research is expected to empirically examine

the challenges militating against knowledge management practices at project level in building construction firms with a view to enhancing best practices.

Tacit Knowledge and Explicit Knowledge

Tacit knowledge is defined by Omotayo (2015) as that knowledge that is stored in the brain of person or individual. Dave & Koskela **(**2009) asserted that management of tacit knowledge becomes necessary in construction industry because of the temporary nature of the industry and also due to the unique nature of the construction project. Similarly, young Engineers, Architects, and Surveyors increase their academic training through mentoring that develops their knowledge in an organization. This experience enhances the daily functioning of organisations and contributes to the attainment of their objectives (Uriate, 2008). Explicit knowledge is concerned with that knowledge contained in documents or other forms of storage devices other than the human brain (Omotayo, 2015). To Akuegwu & Nwi-ue (2013), it is the creation, extraction, transformation and storage of the correct knowledge and information in order to design better policy, modify action and deliver results. The knowledge to be managed includes both explicit, which is documented knowledge and tacit, which is subjective knowledge. Knowledge management skills including knowledge sharing, capturing, mapping and storing are required in the administration of organisations.

Extent of Adoption of Selected KM Practices in Building Firms

Training/E-Learning: A key aspect of knowledge management (KM), according to Ronald (2010) at the personal and team levels is to collectively and systematically' capture the learning and ideas that are taking place. Learning and idea capture is a guide on how to do this. Furthermore, 'The problem is not a shortage of new learning and ideas, but knowledge managers do not effectively capture these learning and ideas—and systematically do anything with them!' there is the need to find better methods, tools, and techniques to do this collectively and systematically. Yusof & Abubakar (2012) suggested that personal capture tools should be integrated with corporate capture tools. Naturally, electronic tools are much preferred to paper-based tools for less risk of omission, speed, and accuracy. However, the key step is to capture learning and ideas manually or electronically.

Peer Tutoring: Ping (2010) argued that tutoring knowledge includes information of common students' errors and misconceptions, and tutoring knowledge is the most important knowledge since it is the key for us to build a customized learning system for each worker, which can deliver appropriate individual instruction to help workers learn more effectively and efficiently and highlighted that Peer provides an avenue for project teams to resolve project issues with outside expertise. Teams can identify real underlying issues, and new approaches and solutions. The ability of the Peer Assist to tap into the experience and knowledge of peers makes it a valuable tool that yields immediate insights and results.

Collaborative Physical Workspace: Chihab, (2009) defined Physical workspace, in this context, literally means as the settings in which actually work takes place, or simply the physical aspects of an office. When workers share or create knowledge, workers usually interact with other people through face-to-face communication—they discuss, dialogue, or simply just ask a question. The physical workspace is where such human interactions take place and it can support knowledge sharing/creation if it is well-designed. Naoki (2010) argued that good physical workspace does not mean luxury office that small and medium-sized enterprises rarely afford. Instead, it is about understanding how people interact—or create and share knowledge, and designing physical environment to support such human activities.

Libraries: Naoki (2010) defined taxonomy as a technique that provides the structure to organize information, documents, and libraries in a consistent way. This structure assists people to efficiently navigate, store, and retrieve needed data and information across the organization. It builds a natural workflow and knowledge needs in an intuitive structure. According to Kamlesh (2010), taxonomy facilitates effective retrieval, capturing, and recognition of content that is important to target users. Taxonomy helps users navigate from need to resource consistently and quickly. It provides context for information needs of the users.

Document Libraries Leading to a Document Management System: Kamlesh (2010) stated that from the Information Management science, and from the Library sciences, information and document management have always been interested in knowledge management. Efficient and effective access to documents is the antidote to 'information overload'. Maintaining a 'document repository' with good categorization and/or taxonomy and metadata (link to these later) is paramount to filing and, subsequently, searching and finding the right information at the right time. Naoki (2010) stated that it is difficult to imagine instances where and when document libraries are not to be used, apart from small, one-off information activities. Well-organized

documents are the first step to effective KM. Document libraries can start simple and use free tools, such as Google Docs, and gradually develop into sophisticated document management systems (Kamlesh, 2010).

Journal: Moonseo, Changbum, hyun-Soo & Seungium (2007) looked at a Blog as a very simple 'journal style' website that contains a list of entries, usually in reverse chronological order. The entries are typically short articles or stories, often relating to current events. However, the entries do not have to be just plain text. They could also be photographs, videos, audio recordings, or a mixture of all the types. A blog should not be used for information that needs to be revised frequently.

Online Network Services: Naoki (2010) defined social network as a group of people who share a common area of interest. Social network services are online systems that support social networking. The core services they offer usually include; finding people who have similar interests or needs; aggregating people into groups, or subgroups, and being able to communicate with those groups; and sharing content, such as documents links to relevant websites, or even streaming video. Social networks can be very powerful knowledge-sharing tools. The benefits of joining an existing network, according to Yusof & Abubakar (2012), is that you will find a collection of like-minded people, and be able to have useful conversations immediately. However, if the topic you are interested in is poorly served, it is certainly possible to create a new network cheaply and efficiently.

Building Knowledge Clusters or Internet: An internet forum is a web application for holding discussion and posting user generated content. Internet forums are also commonly referred to as web forums, message boards, discussion boards, (electronic) discussion groups, discussion forums, bulletin board or simply forums. The terms "forum" and "board" may refer to the entire community or to a specific sub-forum dealing with a distinct topic. Messages within these sub-forums are then displayed either in chronological order or as threaded discussions (Dave, and Koskela, 2009). The term 'Knowledge Cluster' according him is a term given to a group that—as a result of coming together in this new way—create, innovate, and disseminate new knowledge. In other words, different individuals, teams, and organizations can now come together, virtually, on the Internet, to better communicate, collaborate, learn, and share knowledge through the cluster.

Mentor / Mentee Scheme: Pink (2010) defined Mentoring as a work relationship between a senior and junior organizational member with an intentional agenda designed to transfer experience and learning. The mentor has experience and seniority in the organization, and personally advises, counsels, coaches, and promotes the career development of the mentee. Mentoring is an intervention that has proven highly effective and has become especially popular in recent years. Mentoring is an excellent vehicle for general corporate career development. Mentoring is a form of knowledge sharing. It builds a caring, trusting culture. In terms of the knowledge-creation cycle, it creates a space for people where they can internalize explicit knowledge through reflection on their experiences, throw ideas around in a safe socialization space, and work to verbally express what they know (to externalize).

Problems of Knowledge Management Practices in Building Firms

One of the greatest challenges that knowledge management practices faced is implementation. It is one thing for knowledge to be identified, acquired and stored and a different thing to be appropriately applied in the right direction to achieve desired result. Studies have considered knowledge implementation to denote "actualization" of the knowledge (Liao and Wu 2009, Asoh, Belardo and Crnkovic, (2007). It is a decision involving the use of knowledge to enhance organizational performance and goals attainment (Gbolami et al. (2012) and should be applied at various levels or divisions in organization. The typical construction organization does not encourage the culture of sharing knowledge. Wates group, a medium size UK building company, stated it took four and a half years before staff accepted the concept of sharing knowledge (Oke, Ogunsemi and Adeek 2013). Primarily, the cultures of the organizations need to be addressed if KM is to be benefited. There are many other barriers to the successful implementation of KM within construction enterprises. These according to Oke, et al. (2013), are described below:

i. Misunderstanding knowledge management as with information management: many internal stakeholders make the confusion between information management and knowledge management. One of the most important tasks for the Corporate Knowledge Manager was to meet as many people as possible within the company to make the concept of Knowledge Sharing "crystal clear". It means formal and informal meetings, discussions at the Cafeteria, training sessions on tools and put the Knowledge Sharing subject on the agenda of top manager meetings (Oke, et al., 2013)
ii. Lack of time and understanding knowledge management: Sharing knowledge demands additional efforts. This effort may be minimized by work practices and the introduction of better knowledge

sharing tools. Construction projects are always working to tight deadlines. Anything that detracts from the main business is seen as of diminished importance. Chihab (2009) asserted that one of the biggest problems to success is staff members' complaints that they do not have enough time to do knowledge management. This is mostly based on the perception that knowledge management is sometimes "extra" that they believe need to do and not something that is integrated into their daily work environment. Their perceptions need to change for them to see that knowledge management is part of their daily work routine and not something extra that they do. They should be able to see the value added from the activities that they participate in. If more

iii. time were spared between projects, individuals would have more time to combine, collaborate and reflect on knowledge obtained from the last project, resulting in a higher quality of knowledge sharing (Du-Plessis, 2008).

iv. Lack of effective communications among construction professionals: Lack of communication is another barrier for knowledge management. In order to gain the users "buy-in", the benefits of the knowledge management system must be understood by management and explained to the users. When users do not understand the benefits offered by the newly implemented systems, they only see an added responsibility or burden. Additionally, Chihab (2009)'s study showed that in the absence of clear communication and guidance as to the objectives of the knowledge management systems, the negative perception of the systems overwhelmed the positive.

v. Lack of cooperation among the construction professionals: This challenge arises out of the structural imbalance between knowledge seekers and knowledge providers. The knowledge provider, while able to provide knowledge, typically has little or no incentives to do so, i.e. why would anyone in the organization benefit from your experiences and knowledge? Why should one give away the fruits of labour free to others here? As much as a worker would like to pass on knowledge, how could a worker possibly find the time to do it? The knowledge seeker is highly incentivized to receive knowledge, but unable to do so without the cooperation of knowledge provider (Liao and Wu, 2009)).

vi. Lack of adequate and up to date data: According to Love, Fong & Irani (2005), there are three main types of knowledge that result from project-based working:

   a. Knowledge in projects, which resides in project in the form of documentations meeting, repository, discussions
   b. Knowledge about the project is knowledge that is required for executing a project and these include organizational design, designing, planning and controlling.
   c. Knowledge from projects is the experiences achieved from executing project. This is informing of best practices, lessons learned, post-project reviews or after-action reviews.

Unfortunately, not a great deal of time is spent on the latter, as people are pulled out from a project before it is actually completed, which in turn results in valuable lessons from the project not being recorded and therefore being lost. In some cases, the lessons are collected too late or are forgotten when the review is only carried out at the end of a project. This eventually results to difficulty in generalizing and storing knowledge and difficulty in capital valuing intellectual.

Study Area & Research Methodology

The study only covered knowledge management in building construction firms with respect to the application of knowledge management at the project level. The study area for this research work is Lagos State. The choice of Lagos state for this study was premised on the fact that the city has a fair concentration of building construction firms. 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 research involves examining the problems of knowledge management practices at the project level through the collection of detailed data on the existing condition of knowledge management practice and using the data collected to justify the actual conditions to make improvement in building construction firms. Therefore, a quantitative research methodology was adopted for this study through a questionnaire survey as did by other researchers on a similar related area of study (Mukherjee, 2007, Zuofa, Burns and Ochieng, 2015; Oke, Ogunsemi and Adeek, 2013). The use of questionnaire survey was adopted for this study. Kasimu, Roslan and Fabhhlin (2013) highlighted that, the beliefs, perception, ideas, views and thought of construction managers about area under study can be gotten very easily, due to the flexible nature of questionnaire survey which can also be in structured format and can cover large number of sample of individuals from a population.

The population size of 2533 building construction managers which was drawn from 2533 building construction firms was used in this study and was drawn from registered building construction firms retrieved from FIRS 2015. These companies are made up of Micro enterprises, Small enterprises, and Medium enterprises (building construction firms) as categorized by (AbdulAzeez, 2012). This has a corresponding employee's size of 1 to 10, 11 to 99 and 100 to 299 respectively. The nature of the large firms (over 300 workers) are said to have large numbers of workers. Therefore, construction managers in micro, small and medium serve as source of primary data for this research. The respondents were asked to indicate the category of their firms in the questionnaire. Therefore, building construction managers who serve as respondents in construction firms in Lagos State 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 = 254 using the table from Bartlett, Kotrlik, & Higgins. According Bartlett, Kotrlik, & Higgins (2001) a margin of error between 3% and 5% is acceptable for educational research. Salkind, (1999) stated that 10% - 50% of the corrected sample size can be added to the initial sample size. Therefore, 40% of number 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 thus: Number = 254 x 0.40 = 76 ; therefore 76 + 254 = 330. Therefore, the study finally administered 330 questionnaires to building construction managers in building construction firms in Lagos State. 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. The respondents were asked to indicate their numbers of employees in the questionnaire to determine various categories of firms.

Results and Discussion

Figure 1 shows the firms assessed consist of Micro firms, with number of employees (1-9), Small firms with number of employees (10-90) and Medium firms with number of employees (100-299). Questionnaires were administered to managers in these firms, which yielded response rate of Micro 33 (10%), Small 173 (53%) and Medium 51 (15%) respectively. The highest response rate of 53% was gotten from small size firms (10-99) which shows that they constitute a larger portion of responses in this study. In research carried out by Egbu, Hari & Kumar, (2003) on small and large size construction firms, it shows that small firms enterprises have challenges implementing knowledge management initiatives. Therefore, responses gotten from these firms are considered relevant to this study.

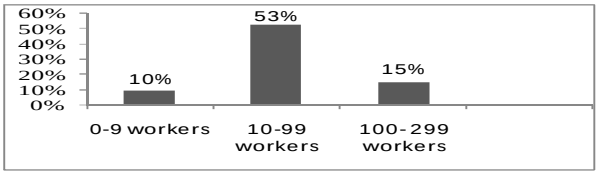

Fig 1: Characteristics of company size responses rate.

Table 1 shows the respondents by qualification. (7) 2.72% mangers hold PhD., (39) 15.18% hold MSc, (134) 52.14% hold BSc and (77) 29.96% hold HND. It could be seen in this research that professionals with Bachelor' degree BSc are those that participated in the research as they made up the largest percentage of the responses. This shows that not all the construction managers are only academically inclined but also have more knowledge on area under study.

Table 1: Distribution of Respondents by Qualification

Qualifications of Respondents	**Frequency**	**Percentage**
PhD	7	2.72
MSc	39	15.18
BSc	134	52.14
HND	77	29.96
Total	**257**	**100**

Source: - Field survey (2017)

Table 2 shows the year of experience of respondents that took part in this research. Thus 22.96% of the construction managers have 0 to 5 years of experience, 46.30% has experience between 5 to 10 years followed by 26.07% respondents with 10 to 15 years' experience and lastly 4.67% responses from managers with over 15 years of experience. As it is observed 46.30% of the construction managers with experience between 10 and 15 years has the highest percentage of responses. Therefore, responses obtained from a sample like this can be characterized as "informed" and have been practicing knowledge management in one way or the other.

Table 2: Distribution of Respondents by working experience

Experience of Respondents	Frequency	Percentage
1 – 5 years	59	22.96
6 – 10 years	119	46.30
11 – 15 years	67	26.07
Over 15 years	12	4.67
Total	**257**	**100**

Source: Field survey (2017)

Table 3 reveals the extent of adoption of selected knowledge management practices in building construction firms. The mean scores ranged from 1.13 to 3.55. Staff meetings (mean=3.55) and telephone calls (mean=3.54) score were high. While the mean scores of Pear tutoring (mean=2.43), conference/event (mean=2.38), seminar (mean=2.36), internet (mean=2.29), Training (mean=2.27), external course (mean=2.25), libraries (mean=1.20) and journal (mean=1.13) were relatively low. From the analysis of data collected, it was clearly shown that the adoption of knowledge management practices in building construction firms were to a low extent (given the overall average mean of 2.34). This agrees with the study by Oke et al. (2013) when they reported that knowledge management application is at a low level. Furthermore, staff meetings received the highest scores (mean = 3.55). This implies that the face to face meetings are always the most popular approach knowledge management practices in building construction firms. Moreover, the items ranked second to third in ascending order were telephone calls (mean = 3.54), pear tutoring (mean 2.43) and conference and events (mean = 2.38). The results reveal that after face to face meetings, other frequently employed means of knowledge management practices is telephone calls, pear tutoring followed by conference/events and seminar. Besides, staff meetings received mean score of 3.55 while telephone received mean score of 3.54. It can be seen that the difference in their means is 0.01. This shows that there is no significant difference between the two means of knowledge management practices. It means that the two knowledge management practices are dominant knowledge management practices in building construction firms. The reason may be as a result of people's preference for more direct approaches to knowledge practice. Training/ E-learning that should provide a platform for people from different locations to express and exchange knowledge and ideas on any specific topic ranked 7th. In any organization, presentations usually invite the participation of people from different projects or in an organization. However, it was found that the use of this knowledge management practice is not widely used in building firms. This agrees with Bashir, et al. (2014) when they reported that the attention given to Nigerian's KM practices has been weak and has consequently affected its effectiveness and utilization. One of the characteristics of training/E-learning discussion group is that it provides an indirect channel for people in different locations to share knowledge. However, this knowledge management practice is not widely used in building firms. The reason may be as a result of people's preference for more direct approaches to knowledge practice. The fact is that if it is widely utilized in building construction firms, cohesive relationship will be established and the nature of long hours lends itself to meeting and discussing easily.

Table 3: Extent of Adoption of Selected KM Practices in building firms N = 257

KM Practice	VH	H	L	VL	Mean	Std. D	Rank	Decision
Staff meetings	154	89	14	0	3.55	0.700	1	High Extent
Telephone calls	152	94	9	2	3.54	0.703	2	High Extent
Peer tutoring	47	80	68	62	2.43	0.585	3	Low Extent
Conferences / events	43	76	73	65	2.38	0.217	4	Low Extent
Seminar/presentation	41	77	75	64	2.36	0.613	5	Low Extent
Internet	30	70	100	57	2.29	0.240	6	Low Extent
Training/E-learning	20	70	127	40	2.27	0.594	7	Low Extent
External course	10	60	172	15	2.25	0.633	8	Low Extent
Libraries	2	7	30	218	1.20	0.650	9	V. Low Extent
Journals	1	6	20	230	1.13	0.600	10	V. Low Extent
Average Means					2.34			Low Extent

(4= (VH) Very High; 3-=(H) High, 2-=(L) Low, 1= (VL) Very Low) *Source: Field Survey (2017)*

Table 4 shows that all the respondents agreed that items 1-7 on the table (Mean ranged from 3.29 to 3.00), were the challenges confronting knowledge management practices in building construction firms, given the overall average mean of 3.12. Lack of effective communications among the professional's top the list (mean = 3.29), followed by lack of adequate and up to date data and difficulty in capital valuing intellectual (mean = 3.15). Lack of cooperation among the construction professional (mean = 3.11); difficulty in generating and storing knowledge (mean = 3.01); misunderstanding of knowledge management as with information management (mean = 3.06) and lack of time and understanding knowledge management (mean = 3.00). This is in agreement with (Oke, et al., 2013).

Table 4: Challenges confronting KM in building construction firms

S/No.	Challenges	SA	A	D	SD	Mean	Std. D.	Rank	Decision
1	Lack of effective communications among construction professionals	91	151	13	2	3.29	0.198	1	Agree
2	Difficulty in capital valuing intellectual	76	145	35	1	3.15	0.193	2	Agree
3	Lack of adequate and up to date data	54	188	15	0	3.15	0.228	3	Agree
4	Lack of cooperation among the construction professionals	62	155	27	4	3.11	0.207	4	Agree
5	Difficulty in generating and storing KM	49	183	25	0	3.10	0.225	5	Agree
6	Misunderstanding KM as with information management.	44	183	30	0	3.06	0.228	6	Agree
7	Lack of time and understanding KM	52	153	50	2	3.00	0.205	7	Agree
	Average Mean					**3.12**			Agree

Source: Field Survey (2017)

One of the most important tasks for the building construction Manager was to meet and discuss with many people as possible within the company to clarify the concept of Knowledge Sharing. Construction managers should arrange for formal and informal meetings, discussions, and training sessions require on tools and put the Knowledge Sharing subject on the agenda of top manager meetings and at appropriate time. If the construction manager is able to make employees to recognise the value added from the activities that they participate in according to (Du-Plessis, 2008), they should have known that KM is part of their daily work routine and not something extra that they do. Though, employees usually have no time to share and evaluate knowledge before going on to the next project, it is believed that if there has been tangible demonstration of value during the early days/months of the projects and more time were spared between projects, individuals would have more time to combine, collaborate and reflect on knowledge obtained from the last project, resulting in a higher quality of knowledge sharing that will keep knowledge gained from project. It is necessary to explain the benefits of the knowledge management system to the users by management. When users do not understand the benefits offered by the newly implemented systems, they only consider it as an added responsibility or burden. Additionally, Chihab (2009)'s study showed that in the absence of honest communication and guidance as to the objectives of the knowledge management systems, the negative perception of the systems overwhelmed the positive.

Lack of cooperation among the professionals was as a result of the structural imbalance between knowledge seekers and knowledge providers. Those that have knowledge, typically, were not encouraged to share it, for

the fact that they don't want anyone in the organization benefit from their experiences and knowledge. As they don't want to give away the fruits of their labour for free to others, hence, they resulted into question like how could one possibly find the time to do it? Even if the knowledge seeker is highly incentivized to receive knowledge, it will be difficult without the cooperation of knowledge provider (Chihab, 2009). Human Resource Management (HRM) practices can also impact on workers' attitude towards and participation in KM activities (Hilsop, 2013). The use of HRM practices can be seen to be concerned not only in attempting to create a positive towards, and a willingness to participate in organisational KM activities but also with making employees committed and loyal to their employer, this is fundamental, because if employees are not committed and loyal to their organisations, there is a risk of losing knowledge possessed by the employees through staff turnover. Knowledge in projects, knowledge about the project, and Knowledge from projects is the experiences achieved from executing project. This is in form of best practices, lessons learned, post-project reviews or after-action reviews. Unfortunately, not a great deal of time is spent on the latter, as workers are pulled out from a project before it is actually completed, which in turns resulting in valuable lessons from the project not being recorded and being lost. It is important to manage these experiences for the survival of an organisation.

Conclusion

In the assessment of knowledge management practices in building construction firms, it is worth noting that the adoption level of knowledge management practices by building construction firms is improving. Although, there was low level of knowledge management practices within the construction firms, it can be better. Besides, training practice was not widely used. It was also concluded in this study, that knowledge management practices faced with some challenges. Such challenges include lack of effective communication; lack of adequate and up to date data; lack of cooperation among the construction professional. The implication is that without honest communications among the construction professionals, and creating time for knowledge management, it will be very difficult to capture and share knowledge within an organization. This will eventually lead to continuous loss of gained project knowledge by the organization. Though it was admitted that most construction workers are competitive by nature and would be less inclined to share the knowledge they possess, the need for knowledge sharing among the construction workers in construction firms could never be overemphasized. Besides, building construction firms need to introduce system that appreciate and recognize worker's contribution towards the knowledge management practice. Moreover, training support needs to be provided in the present of effective communication to keep construction workers abreast of relevant knowledge of recent trends in the firm.

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COLLABORATION IN CONSTRUCTION PROJECTS AND EFFECTS ON PROJECT PERFORMANCE

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Abstract
In recent years collaboration amongst project players has drawn much attention within the field of construction management. Several case studies support the argument that collaboration has positive effects on project performance. There is however, a need for quantitative studies investigating statistical relationships between collaboration and project performance. The purpose of this study is to investigate how collaborative tools affect collaboration and further collaboration's effect on project performance. The empirical data was collected through a survey responded to by 106 construction professionals within FCT Abuja. Results from hierarchical regression analyses show a positive relationship between collaborative tools and collaboration suggesting that joint activities are crucial for collaboration to emerge. A positive relationship was also found between collaboration and project performance. The statistical results support previous case study findings where collaboration is positively affected by joint activities and project performance is enhanced by collaboration.
Keywords: Collaboration, Collaborative Tools, Construction Management and Project Performance

Introduction

Construction is a project-intensive industry (Morris, as cited in Papadonikolaki, Oel, & Kagioglou, 2019). Project-intensive industries rely upon temporary or semi-permanent project teams (Turner, as cited in Papadonikolaki et al., 2019), and thus managing information, communication and knowledge is highly significant. The integration of management, communications management and stakeholder management is known as collaboration and are key knowledge areas of the discipline, all of which are related to collaboration of these temporary teams. (Project Management Institute, 2017) asserted that construction projects are temporary endeavours with a definite start and end to create an end product satisfactory to the client. Project Management Institute (2017) asserted that these projects are initiated due to some consideration such as market demand, client's needs and the projects are established with a specific aim of accomplishing a complex task. Collaboration in construction projects takes different dimension, as different projects have different ingredients, it continues to be ambiguous (Bjorvatn & Wald, 2018; Yan & Wagner, 2017) . It could come as a result of technical skills required, size of project and can be measured base on the level of complex nature (Hobday as cited in Zaib, 2019). Streams of literature have been established by different authors relating impact of collaboration on project performance (Nguyen, Le-Hoai, Tran, Dang, &Nguyen, 2019; Zaib, 2019; Bjorvatn & Wald, 2018; Cristóbal, 2017; Dao, Kermanshachi, Shane, & Anderson, 2016; Dao, Kermanshachi, Shane, Anderson, & Hare, 2016; Floricel, Michela, & Piperca, 2016; He, Luo, Hu, & Chan, 2015).

Achieving Project Goals through Collaboration

Collaboration and cooperation are interchangeable terms which are defined as a recursive process where people or organisations work together in an intersection of common goals by sharing knowledge, learning and building consensus (Dietrich et al., 2010). Mattessich & Monsey (as cited in Papadonikolaki et al., 2019)defined collaboration as a dynamic and mutually beneficial and well-defined relationship entered into by two or more organisations to achieve common goals. There is a broad consensus among scholars and practitioners that collaboration in teams generates positive work outcomes, especially in the context of innovative projects (Walker et al.; Kotlarsky and Oshri as in cited in Caniëls, Chiocchio, & van Loon, 2019). Effective collaboration among team members is viewed as the key success factor in projects (Gransberg et al.,; Vaaland, as cited in Caniëls et al., 2019). Collaboration is associated with effective coordinate on and communication that come forward from a shared understanding of the context and assumptions inherent to an innovation project (Chiocchio et al., as cited in Caniëls et al., 2019).

Construction is a highly project-based industry (Gann andSalter; Morris as cited in Oraee et al., 2019) in which various organisations must couple with each other through project-specific collaborative relationships (Cao et al., as cited in Oraee et al., 2019)). Construction activities are therefore inherently contingent upon collaboration among team members (Greenwood and Wu; Papadonikolaki et al., as cited in Oraee et al., 2019). Conversely, the lack of collaboration in construction project teams results in misunderstandings,

misinterpretations of data, poor communication and, consequently, increased rework(Greenwood and Wu; Hosseini et al; Kalay; Nikas et al., as cited in Oraee et al., 2019). Thereby, collaboration is seen as "the mainstay" for improving efficiency, integrating processes and resources, increasing profit and enhancing the quality of products on construction projects (Ey et al.; Fulford and Standing; Greenwood and Wu; Kalay as cited in Oraee et al., 2019).With BIM's advent, its technical capabilities in facilitating a collaborative environment have been a major motivator for construction projects in their move towards BIM's implementation (Alreshidi et al., 2016a; Bassanino et al., 2014; Cao et al.,2016; Hosseini et al., 2016).

The industry is a complex and high-risk multi-actor business that over a long period of time has received criticism for its relationship between client and contractor, where poor collaboration, ineffective communication, unbalanced risk allocation provisions, limited trust and lack of customer focus are cited amongst its shortcomings. Projects are becoming more complex due to unexpected emergent behaviour, characteristics and technology involved (Bakhshi, Ireland, & Gorod, 2016). Kermanshachi et al., (2016) presented that complexity is widely used in the construction but the construct is perceived as different interpretation by industry experts but ultimately it is believed that complexity has impact on a number of industry practices such as project delivery, management practices and project performance. Complexity affects project management including expertise & experience requirements of project managers; also it affects the evaluation, control of project and objective such as time, cost, quality and safety. Hence, Managers needs to share information, collaborate to increase the chances of project success.

Types of Collaborative Tools

Collaboration or partnering overhauls the traditional adversarial relationships between contracted parties with a shift towards more collaborative and caring environments. To facilitate effective partnering a range of collaborative methods and joint activities with the purpose to enhance the collaborative spirit among contracted parties, collectively named collaborative tools, are required Kermanshachi et al., (2016). Examples of collaborative tools are: joint objectives, follow-up workshops, dispute resolution techniques, joint IT-database, joint project office, team building activities, partnering facilitator, and joint risk management (Alreshidi et al., 2016a; Bassanino et al., 2014; Cao et al., 2016; Hosseini et al., 2016). A joint IT-database, designed to reflect the projects strategic vision and environmental factors, is an effective tool to increase collaboration and information sharing among construction companies.

Hypotheses

Hypothesis 1: The higher the usage of collaborative tools, the better the collaboration among contracted parties in a construction project.

Hypothesis 2: The better the collaboration among contracted parties in a construction project, the better the project performance.

Figure 1 below shows the proposed model in which collaboration works as a mediator between collaborative tools and project performance. A full mediating effect hypothesize that there is no direct relationship between collaborative tools and project performance.

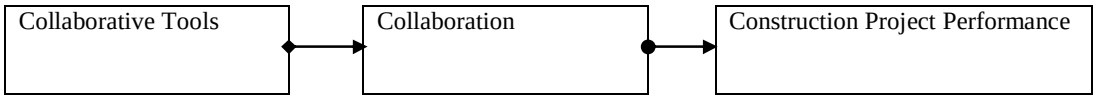

Figure 1.The proposed project performance model.

Methodology

The empirical data were collected through a questionnaire administered purposefully to selected registered construction professionals practicing in Abuja. The population consists of Architects, Builders, Quantity surveyors and Civil Engineers. The organizations were initially approached for the investigation and then subsequently registered contact persons were telephoned, in order to inquire about theirs or other more suitable person´s willingness to participate in the study; given that the survey involved procurement, project management processes and project performance. Six respondents declined participation due to lack of time. In a third stage, questionnaires were posted to the 134 potential respondents that had agreed to participate in the investigation. After two reminders a total of 111 responses were received. In a fourth stage respondents who had not answered all questions were telephoned and asked to respond to such questions. This resulted in minimization of the amount of missing values. Nevertheless, in five responses there were a lot of missing

values, for which reason they were discarded. Accordingly, from the population of 140 professionals, 106 usable responses were received, resulting in a response rate of 76%. In the questionnaire the respondents were asked to what extent they use different collaborative tools in their construction projects, and how satisfied they are with various aspects of project performance, including collaboration among project actors. The questions were measured using seven-point Likert scales anchored by 1 = very seldom/very dissatisfied and 7 = very often/very satisfied. The questions did not measure these aspects in a particular project but involved firm-level behaviour and project performances in the firms' portfolios of procured and finished projects. Furthermore, three control variables were measured through a nominal scale: if the organization follows public procurement regulations or not, if the construction collaboration affects performance activities involving new construction/rebuilding projects or continuous maintenance work, and if the firm is active on a local/regional or national/international market.

Data Presentation and Analysis

Usage of collaborative tools: The most commonly used collaborative tool is joint objectives (4.35) followed by joint IT-database (4.26). The least common used collaborative tools are partnering facilitator (2.46) and joint project office (2.46). The eight items of collaborative tools (joint objectives, follow-up workshops, arena for relationship discussion and dispute resolution, joint IT-database, joint project office, teambuilding activities, partnering facilitator, and joint risk management) were subjected to principal component analysis (PCA) with Oblimin rotation using the Statistical Package for the Social Sciences (SPSS) version 16. Oblimin rotation is justified when it is reasonable to expect correlation between perceptual dimensions (Hair et al., 2006). The Kaiser-Meyer-Oklin (KMO) value was 0.87, exceeding the recommended value of 0.6 and the Bartlett Test of Sphericity reached statistical significance (0.00). The analysis on collaborative tools resulted in a one-dimensional factor with factor loadings between 0.39 and 0.80. Hence, collaborative tools was computed into a single factor in later analysis. The computed factor of collaborative tools have Cronbach alpha CA = 0.84 and factor mean value MV = 3.24. The relatively low mean value indicates that collaborative tools are not used to a high extent by construction companies in Abuja.

Project performance: The respondents are satisfied with project performance: customer satisfaction (5.90) receives the highest score and time schedule minimized (4.70) the lowest (Table 1). The ten items of project performance are theoretically related to the four aspects of cost, time, quality and collaboration. In order to investigate if the empirical data supports such a grouping of performances the ten items were subjected to a PCFA with Oblimin rotation, which was forced into four solutions. The Kaiser-Meyer-Oklin (KMO) value was 0.76 and the Bartlett Test of Sphericity reached statistical significance (0.00), supporting the expected four factor solution, explaining 42.2%, 14.8%, 9.7% and 8.7% of the variance respectively. The identified factors are; 1) Quality (CA = 0.87, MV = 5.76), 2) Time (CA = 0.60, MV = 5.17), 3) Cost (CA = 0.73, MV = 5.09) and 4) Collaboration (CA = 0.59, MV = 5.73). To be able to address H2 the collaboration factor is used as an independent variable potentially affecting the performance factors quality, time and cost.

Table 1: Principal component factor analysis of project performance

	Item Mean	Factor 1 Quality	Factor 2 Time	Factor 3 Cost	Factor 4 Collaboration
Function according to specification	5.75	0.91	0.04	0.13	-0.14
Expected quality is achieved	5.70	0.90	0.01	-0.03	0.03
High customer satisfaction	5.90	0.77	-0.04	-0.06	0.20
Time schedule is minimized	4.70	-0.09	0.92	-0.02	0.07
Within time schedule	5.61	0.25	0.60	0.30	-0.06
Within project budget	5.51	0.01	0.05	0.94	-0.07
Project cost is minimized	4.95	-0.06	0,14	0.77	0.16
Life cycle costs are minimized	4.87	0.32	-0,24	0.48	0.20
Negotiations don't end up in disputes	5.18	-0.10	-0,05	0.18	0.87
Good cooperation among project actors	5.41	0.30	0.19	-0.12	0.67
Percentage of variance		42.16	14.76	9.70	8.56
Crombach alpha (CA)		0.87	0.60	0.73	0.59
Factor mean value (MV)		5.76	5.17	5.09	5.73

Collaborative tools' effect on collaboration

Hierarchical multiple regression analysis was used to assess the ability of collaborative tools to predict levels of collaboration, after controlling for the influence of three control variables (if the organization follows public procurement regulations or not, new construction/rebuilding projects or maintenance work, and local/regional or national/international market). Model 1 in Table 2 only consists of the control variables, explaining 2.4% of the variance in collaboration. In Model 2 collaborative tools were entered and the model as a whole explained 11.6% of the variance in collaboration. Hence, collaborative tools explained an additional 9.2% of the variance, which is a small but definite correlation (Hair et al., 2006). The control variables are not statistically significant ($p > 0.05$) and can be rejected whereas Model 2 was statistically significant ($p < 0.05$). H1 is therefore confirmed with a small but definite positive relationship between the usage of collaborative tools and collaboration among project actors (R^2 change = 0.092).

Table 2: Hierarchical regression analysis testing Hypothesis 1

	Model	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig.F Change
1	0.15	0.024	-0.01	1.07	0.024	0.83	3	102	0.48
2	0.34	0.116	0.08	0.98	0.092	10.49	1	101	0.02

Collaboration's effect on project performance

Project performance is divided into three dependent variables; quality, cost and time and the collaboration construct functions as an independent variable. A hierarchical multiple regression analysis was used to assess the ability of collaboration to affect the three factors of project performance, after controlling for the influence of four control factors (if the organization follows public procurement regulations or not, new construction/rebuilding projects or maintenance work, local/regional or national/international market, and collaborative tools). Model 1 for each performance factor represents the results only from the control variables whereas Model 2 represents the results from control variables and collaboration (Table 3). The results from the three regression analyses show that none of the Model 1 solutions are statistically significant ($p > 0.05$). This indicates that the three original control variables together with collaborative tools do not affect project performance. To further verify this result bivariate regression analyses with collaborative tools as independent variable and the three performance factors as dependent variables were conducted. These analyses verify that there is no statistically significant relationship between collaborative tools and any of the three aspects of project outcome ($p > 0.05$). Collaboration's effects are statistically significant ($p < 0.05$) on all three aspects of project performance. Collaboration accounts for 23.7 % of the variance in quality, 22.1 % of the variance in cost and 4.5% of the variance in time. For quality and cost collaboration accounts for significantly more than the control variables which is not the case for time where control variables accounts for 7.9% compared to collaboration 4.5%. The effects collaboration has on quality and cost are moderately strong and its effect on time is small but definite (Hair et al., 2006). H2 is thus confirmed with a positive relationship between collaboration and all three aspects of project performance.

Table 3: Hierarchical regression analysis testing Hypothesis 2

	Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
						R Square Change	F Change	df1	df2	Sig.F Change
Quality	1	0.17	0.029	-0.01	0.92	0.029	0.74	4	101	0.56
	2	0.52	0.265	0.23	0.80	0.237	32.20	1	100	0.00
Cost	1	0.25	0.061	0.02	1.09	0.061	1.65	4	101	0.17
	2	0.53	0.283	0.25	0.95	0.221	30.85	1	100	0.00
Time	1	0.28	0.079	0.04	0.91	0.079	2.15	4	101	0.08
	2	0.35	0.124	0.08	0.89	0.045	5.18	1	100	0.03

Discussion

Based on the notion that the nature of collaborative tools is to encourage, foster and maintain a collaborative spirit among project actors (Bayliss et al., 2004), the study show only a small but definite relationship between the usage of collaborative tools and the achievement of collaboration (R^2 0.092). Even if H1 is confirmed it is not entirely in line with previous research which argues for a strong relationship between them. The difference in results could be explained by the difficulties in effective implementation of collaborative tools in a construction project. This study only investigates to what extent construction professionals use collaborative tools and does not address questions of implementation, time of

implementation nor which actors that participated in the joint activities. The difference in results could also be explained by the criticism previous research received arguing that the studies in some extent is limited in scope and based on evidence from successful projects in which strong collaboration was achieved. Hence, the effect of collaborative tools on collaboration may be exaggerated if the relationship is not investigated on an industry level, including both successful and failed partnering relationships.

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CHOOSING BUILDING PROFESSION AS A CAREER: A MARKET INVESTIGATION

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Abstract
The issues affecting entry into the building profession programme require the efforts of those concerned with the supply of high-quality building production management in the country to rethink the promotion and support of the profession. The current study seeks to address the following research questions: (i) what can be done to give students more and better information on career? (ii) What do students and the individuals who influence students know about building profession? (iii) What has already been done to recruit students into building profession? (iv)What can be done to have a better job of recruiting and retaining building students? A qualitative research approach was adopted. A total of Seventy-seven (77) semi-structured interviews were conducted with students, parents, teachers, counsellors and professional builders in two states of western part of Nigeria. The result of the study reveals that the building profession faces image and recruiting problems in the construction industry. The image of building profession among students and other individual advisers is hard, not well known, unflattering and misconstrue. The study suggests that, to be successful in enhancing the building profession pool, Nigerian Institute of Building must think and consider the following: (i) Commit to continuing involvement in primary and secondary education; (ii) Mount on serious public awareness campaign; (iii) Enhance building profession curriculum; (iv) Construction sites excursion; (v) Engage in career talk for Senior Secondary School; (vi) Implementation/enforcement of laws in the construction industry; and (vii) Approval of salary grade for building graduates by federal government of Nigeria. The outcomes of this research define the way to inform students, parents, teachers, counsellors and other individual advisers on careers in building profession and also how to retain motivated and interested students.
Keywords: Building profession, career, market investigation, Nigeria

Introduction

The number of building graduates produced by Nigerian universities and polytechnics per year are apparently less compare to other key professions in the built environment. Gazing at the future pools of university and polytechnic students, the number of new building graduates may not significantly increase. At most, the annual number of building graduates would be near the present level. At worst scenario, sudden decline in the annual number of building graduates may be experienced. What next? Maybe there is no need for many building graduates. Advanced building production management with the aid of advanced technology and better use of craftspeople and artisans has greatly increased the productivity of professional builders. Besides, if there are few hands to handle the work of professional builders, would not financial income increase or bank accounts swell up, thereby attracting people into the profession?

Though this observation may sound true, certainly it does not inform the complete story. The Nigerian institute of building (NIOB) and council of registered builders of Nigeria (CORBON) have reported that the construction industry and government agencies will need many more professional builders than they have been engaging in the past. In addition, the construction sector of Nigeria is facing many problems and challenges of all kinds (Osuizugbo, 2020). These challenges includes but not limited to cost overruns, project delays, designs that cannot be economically constructed, poor workmanship, rework, poor specifications, impracticable and uncontrolled schedules, poor detailing, misunderstanding among members of the project team, project abandonment, uncompleted public and private building projects and building failure and collapse (Abiodun, Segbenu & Oluseye, 2017; Abisuga, Amusu & Salvador, 2014; Babalola, Oluwatuyi, Akinloye & Aiyewalehinmi, 2015; Osuizugbo, 2020). These are indeed serious issues that need motivated, talented, socially and analytically minded builders working on the aforementioned problems. However, this paper is not focused on potential professional builders' shortage, although enough information is recited to introduce the subject. Hence, the paper sets to address the following research questions:
What can be done to give students more and better information on building career?
What do students and the individuals who influence students know about building profession?
What has already been done to recruit students into building profession?
What can be done to have a better job of recruiting and retaining building students?

The issues affecting entry into the building profession programme require the efforts of those concerned with the supply of high-quality building production management in the country to rethink the promotion and support of the profession. Reputable organisation involved in this effort is Nigerian Institute of Building (NIOB). The primary vision of NIOB "is to provide Nigeria with the profession that will be responsible for the complete construction of new buildings, maintenance of existing buildings and building production management, utilizing high standard of practice and providing modern and appropriate construction techniques, with more emphasis on improved training, safety, quality and value management for the benefit of our fatherland" (NIOB, 2002). The fundamental drive for this study is that everyone who may have the interest and ability to become a professional builder should have the opportunity to learn something about the profession.

Literature Review

Choosing a career is one of the most important decisions to make in life. According to Kazi and Akhlaq (2017), making a career choice is a defining stage in every student's life. A career is the progression of occupations, jobs and positions held during the course of life (Ezeani, 2013). Occupation has been defined as a means of living, which has the power to determine social status, change personalities, determine social groups, and predict expected earnings (Kazi & Akhlaq, 2017). Career building begins with the development and identification of values, aims and ideas, which change habits, attitudes and eventually shape behaviours to achieve aspirations (Borrelli, Farwana & Agha, 2017). Career choice is no longer about what you want to be, but also of whom you want to become (Holmegaard, Ulriksen, & Madsen, 2010). Careers can be motivating, defining, inspiring and requires continual and active engagement in their occupation and constantly develop as new knowledge and experiences is gained (Borrelli et al., 2017).

Career choice is considered as one of many difficult task young people faced when nearing the end of their secondary schools (Balyer & Özcan, 2014; Afolabi, Ojelabi, Amusan & Adefarati, 2017). Studies have revealed that many secondary school students choose careers without having enough detailed information concerning their choice of career (Olayinka, 2008; Ezeonu, 2012; Eremie, 2014). And this often affects them in future. For instance, many of such students after their first year of study either change course of study or drop out of the university (Afolabi et al., 2017). Therefore, it is important that secondary school students are well informed with sufficient career information (Ehigbor & Akinlosotu, 2016). The studies of Afolabi et al. (2017) revealed 'parents' to be the major source of obtaining career choice information among secondary school students and that the significant factors affecting the career decision of secondary school students in choosing a profession in the university are majorly JAMB scores/WAEC result of the students, environment and society and self-interest.

Young people's interest in Science and technology has been area of concern for research (Osborne, Simon & Collins, 2003; Sjøberg & Schreiner, 2005). The number of young people considering construction work as a career choice is on the declining side, most youths think that all construction jobs are dirty and hard (Clarke, PE & Boyd, 2011; Afolabi et al., 2017). The research conducted by Afolabi et al. (2017) revealed that students and teachers are not aware of the major roles to the building profession (e.g. building production management process on site, preparing building production management documents and buildability and maintainability analysis). In order to deal with these challenges, Afolabi and Oyeyipo (2017) opined that, the major solution is to target the younger generation to avoid a dearth of the profession. These issues are what necessitated this present study. Several studies have developed strategies to assist younger generation in making a career choice. For example, Ezeani (2013) outlined four phases of the conceptual model of career education to include; (i) Career awareness - Elementary 1 through 4; (ii) Career exploration - Elementary 5 and 6; (iii) Career Orientation - Classes 1 through 3 (junior secondary school); and (iv) Career preparation - Senior Secondary Classes & continuing advancement education. The studies of Afolabi et al. (2017) developed a web-based building profession career portal as a guidance information system for secondary school students. Figure 1 shows the web-based features in a block diagram.

Research Methodology

The principal approach of survey data collection for this study was a market research investigation designed to determine how people make career-choice decisions and what underlying perceptions and attitudes they have about building profession. A qualitative research method was adopted for this study. According to Shahid and Li (2019), qualitative method is mostly exploratory research to gain an understanding of the

opinions, reasons and perspectives in order to solve a research problem. Since the objective of the study is to include the opinions and perspectives of people about building profession, a qualitative research method is considered appropriate and suitable for the study. In order to gain an understanding of the main themes, an in-depth review of literature was conducted. Interview questions were designed based on the literature review conducted. Then a one-on-one interview was conducted to obtain the required data for the study. The data provided exact words of the respondents regarding career in building profession in western part of Nigeria.

A purposive sampling method was used where the respondents are included in the study to serve a specific purpose. The respondents selected for the study were students (S), parents (P), teachers (T), counsellors (C), and professional builders (PB) in western part of Nigeria. Reason for this research population is because, studies have shown that they influence career decision making (Escamilla, Ostadalimakhmalbaf & Bigelow, 2016; Oo, Li & Zhang, 2018; Oo, Liu & Lim, 2020). A semi-structured interview guide was designed to address the research questions. The data was collected from a semi-structured face-to-face interview, from October 2019 to December 2020. The interview questions were mainly the same for each of the respondent, however the tone and framing of the questions varies. A set of 18 interview questions were developed to answer the research questions to the study. However, provisions were made to add additional questions in the interview depending on the research context. The duration of interview for each respondent varied in length between 30 and 40 minutes. Each interview was recorded with permission, transcribed, and analysed. A total of seventy-seven (77) interviews were conducted for the study. This comprises of S = 25, P = 11, T = 14, C = 9 and PB = 18 (Table 1 in Appendix). Table 1 provides key background information about the respondents. The 77 respondents that participated in the study were Nigerians.

Results and Discussion

This section of the paper presented in details, what students and the individuals who influence students know about building profession, how they learn about it and how better information can be provided.

Interview Analysis

Findings from the interviews conducted in two states of western part of Nigeria reveals that, (i) career related materials are hardly used in primary and secondary schools, (ii) building profession is not well known by most people, including parents and students, and (iii) exposure to practicing professional builders is the best way to learn what professional builders do. The key questions of the interview are as follows:

i. What is the image of building profession?
ii. How do students learn about building profession?
iii. Are primary and secondary schools helping building profession pool?
iv. Do students care about career planning?
v. What will attract students to building profession?
vi. What should be done to enhance building profession pool?

What is the Image of Building Profession?

The market investigations suggest four main responses regarding the image of building profession: (i) hard; (ii) not well known; (iii) unflattering; and (iv) misconstrue. The major factor restraining the attraction of students to building profession is that most people do not know about the profession. This study has revealed that most people simply do not know what building profession is all about. Those who think they know about building profession often have wrong or negative impressions or images concerning the profession. Most students and parents know few or nothing about building profession. Majority of students says they do not know about building profession [S01, S02, S03, S04, S05, S07, S08, S09, S10, S12, S13, S14, S16, S19, S22, S25]. Some of the interviewees commented that:

"Building profession is a job that is not easy and is a job you think before doing some necessary things" [S17]."...building profession mix cement for making a house" [**S11**].

According to interviewee PB09, "building profession in the past decades was been misconstrued as been the same as civil engineering but awareness became laudable to be a discipline of its own, civil engineering for bridges, etc., whereas building professionals take care of production of building". There is a mix up in clarification, because most people are taking artisans to be professional builders [PB14]. Interviewee PB09 commented that: "...without missing words, building profession has not really assumed its rightful place as the work of builders is given to civil engineers" [PB09]. The awareness problem of building profession is

the dissemination and understanding of the scope of services of professional builders in building production management [PB08]. These services include; (i) buildability and maintainability analysis; (ii) construction planning; and (iii) managing site production process (Osuizugbo & Ojelabi, 2020). Therefore, there is a need to enlighten populace the scope of services of professional builders and enhance the image of building profession by marketing the services of professional builders. The challenge of creating interest in building profession goes beyond what we call it and the way we generate basic awareness. The real challenge is to communicate the marketable services of professional builders and problems confronting professional builders in this present century.

How do Students Learn about Building Profession?

Though, there are several routes to higher institutions or professions, this study found the major sources of exposure to building profession to be: (i) university/polytechnic admission list; (ii) university/polytechnic catalogues; (iii) joint admission and matriculation board (JAMB) brochure; and (iv) role model. The interviewees acknowledged institutions admission list as a source of exposure to building profession. Most students hope to study a particular course in higher institution, but when the school releases its admission list, the students end up studying different course not apply for. Some of the interviewees commented that: "*I intend to study Electrical Electronics (EE) in the university, I sat for JAMB, eventually I found myself in the polytechnic, I equally choose EE but I was given building to study as a course"* [PB02]. *"I wanted to do Science Laboratory Technology but I was given an option of Building, that is why I became aware of building profession"* [PB05]. Institution-based information resources such as catalogues are also cited by the interviewees as being helpful in knowing about building profession. Interactions with academic advisors or other college/faculty members can also be helpful, but students must seek out such assistance. More importantly, JAMB brochure was mentioned by the interviewees as a means they came to know about building profession. Five of the interviewees said, *"I know about building profession through the JAMB brochure*" [T06, T13, S21, C09, C01].

Role model was acknowledged as a source of exposure to building profession by the interviewees. The importance of role models (such as parents, family friends, uncles, cousins and others who are involved in building profession or construction) cannot be overemphasized. Some of the interviewees reported that they came to know about building profession through these role models. For instance, two of the interviewees commented that: "*I know about building profession because my father is a builder" [S20]."...because I have an uncle who is an architect, that is why I know about building profession"* [S23].

Are Primary and Secondary Schools Helping Building Profession Pool?

Most of the interviewees reported negatively in answering whether primary and secondary schools are helping in building profession pool. For example, one of the interviewees said: "...frankly speaking they are not helping..." [T10]. In addressing this question, two areas are to be considered; namely, counselling and curriculum. Guidance counsellors are often taken to be the main source of access to career information. But nowadays, it has been shifted from what it used to be. For instance, some of the interviewees commented as follows: *"...counsellors spend more time helping with admission process and school image, having less time for career advising..." [S18]. "...I could remember in my secondary school, we have a GN teacher (guardian and counsellor) who we usually meet, she will even interview us; study this, why do you want to study this, what if you are very good at this one instead of that one. In government schools today, no such things again. So there are many things that need to be added in school curriculum" [T06].* It is important to note that guidance counsellors are untapped resource that should be included in any building profession career marketing plan.

Nearly all the interviewees said there is no building profession materials in-use in primary and secondary schools. They all mentioned technical drawing as a subject taught in secondary schools. When question about what can be done to give students better information, two of interviewees commented as follows: *"...introduced building subject to schools..." [T11]. "...students need to have in-depth knowledge of building profession before agreeing to go into the profession". [T06].* Most of the survey participants commented that, there should be a practical approach to building profession subjects in primary and secondary schools. One of the interviewees said: *"...the truth is that students are carried away by what they see, I could remember in a TD class, we are explaining a particular subject, and it was very difficult for the students to understand, so I connected a projector and downloaded what I want them to know, when I played the video,*

under few minutes they understood the whole thing" [T06]. It is not hard to imagine using building construction examples in these classes. Using better examples would motivate students to choosing building profession as a career. The survey participants agree that career-related materials could be used within the context of existing technical drawing class. This is very vital as one of the interviewees said: *"...there is no much space within the existing curriculum to add new material..."* [C03]. Such materials will be used if packaged in convenient modules and teachers trained on how to use such materials.

Do Students Care about Career Planning?

Many students care more about getting admission into higher institutions while very few pay attention to choosing a career. Most of the survey participants view primary school years to be too early to select a particular career. Here are some of opinions of the interviewees: *"Primary school time is the right time to start creating awareness to career paths" [PB14, T07, C01]. "...career options should be looked at seriously in secondary schools..."* [PB10].

Also, two the interviewees commented as follows: "*Some students do not care about career planning because, when I was still teaching where I taught as a maths teacher, I asked some students a question one day. What will happen if you study this course in university, will you die? They said the same thing, no, my mother want me to study this particular one because it pays more. So, they were not informed or given knowledge from the basis. They only know the course that pays and one that doesn't"* [T06]. *"The major challenge we have in this part of the world is the problem of parents over their children, choosing a career for them without allowing them to make their own choice" [PB18].*Based on the survey results, the career information students want to know about are: (i) Financial benefit; (ii) Product of the profession; (iii) Educational qualification; (iv) Successful professionals; (v) Job opportunities; and (vi) Nature of the job. These information are very important to students when choosing a career path. One of the interviewees commented that: "...parents definitely want right career information to be made available. Parents do not want any person to place their children on a particular career that may not be appropriate..." [PB04].

What will Attract Students to Building Profession?

Building profession has many attractive features that can be highlighted in a marketing campaign. The main attributes of building profession that can be marketed are broadly categorized by the interviewees as follows: (i) financial benefits; (ii) technology advancement; (iii) broad career opportunities; (iv) job opportunities; (v) professional licensing.

Financial Benefits

i. There is money in building/construction, good enough to interest students,
ii. Success is a key factor for attracting students, and
iii. Approved salary grade for building graduates by federal government would attract many more students to study building.

Technology Advancement

i. Students are interested in jobs associated with innovation.
ii. Professional builders use computer systems and other types of advanced technology in their day-to-day activities.

Broad Career Opportunities

Builders are identified as operating in the following field of activities: Consulting, Contracting, Property development, Building education and research.

Job Opportunities

There are many types and sizes of employing organizations for professional builders. Builders are employed in the following broad sectors of the Nigerian economy:

i. Building construction companies
ii. Private consultancy firm of builder practices
iii. Public sector – i.e. Federal and State Ministries and Parastatals
iv. Local government
v. Urban and Regional Planning Board and Local Planning Authorities in all the states of the federation
vi. Nigerian Armed Forces; Army, Naval, Air Force
vii. Nigerian Police

viii. Nigerian Customs Service
ix. Nigerian Prison Service
x. Academic Sector; as lecturers, staff of works and services departments
xi. Private Sector: Commercial, Merchant and Mortgage Banks/Finance; Insurance; Mining/Petrochemical Industries; Oil and Gas Companies; Multinational Corporations; Building and Engineering Manufacturing Industries; Property Development Companies; Private individuals etc.

Professional Licensing
Confers added distinction in the eyes of public, and thus commands respect.

What should be done to Enhance Building Profession Pool?
The themes that emerged from the interview transcripts are seven in number. The identified themes are: (i) Commit to continuing involvement in primary and secondary education; (ii) Mount on serious public awareness campaign; (iii) Enhance building profession curriculum; (iv) Construction sites excursion; (v) Engage in career talk for Senior Secondary School; (vi) Implementation/enforcement of laws in the construction industry; and (vii) Approval of salary grade for building graduates by federal government of Nigeria.

Commit to continuing involvement in primary and secondary education
The Nigerian Institute of Building (NIOB) has a vital role to play in this regard. Primary and secondary schools need assistance from the building profession body. The schools in question cannot develop building profession career-awareness materials alone. Long-term involvement with NIOB will be of great benefit. NIOB need to create awareness of building profession among primary and secondary school students and admonish the students to study science subjects. NIOB need to give primary and secondary school students' better information on building profession as a career choice. To attain these objectives, NIOB should endeavour to:

i. Sponsor building profession competitions and help run building projects in schools
ii. Sponsor the participation of students, teachers and counsellor in NIOB national programme and conferences
iii. Send professional builders and building students into the schools to visit building or building related course classes and conduct building project activities
iv. Provide the profession builder and student visitors with materials and training to ensure that the visits are effective
v. Develop science curriculum modules that demonstrate building profession in action
vi. Develop and sponsor programmes to educate teachers and guardian counsellors about building profession and train them in the use of the curriculum modules.

Mount on serious public awareness campaign
As earlier mentioned, misconstrue and poor knowledge of building profession are the main hindrances to building profession recruitment. Mostly all the interviewees acknowledged awareness as a factor towards enhancing building profession pool. Some of the interviewees commented as follows: "...more sensitization is needed for people to be aware about the profession and what it takes to become professional builder" [PB02]. "For professional builders to be known, more advertisement is needed and it could be during Primary and Secondary schools P.T.A meetings; TV programme is also important" [PB15]. "...NIOB should help in the area of NYSC posting; this is a way of creating awareness of the profession..." [PB10]. Creating greater public awareness of building profession will promote greater appreciation of building profession's contributions to humanity.

Enhance building profession curriculum
Improving the attractiveness of a product is a strategy to increase its sales. This rule also applies to the building profession programme in higher institutions. Alterations that might encourage studying building as a degree course includes; more flexibility, less required credit hours, more emphasis on production and management skills and technology. These changes should be done in such a way to maintain or increase the programme quality. The curriculum should be standard and same to every institutions running building degree programme. Secondly, another improvement would be the earlier involvement of building related

courses in primary and secondary schools. Early involvement in Building profession will greatly enhance the retention of building students.

Construction sites excursion
NIOB state chapters should from time to time organise sites excursion for primary and secondary school students in their state. This will educate and motivate more students to have interest for building profession. Exposure to professional builders on the job is the most effective recruiting means. It is important to let students see structures and as well let the students to know the implications of not doing it right.

Engage in career talk for Senior Secondary School
Career talk programme for building profession should be organised mainly for senior secondary school. Understanding of building profession is a key factor towards accepting the profession as a career among students. This programme will certainly go a long way in enhancing the building profession pool.

Implementation/enforcement of laws in the construction industry
Laws should be respected among professionals in the built environment. One of the interviewees commented as follows: "...start with the issue of legislation; there are so many legislations, but the issue of implementation is another problem. We need to allow these professionals to take their place in the building construction. For example, there is building production management agency in Ogun state; this legislation has been on ground but implementation has been its major problems. Also, national building code has been on ground since 2005; till today the issue of implementation remains a problem. All these legislations need to be put in place and proper implementation such that every professional get their place in the built environment. CORBON and NIOB need to do more of what they have been doing before so that builders will be given their own share in every state, ministry, agencies and all that. One needs to get the government fully aware of building profession. Once the professional builder's place is secure, more people will be encourage to come into the profession and they will be equally engage" [PB18].

Approval of salary grade for building graduates by the federal government of Nigeria
The low turn-up of professional builders can be improved if government approves salary grade for building graduates. This will attract sufficient entrants to eliminate the low turn-up. The best way to enhance the building profession pool is to offer salaries high enough to attract a better qualified and more diverse group of students.

Conclusion
The outcomes of this research indicate the way to inform students, parents, teachers, counsellors and other individual advisers on careers in building profession and also how to retain motivated and interested students. Additionally, interest in building profession should be retained until the student either earns a building degree or makes an informed decision that a different career is more suitable. The end result of these efforts should be a better informed, more highly motivated, and more diverse pool of building students and graduates. The issues affecting entry into the building profession programme require the efforts of those concerned with the supply of high-quality building production management in the country to rethink the promotion and support of the profession. The study identified attractive features of building profession that can be highlighted in a marketing campaign towards recruiting more students to the profession. These features include financial benefits, technology advancement, broad career opportunities, job opportunities and professional licensing. Secondly, there should be commitment to continuing involvement in primary and secondary education by mounting serious public awareness campaign; enhancement of building profession curriculum; embarking on construction sites excursion; engagement in career talk for Senior Secondary School; implementation/enforcement of laws in the construction industry; and approval of salary grade for building graduates by federal government of Nigeria; among others were identified as means of enhancing building profession pool. The study has contributed to the body of knowledge in terms of career building on building profession.

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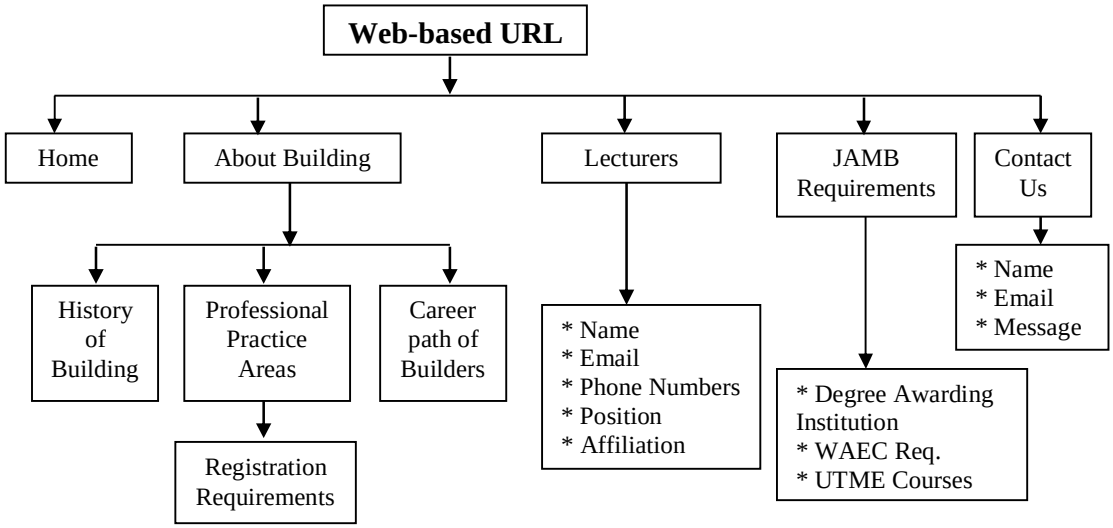

Figure 1: Block diagram of the web-based career panel (Afolabi et al., 2017)

Table 1: Respondents' background information

Respondents' Code	Respondents' Designation	Location
S01	Senior Secondary Class 3 Student	Lagos State
S02	Senior Secondary Class 3 Student	Lagos State
S03	Senior Secondary Class 3 Student	Lagos State
S04	Senior Secondary Class 3 Student	Lagos State
S05	Senior Secondary Class 3 Student	Lagos State
S06	Junior Secondary Class 2 Student	Lagos State
S07	Junior Secondary Class 2 Student	Lagos State
S08	Junior Secondary Class 1 Student	Lagos State
S09	Junior Secondary Class 3 Student	Lagos State
S10	Junior Secondary Class 3 Student	Lagos State
S11	Senior Secondary Class 1 Student	Lagos State
S12	Primary 4 Student	Ogun State
S13	Primary 6 Student	Ogun State
S14	Primary 5 Student	Ogun State
S15	Senior Secondary Class 2 Student	Lagos State
S16	Senior Secondary Class 2 Student	Lagos State
S17	Senior Secondary Class 3 Student	Lagos State
S18	University Undergraduate Student	Ogun State
S19	University Undergraduate Student	Ogun State
S20	University Undergraduate Student	Ogun State
S21	University Undergraduate Student	Ogun State
S22	Senior Secondary Class 3 Student	Ogun State
S23	Polytechnic Undergraduate Student	Lagos State
S24	Polytechnic Undergraduate Student	Lagos State
S25	Senior Secondary Class 3 Student	Lagos State
P01	Parent	Ogun State
P02	Parent	Lagos State
P03	Parent	Lagos State
P04	Parent	Lagos State
P05	Parent	Ogun State
P06	Parent	Lagos State
P07	Parent	Lagos State
P08	Parent	Ogun State
P09	Parent	Ogun State
P10	Parent	Ogun State
P11	Parent	Lagos State
T01	Teacher (University)	Ogun State
T02	Teacher (University)	Lagos State
T03	Teacher (Secondary School)	Lagos State

T04	Teacher (Secondary School)	Ogun State
T05	Teacher (Secondary School)	Ogun State
T06	Teacher (Secondary School)	Lagos State
T07	Teacher (University)	Ogun State
T08	Teacher (Primary School)	Ogun State
T09	Teacher (Primary School)	Ogun State
T10	Teacher (Secondary School)	Lagos State
T11	Teacher (University)	Ogun State
T12	Teacher (Polytechnic)	Ogun State
T13	Teacher (Secondary School)	Lagos State
T14	Teacher (University)	Ogun State
C01	Counsellor (Secondary School)	Lagos State
C02	Counsellor (Secondary School)	Ogun State
C03	Counsellor (Secondary School)	Ogun State
C04	Counsellor (Primary School)	Lagos State
C05	Counsellor (University)	Ogun State
C06	Counsellor (Secondary School)	Lagos State
C07	Counsellor (Primary School)	Ogun State
C08	Counsellor (Secondary School)	Ogun State
C09	Counsellor (Secondary School)	Ogun State
PB01	Professional Builder (in industry)	Lagos State
PB02	Professional Builder (in industry)	Lagos State
PB03	Professional Builder (in industry)	Lagos State
PB04	Professional Builder (in academia)	Ogun State
PB05	Professional Builder (in academia)	Lagos State
PB06	Professional Builder (in industry)	Lagos State
PB07	Professional Builder (in industry)	Ogun State
PB08	Professional Builder (in academia)	Ogun State
PB09	Professional Builder (in industry)	Lagos State
PB10	Professional Builder (in ministry)	Lagos State
PB11	Professional Builder (in industry)	Lagos State
PB12	Professional Builder (in industry)	Lagos State
PB13	Professional Builder (in ministry)	Ogun State
PB14	Professional Builder (in academia)	Lagos State
PB15	Professional Builder (in industry)	Ogun State
PB16	Professional Builder (in industry)	Ogun State
PB17	Professional Builder (in industry)	Lagos State
PB18	Professional Builder (in industry)	Ogun State

INDOOR ENVIRONMENTAL QUALITY OF SELECTED OFFICES IN MICHAEL OKPARA UNIVERSITY OF AGRICULTURE, UMUDIKE, NIGERIA

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Abstract
The comfort and productivity of workers could be influenced by indoor environmental quality (IEQ). This study assessed the IEQ of selected offices in Michael Okpara University of Agriculture, Umudike. One hundred and fifty-four desk spaces distributed across eighty-one offices at different floors of eleven Colleges and the administrative block were randomly selected for this study. In the selected offices as well as the ambient environment, light levels temperature and relative humidity were measured using hand held meters. Results show that all the selected offices had suitable and sufficient day lighting (above the international standard of 340-430 lux. However, air temperature and relative humidity levels were not suitable and were above the international standards (maximum of 24°C for temperature and maximum of 55% for relative humidity) for workplace irrespective of the floor of the buildings. The light, temperature, and relative humidity in the building's ground floor were lower than the first floor throughout the survey period in some Colleges. Unsuitable air temperature and relative humidity levels could pose health risks and discomfort for office workers and may affect worker motivation and productivity. The use of a dehumidifier and air conditioners when windows are closed, may effectively remove internal moisture and keep air temperature at a comfortable and healthy level.
Keywords: Day lighting, Indoor Environmental Quality, Relative humidity, Temperature

Introduction

Indoor environmental quality (IEQ) is a relative measure of comfort perception by people exposed to indoor conditions (Schibuola and Tambani, 2020). IEQ is a general indicator of the quality of conditions inside a building (Ogedengbe, 2015). It can also be referred to as the quality of a building's environment in relation to the wellbeing of those who occupy space within it (Mujan *et al*., 2019). The concept of IEQ is vast and depends on many variables such as temperature, relative humidity, air velocity, airflow, occupancy, the concentration of pollutants, noise, daylighting (Pereira *et al.,* 2015). These can be grouped into four major areas that define the quality of the environment inside space, thermal comfort, indoor air quality, visual comfort, and acoustic comfort. (Franchimon *et al.,* 2009).An essential requirement of an office worker's performance and productivity improvement is IEQ. The indoor room temperature, relative humidity, and illumination are essential factors that affect office workers' performance (Parkinson *et al*., 2019). The thermal discomfort caused by elevated air temperature affects office workers' performance (Saraiva *et al.*, 2018). Averagely daily, office workers spend about 90% of the time in an indoor environment. The indoor environment has a direct relationship with the office worker's health and wellbeing. About 10% of the office worker's performance may be improved by achieving the best IEQ (Roelofsen, 2002). The office workers develop negative emotions and have to use more effort to maintain performance under slightly warm or slightly cool environment conditions (Lan *et al.,* 2009).

Increased evidence shows that indoor environmental conditions substantially influence health and productivity. Building services engineers are interested in improving indoor environments and quantifying the effects (Franchimon *et al.,* 2009). Potential health and productivity benefits are not yet generally considered in conventional economic calculations on building design and operation. Only initial costs with energy and maintenance costs are typically considered (Savelieva *et al*., 2019). A few sample calculations have shown that many measures to improve the indoor air environment are cost-effective when the health and productivity benefits resulting from an improved indoor climate are included in the calculations (Fisk, 2000, Seppänen *et al*., 2003).

An office environment where workers spend about 40 hours a week impacts their bodies, minds, and health. Poorly designed daylighting will deliver either inadequate amounts of light, so that electric lighting has to be used, or copious amounts of light together with discomfort and disability glare, as well as strong shadows and veiling reflections (Seppänen and Vuolle 2000). An unhealthy and uncomfortable environment where room temperature and natural light are not suitable for working can cause various problems for workers. Such problems could range from chronic back and neck pain to carpal tunnel to depression (De-Giuli *et al*.,

2013). In commercial buildings where the room temperature is not ideal (too hot or cold), an individual or employee is more likely to be unproductive for the day (Zuhaib *et al*., 2018). Features such as daylighting programs (including solar gain control) and heat recovery ventilation systems for consistent fresh airflow contribute to occupant health, comfort, and happiness. Inadequate daylighting, relative humidity, and temperature in office buildings can cause several problems for the employees working underneath them (Kang *et al*., 2017). Eye strain, headaches, and general feelings of malaise are common complaints among office workers. Therefore, this study aims to assess the indoor environmental quality of selected offices in Michael Okpara University of Agriculture, Umudike. In this study, daylighting, indoor temperature, and relative humidity components of IEQ were assessed.

The Study Location, Materials and Methods

The study was carried out at Michael Okpara University of Agriculture Umudike, located in the Southern part of Umuahia in Ikwuano local government area of Abia State. It lies between latitude 05°28'N and 05°30'N and longitude 07°31'E and 07°33'E. The area falls within the tropical rainforest zone having an altitude of 6 m above sea level. The mean monthly temperature is always around 25°C with a peak at about 32°C during April-October. The mean annual rainfall is 2200mm annually distributed over 7-9 months in a bimodal rainfall pattern; these are early rain (April-July) and late rain (August-October) with five months dry season and a short heat period in August, particularly called August break (Ogedengbe, 2015). One hundred and fifty-four desk spaces distributed across eighty-one offices in all eleven colleges and the university administration block were randomly selected for the study. The colleges/Administrative block and the type of building are;

University Administration Block – two storey building
College of Agricultural Economics, Rural Sociology, and Extension (CAERSE)one storey building
College of Applied Food Science and Technology (CAFST) – one storey building
College of Crop and Soil Sciences (CCSS) – one storey building
College of Engineering and Engineering Technology (CEET) – one storey building
College of General Studies (CGS)- bungalow
College of Natural Resources and Environmental Management (CNREM) – one storey building
College of Education (COED)-bungalow
College of Management Sciences (COLMAS) one storey building
College of Natural Sciences (COLNAS) one storey building
College of Physical and Applied Sciences (COLPAS)-bungalow
College of Veterinary Medicine (CVM) - bungalow

In the selected offices, light levels were measured using a digital light meter (Extech 401025). While temperature and relative humidity were measured using a digital thermometer (Extech CO240). A variety of lighting systems were used in the facilities. Every office had about two 2 to 4 inch recessed fluorescent lights. Wall switches located inside each office near the door controlled these fluorescent lights. All office lighting, fan and air conditioner were switched off before measurement. Light intensity, room temperature and relative humidity data were collected in the offices during the period of power outage..The data collected from each floor offices were compared with Analysis of Variance (ANOVA) to test for any significant difference at ($p<0.05$). The office floors were compared with the T-test. Correlation analysis (Pearson Correlation) was used to determine the correlation between light intensity, temperature, and relative humidity.

Results

The results of the ambient light intensity, temperature, and relative humidity is presented in table 1 while tables 2 to 13 shows the indoor light intensity, temperature, and relative humidity of the selected offices .

Table 1: Ambient Light Intensity, Temperature, and Relative Humidity around the Selected Colleges

Statistic	Light (Lux)	Temperature (°C)	Relative Humidity
Mean ± Standard deviation	11101.25±69.55	32.48±1.30	64.81±5.63
Minimum	10970	30.1	60
Maximum	11200	33.8	78

n=32

Table 2: Level of Light Intensity, Temperature, and Relative Humidity in offices at the Univ Administration Block

Location	Office Floor	Office	Light (lux)	Temperature (°C)	Relative Humidity
ADMIN	First floor	Office 1	662.5±55.6[a]	30.73±0.15[a]	65±1.16[a]
		Office 2	665±52.6[a]	30.83±0.05[a]	69±1.16[a]
	Ground floor	Office 1	615±12.91[a]	31.13±0.05[a]	66.25±2.87[a]
		Office 2	617.5±15[a]	30.43±0.15[a]	73.5±0.58[b]
	Second floor	Office 1	657.5±38.62[a]	30.8±0[a]	75±3.16[a]
		Office 2	612.5±5[b]	30.5±0[a]	64.5±2.38[b]
	Third floor	Office 1	610±8.17[a]	30.83±0.05[a]	72±1.41[a]
		Office 2	612.5±12.58[a]	30.43±0.15[a]	72.25±0.96[a]

Values with different letters in each column are significantly different between the office at each floor ($p<0.05$), n=8

Light intensity was significantly higher in offices at the first floor compared to the ground and third floor ($p<0.05$) (Table 2)., However, it varied significantly ($p<0.05$) between the offices at the second floor. Temperature and relative humidity were not significantly different ($p>0.05$) between the first, second and third floor in offices in the administrative block. However, it varied significantly ($p<0.05$) between the offices at the ground and second floor.

Table 3: Level of Light Intensity, Temperature, and Relative Humidity in offices at the CAERSE

College	Office Floor	Office	Light (lux)	Temperature (°C)	Relative Humidity
CAERSE	First floor	Office 1	592.50±5.0[a]	31.275±.99[a]	68.50±.57[a]
		Office 2	637.50±59.09[ab]	32.600±.57[b]	66.50±2.88[a]
		Office 3	710.00±11.54[b]	30.125±.05[a]	78.50±.57[b]
		Office 4	625.00±64.03[ab]	30.125±.05[a]	77.75±1.89[b]
	Ground floor	Office 1	590.00±8.16[a]	31.600±1.0[c]	67.25±1.50[a]
		Office 2	585.00±5.77[a]	30.550±.40[bc]	68.50±4.0[a]
		Office 3	585.00±5.77[a]	29.200±.11[a]	77.50±.57[b]
		Office 4	590.00±8.16[a]	30.150±.05[ab]	65.00±3.4[a]

Values with different letters in each column are significantly different between the office at each floor ($p<0.05$), n=8

Light intensity was significantly higher ($p<0.05$) in the offices on the first floor compared with the ground floor (Table 3). Light intensity also varied among the offices in the first floor ($p<0.05$) while is was similar ($p>0.05$)for offices on the ground floor. Temperature and relative humidity was not significantly different in the offices on the ground floor compared with the first floor ($p>0.05$). Both parameters also varied among the offices in the ground and first floor ($p<0.05$). There was a significantly positive moderate correlation ($r = 0.435$, $p<0.05$) between lighting and relative humidity but a moderate negative correlation between temperature and relative humidity ($r = -0.599$, $p<0.05$). The correlation between lighting and temperature was weak ($r = 0.12$, $p>0.05$) and statistically insignificant.

Table 4: Level of Light Intensity, Temperature and Relative Humidity in offices at the CAFST

College	Office Floor	Office	Light (lux)	Temperature (°C)	Relative Humidity
CAFST	First floor	Office 1	592.5±9.57[a]	30.13±0.05[a]	65.75±1.5[a]
		Office 2	597.5±41.93[a]	29.3±0.93[a]	76.25±1.5[b]
		Office 3	662.5±49.24[ab]	29.5±0.49[a]	76±1.16[b]
		Office 4	705±19.15[b]	30.25±0.06[a]	73.25±2.5[b]
	Ground floor	Office 1	600±14.14[a]	30.1±0.2[b]	77.25±0.5[a]
		Office 2	587.5±9.57[a]	30.15±0.1[b]	76.5±1[a]
		Office 3	580±8.17[a]	30.4±0.12[b]	66.5±1[b]
		Office 4	587.5±5[a]	29.28±0.15[a]	65.5±0.58[b]

Values with different letters in each column are significantly different between the office at each floor (p<0.05), n=8

Light intensity was significantly higher (p<0.05) in the offices on the first floor compared with the ground floor (Table 4). Light intensity also varied among the offices in the first floor (p<0.05) while is was similar (p>0.05) for offices on the ground floor. Temperature and relative humidity was not significantly different in the offices on the ground floor compared with the first floor (p>0.05). Both parameters also varied among the offices in the ground and first floor (p<0.05) except temperature of offices on the first floor which was similar (p>0.05). There was no significant correlation (r = 0.266, p>0.05) between lighting and relative humidity, temperature and relative humidity (r = -0.083, p>0.05) as well as lighting and temperature.

Table 5: Level of Light Intensity, Temperature and Relative Humidity in offices at the CCSS

College	Office Floor	Office	Light (lux)	Temperature (°C)	Relative Humidity
CCSS	First floor	Office 1	607.5±15[a]	29.78±0.38[a]	77±1.16[b]
		Office 2	652.5±67.02[a]	31.35±1.5[a]	76±1.41[b]
		Office 3	677.5±59.09[a]	31.08±0.13[a]	67.5±0.58[a]
	Ground floor	Office 1	595±10a	29.95±0.7[a]	78.75±0.5[a]
		Office 2	582.5±9.57[a]	30.63±0.35[ab]	77.5±1[a]
		Office 3	592.5±8.86[a]	31.13±0.27[b]	70.75±1.67[b]
		Office 4	592.5±15[a]	30.63±0.29[ab]	72.75±0.5[b]

Values with different letters in each column are significantly different between the office at each floor (p<0.05), n=8

At the CCSS, light intensity was significantly higher (p<0.05) in the offices on the first floor compared with the ground floor (Table 5). Light intensity was not significantly different in offices on both the first and ground floor (p>0.05). Temperature and relative humidity was not significantly different in the offices on the ground floor compared with the first floor (p>0.05). Both parameters also varied among the offices in the ground and first floor (p<0.05). There was insignificantly weak negative correlation (r = -0.310, p>0.05) between lighting and relative humidity but significantly negative moderate correlation between temperature and relative humidity (r = -0.484, p<0.05). The correlation between lighting and temperature was weak (r = 0.098) and statistically insignificant.

Table 6: Level of Light Intensity, Temperature and Relative Humidity in offices at the CEET

College	Office Floor	Office	Light (lux)	Temperature (°C)	Relative Humidity
CEET	First floor	Office 1	610±21.6[a]	31.3±0.27[a]	67.75±1.89[a]
		Office 2	587.5±15[a]	31.03±0.15[a]	67.25±1.5[a]
		Office 3	597.5±5[a]	31.63±0.61[a]	66.75±1.26[a]
	Ground floor	Office 1	567.5±5[a]	30.88±0.15[a]	67.75±0.5[b]
		Office 2	597.5±35[a]	31.03±0.29[a]	68.5±0.58[b]
		Office 3	586.25±9.16[a]	31.93±0.79[a]	66±1.85[ab]
		Office 4	592.5±9.57[a]	32±1.09[a]	64.75±1.89[a]

At the CEET, light intensity was not significantly different (p>0.05) in the offices on the first floor compared to the ground floor (Table 6). Temperature and relative humidity was not significantly different in the offices on the ground floor compared with the first floor (p>0.05). However while relative humidity only was significantly different, temperature was similar in both the ground and first floor (p>0.05). There was no significant correlation (r = -0.007, p>0.05) between lighting and relative humidity but negative strong correlation between temperature and relative humidity (r = -0.685, p<0.05). The correlation between lighting and temperature was weak (r = 0.144) and statistically insignificant.

Table 7: Level of Light Intensity, Temperature and Relative Humidity in offices at the CGS

College	Office Floor	Office	Light (lux)	Temperature (°C)	Relative Humidity
CGS	Ground floor	Office 1	610±50.99[a]	31.14±2.13[a]	70.25±4.27[ab]
		Office 2	581.25±8.35[a]	29.79±0.67[a]	71.5±4.84[ab]
		Office 3	595±14.14[a]	30.31±0.36[a]	68±4.63[a]
		Office 4	605±16.9[a]	30.49±0.29[a]	74.63±2.39[b]

Values with different letters in each column are significantly different between the office at each floor (p<0.05), n=8

There was no statistically significant difference in light intensity and temperature in the offices at the CGS (Table 7). Relative humidity varied significantly between the offices on the ground and floor. There was no correlation ($r = -0.261$, $p>0.05$) between lighting and relative humidity but a weak negative correlation between temperature and relative humidity ($r = -0.3.89$, $p<0.05$). The correlation between lighting and temperature was strong and negative ($r = 0.666$) and statistically significant ($p<0.05$).

Table 8: Level of Light Intensity, Temperature and Relative Humidity in offices at the CNREM

College	Office Floor	Office	Light (lux)	Temperature (°C)	Relative Humidity
CNREM	First floor	Office 1	647.5±73.2[a]	32.63±0.51[b]	61.25±1.5[a]
		Office 2	675±66.08[a]	29.53±0.29[a]	74.25±0.5[c]
		Office 3	587.5±17.08[a]	30.65±0.71[a]	73.75±0.96[c]
		Office 4	595±45.09[a]	32.18±0.71[b]	70.75±1.5[b]
	Ground floor	Office 1	615±63.51[a]	31.33±0.29[c]	65.25±0.96[b]
		Office 2	590±14.14[a]	29.45±0.17[b]	59.75±0.96[a]
		Office 3	582.5±18.93[a]	28.58±0.15[a]	79±0[d]
		Office 4	567.5±5[a]	29.58±0.05[b]	76±0.82[c]

Values with different letters in each column are significantly different between the office at each floor ($p<0.05$), n=8

At the CNREM, light intensity was significantly higher ($p<0.05$) in the offices on the first floor compared with the ground floor (Table 8). Light intensity was not significantly different in offices on both the first and ground floor ($p>0.05$). Temperature but not relative humidity was significantly higher in the offices on the first floor compared with the ground floor ($p>0.05$). Both parameters also varied among the offices in the ground and first floor ($p<0.05$).

There was no correlation between lighting and relative humidity($r = -0.310$, $p>0.05$) and between lighting and temperature ($r = 0.098$, $p>0.05$). However, there was a significantly negative moderate correlation between temperature and relative humidity ($r = -0.484$, $p<0.05$).

Table 9: Level of Light Intensity, Temperature and Relative Humidity in offices at the COED

College	Office Floor	Office	Light (lux)	Temperature (°C)	Relative Humidity
COED	First floor	Office 1	587.5±12.58[a]	30.23±0.1[a]	73.75±0.5[b]
		Office 2	640±58.31[ab]	30.13±0.05[a]	76.75±0.5[c]
		Office 3	687.5±67.02[b]	30.13±0.05[a]	67.25±0.96[a]
		Office 4	690±20[b]	30.2±0.08[a]	76.75±0.5[c]
	Ground floor	Office 1	595±10[a]	30.88±1.48[a]	67.5±0.58[a]
		Office 2	582.5±5[a]	31.65±1.73[a]	68.5±1[a]
		Office 3	595±19.15[a]	29.95±0.1[a]	74.75±1.5[b]
		Office 4	587.5±9.57[a]	30.25±0.06[a]	70±3.37[a]

Values with different letters in each column are significantly different between the office at each floor ($p<0.05$), n=8

At the COED, light intensity was significantly higher ($p<0.05$) in the offices on the first floor compared with the ground floor (Table 9). Light intensity was also significantly different in offices on first but not the ground floor ($p>0.05$). Relative humidity but not Temperature was significantly higher in the offices on the first floor compared with the ground floor ($p>0.05$). However while relative humidity only was significantly different ($p<0.05$) temperature was similar in both the ground and first floor ($p>0.05$). There was no correlation between lighting and relative ($r = -0.172$, $p>0.05$),lighting and temperature($r = -0.291$, $p>0.05$) and between temperature and relative humidity ($r = -0.179$, $p>0.05$).

Table 10:Level of Light Intensity, Temperature and Relative Humidity in offices at the COLMAS

College	Office Floor	Office	Light (lux)	Temperature (°C)	Relative Humidity
COLMAS	First floor	Office 1	570±37.42[a]	31.15±0.47[a]	64.5±0.58[b]
		Office 2	575±55.68[a]	32.45±0.79[b]	62.75±1.5[ab]
		Office 3	580±29.44[a]	31.75±0.94[ab]	62.5±1.73[ab]
		Office 4	596.25±14.08[a]	30.78±0.19[a]	61.63±0.74[a]
	Ground floor	Office 1	579.5±5.2[a]	32.25±0.17[b]	64.75±0.96[b]
		Office 2	582.5±5.5[a]	31.3±0.98[ab]	61.25±0.96[c]
		Office 3	587.5±5.9[a]	30.6±0.14[a]	62±0.41[c]

Values with different letters in each column are significantly different between the office at each floor (p<0.05), n=8

At the COLMAS, light intensity was not significantly different (p>0.05) in the offices on the first floor compared to the ground floor (Table 10). Both temperature and relative humidity was not significantly different between the first floor and ground floor (p>0.05). However the parameters differed significantly different in the offices at each floor.

There was moderate negative correlation (r = -0.409, p<0.05) between lighting and relative humidity but negative moderate correlation between temperature and relative humidity (r = -0.465, p<0.05). The correlation between lighting and temperature was weak (r = 0.358) and statistically significant (p<0.05).

Table 11:Level of Light Intensity, Temperature and Relative Humidity in offices at the COLNAS

College	Office Floor	Office	Light (lux)	Temperature (°C)	Relative Humidity
COLNAS	First floor	Office 1	627.5±55[a]	31.1±0.1[a]	67.25±0.5[b]
		Office 2	602.5±12.58[a]	31.18±0.1[a]	67.5±0.58[b]
		Office 3	607.5±20.62[a]	31.1±0.82[a]	62.5±0.58[a]
		Office 4	607.5±9.57[a]	30.45±0.44[a]	62.75±0.5[a]
	Ground floor	Office 1	585±12.91[a]	30.88±0.96[a]	61.75±1.26[a]
		Office 2	595±5.77[a]	30.68±0.05[a]	62.75±0.5[a]
		Office 3	580±8.17[a]	31±0.12[a]	62.5±0.58[a]
		Office 4	597.5±17.08[a]	32.13±0.05[b]	62.75±0.96[a]

Values with different letters in each column are significantly different between the office at each floor (p<0.05), n=8

At the COLNAS, light intensity was significantly higher (p<0.05) in the offices on the first floor compared with the ground floor (Table 11). Light intensity was not significantly different among offices on first and ground floor (p>0.05). Relative humidity but not Temperature was significantly higher in the offices on the first floor compared with the ground floor (p>0.05). While relative humidity was significantly different in offices on the first floor (p<0.05) temperature was similar in both the first and ground (p>0.05). There was a weak negative correlation (r = -0.360, p<0.05) between lighting and relative humidity but a very weak negative correlation between temperature and relative humidity (r = -0.012, p>0.05). The correlation between lighting and temperature was weak (r = 0.184) and statistically insignificant.

Table 12:Level of Light Intensity, Temperature and Relative Humidity in offices at the COLPAS

College	Office Floor	Office	Light (lux)	Temperature (°C)	Relative Humidity
COLPAS	Ground floor	Office 1	605±20.7[a]	30.88±0.1[a]	69.63±4.53[a]
		Office 2	582.5±10.35[b]	31.09±0.12[a]	66.38±1.19[a]
		Office 3	585±11.95[b]	30.79±0.27[a]	68.75±3.41[a]
		Office 4	580±9.26[b]	30.75±0.49[a]	70.25±3.54[a]

Values with different letters in each column are significantly different between the office at each floor (p<0.05), n=8

The light varied significantly between the offices on the ground and floor (Table 12). There was no statistically significant difference in temperature and relative humidity in the offices on the building's ground

floor. There was no correlation (r = 0.233, p>0.05) between lighting and relative humidity but negative moderate correlation between temperature and relative humidity (r = -0.505, p<0.05). The correlation between lighting and temperature was very weak(r=0.029), thereby shows statistically insignificant relationship.

Table 13: Level of Light Intensity, Temperature and Relative Humidity in offices at the CVM

College	Office Floor	Office	Light (lux)	Temperature (°C)	Relative humidity (%)
CVM	Ground floor	Office 1	605±20.7[a]	30.88±0.1[a]	69.63±4.53[a]
		Office 2	582.5±10.35[b]	31.09±0.12[a]	66.38±1.19[a]
		Office 3	585±11.95[b]	30.79±0.27[a]	68.75±3.41[a]
		Office 4	580±9.26[b]	30.75±0.49[a]	70.25±3.54[a]

Values with different letters in each column are significantly different between the office at each floor (p<0.05), n=8

The light varied significantly (p<0.05) between the offices at the ground floor (Table 13). There was no statistically significant difference in temperature and relative humidity in the offices on the building's ground floor. There was no correlation (r = 0.233, p>0.05) between lighting and relative humidity but negative moderate correlation between temperature and relative humidity (r = -0.505, p<0.05). The correlation between lighting and temperature was very weak (r = 0.029) and statistically insignificant.

Discussion

In some Colleges, the light, temperature, and relative humidity in the building's ground floor were lower than the first floor throughout the survey period. Its mean relative humidity was lower than that of the first floor. In COLNAS,61% were recorded against 67.04% recorded on the ground and first floor. On average, the ground floor was 0.5 - 0.9°C warmer than the first floor in CNREM. This is in tandem with Appah-Dankyi and Korateng (2012) study in naturally ventilated classrooms in Accra, Ghana, and Taylor *et al.* (2008) in a rammed office building. The higher temperature on the first floor maybe linked to the roofing material and style. About 82% of the measured temperature data on the first floor were higher than that of the ground floor. However, both floors recorded air temperatures and relative humidity outside the upper and lower limits of the comfort zone (Pereira *et al.*, 2015).

Air temperature recorded in the current study is above the World Health Organization recommended a maximum of 24°C for working in comfort (KorsaviandMontazami,2019). The values were recorded when all the windows in the respective locations are open. Temperature values recorded in this study are higher than those reported by Ogedengbe (2015). When physical activity is high in a hot working environment, the worker is at risk of increased core body temperature (above 38°C), diminished physical work capacity, diminished mental task ability, increased accident risk, and eventually heat exhaustion or heat stroke (Mujan *et al*., 2019). The main factor underlying these effects is the increased core body temperature, but dehydration due to sweating and inadequate liquid intake is also essential. Symptomatic exhaustion and clinical diseases, particularly kidney disease, can be the result of excessive dehydration. When body temperature exceeds 39°C, acute heat disorders (heat stroke) may occur, and above 40.6°C life-threatening 'severe hyperpyrexia' starts to occur. (Kjellstrom *et al.*,2009). The values of relative humidity measured in the colleges were higher than the recommended international standard, and this could cause a problem for workers. The result shows that humidity was always above 60% even though the recommended value is 55%. Generally, the relative humidity should be between 40% and 70%. Peoples' breathing is a primary source of moisture that causes humidity indoors. This study supports Haase and Amato (2009) argument that in the warm-humid tropical climate, the potential of naturally ventilated buildings for sustainable thermal comfort is limited in the hot season. Ogedengbe (2015) suggested that opening of the windows preferably on opposite sides of the building to maintain a good cross airflow and use of dehumidifier when the windows are closed, and the air conditioners are on may be effective method to remove internal moisture and keeping the air at a comfortable and healthy humidity level (Wang and Wong 2007). There was a slight variation in the light intensity measured in the ground floor of some colleges compared to the first floor; however, in all the colleges and administration building, irrespective of the floor, the high value of light intensity recorded falls above the international standard range of 320-430 lux. This might be due to the nearness of the office

cabinets to windows and the opening of doors. The natural light entering is much and is easily dispersed through the furniture. This could be the primary cause of high light intensity. Ogedengbe (2015) made a similar observation. Poor lighting makes the visual system work harder and majorly leads to eyestrain. Also, poor lighting can cause other, more indirect effects (Appah-Dankyi and Koranteng,2012). The natural response to insufficient luminance is to get closer to the task or to look at it from a different direction. This can mean adopting unsuitable postures that lead to other forms of discomfort, such as neck and backache. Fortunately, this may not be the case for staff in the offices with good lighting (Haase and Amato, 2009)

Conclusion

This study assessed IEQ with respect to daylighting, indoor air temperature, and humidity of selected offices in Michael Okpara University of Agriculture, Umudike. A comparative analysis of air temperature, humidity, and lighting on the ground floor and first-floor performance showed that first-floor indoor air temperature, relative humidity, and lighting was higher than the ground floor. In terms of lighting, all the selected offices had suitable and sufficient natural lighting; however, air temperature and relative humidity were above the international standards for the workplace irrespective of the buildings' floor. Therefore, this study recommends that the internal use of a dehumidifier when the windows are closed, and the air conditioners are on may be an effective method to remove internal moisture and keep air temperature comfortable and healthy. Offices should be well ventilated to enable enough daylight intensity, proper temperature, and relative humidity to improve employee productivity. An adequately designed natural ventilation system allows fresh air to enter a large space through low-level inlet ventilators. This can be achieved when a building is properly designed.

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UTILIZING THE LEAST COST PATH ANALYSIS IN SELECTING ALTERNATIVE ROUTE FROM GIREI TO WUROBOKKI IN ADAMAWA STATE, NIGERIA

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Abstract
Roads are important infrastructure that are used in providing mobility for the efficient movements of goods and services apart from helping to provide accessibility to land and land based activities. In most places, the governments are mainly saddled with the responsibility of constructing roads for citizens. It is important to have a proper planning before embarking on the construction of roads. This is necessary to guarantee a strong and long lasting road. Wurobokki town in Girei local Government is blessed with a lot of economic potentials and needed to have good and long lasting roads for free flow of the economic activities. This research seeks to make an analysis of the route linking Girei and Wurobokki as a necessary ingredients in the planning for the construction of the road as an alternative to the existing one. In this research, topography and several land use pattern of the area were considered as criteria in the analysis for the selection of the alternative route using the weighted overlay method. At the end, the alternative route that was discovered shows a significant reduction of 620 meters in terms of distance in addition to other cost benefits to the existing road. The alternative route also avoided areas of high water accumulation and high lands which are generally factors that increase the cost of construction.
Keywords: Geographic information system, Least cost Path analysis, Alternative Route, flow accumulation, reclassified map

Introduction

Road infrastructure plays a great role in providing mobility for the efficient movements of goods and services and also helps in providing accessibility to land and a wide variety of commercial and social activities (Meyer and Miller, 2001:Sweis, Sweis, Hammad, & Shboul, 2008). In many countries including Nigeria, the governments are mainly saddled with the responsibility of constructing roads and other infrastructures. Lack of proper planning and mismanagement in the provision of these infrastructures are among the problems faced in many places (Gajewska, & Ropel, 2011). Poor planning and management of construction projects will leads to delays and other negative effects in project construction (Farah Jawdat Khalid, 2019). With proper management and good planning a lot more infrastructure that will stand the test of time would have been possible. It is therefore important to have an effective and a proper project management whenever a project is to be embarked upon. This will go a long way in saving the cost of executing the project (Delavar and Naghibi, 2003).

Least Cost Path analysis (LCPA) is one of such tools in GIS that is used in the planning processes before embarking on the construction of roads projects. It can be defined as the process of determining the cheapest route between two points on a cost surface.GIS automates the process of finding the least cost path between two specific points and offer scaled, graphical output of the result(Yusof and Baban, 2004). LCPA allows designers to determine the most economical way to link the source and destination points within a cost surface which can be calculated by combining multi criteria to account for different problems (environmental impact, economic investment). LCPA identifies best way from one point to the other by minimizing the construction costs for routing a new highway between two points, it avoids high slope areas, protected wildlife, and unsuitable land uses and finally finds the optimum route.
Many authors have worked on this area in trying to solve specific problems that concerns choice of routes in different places. For instance, Yildirim *and* Nasanci (2010) and Ranya and Wael (2016) compared LCP with the existing route and provided aspect maps for drainage construction along route. David (2012) in his work noticed that LCPA allow for the possibility of discovering routes taken by humans in terms of efficiency and rationality, the system was also tested in the form of examples for the most suitable route planning in the development of mounting sites. Stefano et al. (2011) identifies a most suitable route for a power line by integrating LCPA and multi-criteria evaluation (MCE).Imtiaz et al (2012) also integrates the LCPA and multi-criteria evaluation to determine the best route for a road in a hilly area in Malaysia. Wurobokki town in Girei local Government is blessed with a lot of economic potentials, marketers from all over Adamawa and neighboring Cameroon normally converge on market days to buy and sale goods. A lot of people ply the

road on market days for buying and selling of goods. Government in return gets a lot of revenue and therefore needs to make the market more attractive by providing a long lasting road that connects to the towns. In this research, effort is made to determine an alternative route to the present one; this would be used in the planning process for the construction of a cheaper and long lasting road.

Study Area and Method

The study area lies between longitude 12° 30' 24.97"E to 12° 49' 44.47"E and Latitude 9° 16' 20.43"N to 9° 27' 19.69"N. The area has an average minimum temperature of 23.2^{0}C and an average maximum temperature of 37.4^{0}C. It possesses an average annual rainfall of 718.1mm. The area is characterized by a distinct dry season which begins in November, and ends in April. The wet season begins in April and ends in October or sometimes November. Girei and Wurobokki belong to a low land relief region in the State with a distinct relief configuration that has series of mountains. The area is relatively lying as a sloppy terrain with the slope towards Wurobokki. The soil composed of organic matters, weathered rock materials which falls under the category of the ferruginous tropical soil of Nigeria based on the genetic classification made by the Food and Agricultural Organization (FAO) of the United Nations (UN). The soil ranges from brown to red and are generally coarse in nature. The vegetation is the Sudan Savannah type of vegetation which is characterized by thick vegetation around the hilly and mountain areas.

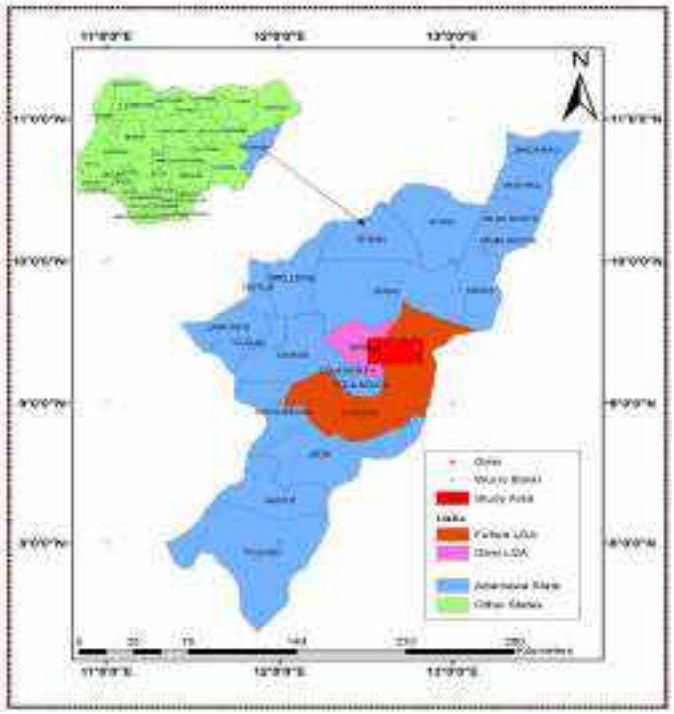

Figure 1: Locational Map of the Study Area. Source: Ministry of Land and survey, Adamawa state.

The materials used in this research include the soil data, images and the software. Landsat OLI, Elevation data (SRTM), ArcGIS 10.3, Soil and Geological information from journals and other papers were used.

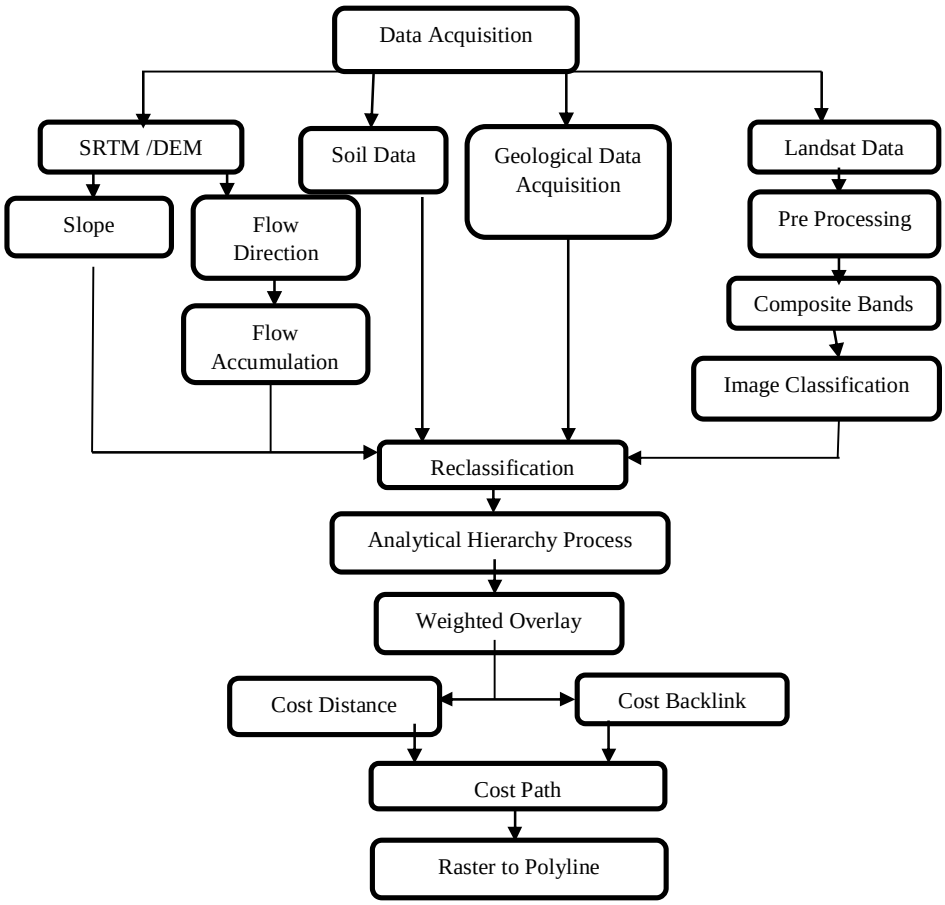

Figure 2: Methodological Flowchart

SRTM DEM was used to derive the Slope and Flow Accumulation Criteria, the Landsat data for the Landuse criteria, the Soil and Geological data for the Soil and Geology criteria. The land use land cover classification and assessment of spatial and temporal change was performed based on the Landsat Image acquired. Land cover land cover was categories into farmland, water bodies, vegetation and build up areas. Slopes are required to identify the rate of change in topography over a specific distance and they are expressed in degrees or percentage. The slope map was generated from the DEM using the spatial analyst tool in ArcMap10.3. Flow Accumulation map was also generated using the ArcGIS software, the flow direction was first determined since it is an essential input in generating the flow accumulation**.** Soil maps and Geological map of the study area was acquired and reclassified into a comparable state to fit in and overlay with other maps composed in the LCP process. All the criteria involved in this research were standardized to a unit of intensity, ranging from 1 to 5 using the re-class tool in ArcGIS. The cost surface map was created using the weighted overlay; this gives the cost intensity of each pixel which takes to cognizance all the criteria maps composed in its generation. As the criteria were standardized, it made it easy to integrate all the criteria to produce the cost surface. The cost surface was then used within GRID to create a least-accumulative-cost distance map to a source cell. Using the Cost distance command, this layer then represents the total cost from the source cell, or origin point for the route, to any other point within the study area. So, if the cell immediately adjacent to the origin point had a total (summarized) cost of 100, it would be a cost of 100 to travel to that cell from the origin. If the next cell in a particular direction had a cost of 150, then the accumulated cost to get to that cell, 2 cells from the origin, would be 250, and so on. This travel cost surface is then used to determine the least cost path between the origin points to any point. The cost distance tool however determines the shortest weighted distance from each cell to the nearest source location; this was accomplished using the cost distance tool in ArcGIS. The cost distance tool produces the cost distance raster and the backlink raster. After driving the accumulative cost distance and backlink raster, least cost path routes was then derived. The cost path tool retraces the destination cells through the backlink raster to the source. This was used to create the final least cost route in this research.

Results and Discussion

Figure 3 represents the landuse/landcover map of the study area. The red areas represent the built up areas, the topaz sand represent the bare surface areas, the yellow represent farmlands, the green areas represent the vegetation and the blue represent the water body. The elevation area is represented in figure 4. On the map there are the elevation map of the study area and the standardized reclassified elevation map of the study area with notable elevation peaks on the south western and north western part. The blue areas are the least cost elevation and the brown areas are the highest elevation cost. Figure 5 is theflow accumulation map and the standardized reclassified flow accumulation map. The flow accumulation map is represented by a stretched color ramp of black to white. The black regions represent the lowest accumulation and the white regions represent the highest accumulation. The standardized reclassified flow accumulation map is classified into 5 classes (1-5) with 1 being the lowest accumulation and 5 being the highest accumulation. Pink color represents lowest accumulation and cream represents the highest accumulation.

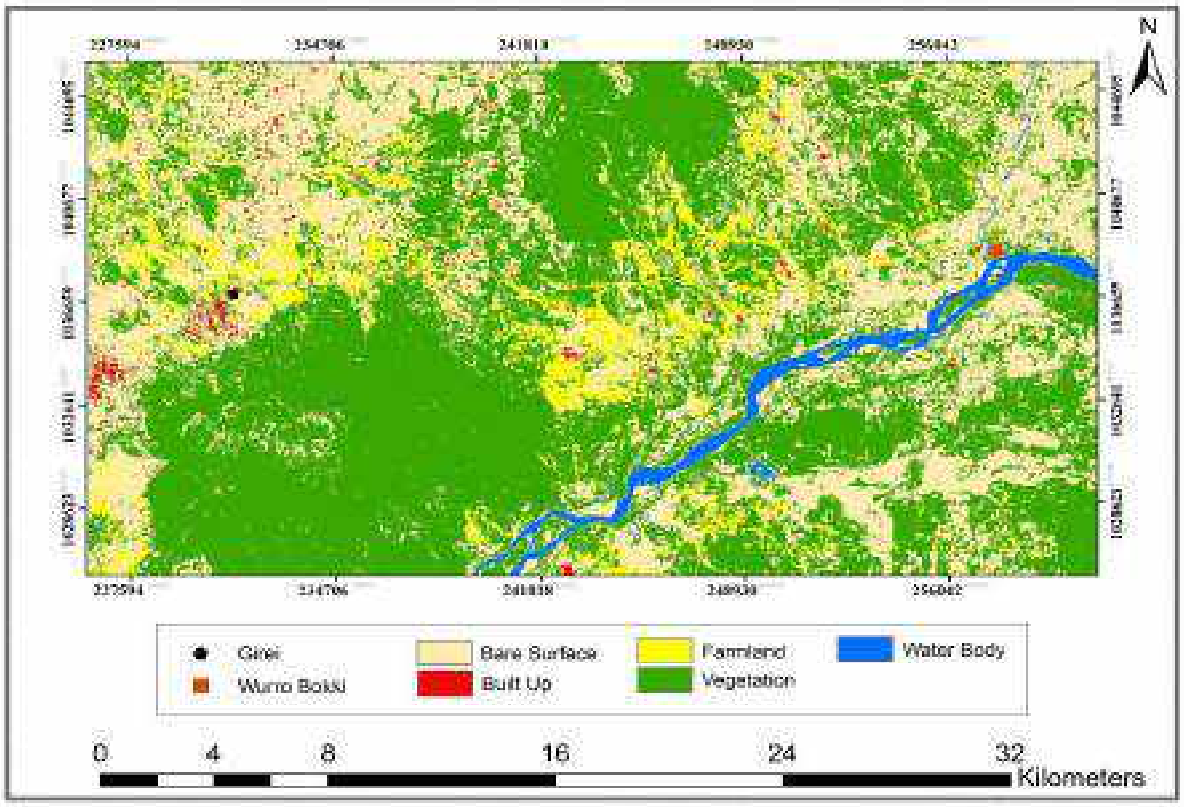

Figure 3: Landuse/Landcover Map

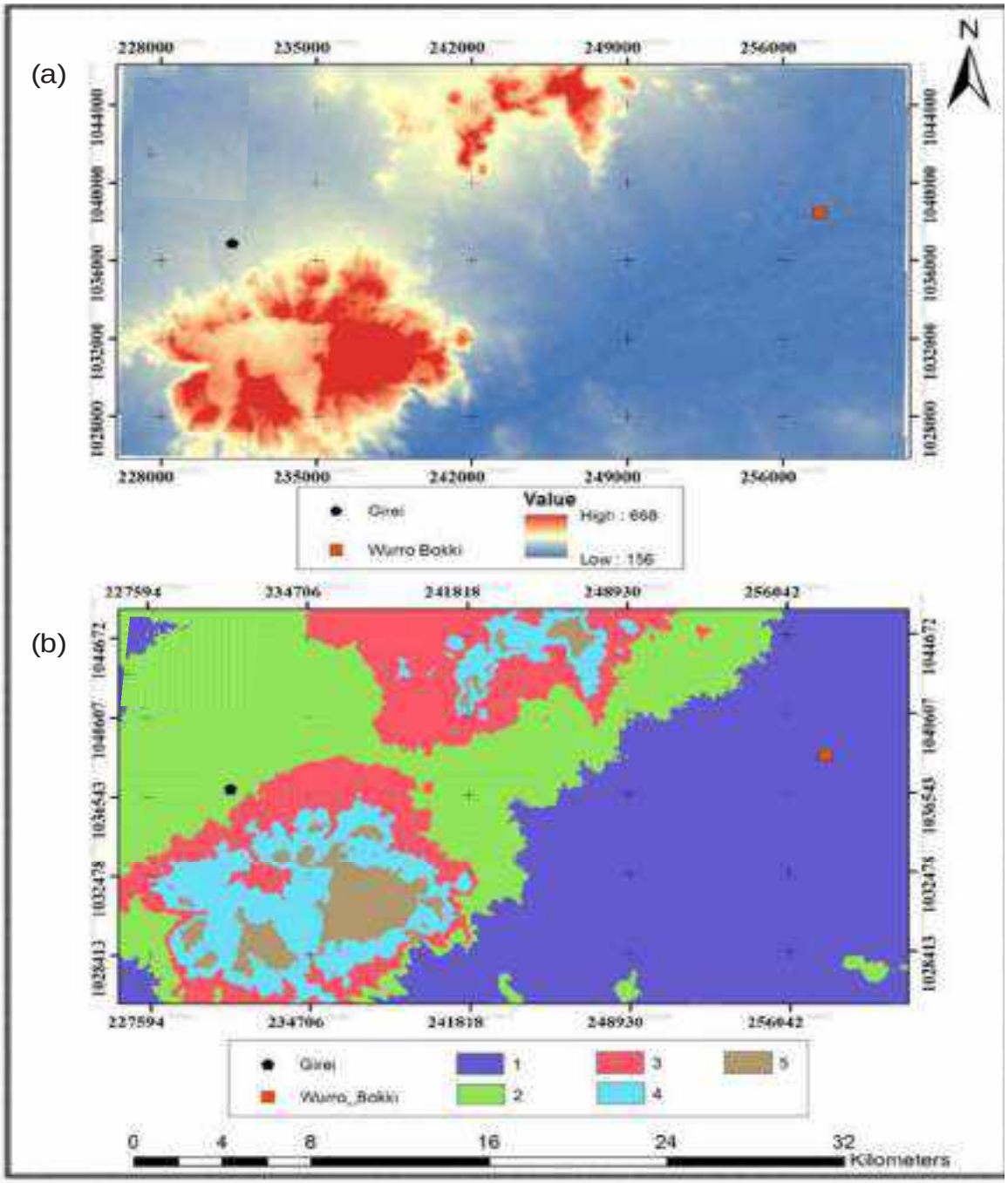

Figure 4: (a) Elevation map (b) Reclassified Elevation map

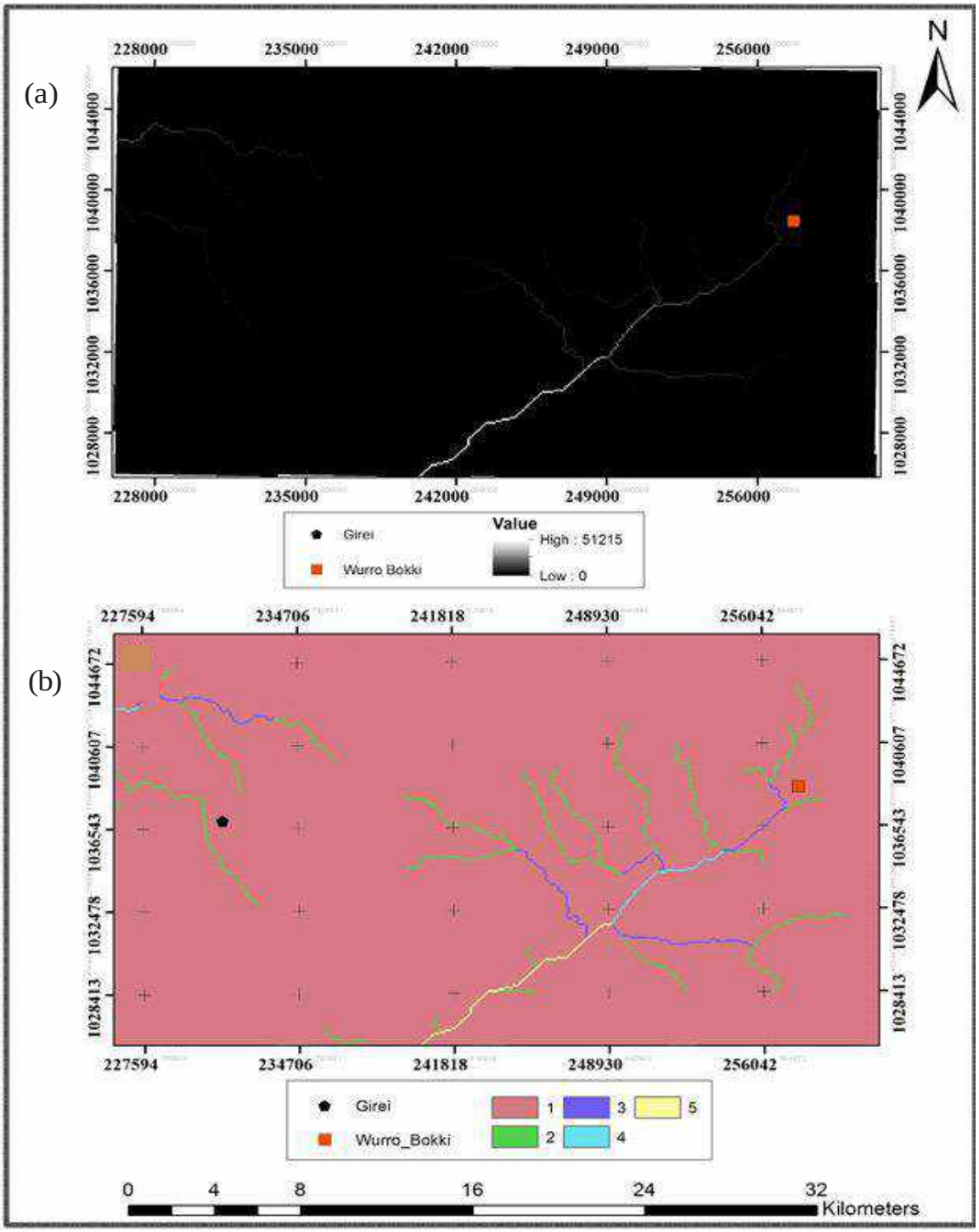

Figure 5: (a) Flow Accumulation map (b) Reclassified Flow Accumulation

Figure 6 is the slope map and the standardized reclassified slope map of the study area. The green area shows the least slope and the red area shows the highest slope in degree. The standardized reclassified slope map is classified into 5 classes (1-5) with 1 being the lowest slope and 5 being the highest slope. The lemon green color represent lowest slope and the purple color represent the highest slope. Figure 7is the soil map; there are basically three kinds of soil in the study area, the ferric luvisols, the fluvisols and the pellicvertisols. The ferric luvisols are represented by the green color on the map and located on the northern part of the study area, the fluvisols are represented by blue color and the pellicvertisols in red in the southern part of the study area. The geological map of the study area is represented in figure 8. The study area

consist of three major geological formations namely; Amphibole schist amphibolite, alluvium, shale-sandclay-calcerous sandstones. The Amphibole schist amphibolite is represented by green, the alluvium in blue and the shale-sandclay-calcerous sandstones in red.

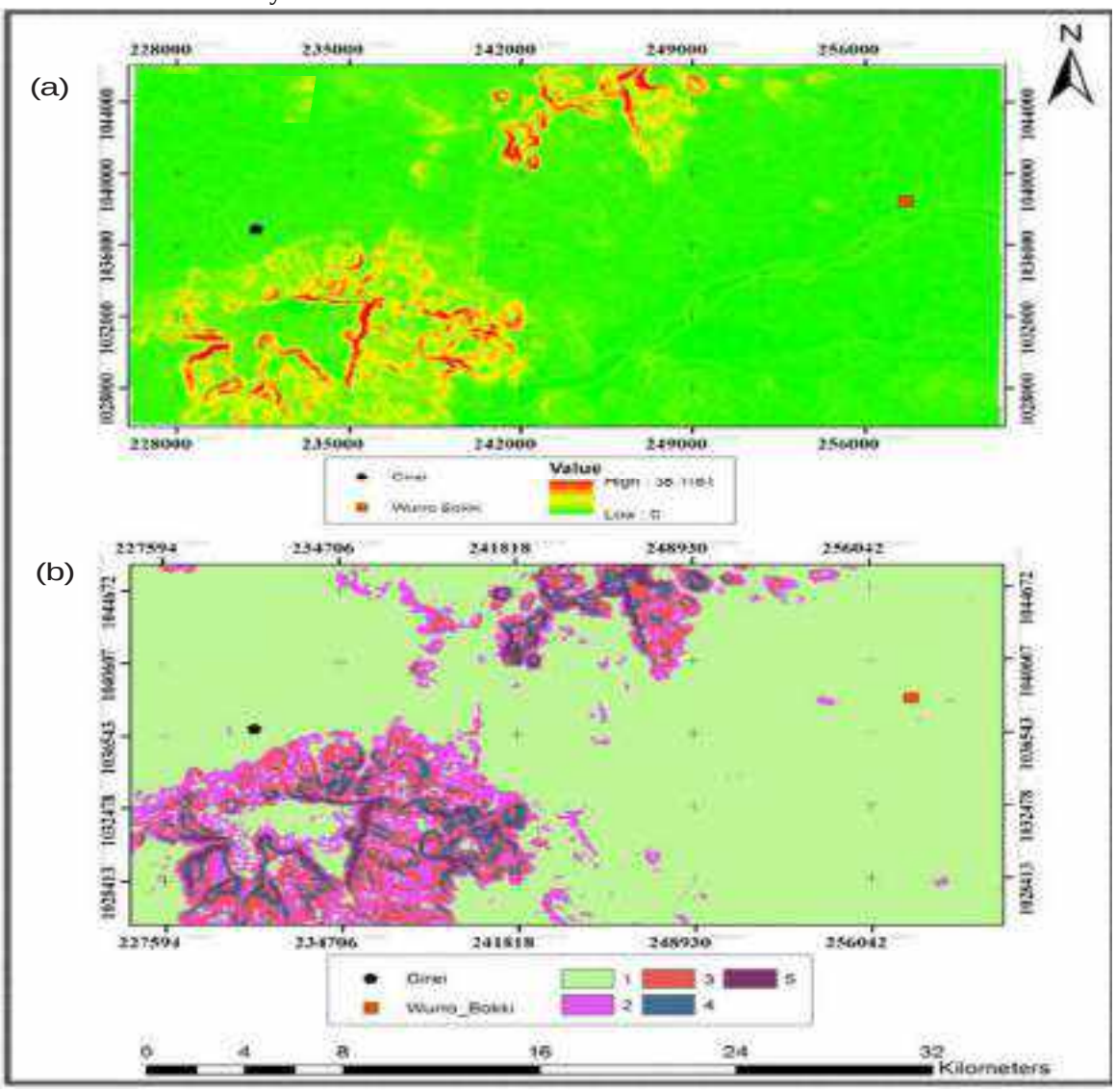

Figure 6: (a) Elevation map of the Study Area. (b) Reclassified Elevation of the Study Area.

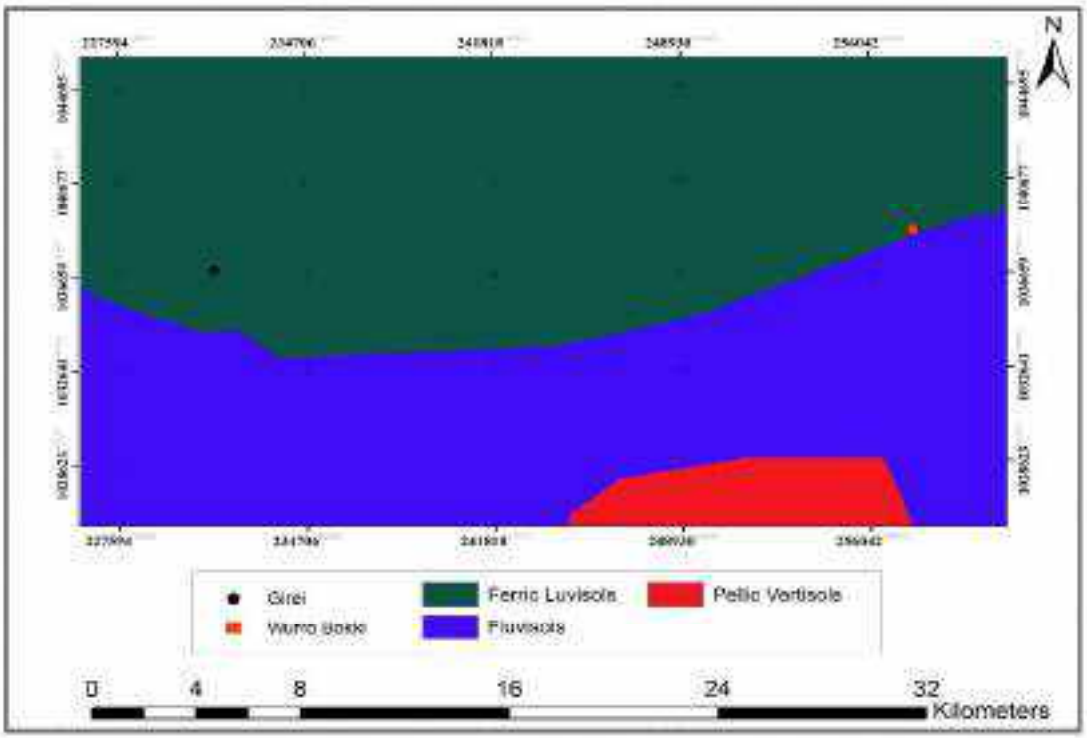

Figure 7: Soil Map of the Study Area.

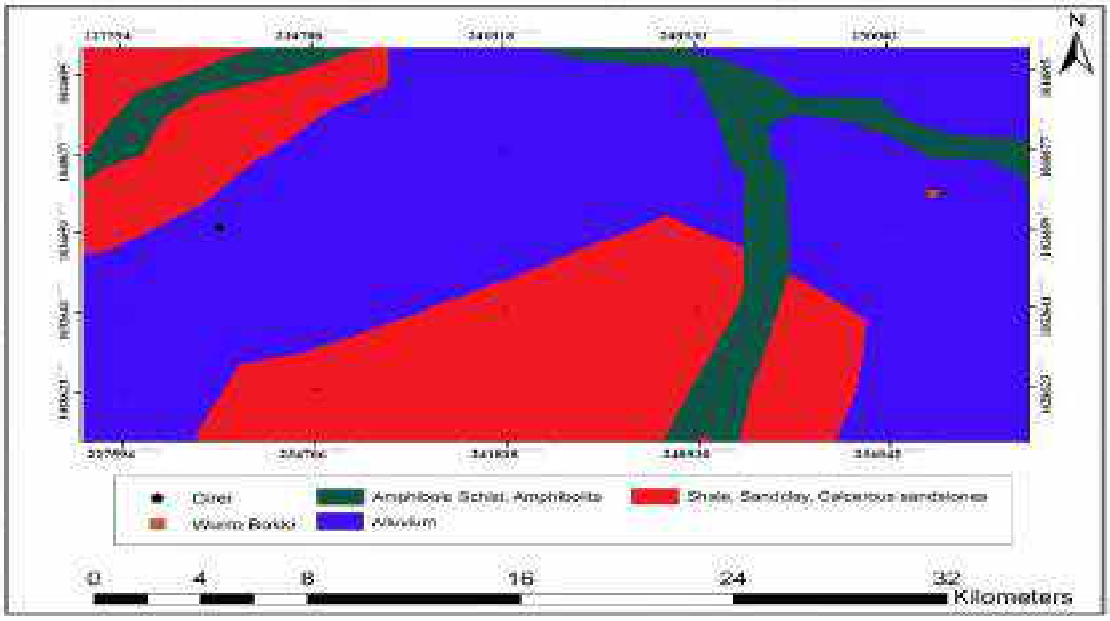

Figure 8: Geology Map of the Study Area.

The cost raster map is presented on figure 9; a map that shows the cost of constructing a route through a particular path with respect to intensity of cost. The weighted overlay tool in ArcGIS was employed for this process and three classes were obtained with class 1 to 3. Class 1 shows the least cost areas and 3 shows the highest cost areas with respect to the criteria under study. The cost raster map is a very important map in least cost path analysis; it is also an input in the production of both cost distance raster and cost backlink raster which are required in the production of the least cost path. Figure 10 depicts the least cost path produced; this was subsequently overlaid on the map of the existing road for comparison. Figure 11 represents an overlay of the least cost path produced and the existing route from Girei to

Wurrobokki in the study area. The least cost path produced is represented in red color while the existing route is represented in black color.

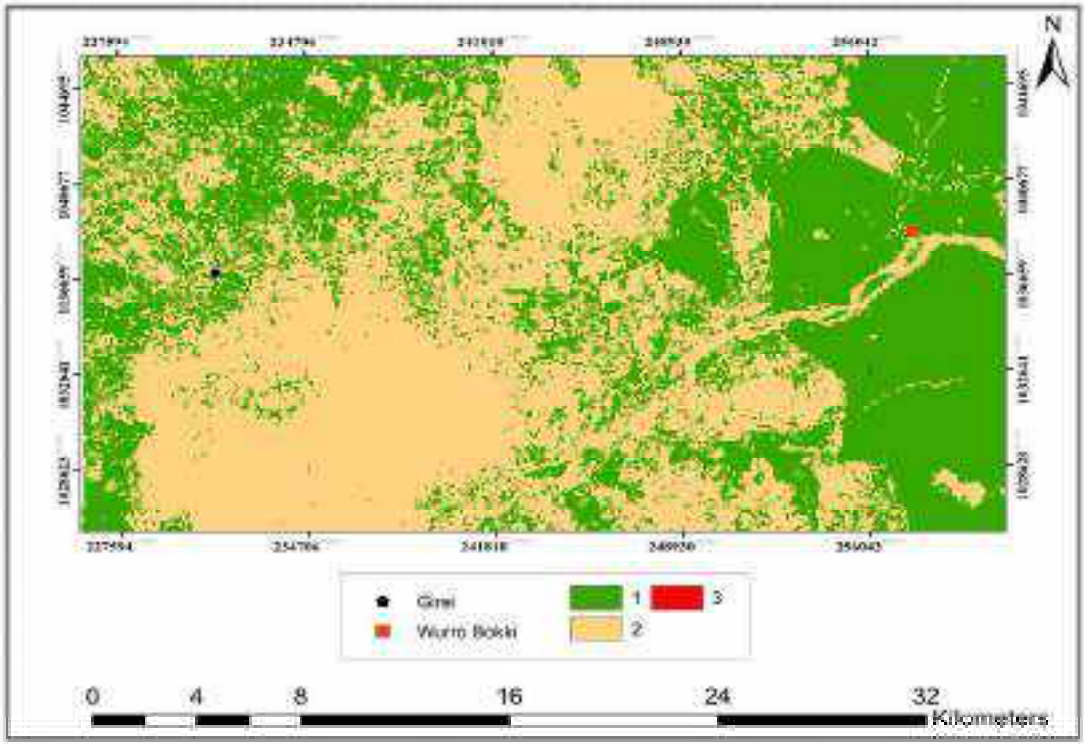

Figure 9: Cost Surface Map of the Study Area

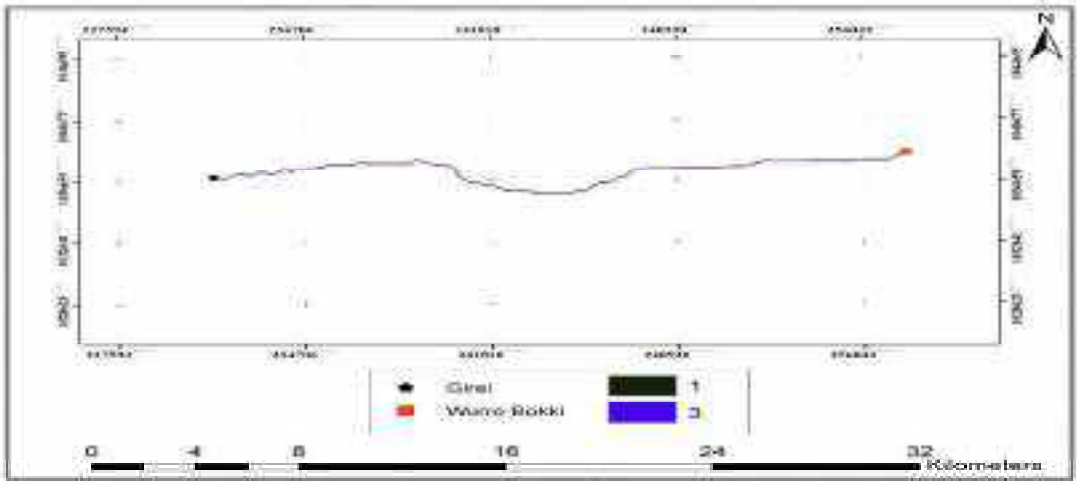

Figure 10: Least Cost Path.

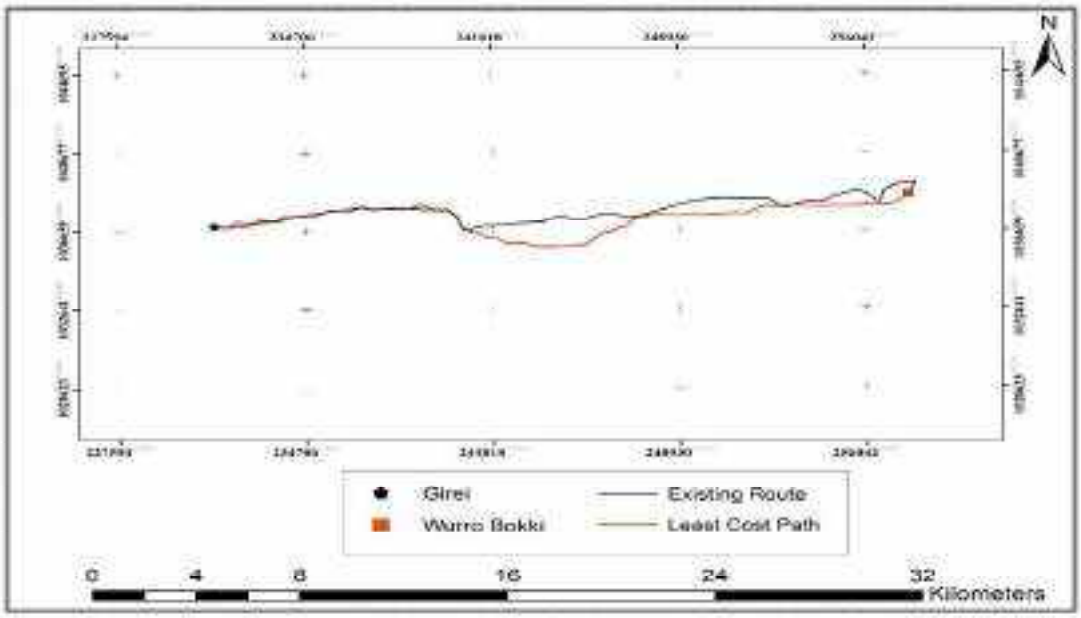

Figure 11: Least Cost Path and the Existing Route

Discussion of Results

Landuse/Landcover maps, Elevation Map, Flow accumulation, slope, Soil and Geology are important criteria in the development of a least cost path from Girei to Wurobokki. The route was developed on a least cost Landuse which avoid high altitude areas, high flow accumulated areas, steep slopes, unfavorable soil and unfavorable geological formations. The adopted criteria will not only ensure the cost effectiveness of construction but also take to cognizance the durability of the route to be constructed and the time that will be spend in the construction. Areas of high flow accumulation were avoided, this is because such areas will either render the road hard to access or alter the lifespan of the road constructed. Soil and geology is an important factor to be considered in construction of road it ensures the durability of the road to be constructed. For instance construction of road on clay content soil will expose the road to cracks. Built up areas were also avoided to reduce the cost of compensation which ultimately will result to raising the cost construction. Crossing of water bodies in road construction will require a bridge or a culvert, such barriers where avoided as much as possible to reduce cost that would have been inquired in the construction. Apart from all the factors mentioned above which were considered and avoided to reduce the cost of construction of the road. The existing road distance and the least cost path distance was also checked. The least cost path distance was 28.89km while the existing road distance was 29.51km. a difference of 620m was noticed and this would also go a long way in reducing the cost of the road to be constructed if the alternative path as determined by the least cost path is to be followed.

Conclusion

The factors used in selecting the least cost path were integrated with respect to the cost of route construction and a cost surface map was produced to show the cost of route construction on every surface in the study area with respect to the integrated factors which serve as criteria in the derivation of the least cost path. Using the appropriate GIS tools shown in the text above, a least cost path was derived to serve as an alternative route from Girei to Wurobokki. The least cost path was observed to be the best in terms of cost effectiveness with a distance of 620m less than the existing road. The research has however demonstrated the effectiveness of the GIS tools in the determination of least cost path. The method is not only limited to roads but can also be applied power lines, pipelines, and other related constructions as earlier shown in some literature above. This research has clearly demonstrated the need to employ the LCPA in the planning process of road and other similar construction to cut cost and increase the life span of projects to be constructed.

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DETERMINANTS OF PEDESTRIAN TRAFFIC IN UYO METROPOLIS

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Abstract
This study examined the volume of pedestrian traffic with a view to identifying major determinants factors of pedestrian traffic in Uyo metropolis. The study adopted a systematic random sampling framework for data collection and 662 household heads across twenty six delineated traffic analysis zones in the study area were utilized. Principal component analysis technique was applied to collapse the fifteen (15) variables data set into 5 components. Factor Analysis result indicated that the data is a five components system explaining 79.17% of the total variance. Simultaneous Multiple Regression Analysis model was further performed on the five new dataset against pedestrian traffic volume to measure the effect on pedestrian traffic volume. The findings indicated strong and positive (.890) level of relationship. The implication of the results shows that, of the five factors, factor 1 which is demographic/facilities factor made the strongest unique contribution (.810) to explaining the variance in traffic volume when all other factors were held constant. The next significant factor was road segment factor as it contributed to explaining the variation in traffic volume (.355) when all other factors are controlled. All the other factors were very weak (X2=.028; X3= -.035; and X4= -.090). The study recommended the formulation and implementation of policies by government that would have bearings on the key determinant factors with a view to encourage and promote sustainable transport development due to its health, transportation, economic and environmental benefits, thereby resolving some of the adverse environmental and health impacts of car dependency in the study area.
Keywords: Pedestrian Traffic, Volume, Factors, Analysis zones, Uyo Metropolis

Introduction

Pedestrian movement is one of the most common and basic forms of transportation. Pedestrian means of transport should be considered the primary form of transport, as it is the most sustainable and environmentally friendly mode. It is the oldest form of urban transportation and until the advent of major transformations in transport technology in the nineteenth century; most cities were structured in ways that supported Pedestrian transport (Newman and Kenworthy, 1999). This particular mode of transport is appealing to everybody and requires no specific or technical skill. Almost every trip between an origin and a destination requires a walking section. It is actually the most vital mode of transportation upon which all societal activities depend.

Pedestrian means of transport is commonly used for short trips or as a feeder for other modes of transport. In spite of the unique attribute of this particular mode of transport, it lacks the necessary transportation facilities in most towns and cities mostly in Africa. This mode of transport has received much attention in most developed nations. The provision of pedestrian facilities in cities of Africa seemed to have been hindered due to high spatial urban expansion with little or no development planning. This has led to a situation where most cities rely more on road-based transport systems, with serious capacity constraints, negative environmental consequences and other limitations. Consequently, many cities in Africa face serious urban transport related problems, such as traffic congestion, air pollution, high accidents rates and inadequate access to transport facilities by the urban poor. In Nigeria, little or no attention has been given to Pedestrian transport in terms of necessary pedestrian facilities. In a bid to make our environment a cleaner place, the use of pedestrian transport should be encouraged towards sustainable transportation and hence, this research. Pedestrian transport mode is unique because no technical skill is required, and the accident rate is quite low compared with other modes of transportation. Additionally, it can be performed at different intensity and speed, based on individual strength.

In Uyo Metropolis, despite the benefits of pedestrian transport, it seems to have been completely overlooked and undervalued. Studies have shown that pedestrian traffic volume and behavior are a function of a mix of factors and conditions (Owen et al., 2004, Cervero, 2010) and where such factors are identified, there seems to be a little understanding about the relative influence or importance of such factors on pedestrian traffic to guide policy makers. From the sustainability point of view and the inherent benefits of pedestrian traffic, this study seeks to examine pedestrian traffic volume and identify the key factors influencing pedestrian traffic in Uyo metropolis against the backdrop that identifying the important factors

and good understanding of them could help in formulating policies that could enhance sustainable transport planning policy in Uyo metropolis.

Literature Review

Much evidence abound which indicate that the geographic distribution of pedestrian traffic along city streets is affected by two main characteristics of the urban environment topological centralities of streets (or street segments) and the spatial distribution of retail and service facilities (Golledge and Stimson, 1997). However, there is still no sufficient knowledge on these relationships, as environment characteristics are more influential than others for predicting pedestrian traffic in the city. Cao, Handy and Mokhtarian, (2006) used a travel survey performed in Austin, Texas to study the effects of land use patterns on pedestrian traffic movement and utilitarian walking trips. The study established that the pedestrian environment at the origin has the greatest impact on pedestrian traffic volume, while the pedestrian environment at the destination appears to be at least as important for utilitarian trips. The study also showed that people are more likely to stroll around or walk to the store when fewer vehicles travel residential and commercial streets. The study finally concluded that strolling accounts for the majority of pedestrian traffic movement, and tends to be undercounted. The study was however, interested in destination and origin factors affecting pedestrian movement in public urban spaces

Lerman and Omer (2016), similarly studied pedestrian movement in traditional and contemporary urban areas in Tel Aviv. Four pairs of adjacent contemporary and traditional neighbourhoods were analysed to determine the build environment factors that influence pedestrian traffic volumes. Manual five and ten minute counts were taken at several locations within each area between the hours of 3 p.m. and 8 p.m. on sunny weekdays. This research analysed spatial, functional, physical, and demographic variables of the built environment, demonstrating that commercial land uses are related to greater pedestrian volumes, and spatial structure, such as road connectivity, have significant impacts on pedestrian traffic. The study here was however emphasized more on built environment factors and data were taken on specific number of sunny days at the hour of 3 pm and 8pm on weekdays.

Somsiri , Yukuo and Takuro (2018) also in similar study established that urban structure plays a key role in providing available paths for pedestrian flow through urban areas. The study uses integrated object detection application and urban spatial analysis in order to investigate the interaction between built-up urban environments and people's perception of accessible routes. The study used three parts of analysis, including pedestrian movement detection, spatial density and path analysis and interpreted the results into geographical data. The result revealed that Land-use planning influences the accessibility behaviours of pedestrian movement controlled by urban structures, activities, and street networks with the unique attributes of each urban area. The study also found that pedestrian movement behaviour is significantly related to the density of commercial activity and concluded that the derived correlation coefficient between the closeness value and the volume of commercial building space indicates a strong relationship between the variables, and further suggested that the proposed method is useful for application in any design of urban spatial plans. The emphasis here is on the urban spatial structure as most significant factor affecting pedestrian movement.

Olojedea, Yoadeb, and Olufemia (2017) identified the major factors that influence walking as an active travel mode in Ilesa. The study identified some factors such as awareness of health benefits, relative cheapness, trip length, non-possession of personal vehicle, safety and security considerations, environmental walkability, easy access, favourable weather and road condition as real predictors of walking in the city. They concluded that transport facilities investments in Ilesa apparently work against pedestrian transport as no conscious provision is made for active travellers as there are neither bicycle lanes nor pedestrian sidewalks. Non-motorized transport is not a choice mode in the city and public enlightenment is needed for residents to understand the benefits of active travel and traffic calming policies and speed limits should be introduced and/or enforced according to a functional classification of spaces, streets and road networks in the city.

Miranda-Moreno and Fernandez (2011) modeled pedestrian activity as a function of land use, density, transit supply, and road connectivity measures. The study observed specifically that commercial space, schools, population, bus stations; number of road segments and the number of four-way intersections all increase the surrounding pedestrian activity. In addition, factors such as large open space and a large percentage of major

arterials were found to decrease pedestrian activity. These factors represent the land use and urban form of the study area and once calibrated with automated counts, are used to predict pedestrian volumes at intersections. The study finally concluded that pedestrian activity is affected by weather conditions such as humidity and extreme temperatures.

Geographical Setting of the Study Area and Research Design

Uyo metropolis is located within longitude 7° 541 and 8°001 east of the Greenwich and 4° 591 and 5° 141 north of the Equator (Figure 1). The study covers an area of 15 kilometres radius and is bounded by Nsit Ibom, Etinan, and Ibesikpo Asutan local government areas on the South, Uruan and Nsit Atai on the East, Itu, and Ibiono on the north and, Abak and Ibiono Ibom to the west. The Town is centrally located as the administrative center of Akwa Ibom State, which cuts across six other Local Government Areas of Etinan, Uruan, Itu, Ibiono, Nsit Ibom, Nsit Atai, Nsit Ubium and Ibesikpo Asutan. It is easily accessible from other cities like Abak, Itu, Ikot Ekpene, Oron, Eket, and Etinan by road. The city can be reached under one hour driving from any part of the state and with improve roads, the time will considerably be reduced. The road from Aba to Calabar on the northwestern flank of the capital city further promotes the accessibility of the city.

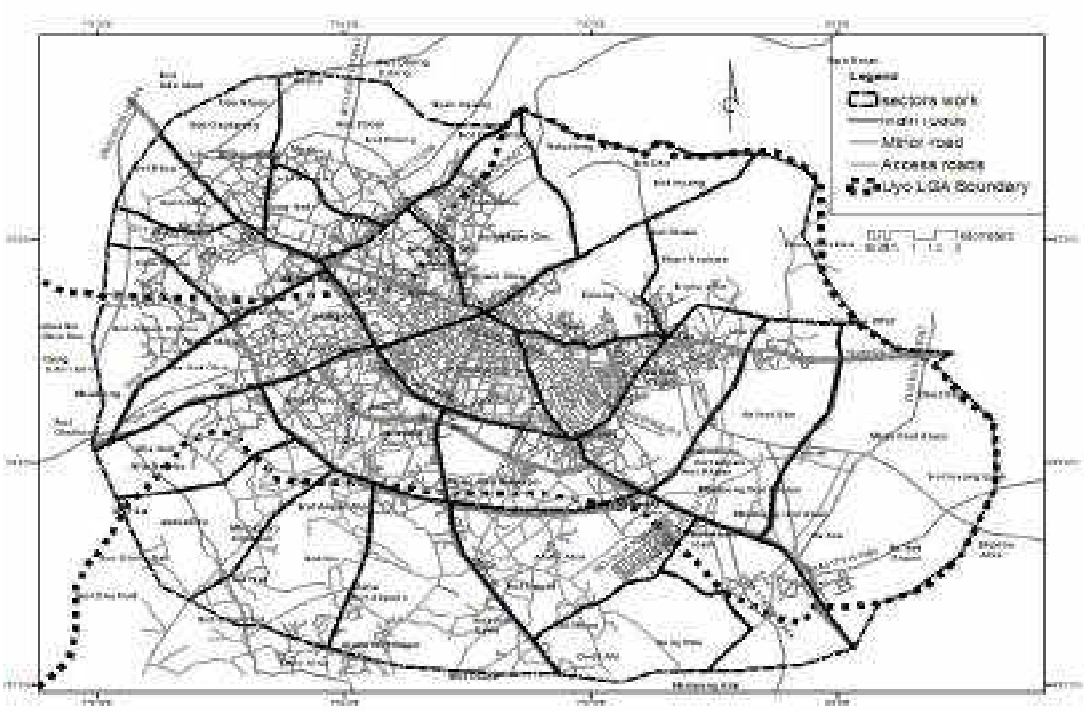

Figure 1: Map of Uyo Urban

The data for this study was collected by using primary and secondary sources. For this study, the primary data collection methods include pedestrian volume survey, interview survey and pedestrian infrastructure survey. The pedestrian volume survey was conducted by using the manual traffic counter between the hours of 7.30 am and 7.30 pm during weekdays at each TAZ, whereas the interview survey was formulated by using a specific guideline. On the other hand, the inventory of pedestrian infrastructure was outlined by a guideline adapted from the best practice of pedestrian studies according to the identified elements, criteria and measures of the existing pedestrian infrastructure. The main elements focused in both interview and inventory surveys are shown in Table 1. The analysis of data was carried out using principal component analysis method and multiple regression analysis.

Table 1: List of Pedestrian Variables

s/n	Variables	Definition of Variables	Unit of measurement	Sources
X1	Estimated Pop.	Number of people/TAZ	Number	Schneider et al. (2009)
X2	Connectivity level	Road network development	Level	Saelens, 2003).
X3	Number of Sec. schools	Number of Secondary school /TAZ	Number	Pulugurtha and Repaka.(2011)
X4	Residential land uses	Residential area	Hectares	Moudon and Hess, (997)
X5	Non residential land uses	Areas with non residential, uses	Sq/.Meter	Pentella, 2009
X6	Population density,	Total number of people/ TAZ	Pop/sq.m	Hankey et al. (2012, 2017).
X7	Number of Primary schools	No. of primary schools/TAZ	Number	Schneider et al. (2010)
X8	Churches	Total number of Churches/TAZ	Number	Okoko,.(2006)
X9	Mean Road width	The mean road width/TAZ	Meter	Maghelal 2010
X10	Distance to the city centre	Distance to the city centre	Kilometers	Miranda-Moreno & Fernandez, (2011),
X11	Accessibility	The number of links in the shortest path	Level	Oni, A., Akindele, D. And Omolade ,B.(2014)
X12	Block density	Total number of blocks/TAZ	Block/sq.m	Miranda-Moreno (2013
X13	Household size	Average household size/TAZ	Number	(Schneider et al. (2009)
X14	Post secondary qualification	Post secondary level of education	Number	Tichelle *et al*, (2016)
X15	Road segment	Total Road segment/TAZ	Number	Hankey et al. (2012, 2017)

Table 2: Pedestrian data from the field

TAZ	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	**Y**
1	6464	1	6	2.2	3.9	495	7	9	5	4.8	1.0	22	4.2	15	20	**390**
2	5557	1	4	6.3	9.1	490	5	7	7	6.6	1.0	16	5.4	10	16	**380**
3	3761	1	4	1.6	1.9	473	7	3	9	3.4	4.3	17	3.8	8	11	**300**
4	8060	0	7	6,9	2,6	322	8	5	11	1.8	10	5	7.2	9	10	**475**
5	3126	1	7	2.8	3.3	326	4	3	8	1.3	1.0	33	3.3	1	36	**310**
6	4640	2	5	1.7	1	527	5	5	7	2.0	1.0	11	5.0	1	13	**427**
7	5320	1	2	3.8	6.1	295	9	7	7	2.2	1.0	45	7.0	1	12	**373**
8	1287	0	2	5.4	1,5	152	3	5	13	3.0	4.8	60	2.3	16	11	**281**
9	10640	1	8	6.0	3.6	1089	8	10	7	2.6	3.3	47	9.2	6	50	**475**
10	1624	1	3	1.5	5.9	318	3	6	8	2.6	9.0	18	5.2	5	120	**368**
11	11054	2	9	7.1	1.1	1990	9	11	8	4.6	1.0	65	9.7	16	100	**675**
12	3261	1	5	4. 1	5.2	532	5	9	8	2.0	1.0	42	5.8	3	13	**234**
13	4975	1	3	5.3	3.9	1452	3	5	8	3.6	3.0	36	4.3	4	30	**375**
14	4202	0	3	4.9	12	465	4	11	8	3.0	5.0	10	3.2	12	22	**295**
15	3193	1	3	3.3	8.6	526	3	6	9	3.2	13.3	17	3.0	2	25	**311**
16	4512	0	3	4,4	6.2	737	3	5	8	3.4	1.0	11	1.8	9	40	**310**
17	2943	1	2	5.5	6	301	6	3	8	3.6	3.6	24	2.8	2	8	**256**
18	2338	1	2	2.9	7.3	203	4	3	8	3.6	2.0	23	3.3	2	15	**258**
19	440	0	2	1.4	7.4	55	2	9	8	2.6	3.0	18	3.1	3	10	**233**
20	1899	1	2	1.5	7.0	162	2	7	8	3.2	2.1	13	2.8	7	36	**229**
21	3973	1	2	2.4	4.7	339	2	3	8	4.6	2,0	21	3.7	10	16	**285**
22	2046	1	2	2.7	6	283	2	5	5	6.0	3.0	17	2.3	12	20	**303**
23	3120	1	2	3.2	4.9	896	2	3	7	2.8	2.0	1	3.0	8	16	**257**
24	1520	1	2	2.1	0.4	229	2	2	9	3.2	2.2	12	2.7	8	25	**236**
25	5571	1	4	4.5	8.4	671	4	6	11	2.0	4.8	15	5.3	2	10	**420**
26	6047	1	5	5. 3	3.9	872	6	8	8	6.8	1.0	80	6.5	32	50	**342**

Presentation of Results

The pedestrian factors affecting pedestrian traffic volume were identified with principal component analyses (PCA). The .relationships between the emerging pedestrian determinant factors and pedestrian traffic volume were analyzed using simultaneous multiple regression analysis. Table 3 shows that the Kaiser Meyer-Olkin (KMO) measure of sampling adequacy is 0.636 which exceeds the recommended value of 0.6 and Bartlett's test of sphericity (.000) is also statistically significant and thus, supports the application of factor analysis.

Table 3: KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.636
Bartlett's Test of Sphericity	Approx. Chi-Square	230.187
	Df	105
	Sig.	.000

Table 4: Components Extracted

	Component Matrixa					Rotated Component Matrixa					**Commu**
	1	2	3	4	5	1	2	3	4	5	**nalities**
X1	.901	.161	-.039	.142	-.156	**.923**	.115	-.098	.005	.103	**.885**
X2	.410	-.327	-.684	-.060	.150	.241	-.106	-.654	-.361	.377	**.769**
X3	.818	.247	-.198	.020	-.007	**.827**	-.021	-.057	-.172	.230	**.770**
X4	.646	.249	.456	.001	-.224	**.696**	.358	.312	.112	-.127	**.738**
X5	-.329	-.098	.370	.790	-.012	-.215	-.083	.008	**.905**	-.082	**.879**
X6	.774	-.077	-.070	.009	.187	**.623**	.244	-.169	-.088	.401	**.646**
X7	.764	.252	-.121	.063	-.341	**.868**	-.009	-.082	-.099	-.109	**.782**
X8	.584	-.037	.307	.546	.047	**.570**	.218	-.044	**.567**	.203	**.736**
X9	-.126	.698	.381	-.473	.087	.006	-.029	**.879**	-.306	-.101	**.878**
X10	.239	-.767	.402	-.062	-.002	-.070	**.810**	-.343	.171	.045	**.811**
X11	-.201	.615	.251	.150	.477	-.082	-.305	**.693**	.209	.328	**.731**
X12	.656	-.134	.254	-.367	.017	.467	**.584**	.048	-.266	.129	**.648**
X13	.883	.227	-.130	.127	-.010	**.893**	.018	-.067	-.051	.245	**.865**
X14	.424	-.444	.594	-.343	.086	.127	**.907**	.063	-.042	.101	**.854**
X15	.477	-.101	-.062	.053	.800	.201	.160	-.019	-.008	**.904**	**.884**
Total						**5.431**	**2.065**	**1.775**	**1.471**	**1.133**	
% of Variance						**36.207**	**13.765**	**11.832**	**9.809**	**7.555**	
Cumulative %						**36.207**	**49.973**	**61.805**	**71.613**	**79.168**	

a. Rotation converged in 6 iterations

From Table 4, the data on fifteen pedestrian variables from the field however, produced five (5) components with Eigen values exceeding 1, which together accounted for a total of **79.17%** of the variance explained. The rotated solution showed that 12 variables loaded positively and 3 negatively on the first component, 9 variables loaded positively on the second component, 6 variables loaded positively on the third and fourth components respectively, while the fifth component had 11 positive and 4 negative coefficients loadings on variables. After identifying the component loadings and the variables they represent, the components were given titles that closely describe the pattern or structure of the positive loadings.

The first factor is named demographic and facilities factor due to its high positive loadings on population related and facilities variables. This factor explains about 36.21% of the variance and is characterized by 7 variables with high and positive loadings on this factor:
Estimated Population (X1) = .923
Number of secondary schools (X3) = .827
Residential landuse (X4) = .696
Population density (X6) = .623
Number of primary schools (X7) = .868
Number of churches (X8) = .570
Household size (X13) = .893
This factor had positive coefficients loadings in only 12 out of the 26 TAZs with 5 TAZs having significant factor scores coefficients values of .5 and above. A close examination of the distribution as shown in Table 6 revealed that 3 out of 26 TAZs had the highest positive component scores above 1 (TAZ 9=2.2296514; TAZ 11= 2.491287; and TAZ 4= 1.494288) and thus represents 11.54 percent of localities with positive demographic and facilities. Negative coefficients loadings were observed in 14 TAZs. The negative scores on this component therefore imply the absence of positive influence of this factor. It is suggested that coefficients loadings in excess of .71 imply 50% overlapping variance and are considered excellent. Coefficients loadings of .63 represent 40% overlapping variance and this is considered very good while coefficients loadings of .55 indicate 30% overlapping variance and are considered good (Comrey and Lee 1992; Tabachnick and Fidell 2007; and Atser & Emankhu 2017). This explains why only coefficients loadings of .5 and above are deemed significant.

The second component accounted for 13.77% of the variance and is named distance and literacy factor due to its high positive loadings on three variables of:
Distance to city centre (X10) = .810
Block density (X12) = .584
Post sec qualification (X14) = .907

From Table 6, out of the 26 TAZs, only 10 had positive coefficients loadings with only 5 out of the 10 having coefficients loadings of .5 and above.

The third factor is named Accessibility factor. It contributed 11.83% of the variance and is so named because of its high positive loadings on two variables. A total of 8 localities out of the 26 had positive coefficients loadings with 6 TAZs having coefficients loadings of .5 and above.
Road width (X9) = .879
Accessibility (X11) = .693

The fourth factor is named non-residential factor. It accounted for **9.81%** to the explanation variance. This factor loads positively high on two variables. For the fourth component, a total of 13 TAZs had positive coefficients loadings with 5 localities indicating coefficients values of .5 and above and thereby implying that the factor has positive impact in those areas.
Non-residential landuse (X5) = .905
Number of churches (X8) = .567

The fifth factor is named road segment factor and it accounted for 7.56% variance. It is so named due to its positive loadings on road segment (X15 = .904). this factor had 10 positive coefficients loadings with only 3 TAZs having coefficients values of .5 and above and thus implies that on a general note the road segment in the study area is poor as it shows significant positive effect in just 3 localities (Table 6). Therefore the pedestrian traffic movement in Uyo can be influenced basically by these five dimensions.

Table 6: Factor Scores as predictor variables and traffic volume

TAZ	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Y
1	0.441626	0.469653	-1.51951	0.440661	-0.40064	390
2	0.38634	0.968463	-0.80657	1.402196	-0.89767	380
3	-0.1748	-0.39286	-0.00808	-1.28673	-0.41034	300
4	1.494288	-0.91414	2.347831	-0.37575	-0.8402	475
5	-0.05781	-1.03853	-0.26752	-1.22931	0.020702	310
6	0.160312	-1.47769	-1.53208	-1.39748	-0.02602	427
7	0.953135	-0.76516	-0.70377	0.239603	-1.22821	373
8	-0.63955	1.591638	2.67138	-1.49744	-0.88465	281
9	2.296514	-0.46126	-0.15928	0.313961	0.376032	475
10	-1.02746	-0.77831	0.66438	0.380864	3.450047	368
11	2.491287	1.040687	-0.56582	-0.71381	2.107613	675
12	0.633509	-0.52415	-0.27457	0.11801	-0.54054	234
13	0.118418	0.221953	-0.04814	-0.37504	0.377159	375
14	0.094689	0.226732	0.795301	2.730334	-0.3625	295
15	-0.53208	-0.87675	1.231937	1.064155	1.230595	311
16	-0.51256	0.40632	0.256372	0.489872	-0.22118	310
17	-0.14995	-0.23358	-0.04123	-0.1134	-1.07537	256
18	-0.67905	-0.34129	-0.45091	-0.02376	-0.58222	258
19	-0.89509	-0.37932	0.266662	1.19242	-0.46831	233
20	-1.07496	-0.19302	-0.41098	0.493465	0.465632	229
21	-0.92273	0.489891	-0.45433	-0.49748	-0.22037	285
22	-1.27347	0.942964	-1.24058	0.588276	0.05158	303
23	-0.77258	-0.28163	-0.63068	-0.26852	-0.04254	257
24	-1.26964	-0.0128	-0.00211	-1.70017	0.034521	236
25	0.483087	-0.96827	0.899265	0.405413	-0.31867	420
26	0.428552	3.28047	-0.01697	-0.38034	0.405547	342

Source: Author's statistical analysis (2019)

To investigate the influence of the key determining factors on Pedestrian traffic volume, the pedestrian traffic volume data (dependent variable) and the factor scores derived from principal component analysis (independent variables) as shown in Table 6 were used. Simultaneous multiple linear regression analysis

was conducted using the factor scores as predictor variables against pedestrian traffic volume. The regression outputs are presented in Tables 7-9.

Table 7: Model Summary of Regression Analysis

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df 1	df 2	Sig. F Change	
1	.890[a]	.793	.741	50.921	.793	15.314	5	20	.000	2.653

Table 8: ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	198550.337	5	39710.067	15.314	.000[a]
	Residual	51859.817	20	2592.991		
	Total	250410.154	25			

Table 9: Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.	95% Confidence Interval for B		Correlations		
		B	Std. Error	Beta			Lower Bound	Upper Bound	Zero-order	Partial	Part
1	(Constant)	338.385	9.987		33.884	.000	317.553	359.216			
	Factor 1	**81.097**	**10.184**	**.810**	**7.963**	**.000**	59.853	102.341	.810	.872	.810
	Factor 2	2.820	10.184	.028	.277	.785	-18.425	24.064	.028	.062	.028
	Factor 3	-3.536	10.184	-.035	-.347	.732	-24.780	17.708	-.035	-.077	-.035
	Factor 4	-8.969	10.184	-.090	-.881	.389	-30.213	12.275	-.090	-.193	-.090
	Factor 5	**35.559**	**10.184**	**.355**	**3.492**	**.002**	14.315	56.803	.355	.615	.355

a. Dependent Variable: Traffic Volume

From the result, variance in the traffic volume is explained by the five factors by the combined coefficient value of .890 which represents 79.3% of the variance in traffic volume and this is quite a high result (Table 7). The significance of this result can be observed in Table 8 on ANOVA as it tests the null hypothesis that multiple regressions equals zero. This result reached statistical significance (Sig. = .000) and therefore calls for rejection of the null hypothesis. Table 9 further explains the performance of this analysis by identifying the factors that made significant contribution towards understanding the variations in the traffic volume. The Beta column under the standardized coefficients compares the different factors with a view to identifying the factors with the highest values. In this case, factor 1 which is demographic and facilities factor (.810) made the strongest unique contribution to explaining the variance in traffic volume when all other factors are held constant. The next significant factor is factor 5 which is road segment as it contributed to explaining the variation in traffic volume (.355) when all other factors are controlled. All the other factors made very weak contribution to the understanding of the variance in traffic volume (X2=.028; X3= -.035; and X4= -.090). The part correlation coefficient when squared, gives the contribution each factor has makes to the total R square which in this case is 79.3%. Factor 1 has a part correlation coefficient of .810 (Table 9) which when squared represents 65.61% and implies that this factor alone uniquely explains 66% of the variance in traffic volume. However, Factor 5 on the other hand uniquely explained 12.60% of the variance in traffic volume going by its part correlation coefficient value of .355. These two factors had a combined effect of 78.20% on traffic volume leaving just 1.1% of the variance in traffic volume to be explained by Factor 2, Factor 3 and Factor 4 thereby making them not significant in predicting traffic volume in Uyo.

Discussion of the result

It was observed in the study area that transport facilities investments in Uyo metropolis apparently work against pedestrian movement as no conscious provision is made for pedestrian transport. Equally, noticeable within the congested road, is competition between pedestrians and vehicles who try to claim right of way and refusal of pedestrians to make good use of footbridges provided for them. Another important finding in the study area is indiscriminate parking of vehicles along the road corridors meant for pedestrians and therefore exposed them to dangers of road accidents. The result of Principal Component Analysis (PCA) revealed that, the data on fifteen pedestrian variables from the field however, produced five (5) components with Eigen values exceeding 1, which together accounted for a total of **79.17%** of the variance explained of all the traffic analysis zones in the study area. These include, demographic and facilities factor, distance and literacy factor, Accessibility factor non-residential factor, and road segment factor. The result corroborated with that of Nawrocki, Nakagawa, and Oba (2014) whose study concluded that using Principal

Components Analysis for quantifying walkability and pedestrian movement yields fruitful useable results in pedestrian studies in USA and Japan.

In addition, the result of the overall significant of the regression of the predator variables on the dependents variable at 0.005% significant level in the twenty six traffic analysis zones of the study area showed that the predators significantly explained variations in pedestrian traffic volume. The demographic and facilities factor (.810) made the strongest unique contribution to explaining the variance in pedestrian traffic volume followed by factor 5 which is road segment when all other factors are held constant. All the other factors made very weak contribution to the understanding of the variance in pedestrian traffic volume. This result tend to agree with the findings of Robertson, *eta l* (2012) and Schneider, (2009) that land uses, design characteristics and socio-economic factors influence pedestrian traffic movement in public urban realm. It was therefore, concluded that there was a statistically significant relationship between emerging pedestrian determinants (demographic and facilities factor, distance and literacy factor, Accessibility factor, non-residential factor, and road segment factor) and pedestrian traffic volume in Uyo metropolis at ($p=0.000$; $p<0.05$).

Recommendations

It is expedient for Akwa Ibom State government to formulate and implement policies that would have bearings on the key determinant factors with a view to encourage and promote sustainable transport development due to its health, transportation, economic and environmental benefits, thereby resolving some of the adverse environmental and health impacts of car dependency in the study area. Public enlightenment is needed for residents to understand the benefits of Pedestrian transport. Pedestrian transport facilities should be integrated into the transport infrastructure in the city by the government through relevant agencies, traffic calming policies and speed limits should be introduced and enforced according to a functional classification of spaces, streets and road networks in the city, supported by appropriate infrastructure design criteria to create a low-risk and amenable environment for pedestrian traffic. In addition, Safety measures should be incorporated in the design of commuter and pedestrian facilities. Transportation in Nigeria is a peculiar one as it is predominantly car-based, and the available road infrastructure is hugely overstretched. In Uyo, the residents rely heavily on informal paratransit modes such as minibuses, taxi services, tricycles, and motorcycles, due to low attention that has been paid to pedestrian transport. The trend toward increased motorisation is especially dangerous for the urban populace and should be discouraged.

Conclusion

Studies have shown that this form of transportation has been greatly marginalised in many cities as traffic congestion and automobile-oriented design have driven pedestrians away from the streets Saelens, and Frank, (2003). This situation has encouraged the use of private car for everyday activities. Yet there is growing concern about the unsustainability of urban environments and a related acknowledgement of the need to reduce auto- dependence and encourage pedestrian transport. Various socio-environmental problems are attributed to increased automobile dependency in cities, including social exclusion for those without access to a car, and a loss of community and street life and pollutants emissions South worth, (2003) and Victor and Akpan, (2016). To this end, study has established, with respect to Uyo metropolis, the five major factors influencing pedestrian transport. Therefore, basic standards should be set with regard to these parameters and compliance should be strictly monitored by the urban designers and other relevant authority such as, Urban and town planning and Ministry of transport, Uyo capital city development authority and federal road safety commission (FRSC). Therefore, constant improvement of the service level of these factors should constitute part of the public transportation planning and administration agenda of the Urban and town planning and Ministry of transport hence forth.

The study area was demarcated into twenty six zones based on the major roads, population, boundaries and settlements. Inferential statistics model were developed using principal component analysis and multiple regression. Assessment of the major factors affecting the pedestrian mode of transportation was also done. It can be concluded from the research that the central zone showed the highest percentage of pedestrian movement in the study area. The statistical model showed that

pedestrian movement and socio-demographic and facilities factor are inversely proportional. The R^2 value of 69.4% established the robustness of the model and thus confirms the positive relationship existing between pedestrian mode of transportation and socio-demographic/facilities factor. Based on the result of the analysis, it can be concluded that demographic/facilities factor and road segment factor are the major factors affecting pedestrian transport.

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EFFICIENT MODEL FOR HARNESSING WIND ENERGY THROUGH PUBLIC-PRIVATE PARTNERSHIP (PPP): DEVELOPING COUNTRIES PERSPECTIVE

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Abstract
The aim of this paper is to work out an efficient model for Public Private Partnership (PPP) in wind power generation for developing countries, with proper definition of the role of the key stakeholders The design is a in-depth understanding of what factors lead to successful outcome of Public Private Partnership (PPP) for wind energy projects in a big developing market like India. The data was collected through personal interviews/ interaction with clients, other sources, administering questionnaire to the clients and then factor analysis (SPSS) was applied to obtain needful factors for working out an efficient PPP model for wind energy in a developing market. In the efficient PPP model, the four key stakeholders were been identified as - private developers, government, utilities and the communities. With application of factor analysis, the importance of each stakeholder and the role they should be playing has been identified. The private developer is the first most important stakeholder with key contributions.
Keywords: Wind Energy, Competencies, Public Private Partnership (PPP), Policy, Tariff

Introduction

Exploiting wind for electricity generation has opened-up new horizons for the world. The major advantage of wind for generation of electricity is that it is pollution free green energy and is available in plenty free of cost. In-spite of efforts by the government, the power deficit in the country like India has not been bridged due to structural issues and scarcity of funds. With the ongoing policy framework, the current installed capacity of approximately 38000 MW wind power has been achieved, out of the total renewable energy capacity of approximately 87000 MW in India at present. By year 2022, target of 60000 MW of wind power has been planned which will take up the wind energy contribution to 16-17 percent of the total installed capacity of electricity of 375323 MW in India (central electricity authority). Private participation in the wind power generation has become imperative with a clear learning that without private developers, power sector reform is difficult to take place in the country. Wind energy is one of the cheapest means of electricity generation the world over. More than 90 countries are harnessing wind energy and 9-10 countries have harnessed more than 10000 MW each till date. In the years ahead, wind is going to be more competitive on price, technology and performance.

Literature Review

Though PPPs are becoming increasingly popular for the development of various infrastructures, in the review it has been found that there are no systematic PPP guidelines for the smooth execution of wind energy projects. There is some coverage of PPP on harnessing wind energy in Portugal but not discussing specifically about the critical success factors (Ana Cravinho Maetin, Carllos Olivier Cruz, 2011). Madhu and Payal (2014) extensively reviewed the wind energy situation in India and tried to cover some existing gaps in terms of how to harness it better. Carolin Mabel, Fernandez E (2007), have stated that there is enormous potential of wind energy in some Southern and Western states of India covering Tamil Nadu, Andhra Pradesh, Maharashtra, Gujarat, Karnataka and Rajasthan. The wind potential initially assessed at a certain web height has now been revised with proper and accurate wind resource assessment data at a proper rotor height of 80/120 meters and above. Darrin Grimsey, Mervyn K Lews (2007) state that normally constraints in availability of public funds for infrastructure projects have compelled ggovernments to go for private sector participation for executing the projects. It has been clearly stated and established that PPP is not merely an approach/strategy to develop the projects by transferring all the risks to private sector with no further involvement of government. Many papers have suggested the need of research and development to be taken up jointly by industry and academia to link up the missing pieces.

It has been further observed that deficiency still exists in smooth execution of public private partnership (PPP) model relating to contractual issues and role clarity. The status of the public private partnership in a few Indian states and to some extent on national level has been described by Ashwin Mahalingam (2007). Institutional barriers, government policy, regulatory frame-work, risk allocation and non-clarity on contractual aspects have been projected. The literature depicts good amount of information/details on role of

PPP in infrastructure development but not specifically on wind energy. Very few papers have deliberated on framework of good model of PPP for wind energy. After critical review of the literature, it is evident that there are gaps in the framework of PPP model, particularly for wind energy in the developing markets. Keeping this in view, effort has been made here to bring out an efficient PPP model for wind energy for the developing markets.

Method and Data Gathering

After evaluation of various research methods, finally the case study approach was selected with both qualitative and quantitative aspects. Secondary sources like utility reports, journals, books and conferences on wind energy were quite useful in collecting the relevant data. This study adopts a *Case Study Approach*: The study is based on information collected from India, a country having a good wind potential and harnessing wind energy well. Personal interviews were conducted with the concerned officials of the various states covering the policy framework and other aspects of the project. Data required for the design is obtained through well framed open and close ended questionnaires. Additionally more details were collected by attending conferences on wind energy as well as from secondary sources like research journals, books and government reports (Chawla Deepak, Sondhi Neena). The study and comparison of performance of various wind energy projects in India has given useful inputs and insight for working out the model. After interviews with the officials and analysis of the secondary sources, the competencies table was developed as shown below in table 1. Competencies highlight the various key activities of the project which need to be carried out properly for the successful implementation of the project.

Table 1: Competencies of the Wind Project

Set 1 (Project approval)	i. Project identification ii. Appointment of consultant iii. Wind resource data iv. Wind farm location/selection v. Project report approval vi. Technology/know how
Set 2 (Capital, contracts)	i. Capital funding ii. Contract management iii. Power purchase agreement iv. Project procurement v. Inspection certificate
Set 3 (Land acquisition)	i. Land acquisition ii. Forest clearance
Set 4 (Project execution)	i. Transport to site ii. Erection, commissioning iii. Operation, maintenance iv. Training and education
Set 5 (Grid, transmission)	i. Grid/Transmission ii. Tariff fixation iii. Policy, regulatory
Set 6 (Payments)	i. Payment to developers ii. Financial closing
Set 7 (Operations)	i. Wind power storage ii. Hybrid system operation iii. Managerial expertise
Set 8 (Communities)	i. Awareness about wind energy ii. Education/training iii. Co-operation with authorities

Source: Activities of typical Wind Energy Project

Keeping in view the set-up of overall wind projects and the various competencies/activities (Table 1), qualitative questionnaire was prepared covering various stake holders and agencies involved such as consultants, manufacturers, utilities/state electricity boards, grid, Ministry of New and Renewable Energy (MNRE) and communities/villages. Another equally important exercise was the selection of suitable respondents and their contacts. In this case it was not a general coverage/survey but a selection of persons having relevant expertise in the wind energy.

Qualitative Findings

Most important competencies as per qualitative feedback:

***Wind farm location/selection*:** Suitable site/land selection is of utmost importance and has to be based on wind resource data provided by National Institute of Wind Energy (NIWE).

***Land acquisition*:** This is the foundation of the project. Availability of land free from all disputes/legal aspects should be made available timely.

***Technology*:** Technology is presently available to manufacture sets up to 2 to 2.5 MW indigenously. Technology for higher capacity which may be required in near future and for off-shore plants needs to be developed indigenously.

***Power purchase agreement*:** This is the most vital aspect in the contract and needs proper attention, agreement and implementation.

***Grid availability*:** Grid/Transmission lines readiness is as important as the land acquisition.

***Tariff*:** This is to be decided between the developer and the utility. All concerned like developer, Central Electricity Regulatory Commission (CERC), State Electricity Regulatory Commission (SERC), Ministry of New and Renewable Energy (MNRE) have to work in unison to arrive at the right tariff.

Quantitative Findings

Relevant questions were framed making use of competencies of the project and qualitative findings, for mailing to the key stakeholders. Questions were further consolidated during meetings with the clients in wind energy conferences. Well framed questionnaire was mailed to 90 respondents involved in different areas of the project on wind energy. The number of respondents was limited as only relevant officials having sufficient experience in the said field were contacted. Sixty (60) respondents responded to the questionnaire.

Factor Analysis: Factor analysis was carried out using SPSS software, clubbing the attributes and to arrive at the main factors. Factors derived from the analysis are stated below.

Factor 1

PRIVATE DEVELOPER
(Factor 1-> Variance explained = 31.2%)
Attributes:
Amount of capital invested
Strong management inputs
Latest technology provided
Grid co-ordination work with utilities
(All above have factor loadings > 0.6)

Private developer provides the capital needed for the project with proper incentive from the government. Private developers have found wind energy business quite beneficial/attractive to invest. With their funds, efficient management, latest technology acquisition and grid co-ordination, private developers play an important role in wind energy projects.

Factor 2

GOVERNMENT
(Factor 2-> Variance explained = 24.1%)
Help in land acquisition & forest clearance
Helpful policy/regulatory framework
Attributes:
Transparent tariff fixation
(All above have factor loadings > 0.6)

Government plays a very big role in giving boost to wind energy with provision of suitable land, progressive policy framework, incentives/subsidies, tariff fixation, transmission lines, wind resource data and testing facility for wind turbines. An important point to note is that the grid which is normally in the scope of government / Power Grid Corporation of India limited (PGCIL) needs timely completion to intake the wind power generated. This causes a great setback/delay to the wind projects. It is suggested that private developer should be associated right from the beginning with the monitoring of grid to ensure its timely availability.

Factor 3

MARKET (Factor 3-> Variance explained = 19.8%) Attributes: Clear role of state/town electricity boards and utilities Utilization of renewable in the total power mix of utilities Land/ site provision assistance (All above have factor loadings > 0.6)

Wind power is considered as a commodity that is tradable, exchangeable and transparent like other forms of energy. State electricity board (SEBs) and utilities play an important role in smoothly transferring the wind power generated into the overall grid system and further distribution..

Factor 4

COMMUNITIES (Factor 4-> Variance explained = 13.1%) Attributes: Awareness regarding wind energy and how it helps them in an environment friendly way? Education/ Training on the best use How co-operation with authorities can help communities in the long run? (All above have factor loadings > 0.6)

This aspect is very important and needs focused attention from the government as well as the private developers. Communities/villages near the wind energy project should be made aware of and educated about environmental benefits of wind power and how the wind energy projects help through proper education/training. This will help in getting their co- operation for the wind energy projects set up.

***Overall*:** Hence, the four factors emerged as Private developer (Factor 1, variance explained = 31.2%), Government (Factor 2, variance explained = 24.1%), Market (Factor 3, variance explained = 19.8%) and Communities nearby wind generation source (Factor 4, variance explained = 13.1%). Total variance explained by the four factors is = 88.2%, which is quite significant. The key attributes outlined under each factor in the PPP model have a factor loading of > 0.6.

Combining these four important factors, an efficient PPP model for wind energy in developing markets has been developed as shown in fig.1 below. This model can act as a guide for executing wind energy projects using PPP tool in developing countries.

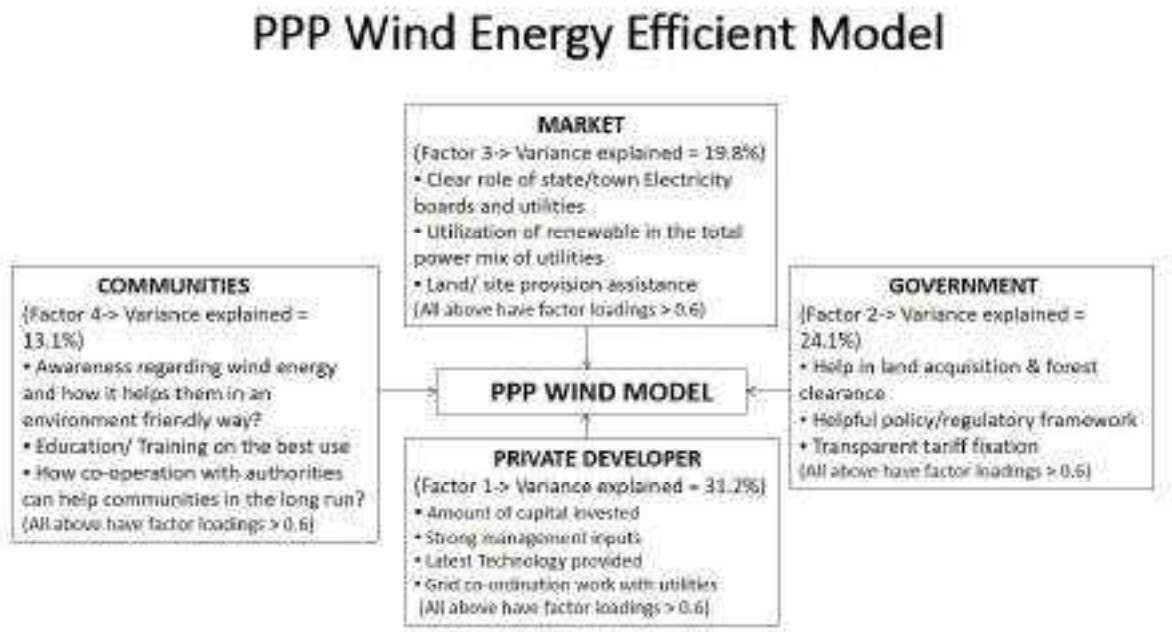

Fig 1 PPP Wind Energy Efficient Model

Conclusion and recommendations

The research topic was chosen after in depth survey of literature keeping in view the need of power sector reform in the country and also the role which renewable energy can play in climate change. Earlier not much information was available on Public Private Partnership aspect for wind energy. Effort has been made to bridge the knowledge gap by working out an efficient PPP model. In light of the existing scenario, PPP arrangement would be the most feasible and justified option for the policy makers and stakeholders in a developing country like India. The job is not that simple as it needs a stable government with sound economic state in the country. Another important issue is the grant of subsidies/tax benefits to the private developer which is again in the government hands .This acts as a big boosting factor and a catalyst for stakeholders to concentrate on development of wind energy. Of late the trend is either to minimize the subsidy or totally withdraw. In view of not many examples existing globally today on use of PPP in harnessing wind energy, the findings here will definitely establish a strong foothold .It can be very well summarized here that the results look quite optimistic, favourable and likely to generate some useful debate and research for further improvement in this field. In view of the power sector reforms taking place at a fast pace in India, the renewable/clean energy attains the top-most priority. The pre-supposed hypothesis has been suitably addressed that with the use of efficient PPP model and with the proper involvement of stakeholders, wind energy harnessing can be better achieved in the country.

In India, wind projects are being executed by private developers with the help of progressive policy framework from the Government. With encouraging government policy and incentives in place, private developers can invest right capital in setting up the wind farms in a big way. The efficient PPP model developed here can be suitably adopted in various infrastructure projects like airports/ports, bridges, housing, education, healthcare, water schemes and waste management in developing countries. The Government is trying a well established policy/programme of reform, targeting more sustainability and efficient taxation and subsidies (for renewable energy like wind).Some implications do crop up in the initial stages of the project like availability of suitable land, environment clearance and acceptable tariff fixation.

Scope for future research

Industry and academia need to work together on wind energy solutions as this field requires lot of research and development to achieve better technology. Thrust on hybrid system projects, wind and solar combined plants in the same location, could be a good preposition in future.

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Declaration of Interest: None

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SOIL EROSION MODELLING IN AKWA IBOM STATE USING REMOTE SENSING, GEOGRAPHIC INFORMATION SYSTEM AND REVISED UNIVERSAL SOIL LOSS EQUATION

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Abstract
Soil erosion is one global challenge today that calls for urgent intervention. Akwa Ibom State is faced with one form of erosion or the other. Impact of soil erosion is evident in soil loss, loss of agricultural land, poor agricultural productivity, loss of eco-system, landscape deformation, reduction in surface water quality and poor and unhealthy development in many parts of the world. Modelling of soil erosion is important for the achievement of sustainable management and control practices. The Revised Universal Soil Loss Equation (RUSLE) is a widely accepted erosion model that can simulate soil erosion and give quantitative estimate of soil loss in a region. The present study adopted the RUSLE model with remote sensing and GIS to assess soil erosion in a section of Akwa Ibom State. Parameters of the RUSLE model which include rainfall erosivity, soil erodibility, slope length and slope steepness, land use land cover and support practice factor were processed through remote sensing, GIS and laboratory analysis. Data sources included ASTER DEM of 30m resolution, Landsat 8 satellite image 30m, rainfall data of Akwa Ibom state and raw soil samples obtained directly from field. The result of average annual soil loss for the region ranged from 0 to 1183.17 tons/ha/yr and the average soil loss rate was estimated at 6.36 tons/ha/yr. Erosion severity map was generated and reclassified into 5 probability zones of extreme, high, moderate, low and very low. Extreme class covered 9.6%, high class was 10.4%, moderate class was 10.5%, Low vulnerability zone was 16.7% and very low range of vulnerability covered 52.8%. The result also revealed that rainfall, farming practices, soil and topographic factors were the major causes of soil loss in many parts of the state. The result of this study can aid in planning and implementing best strategies for the management and control of erosion in Akwa Ibom State.
Keywords: soil erosion, modeling, soil loss equation, GIS, Akwa Ibom State

Introduction

Soil erosion one of the most significant global challenges facing the environment today. It is one of the major causes of land degradation and soil loss. The overall effect of soil erosion is seen in soil loss, loss of agricultural land, poor agricultural productivity, loss of eco-system, landscape deformation, reduction in surface water quality, poor and unhealthy development in many parts of the world. Amsalu and Mengaw, (2014) asserted that soil erosion is a function of spatial and temporal variation and interaction of different natural and anthropogenic factors. Badulescu et al. (2017) stressed that soil erosion is a natural occurrence that models the land surface, building large geological ensembles and erosion relief. Soil erosion results from several natural and anthropogenic factors ranging from rainfall, topography, soil, land use land cover and management practices. In recent times several regions of Akwa Ibom state have witnessed one form of erosion or the other, and these have posed some level threats to many. The effects have been seen in loss of houses, destruction of portions of major roads, destruction of valuable lands and hindrance to sustainable development. The overall impacts have affected the social, political, economic and environmental setting of various portions of the state. Effort by individuals, government and other agencies to curb the situation will only be sustainable when there is necessary information on the spatial distribution, magnitude and extent of degradation done by erosion. Identifying critical areas and assessing the rate and magnitude of degradation will assist developing strategies, assessing priorities and implementing the best management practices. A geospatial assessment and modelling of soil erosion vulnerability is a very vital tool for effective planning and management of the available natural resources and will support sustainable development. Erosion is dynamic in nature it becomes necessary to examine the dimensions, nature and complexity of the various factors that play in erosion menace including anthropogenic factors, soil features and climatic factors and terrain parameters. Soil erosion mapping with remote sensing and GIS provides a reliable platform to identify areas of potential soil erosion risk and can yield useful information on the estimated value of soil loss with respect to locations (Tang et al. 2013, Ashiagbor (2013, Tagore et al. 2012). The integration of experimental data and erosion models with remote sensing and GIS provides an excellent platform in interpreting realities and analysing the spatial dimensions and extent of erosion and other ecological parameters. Remote sensing and GIS are effective and complementary tools in modelling and analysing environmental phenomena (Kalambukattu and Kumar 2017; Kumar and Kushwaha 2013; and Farhan and Nawaiseh, 2015). The Revised Universal Soil Loss Equation (RUSLE) is an erosion model that can model

soil erosion and give quantitative estimate of soil loss in a region. This work seeks to assess soil erosion, map soil erosion vulnerability and estimate the average annual soil loss in a section of Akwa Ibom State using the Revised Universal Soil Loss Equation (RUSLE), Remote Sensing, and GIS.

Study Area and Methodology

The study area is a section of Akwa Ibom State which spans through the north, central and eastern part of the state. It covers seven local government areas including Ini, Ikono, Itu, Ibiono Ibom, Uyo, Ibesikpo Asutan and Uruan LGA. The study is located in the coastal and southern part of Nigeria and is bothered in the south by the Atlantic Ocean. Akwa Ibom state is a major coastal zone in Nigeria with sandy beach and mangrove forest. It is bounded by latitudes $4^{0}20^{1}$N and $5^{0}12^{1}$N and $7^{0}31^{1}$E and $8^{0}11^{1}$E. The underlying geology is mainly the coastal plain sediments which comprises of poorly consolidated sands and sandstones. Around Itu, Ibiono Ibom and Ini Local Government Areas, there are large deposits of coarse sand and mud along the various river valleys (Udosen, 2008). Akwa Ibom State is generally of a flat terrain but has an undulating topography in some locations especially in the study area. Some areas are as high as 200 feet above sea level. The area is generally characterized by two major climatic seasons; the wet season and the dry season. The wet season lasts between the month of March and October and in some years may extend to November. Soil types include coarse sand, fine sand, very fine sand, silt and clay. Soil analysis indicates that there is a very high proportion of coarse sand, low proportion of fine sand, and very low proportion of very fine sand, silt and clay. The low percentage of clay in the soil samples suggests high susceptibility to erosion especially in the absence of vegetative cover. Land use land cover types include vegetations, farmland, water bodies and settlements.

Primary data sources used in this work include soil samples taken from the field and the GPS coordinates of the locations of these soil samples. Secondary data are mostly satellite data which include Optical Multispectral Imagery (ASTER DEM), the Operational Land Imager (OLI) of landsat 8, 2016 satellite imagery and rainfall data.

Landsat 8 (OLI) image of 2016 was of 30m resolution and had a path 188, row 56 and 57. The Landsat image was used to derive the cover management C factor through the Normalised Difference Vegetation Index (NDVI). Advance Space Thermal Emission and Reflection Radiometer (ASTER) DEM was of 30m spatial resolution. It was obtained from the website of USGS. The Revised Universal Soil Loss Equation (RUSLE) is an empirical-based soil erosion model that was developed in 1960s by Wischmeier and Smith as Universal Soil Loss Equation (USLE) and used in predicting annual soil loss. It is the most frequently used empirical soil erosion model worldwide. The USLE was the earliest model which was later modified into the Revised Universal Soil Loss Equation by including improved means of computing soil erosion factors and other versions have been derived from it such as the Modified USLE (MUSLE). RUSLE predicts the long-term average annual rate of erosion based on the rainfall pattern, soil type, nature of terrain or topography, cropping system and management or control practices. It is the most adopted erosion model applied worldwide to soil loss prediction today. This model has convenience in application and compatibility with GIS (Kartic et al. 2014). The RUSLE relates six factors in calculating soil loss and the parameters are expressed in the equation as

$A = R * K * (LS) * C * P$ Where A = Computed Soil Loss per Unit Area or average annual erosion rate (tons/ha/yr) or (ton/acre/yr); R = Dimensional Rainfall-Runoff Erosivity Factor (Index) (MJ/ha*/mm/hr); K = Dimensional Soil Erodibility Factor (tons/ha/yr)/(MJ/ha*mm/hr); LS = Slope Factor (unit less); C = Land use/ land cover Factor (unit less); P = Conservation Practice Factor (unit less)

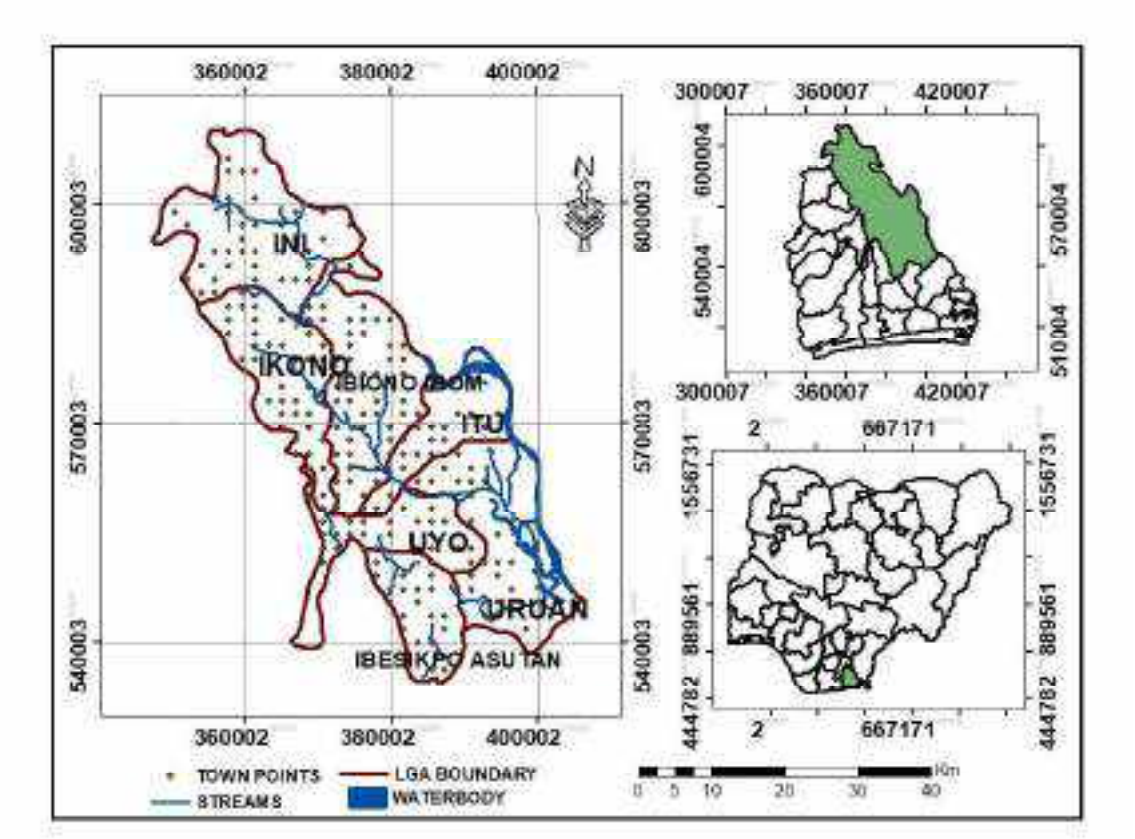

Figure 1: Map of study area

Average Annual Soil Loss (A): The average annual soil loss A represents the potential long-term average annual soil loss in tonnes per hectare (tons per acre) per year ($t/ha^{-1}/yr^{-1}$). This is the estimate which is compared to the tolerable soil loss extent.

Rainfall erosivity (R): Rainfall erosivity R is the amount of the intensity of rainfall and subsequent effect on soil erosion. Rainfall erosivity is the capacity of rainfall to cause soil erosion by water. The erosivity index of rainfall for a rainfall event (energy-intensity values – EI30) is calculated using the total kinetic energy and maximum 30 min intensity of individual events (Yin et al. 2015). EI30 refers to the erosivity index of a storm in 30 min. E is the total kinetic energy for the event and I30 is the maximum 30 min intensity, i.e., the potential ability of rain to cause soil erosion within 30 min of the storm (Kusimi et al. 2015). Rainfall erosivity is used all over the world to assess soil erosion. The higher the velocity and larger the size of the raindrops, the higher the kinetic energy and subsequently soil loss (Isikwue et al (2015). Also, Yin et al (2017), opined that when the intensity and duration of the rain storm is great, it increases the erosion potential.

Soil Erodibility (K): Soil Erodibility factor (K) is used to represent soil susceptibility to erosion, transport tendency of the sediment and the measure of surface runoff given a particular rainfall input, as measured under a standard condition. K is the detachment and disintegration capacity of soil materials on exposure to rainfall and runoff. The major factors affecting soil erodibility include soil structure, organic matter content and permeability. The higher the K value, the greater the susceptibility of the soil to rill and sheet erosion by rainfall. In general, soils with stronger permeability, higher amount of organic matter and quality soil structure have a better resistance to erosion hence a lower K value. Soils containing silt, very fine sand, and clays and has a high shrink swell capacity brings about a higher K value, whereas sandy soils, sandy loam soils and loamy soils tend to be less erodible (Vermont Environmental Conservation). Soil erodibility values could be generated from exiting soil databases or soil maps where they are available such as the Harmonised World Soil Database (HWSD), and can also be obtained from analysis of soil samples obtained from directly from the field. Annemieke de Kort (2013) observed that the most suitable way to calculate the *K* factor is by using data obtained during field work.

Slope Length and Slope Steepness LS: Slope length L is the distance from the point where overland flow begins to the point where concentrated flow or deposition occurs. The LS factor represents a ratio of soil loss

under given conditions to that at a site with the "standard" slope steepness of 9% and slope length of 22.13 m (72.6 ft). The steeper and longer the slope, the higher the risk for erosion. Many studies have revealed that soil loss is much more sensitive to changes in slope steepness than to changes in slope length. In RUSLE and its computer program, complex slopes can be readily represented to provide a better approximation of the topographic effect (McCool et al. 1995).

Land use Land cover Factor (C): The C factor reflects the effect of surface cover and roughness on soil erosion. The C factor is a ratio that compares the soil loss from an area under a specific cropping system and management practices to the corresponding loss from continuously fallow and tilled land. The C factor is applied in the RUSLE to represent the impact of cropping and management system on erosion rates, and is the index used most often to explore the relative impacts of management methods on conservation plans. The C factor reflects the way conservation plan will affect the average annual soil loss and how that soil-loss potential will be managed in time during other activities like construction, crop rotations, or other management schemes (Yoder et al. 1997).

Support Practice P: The Support Practice Factor (P) in RUSLE is used to describe the ratio of soil loss with a particular support or management practice to the corresponding soil loss with straight row upslope and down-slope tillage. The P factor defines the control practices that minimize the erosion potential of the runoff by their impact on drainage patterns, concentration of runoff, runoff velocity, and hydraulic forces exerted by runoff on soil. (Kim 2006). It represents control structure and practices aimed at controlling erosion. Such may include terracing, contouring, ridging and strip cropping etc. The P factor represents the effect of surface condition on flow path and flow hydraulics.

Soil sample: A plan for collection of soil samples was developed for the study area to cover all the LGAs in the study area. Locations were selected in a number of villages to allow an even spread of samples over the area. Stratified random sampling criteria were used in collecting the samples. A total of 76 soil samples spread across the entire study area was collected (38 main samples and 38 composite samples). This was to increase the precision of soil erodibilty estimations on the entire study area. Two different samples were taken at two specified depths; (0-15cm and 0 - 45cm depth) at the designated locations. GPS coordinates were recorded for all positions where soil samples were taken. The samples were immediately taken to the laboratory for air drying in each day of field operation in order to maximize changes in the concentration of extractable nutrients and some organic constituents. The soil samples were subjected to laboratory test and analyses where soil samples were processed to determine certain physical and chemical properties of the soil. Such properties include particle size (sand, clay and silt), porosity level, bulk density, hydraulic conductivity, aggregate stability and organic matter content.

Soil erodibility (K) was calculated from the following equation developed by Wischmeier and Smith (1978).

$$K = \frac{2.8 \times 10^{-5} \times M^{1.14} \times (12-a) + 0.43 \times (b-2) + 3.3 \times (c-3)}{100}$$

Where M = (% silt + % very fine sand) × (100 −% clay); where M is particle-size parameter, *a* is the percentage (%) of soil organic matter content, *b* is soil structure code (1 = very fine granular; 2 = fine granular; 3 = medium or coarse granular; 4 = blocky, platy, or massive), and *c* profile permeability (saturated hydraulic conductivity) class [1 = rapid (150mmh−1); 2 = moderate to rapid (50-150mmh−1); 3 = moderate (12 50mm^{-1}); 4 = slow to moderate (5–15mmh−1); 5 = slow (1–5mmh−1); 6 = very slow (<1mmh−1)]. The calculated erodibility K values were assigned to different locations based on their location coordinates and Inverse Distance Weight (IDW) method of interpolation in ArcGIS was implemented to generate the K-Factor map depicting the spatial distribution of K factor values.

Rainfall erosivity R: In determining rainfall erosivity, 25years rainfall data for 4 rain gauge stations in and around the study area were considered. Spatial distribution of average annual precipitation (P) in the study area was estimated using 'Inverse Distance Weight' (IDW) method of interpolation in ArcGIS. The input used were point datasets such as location coordinates of the NIMET stations. Arcmap cannot read data in degrees, minutes and seconds, therefore the data were converted to decimal degrees before importing using the 'Add XY' tool in ArcGIS 10.5 to generate the point map of the rainfall erosivity before interpolation. The IDW spatial analyst tool in ArcGIS 10.5 takes the concept of spatial autocorrelation literally. It assumes that the nearer a sample point is to the cell whose value is to be estimated, the more closely the cell's value will resemble the sample point's value.

Slope Length and Slope Steepness Factor (LS)

The LS factor accounts for the effect of topography on erosion in RUSLE. The DEMs were processed to derive topographic factors (LS). By visual interpretation and checking of the pixel values of the DEM data,

it was observed that the DEM image statistics was a little distorted. The DEM data had some inherent errors which are called Sinks. Sinks are errors that are often caused by resolution of the data, sampling effects and the rounding of elevations to the nearest integer value. Sinks were filled to ensure proper delineation of basins and streams. The Fill sink was implemented using the ArcHydo extension tool in ArcGIS 10.5. The Fill tool uses the equivalents of several tools, such as Focal Flow, Flow Direction, Sink, Watershed, and Zonal Fill, to locate and fill sinks. The tool iterates until all sinks within the specified z limit are filled. The DEM data were resampled using the nearest neighbour algorithm to keep the original pixel values. The slope length and slope steepness factor were obtained using the map algebra in ArcGIS environment where the following parameters were considered; flow direction, flow accumulation, slope and resolution of DEM. A slope degree map was then generated for the study area from the filled DEM. Flow direction and flow accumulation were also derived in order to generate the LS factors. The Flow Accumulation tool calculates accumulated flow as the accumulated weight of all cells flowing into each downslope cell in the output raster. Flow accumulation is area of concentrated flow and may be used to identify stream channels. In this project, the slope length and slope steepness factor (LS) was calculated using the raster calculation between flow accumulation and slope of watershed because the datasets are easily derivable in a GIS. LS factor was computed using the equation proposed by Wischmeier and Smith (1978) with the DEM as an input data.

$$L = (m+1)\left(\frac{\lambda_A}{22.1}\right)^m$$

Where L is the slope length factor at some point on the landscape, λ_A is the area of upland flow, m is an adjustable value depending on the soil's susceptibility to erosion and 22.1 is the unit plot length. Generally, m = a constant dependent on the value of the slope gradient; 0.5 if the percent slope greater than or equal to 5%, 0.4 on slopes between 3.5% and 4.5%, 0.3 for slopes between 1% and 3% and 0.2 for uniform gradients with slopes less than 1% (Wischmeier and Smith, 1978). As the slope steepness increases, the soil erosion also increases as a result of increase in the velocity and erosivity of runoff.

Deriving cover management factor C

In erosion studies, land use land cover is used to derive the cover management C factor for erosion models. C factor can also be determined from the Normalised Difference Vegetation Index NDVI. The Normalised Difference Vegetation Index (NDVI) is a numerical indicator that applies the red and near infra red bands of the spectrum to assess plant health. The NDVI have extensive application in assessing the relationship between Spectral differences and the changes in the rate of vegetation growth. When plants are healthy, they absorb most of the visible red light and reflect a large amount of the near infra red light and show high NDVI values. Unhealthy plants or sparse vegetation absorb more of visible light and reflect less of the near infra red light. Zeros and negative values of NDVI show surfaces or features that are non- vegetated such as rock, soils, water and ice. NDVI is used in remote sensing to assess whether the target or object being observed contains live green vegetation or not. (Meera et al. 2015). NDVI is derived from the red and near-infrared reflectance measurements of the spectrum as;

$$\textbf{NDVI} = \frac{rNIR - rRed}{rNIR + rRED}$$

Where; NIR is the near-infrared band response and RED is the red band response for a given pixel.

The Landsat image was used to derive the cover management C through vegetation health evaluation using NDVI. The NDVI was first derived using the formula; NDVI = (NIR – R) / (NIR + R); Where; NIR and R indicate channel or band of Landsat 8 which are near infrared and visible red respectively. The band 5 (Near Infra red) and Band 4 (red) of the study area were imported and the formula was implemented in Map algebra in ARCGIS 10.5 using the raster calculator tool. The result from the NDVI was used to compute for the C factor using the equation C = 0.6 – 0.77 NDVI

Estimation of Soil Loss with RUSLE Model

The individual results of the various factors; Climate (Rainfall), Soil, Topography, land cover (vegetation Density) and management practice were obtained. These factors were brought into the RUSLE equation and implemented in a GIS environment to give the estimated average annual soil loss. By bringing the various parameters into the RUSLE model in a GIS environment, the estimated soil loss for the study area was obtained. Overlay operations were performed to reveal different scenarios and classes of erosion and also to validate results obtained from the study. The RUSLE factor maps were overlaid in a GIS environment to reveal the severity of soil loss and vulnerability of erosion in the area. Five classes of erosion severity were considered. They were very low, low, moderate, high, and extreme soil erosion classes.

Result and Discussions

Rainfall Erosivity (R) factor

It was observed that highest rainfall occurred in the south-western part of the study area (Uruan)with erosivity value of 1250.18MJmm/ha/h/yr, and lowest rainfall occurred in Uyo and Ibesikpo Asutan which are in the lower part of the Basin with erosivity value of 1052.3 MJmm/ha/yr. High rainfall erosivity occurring in Uruan might be due to the fact that Uruan is in the coastal region which is always known for heavy and erosive rains. Rainfall pattern in the area is such that rainfall increases southward towards the coast and is less in the hinter-land.

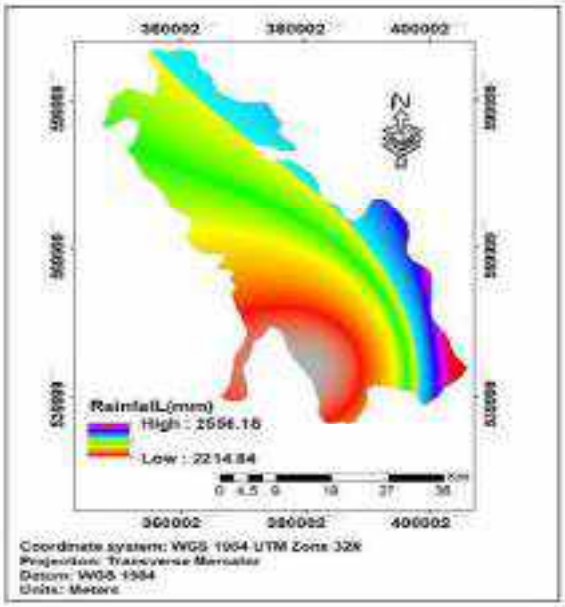

Figure 2: Annual rainfall

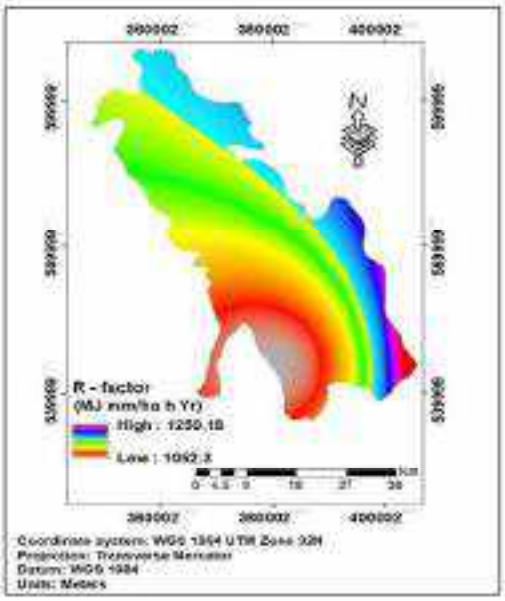

Figure 3: Rainfall Erosivity Map

Soil Erodibility K factor

The erodibility factor K was estimated on the basis of soil texture, soil structure, organic matter content and permeability. Certain intrinsic properties of the soil were determined through laboratory analysis which included particle size analysis and aggregate size distribution. Soil erodibility values ranged from 0.039 (low) to 0.078 (high). Soil erodibility values and the GPS coordinates of soil sample locations were used to generate a soil erodibility map for the area.

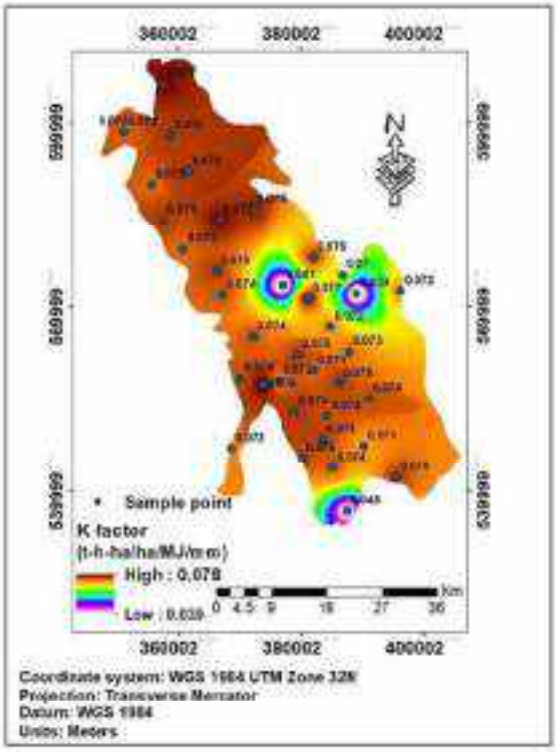

Figure 4: Soil Erodibility Map

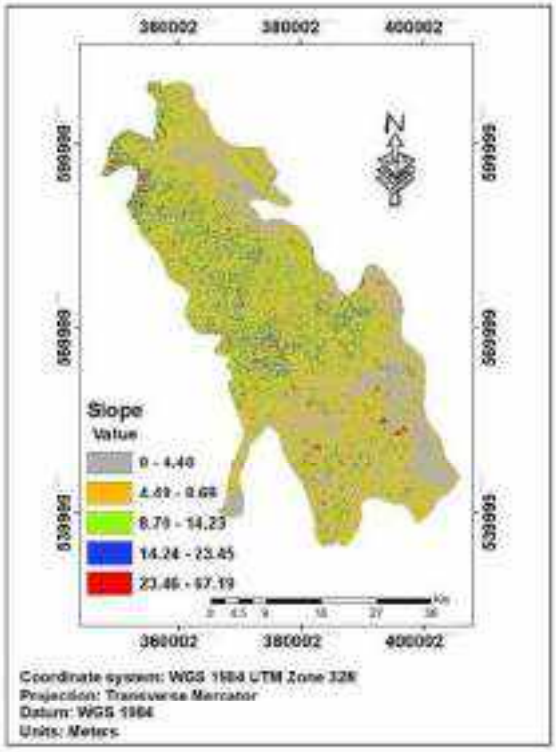

Figure 5: Slope percentage

Topographic Factor – Slope length and Slope Steepness (LS)

Slope Length and Slope Steepness factor (LS) were determined by determining the slope, flow accumulation and flow direction. Slope steepness produces greater impact on soil loss than slope length. The entire area was classified into five different slope classes. The slope classes in the DEM ranged from 0 – 67.19. The slope analysis revealed that a greater percentage of the study area had slope values falling within the range of 0 – 14.23 while a smaller percentage fell within the range of 14.24 – 67.19. Result from slope analysis showed that the longer the slope length, the greater the amount of cumulative runoff. LS factor ranged from 0 (low) to 40 (high). Majority of the study area had low LS factor values whereas very few locations had high LS factor values. The high values may be due to highly dissected terrain with abrupt slope changes in a few locations of the study area. The higher LS factor values were scattered and observed in hilly or mountainous areas and gully areas with steep topography and these areas are more prone to erosion and soil loss. Areas with a high degree of steepness were observed to experience soil loss even with slight and moderate amount of rainfall and soil disturbance. High values of slope steepness were observed in Ini, Ibiono Ibom and Itu.

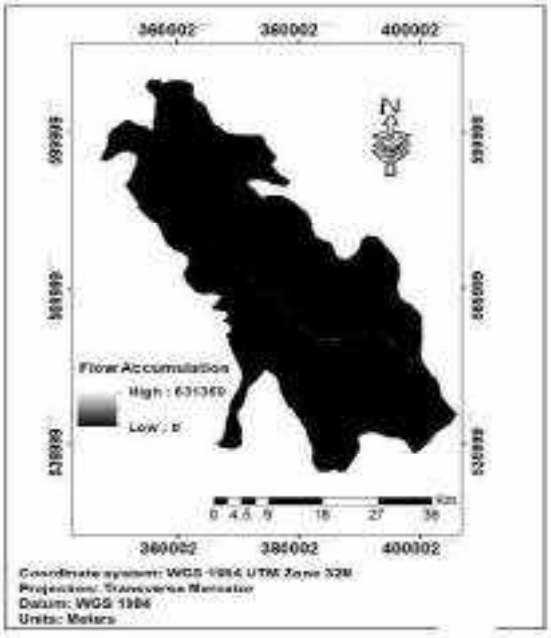

Figure 6: Flow accumulation

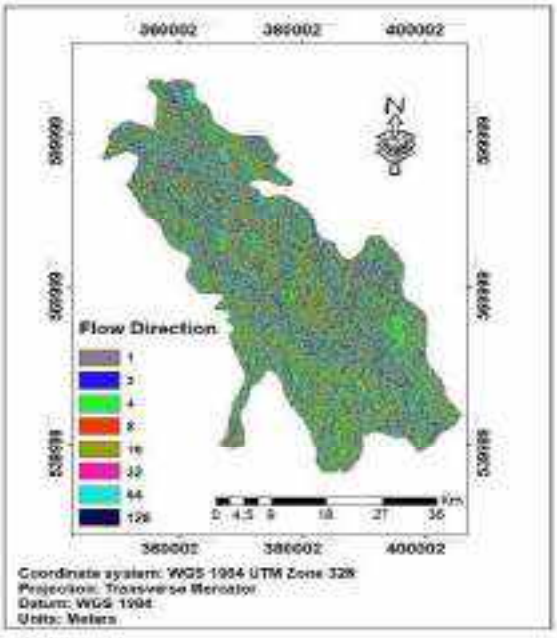

Figure 7: Flow direction

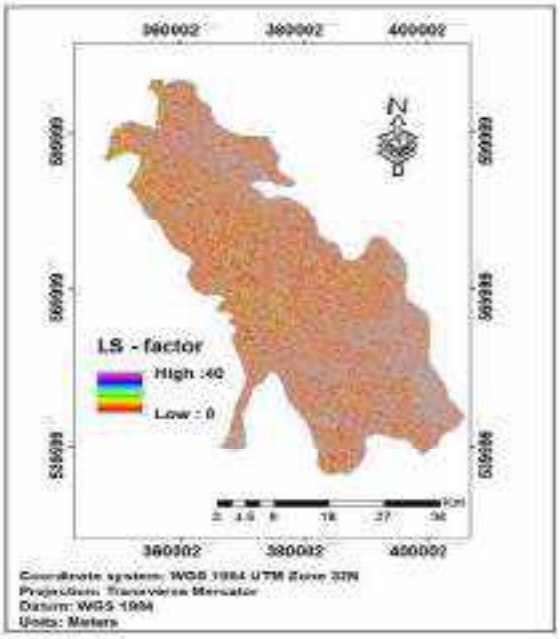

Fig 8: Slope length and slope steepness (LS) Factor map

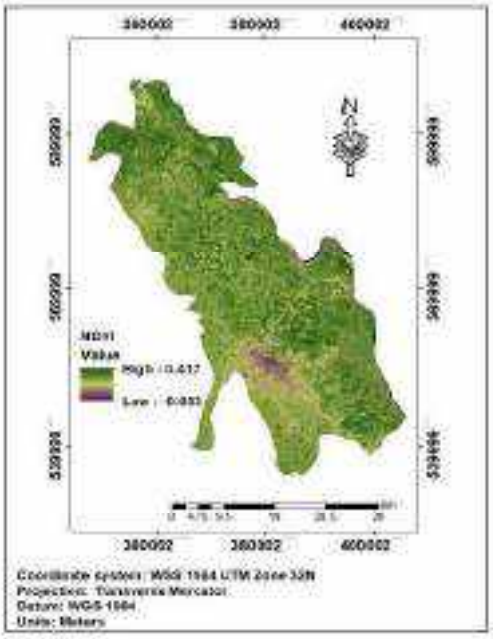

Fig 9: Normalized Difference Vegetation Index (NDVI)

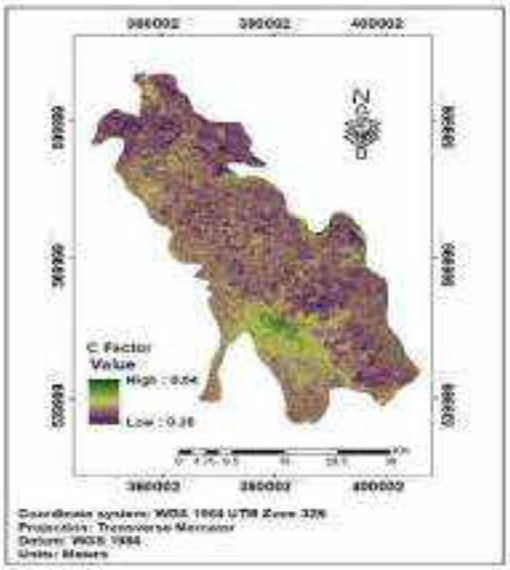

Fig 10: Cover management C factor-derived from NDVI

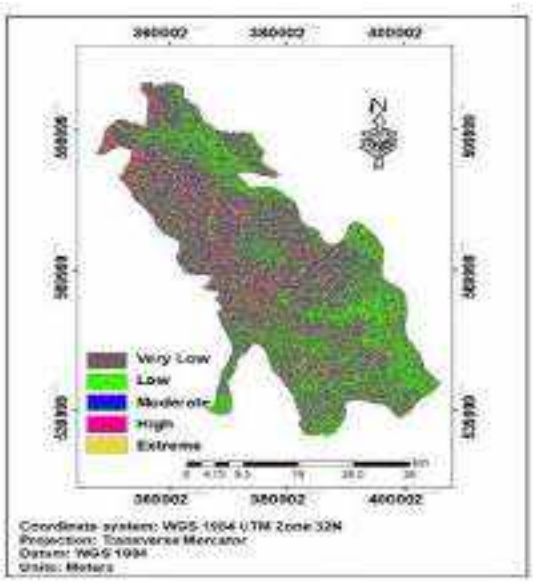

Fig 11: Soil loss map of the study area

Result from NDVI ranged from 0.28 (low) to 0.64 (high). Low C factor values occurred in forested areas, vegetation, and cultivated lands. High values occurred in built up areas.

Support Practice or control practice (P) Factor

P factor represents the index of erosion control based on erosion control practices. During site inspection and ground truthing exercise, it was observed that there was really no practical effort to control soil erosion in almost all parts of the study area. A large portion of the study area were under built up, agriculture and forest and had no support or erosion control practices giving it a support practice factor of 1.0.

Estimated Result of Average Annual Soil Loss from RUSLE Model

The RUSLE sub factors (R, K, LS, C and P factors) were integrated into the equation (A = R *K*(LS)*C*P) by multiplying them together in a GIS environment to obtain the average annual soil loss A within the River Basin. This was achieved using the raster calculator of Arc GIS 10.5. The estimated soil loss rates ranged from 0 (zero) to 1183.17 tons/ha/yr and the average soil loss rate was estimated at 6.36 tons/ha/yr.

Erosion Severity Hazard Map

The integration of the RUSLE model with GIS enabled the estimation of the magnitude and spatial distribution of soil erosion. Maps prepared for the RUSLE factors – rainfall erosivity, soil erodibility, land use land cover, slope length and slope steepness factor and conservation or management practice factor were overlaid in a GIS environment to generate a composite erosion severity hazard map of the study area. The soil erosion hazard map was reclassified into extreme, high, moderate, low and very low erosion classes. The percentage of severity for each class were; Extreme class: 9.6%, high class: 10.4%, moderate: 10.5%, low: 16.7% and very low: 52.8%. Result obtained from the analysis indicated high and extreme classes of erosion were scattered all over the entire study area, and every part of the study area had some level of erosion severity. The higher values of soil erosion were found to occur on abrupt slopes including streams and rivers. Those regions with higher slopes were also affected by rills, gullies as well as mass movement of sediments which were clearly visible during field surveys.

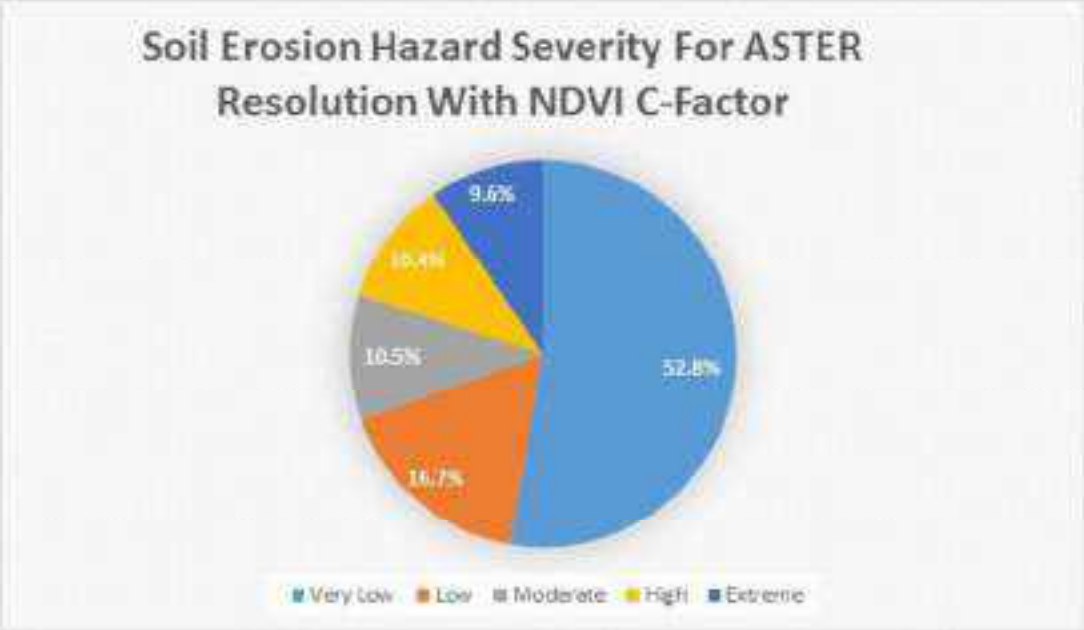

Figure 12: Percentages of erosion severity

The chart above shows the percentage of erosion susceptibility and soil loss according to the class of severity. The result is as follows; Extreme class covered 9.6%, high class covered 10.4%, moderate class covered 10.5%, low vulnerability was 16.7% and very low range of vulnerability covered 52.8%. The result of this study revealed that environmental factors have contributed maximally to soil erosion within the study area. Rainfall, soil and land use land cover were the major factors responsible for severe soil loss in the area. Areas with steep slopes rugged topography were prone to heavy soil loss. [In the study area, bare surfaces were seen to be highly prone to erosion whereas the forested areas were less prone to soil loss. Intensive agricultural practices on steep sloping lands were also observed in most parts of the study area and this could be correlated with the enhanced soil erosion in some part of the study area. Large portions of the vegetative cover were usually cleared yearly for farming purposes which exposed the soil directly to agents of erosion and provoked subsequent detachment and transportation of soil materials. It was observed that there was practically no attempt to check or control soil erosion in almost all part of the study area. Also, the study area is generally made up of built up and forested land. Settlement patterns, nature of buildings and infrastructural development were sited in an unplanned manner without proper drainage systems and due consideration to natural flood paths and routes. Erosion severity/ vulnerability assessment was carried out by classifying the area into five groups according to erosion severity. The classes include extreme, high, moderate, low and very low. From the spatial distribution, severe and extreme erosion was distributed non-uniformly at the pixel level. Extreme cases were seen at the north, central and north east part of the study area.

Conclusion

The rate of soil erosion and subsequent land degradation is increasing and posing some forms of threats to human, properties, agriculture, ecosystems and the environment in general. Empirical soil erosion models provide mathematical estimates of soil erosion and allow precise determination of soil loss and erosion probability zones. A combination of remote sensing, GIS and RUSLE model provides an effective approach for the estimation of soil loss in a River Basin. This research demonstrates the application of an empirical model – RUSLE in combination with remote sensing and GIS to estimate soil loss. Parameters of the RUSLE model were comprehensively evaluated and determined through remote sensing, GIS and laboratory analysis. An attempt was made to study the impact of various factors on soil erosion in the study area such as Land use land cover, soil erodibility, rainfall, topographic factors and support practices. The results and analysis revealed that soil, topographic factors and certain land use types were the major causes of soil loss in the region. Erosion rates and magnitude were also seen to be accelerated by human activities like farming and unplanned land uses. Sand mining was also observed as a common practice in some parts of the study area which is also a major cause of land degradation and a threat to soil erosion. It was also observed that the

rate of erosion varied depending on terrain parameters and agricultural practices. In general, the application of RUSLE model, GIS and remote sensing has proven to be very effective tool in modelling soil erosion. The result of this study will be useful in determining priorities and adopting management and control strategies to reverse the ugly trend of erosion menace in the state.

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EXAMINING THE CONSTRUCTION WASTE MANAGEMENT CONSTRUCT IN ABUJA NIGERIA: A VALIDATION STUDY

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Abstract
This study validates construction waste management (CWM) constructs among construction organisations in Abuja, Nigeria. Using a structured self-administered questionnaire, the data was duly collected from one hundred and seventy-eight project managers/managers of construction organisations. Partial Least Square – Structural Equation Model (PLS-SEM) technique was employed; the data was analysed using Smart-PLS 2.0 M3 software statistical package. Results of this study revealed that all the dimensions of technology readiness namely; optimism, waste recycling and waste reduction were highly relevant. Adequate level of internal consistency reliability, convergent validity and discriminant validity for each of the construct of the construction waste management were established. Based on the results, it is recommended that the CWM instrument could be useful for measuring all the constructs of construction waste management among construction organisations for the achievement of efficient and correct operative construction waste management practice.
Keywords: construction waste management, waste reduction, waste recycling, optimism, Abuja.

Introduction

The waste generation per unit output is greater in Nigeria compared with other developing world due to the inefficiency in construction processes (Opeyemi,2012).Studies have been conducted by scholars to examine the problem of waste management in an attempt to address the issues associated with the construction and demolition waste management. For instance, a study was conducted on the practice and advantages of the onsite-waste reduction as well as the construction waste technology for the reuse of construction and demolition waste(Andersen, 2011).In a related study, Wang (2008) examined the on-site complexity of waste management through the use of a system dynamics approach; it was found that the lack of sufficient Waste Management skills and the use of traditional construction techniques were among the problems associated with waste management. In another study, it was revealed that, lack of motivation to execute the construction and demolition on-site reduction of waste contributed to the ineffectiveness in the management of construction waste. In addition, there is urgency for a set of government rules on Waste Management relatively with low charges of landfill in China (Yuan, 2008). Poorly designed landfill management creates unpleasant environmental impacts in African countries. Cases in point are, windblown waste, breeding pests, and fluid leaked generation. Also, one more basic result of landfills is the release of offensive gas, where the gas is transported from the anaerobic breakdown of the natural environment. The problems of odour created by the gas tend to destroy the natural vegetation and contribute to greenhouse gas (Nagapan, 2012).The ineffective and inoperative waste management practices among construction organisations necessitate for this study.

Review of Literature

Construction waste management has been considered as the collection, transport, treatment and disposal of waste including maintenance of disposal sites (Gbekor, 2003). According to Yusuf *et al* (2016) the construction waste management is referred to as the planning, coordinating, implementing, controlling, supervision and control of non-hazardous material waste or debris created or generated as a result of construction or demolition works to achieve optimum efficiency and better environmental quality. EL-Haggar (2010) stated further that, appropriate construction waste management will offer economic benefits by diminishing the project cost through appropriate waste management plan implementation. The model includes factors, for example, the series of construction activity, the types and the quantity of rate of construction materials, the material waste rate created, the resource availability and capability of waste collection bins, costs and incomes. The key objective of this model is to provide engineer's tool, and to allow the planners and contractors to focus on the best waste management plan situation for construction sites.

They closed by proposing a further development of the model to foresee and develop an efficient waste management. Their work focuses on the effect of waste management reduction. Garas *et al.* (2001) while

examining the construction industry in Egypt, identified the absence of waste management in the Egyptian construction industry plan before the execution stage among others as factors deemed responsible for material wastage. The government waste administration scheme in Hong Kong, obliges contractors to plan and actualise a waste management and carry out on-site sorting of waste before specific payments are made (Poon *et al.*, 2004). Likewise, McDonald and Smithers (1998) submitted that appropriate waste management has significantly helped waste from the site to be eliminated, where there was approximately fifty percent (50%) cost savings for handling charges of waste, fifteen percent (15%) of the volume of waste reduction close to reaching on site, and about forty three percent (43%) of waste reduction in landfill. Additionally, Poon *et al*. (2004) submitted that a point by point waste management plan is imperative for building sites to accomplish a sound waste management and waste reduction. Construction waste Management, renovation and demolition or destruction of projects are part of the growing movement to better manage materials and make sustainable communities. Building and demolition exercises are integrating "sustainability" or "green" management strategy design to ensure the environment, save resources (including financial resources), and monitor the energy to guarantee the prosperity of current and future generations.

Dimensions and Operationalisation of Construction Waste Management

The dimensions of construction waste management considered for this study include: Waste reduce and waste recycling.

Waste Reduction: Studies have shown that waste reduction regarded as "resource optimisation, is the most vital and the first step in waste prevention practice and materials efficiency". It consists of a set of actions to eliminate or reduce the quantity of on-site waste material utilisation before being disposed to landfill. For instance, reducing the quantity of packing that goes to the "site or using proficient framing techniques in reducing the amount of packaging that will be taken to site or using efficient framing techniques (Vleck, 2001). Gören (2015) maintained that another alternative way to reduce waste is to change design principles and practices as part of the waste reduction efforts. A modular basis structure should be designed by the architects that fit the utilisation of standard size materials. Additional to the modular plan, however, the estimating is very important. Any large quantities of materials brought to the construction site will at least be used, or stolen. Therefore, materials are sometimes transported to another job site for utilisation. Planning is the key to reducing; by thoroughly planning the entire construction process, reduction can simply be facilitated". Waste reduction is referred to as the most efficient construction waste management method. It is a way of minimising the production of construction waste, however, slashes the waste transporting, recycle and disposing cost (Esin and Cosgun, 2007).. However, previous researches extensively examined the waste reduction as the highest priority for managing construction waste.

Waste Recycling: Waste recycling includes waste being segregated into recyclable materials and non-recyclable materials. Therefore, the wastes that are recyclable are somehow reused; normally in the production of new materials using recycled materials. Virgin materials are replaced with recycled material, thereby protecting and preserving natural resources and energy. However, the economy will be improved through the adoption of this recycling method, also by way of supporting both occupations and creating investment opportunities. Therefore, the recycling industry had employed over 13,000 individuals in Florida (Victoria, 2005). Steps to reduce the disposal of waste in landfills have been achieved by some developed countries such as Hong Kong and Germany. Recycle activities have been supported by the Germany government very well. An investigation of the lightweight concrete raw material demonstrates the country's commitment to sustainability. Hence, it indicates that there is full commitment for adopting green practice in their country (Kralj, 2011). .

Research Method

This study used Nigerian construction organisations as the target respondents, 178 out of the 331 managers participated in this study. In particular partial least square (PLS) demands considered smaller sample size. The minimal recommended range for PLS is 30 to 100 cases, being at the organisational level of analysis. The sample size of this research is rather small (that is, 30 or less in the pilot study and 178 or less in the main study).

In this regard, GPower 3.1 was employed to acquire better sample size. According to the result obtained from GPower statistics, the suitable sample size of 331 was measured having power (1-β err prob. = 0.95). Moreover, according to Sekaran and Bougue (2013), the ideal sample would be 89. In the light of aforementioned discussion, the study managed to get response from 178 respondents, whereas the survey was self-administered which is the most suitable approach if the survey is limited to locality where potential respondents can be approached. Though taking care of an important factor of "heterogeneity of sample, the number of variables used in the study and intended statistical tool to be used for the data analysis", the choice of proportionate stratified random sampling was made and utilised. Proportionate sampling approach is simpler, easier, appropriate, and more affordable to collect data from one or multiple strata, compared to other sampling techniques. Keeping in view the total numbers of eligible respondents in every stratum which is the project managers of construction organisations in Abuja–Nigeria, samples were randomly selected. This study validates the construction waste management (CWM) constructs in the context of construction organisations in Nigeria. Using a structured self-ministered questionnaire, the data was duly collected from one hundred and seventy eight project managers of construction organisations. Keeping in view the prime importance of the phenomenon, this study investigates construction waste management among construction organizations.

Results and Discussion

Demographic profile

The respondents' demography is provided in Table 1 where category of organisation, designation, age, marital status, gender, qualification and years of organisations' operation are displayed. This study shows that among the four categories of construction organisations in Nigeria, category C constituted 69 responses, representing (38.7 %) of the total response, followed by category D with 44 responses, representing (24.7%), the next is category B with 38 responses, representing (15.3 %) and lastly category A had 27 responses representing (15.3%). Regarding the designation, 178 responses (100 %) are managers of construction organizations in Nigeria. As regard the age, 98 out of the total responses representing (55%) are between the age of 26 – 50years, then between 51 – 70with 56 responses (31.5%), and finally age group between 18 – 25 years with 24 responses (13.5%). In terms of the marital status of the respondents, the married dominated with 124 responses (69.7percent) while the Single had 54 responses (30.3%). Most of the responses in this study were given by male with 161 responses or 90.4 percent while the female had 17 responses, representing 9.6 percent. In terms of the educational qualification, those with PGD/Master's Degree holders constituted 86 responses or 48.2 percent of the total responses, followed by HND/Degree holders with 56 responses which represent 31.5 percent. Those with PhD certificates were 30 in number; representing 16.9 percent while finally those with other certificates amounting to 4 responses represent only 3.4 percent of the total responses. This points out clearly that majority of the construction organisation managers are the holders of PGD /Master's degree certificate followed by HND/Degree holders, and the next are those with PhDs and lastly other certificates with the least percentage of (3.4%) which is insignificant. In the meantime, with regard to the number of years in operation, 100 respondents had between 11 – 21years in operation (56.2%), 49 respondents (27.5%) had less than 10 years, 26 respondents (14.6%) had between 21 – 30years of existence, whereas 31 – 40years accounted for the least number of respondents of just 3(1.7%).

In validating the construction waste management among construction organisations in Nigeria, PLS path modelling was employed to investigate the data by using Smart-PLS 2.0. Equally the PLS-SEM is good for better forecasting and analysing statistical framework. As a familiar second generation structural equation modelling technique (Ringle, Wende & Will, 2005; Wold , 1982), it is considered as a useful and appropriate tool to analyse complex model and real time applications, The development and validating of complex model are been carried out with PLS path modeling (Zhao and Chua 2003; Zhao and Chua 2003; Akter, D'Ambra & Ray 2011; Fornell & Bookstein 1982; and Hulland 1999). Additionally, PLS allows the use of multiple outcomes variables at the same time, calculates error model and direct computation and incorporation of moderator into a model. Non-normal data is accepted by PLS in social science studies as one of the common issues.

Table I: Demographic

Demographic Variables	Category	Frequency	Percentage
Category of organisations	Category A	27	15.3
	Category B	38	21.3
	Category C	69	38.7
	Category D	44	24.7
Designation	Manager	178	100
Age	18-25years	24	13.5
	26-50years	98	55.0
	51-70years	56	31.5
	70 and above	0	0.00
Marital status	Single	54	30.3
	Married	124	69.7
Gender	Male	161	90.4
	Female	17	9.60
Educational qualification	HND/Degree	56	31.5
	PGD/Masters	86	48.2
	PhD	30	16.9
	Others	6	3.40
Years of operation	Less than 10years	49	27.5
	11-20years	100	56.2
	21-30years	26	14.6
	31-40years	3	1.70

SEM has been endorsed as one of the most trustworthy statistical tools for social and behavioural sciences that allows the investigation of more than one relationship simultaneously. While following the analysis mood and objectives to validate construction waste management constructs, measurement model approach was employed in the study (Figure 1). Items validity, individual reliability, internal consistency, convergent validity and discriminant validity by looking at three values: outer loading, average variance extracted (AVE) and the composite reliability (Henseler, Fornell & Larcker 1982; Barclay *et al.* 1995). Hulland (1999) suggests that values of AVE and outer loadings should be greater than 0.5 each. Composite Reliability, according to Hair *et al.*(2011) should be greater than 0.7. Hulland (1999) recommended that items with loading values of less than 0.4 should be deleted.

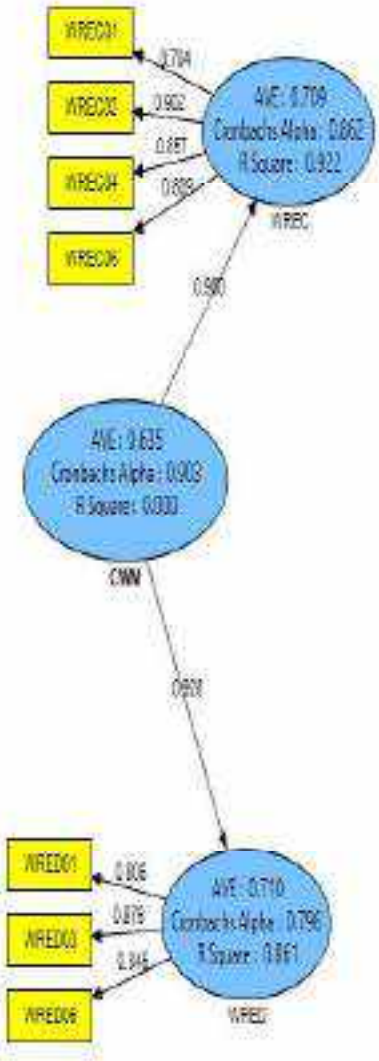

Figure I: Measurement Model

Table 2: Results of the confirmatory factor analysis for Construction Waste Management

Code	Indicators	1	2
WREC01	Our organisation Management Support waste recycling	0.79	
WREC02	Our organisation Set Goals for recycling waste	0.90	
WREC04	Our organisation is Finding Markets for recycled waste	0.85	
WREC05	Our organisation encourages education and Motivation for waste recycling	0.80	
WRED01	In our organisation, we avoid damage by handling and storing materials properly		0.80
WRED03	In our organisation, we use materials efficiently and use less of them		0.87
WRED05	In our organisation, we reduce the use of non-recyclable materials		0.84
	Average Variance Extracted (AVE)	0.70	0.71
	Cronbachs Alpha (CA)	0.86	0.79
	Composite Reliability (CR)	0.90	0.88

WREC=Waste Recycling, WRED= Waste Reduction

Individual Item Reliability: In confirming the component of individual reliability, each item reliability of construction waste management scale is considered. The Individual item reliability was assessed through outer loadings. Usually, the bench mark for the outer loading value of 0.4 and above is considered to validate individual item reliability (Duarte and Raposo, 2010; Hair,2014). Further the standardized loadings for all the 11 items were observed; 7 items associated with waste reduction and waste recycling were found greater than the standard cut-off i.e. above 0.4, whereas four items (WREC03, WRED02,WRED04 and WRED 06) from "Waste Recycling and Waste Reduction" were removed due to the lower value. In total, 7 point loadings ranged between 0.79 and 0.90, were kept. Following Nasidi, Bamgbade, Adeleke, and Ali (2016) all the retained items sufficiently met the acceptable criterion set for individual item reliability.

Internal Consistency Reliability: The internal consistency reliability can be defined as "the degree to which every item in an individual scale (or sub scale) measures the same concept" (Bijttebieret *et.al,*, 2000; Duarte & Raposo, 2010). Two methods i.e. Cronbach's alpha coefficient and composite reliability, have been widely employed for internal consistency reliability assessment (Bacon, Sauer and Young 1995; McCrae, Kurtz, Yamagata, and Terracciano 2011; Peterson and Kim 2013). This study, while following the suggestions of Hair *et al* (2011) and Bagozzi and Yi (1988), employed cronbachs Alpha and composite reliability coefficient for the assessment of internal consistency reliability of the construction waste management (CWM). According to Bagozzi *et al.* (1988), Wong *et al.* (2013), Nunnally *et al*.(1997), Chin (1998), and Hair *et al.* (2011), the cronbachs Alpha and the composite reliability should be greater than 0.7. The composite reliability coefficients, provided in Table 2, retained the value ranged between 0.796 and 0.862.While the composite reliability ranges between 0.88 and 0.97. The acquired values of coefficient retained shows that, all the variables of this study confirmed sufficient internal consistency reliability (Hair *et al*.,.2011).

Convergent Validity: Convergent validity is defined as "the degree by which items truly represent the intended latent constructs and correlate with other measures of the same latent construct Hair et al., 2006. The convergent validity was established considering the average variance extracted (AVE) of the latent constructs obtained. According to Chin (1998), the AVE loadings for each of the latent construct should be 0.5 or above. Table 2 shows that the AVE obtained for waste recycling and waste reduction were found greater than required cut-off value i.e. above 0.5 and valued as 0.709 and 0.710 respectively.

Discriminant Validity: Discriminant validity can be defined as the level to which a certain item varies from the other one (Hulland, 1999). According to Chin (1998), it can be measured by assessing the cross-loadings by following the rule where "the items should have a higher correlation with the latent variable that they are supposed to measure than with any other latent variable in the model". Further, the square root of the AVE for each construct can be used to examine the discriminant validity. According to Fornell and Larcker (1981) , the square roots of AVE coefficients should be placed in the correlation matrix next to the side of the diagonal. The results are considered confirmed for the discriminant validity, if the squared AVE

is found greater than squared correlation estimates, where "the diagonal coefficients or elements must be greater than the off-diagonal coefficients or elements in the corresponding rows and columns" (Chin ,1998, Hair et al 2006). Keeping in view the above mentioned criterion, table 3 provides the confirmation of discriminant validity.

Table 3: Discriminant Validity

Latent Variable Correlations	1	2
Waste Recycling	1.492	
Waste Reduction	0.787	1.493

The boldface values shown in Table 3 are square root values of the average variance extracted. Since, all the values of square root of AVE were greater than the correlations, the AVE values show that all the latent constructs have successfully confirmed sufficient level of the discriminant validity (Ali,Nawanira, Nasidi and Bamgbade, 2016). Hence, it can be concluded that all the measures of the CWM have met the discriminant validity requirements.

Discussion and Conclusion

Vleck (2001) established a construction waste reduction and waste recycling questionnaire to facilitate study in investigating the integrated waste management. A thorough literature review made it obvious that integrated waste management have been studied in the perspectives of developed and Asian countries. For the reasons present, the study investigates construction waste management among construction organizations in Abuja Nigeria, according to World Bank Report 20014 a country with a population of over 178 million, with high construction activities to meet the infrastructure need of the populace in terms of residential, commercial, agricultural, transportation and other land use purposes, lead to the creation of large quantities of construction waste with little attention on effective and efficient waste management system. Empirically, construction waste management related studies show inconsistent results. This study validated CWM constructs among construction organisations in Abuja, Nigeria. The targeted population for this purpose was the construction organisations. All the constructs have met the criterion and proved that the construction waste management constructs are appropriate to measure construction waste management among construction organizations in Abuja. Results of the confirmatory factor analysis, reliability, and validity tests established the appropriateness of CWM dimension i.e. waste recycling and waste reduction. For the prospect study, the scale can be studied further in the different perspective.

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PHYSICAL PLANNING IMPLICATIONS OF THE SPATIAL EXPANSION OF MPAPE TOWN, ABUJA

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Abstract
Dynamics of urban expansion holds implications on the future quality of urban environment. Data on the rate of expansion is however critical for timely planning to tame these implications for sustainable livable urban environment. This study examined the physical development planning implications of the spatial expansion of Mpape Town, a suburb of Abuja, FCT Central Nigeria between 2000 and 2019. This is with a view to providing empirical data aimed at guiding physical development planning decisions. The study made use of satellite imageries using the google earth Pro software system to collect image data on changes in the physically developed (built-up) structures. The google Pro imageries were analysed using ArcGIS 10.2 software. Survey research design was used (using questionnaires) to elicit data on socio-economic characteristics of respondents from the sample population. This was analysed using percentages and frequency distribution. Findings revealed that between 2000 and 2019, Mpape town grew by 0.93km^2 representing 48.6%. The highest rate of change (0.88km$^{2)}$ among the six communities in the area occurred in Gwadiko. Most of the people that responded were within the age group 21-40years (60%) while their highest qualification falls around OND and NCE. Majority (44.6%) were civil servants and earned annual income range of #1-500,000. The physical development planning implications of the findings include: need to plan for the provision of more social infrastructure to provide services in tune with the rate of expansion and the development of appropriate regulatory and monitoring measures. Similarly, the application of better physical development management measures will avert governance conflict and the need for planning considerations for the development attributes. The study concluded that urban expansion in the study area portends social and environmental concerns and recommends that current data be used to guide planning decisions and policies in the study area for sustainable better living environment.
Keywords: urban dynamics, spatial expansion, infrastructure, development control, Mpaape town

Introduction

Literature suggests that urban expansion if effectively coordinated promotes consolidated development and ease effective and efficient service delivery and urban management thereby contributes to ameliorating the socio-economic and environmental ills usually associated with uncontrolled urban growth. Understanding the rate of expansion is also critical to predicting and managing future changes and trends around urban development and their potential effects.However, information about the nature and structure of urban growth of any particular place is critical for appropriate measures that will achieve the desired result and for sustainable growth and development(Sharma, Pani and Mohapatra 2014).Urban growth and expansion is used to describe a spatial increase in the size of a city due to increasing human population. Some scholars associate it with an increase in population size and territorial expansion in the size of the urban areas. Onibokun (1998) and Olatumbosun (2018) averred that this process encourages the expansion of substandard environments including slums and sprawls leading to declining quality of life and other negative consequences. There are numerous implications for the rate and pattern of growth of a particular city. Olayiwola and Igbavboa (2014) reported that this growth holds implication on social infrastructural development because more high ways and roads as well as other relevant infrastructure will need to be provided to link the different zones. The study averred however that concentrating large numbers of people into a compact space means that places of work, homes, schools and services becomes closer together and also basic services such as electricity, water, food and transport can be delivered more efficiently with less waste. Urban expansion may occur at different rates and in different directions and may take a pattern due to varying factors. Shahraki et.al (2011) averred that, all these affects sustainable city development and have being the concern of authorities and a subject of debate in many countries. In view of this some scholars reported that government normally moves to curtail uncontrolled urban expansion by adopting planning policies and measures to encourage greater urban consolidation and higher density residential development. However, despite the ills of urban growth and expansion, it is usually viewed as an essential variable of economic advancement in many countries (Sharma, Pani and Mohapatra, 2014).

Nigerian cities are witnessing many population and form changes, for instance, the World Urban Forum 2012 (cited in Sharma, Pani and Mohapatra 2014) reported that about 47 percent of the country Nigeria is urban and the pattern of migration into the cities is affecting urban living by increasing competition for

resources on daily basis. Uji (2015) however asserted that political and socio-economic development in post-colonial Nigeria led to the emergence and growth of several towns in the Benue Basin. In more recent times several other studies reported that the influences of ethnic crises as well as administrative status of many towns have influenced the sporadic growth of many towns in the basin. In the context of the study area, observation has shown that Mpape a suburb of the FCT also seems to be spatially expanding unlimitedly in different directions with sprawling influence. Understanding the nature of urban expansion helps in providing data that guides the physical development process and promotes urban social economic and environmental quality. The United Nations Millennium Declaration identified Environmental Protection as a key principle for sustainable Development. In view of these Oduwaye (2013) studied urban planning implications of changing land use structure in Metropolitan Lagos while Owoeye and Ibitoye (2016) analyzed urban land use change in Akure. On the other hand Sharma, Pani and Mophapatra (2014) investigated rapid urban expansion and its implications on geomorphology in Gwalior, India while Ujoh et.al (2010) studied urban sprawl in the Federal Capital City, Abuja. In all of these studies none focused on the physical expansion of the built up area of Mpape, FCT and its physical planning implications. The irony is that, the Federal Capital Territory (FCT) is experiencing rapid urbanization leading to the outgrowth of its suburbs such as Mpape; there is however paucity of known data about the nature of expansion in the study area. This research seeks to unearth the nature of emerging urban change in the study area between years 2000immediately after the return of democratic governance in 2019. This is with a view to providing data to guide planning decisions. The questions therefore are; what is the rate of urban (built up) change in Mpape?, what are the socio-economic characteristics of those causing the change?, what are the urban development implications of the change in the area?

Literature Review

Urban expansion results to both physical and population expansion; this has being a great concern because population concentration invariably results to physical expansion with a myriad of urban problems. In other words urban management problems arise due to problems of urban growth (physical expansion), understanding growth helps in urban management decisions and may lead to improvement in quality in public environment. According to Adeboyejo and Olajoke(2006), the built up area of Ogbomosho in Osun state increased by 48.8% in 35 years (1914-1949) with an annual rate of 1.4%. The most dramatic expansion was in 30years (1949-1978), an average annual increase of 12.5%. This increase was partly attributed to eviction of Nigerians from Ghana (Ogbomosho reportedly had a significant proportion of its population in Ghana). The study found that the expansion followed the transportation routes which were also linking some major land uses and institutions such as Ladoke Akitola University of Technology; these further attracted other land uses particularly residential.

A study by Ujoh et.al (2010) shows the annual rate of expansion in the Federal capital City between 1987 and 2006 was 10.6km^2. This revealed a rapid change in the physical expansion of the area. On the other hand Sharma et.al (2014) in a study titled rapid urban expansion and its implications on geomorphology in Gwalior city, central India (four decades 1972-2013) revealed urban built-up area increased by 08.48sq.km during the first eighteen years (1972 to 1990), it increased to 16.28km during the next sixteen years (1990-2006). The built-up area further went up to 23.19sq.km.in the next seven years (2006-2013). This reveals that the city witnessed significant expansion within the time period 1972-2013. The total urban areas during 1972 were 34.11sq.km. out of which the share of the built-up areas was 23.84km.sq. leaving 10.27km.sq. marked as non-built-up area. This suggests that variations exist in the rate of change of urban areas which may be explained by prevailing reasons.

According to Habibi and Asadi (2011) urban expansion may be characterised by disorganised and unattractive expansion into the adjourning countryside. It may be leapfrog development which may carter for low income households (Brudelt, 2018).Sharaki et.al (2011) using satellite images for four periods (1975, 1987, 2000 and 2009 reported that from 1975 to 2009, the urbanized area increased from 1843 ha to 13,802ha in Yazd, central Iranian city. This rate was reportedly close to three times the population growth observed for the same period. This has resulted to the emergence of unplanned disordered pattern and other problems, raising social and environmental concern such as lack of enough services and facilities for the residents, insecurity, increase commuting length and energy consumption. Findings by Oluseyi (2006) in a study on urban land use change analysis in Ibadan Metropolitan (1972-2003) area used remote sensing data

and found that the period between 1972 and 1984, experienced unprecedented expansion most in the Metropolis given rise to Shanties and ran shackles of buildings.

Most cities in Nigeria seem to be growing ahead of planning. Urban growth process portends a number of chain effects which holds implication on the quality of life of the urban residents, urban environment as well as urban management. According to Omololu and Lawal (2013), the challenges associated with the rapid rate of urban growth include; inadequate infrastructure and public utilities, expansion of slum areas high crime rates, inadequate housing, traffic congestion and increased production of human and industrial wastes. Similarly, Tsai (2005) emphasised that the pattern of expansion if not well monitored could sometimes become a traffic safety problem. Sudhir and Sinha (2013) averred that because the physical development in Noid, India is defying laid down policies and regulations the growth process has promoted privately automobile dependent depriving credible public transport system in the area. Furthermore, Galster et.al (2001) averred that the low-density, single family dwellings and abundance of large-lots (usually 1-5 acres depending on development context) may promotes long distances between dwelling units while residences depend mostly on automobiles at the expense of alternative forms of transportation. Despite all the physical planning implications of the physical expansion of built up areas reported in literature, there is no known data on the study area. There is therefore the need to understand the rate of built up of the study area with a view to evolving rational and appropriate policies and measure that will guide physical development and improve environmental quality.

Study Area & Methodology

The research was carried out in Mpape district, one of the suburbs of the Federal Capital Territory (FCT), Abuja central Nigeria which consist of six communities, namely; Gwadiko, Kachimo, Takumo, Mashampe, Gwatampe and Katagari. The district is one of the areas observed to be experiencing outward expansion. The study population consisted of all the built up (physically developed housing structures). It is an informal settlement found in Bwari Area Council, situated on the hills just outside the Outer Northern Express Way (ONEX) in the northern part of Abuja. It is located between latitude 9^0 5'8''N to $9^0$9'37'' N and longitude and 7^0 27' 13''E and 7^0 35' 49''E. The community is bounded in the north by Share, south by Municipal area council and east and west by Dutse and Gidagogo. There is the presence of major mining and construction companies in Mpape. The area is occupied by a small "indigene" population of native *Gwari* / *Gbagyi*, however the vast majority of inhabitants are so-called "settlers" who have moved to Mpape during recent decades because of its relative affordability and proximity to employment opportunities. Some of the "settlers" were also resettled to Mpape following the demolition of districts such as Wuse and Garki within the FCT to make way for the implementation of the "Abuja Master Plan."Mpape population reportedly grew geometrically following the demolition of some settlements in Abuja like Karmo, Durumi, Gwarimpa village, Kado village, Apo and various other settlements along airport road. Figure 1 and 2 shows the location of Mpape, FCT

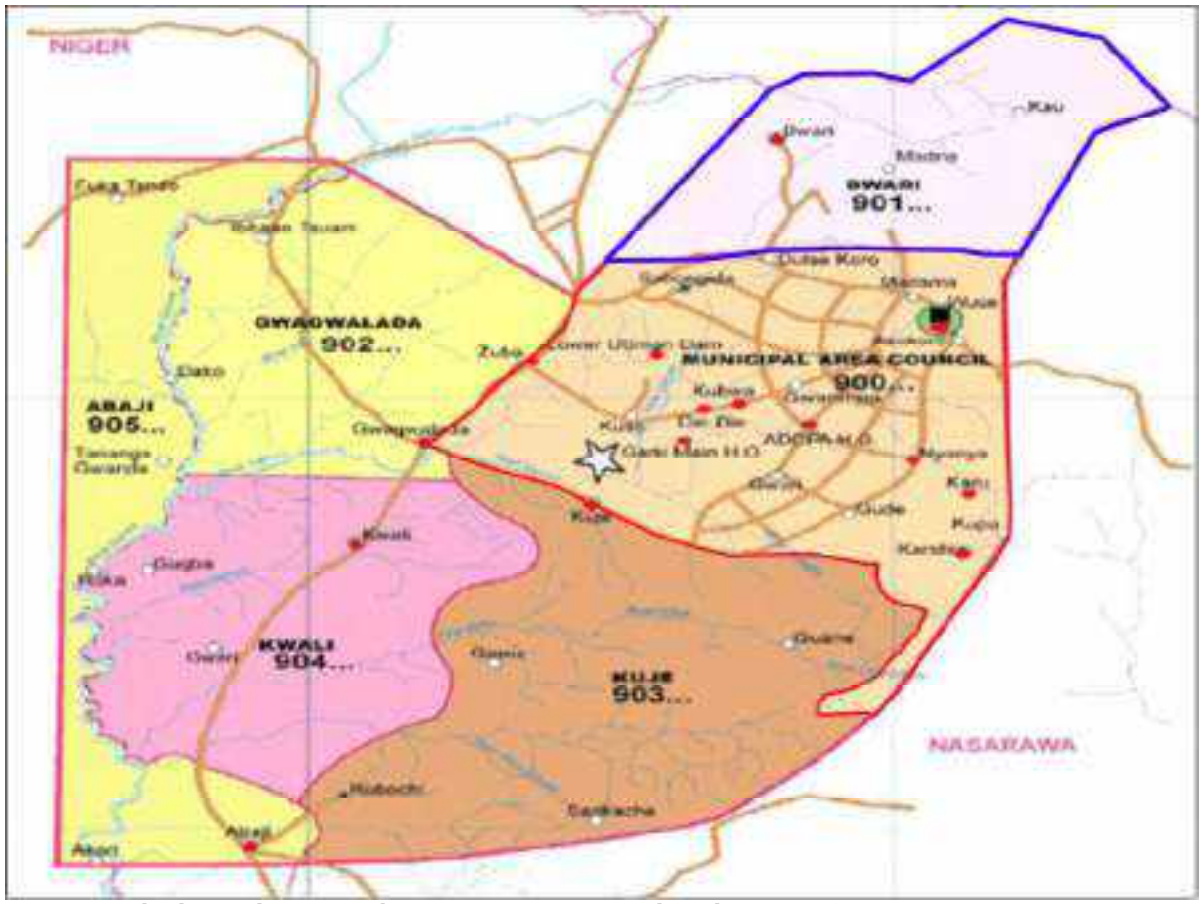

Figure 1: Federal Capital Territory Showing Bwari Area Council (Scale: 1:10,000)
Source: AGIS (2019)

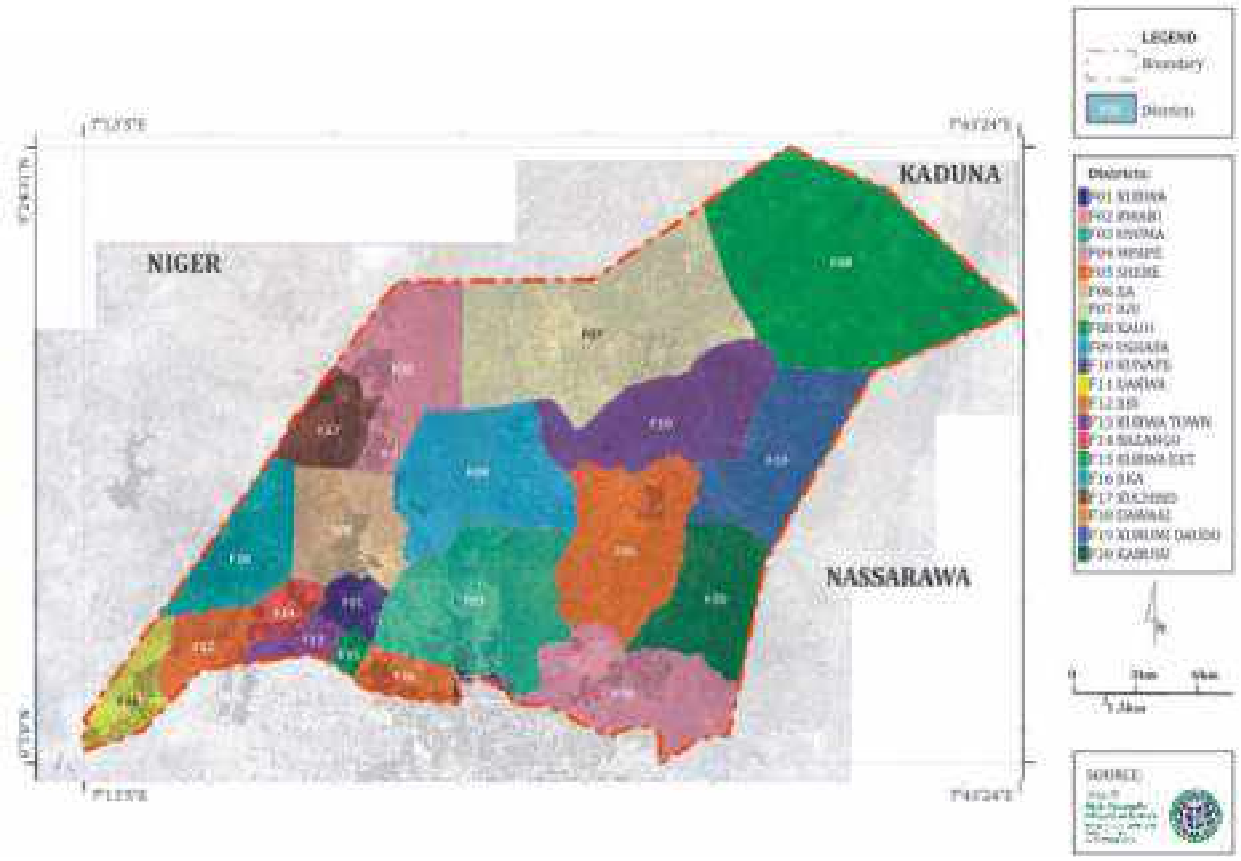

Figure 1.2: Map of Bwarri Area Council showing Study Area (Mpape District)

Data used for the study consisted of the physically developed housing structures of the area between 2000, a year after the return of democratic governance in Nigeria to 2019. The existing spatial wards were purposively sampled to collect data about the physical expansion of the area.In order to determine the spatial rate of change of the built up area of Mpape, satellite imageries for the time span for the six wards were used for data collection alongside with personal observations. The google Earth Pro, software system which interact with the satellite was used to collect image data on the physically developed structures. This system captures and store imagery of the physically expanding features on the earth's surface. The technique used to analyse the spatial rate of change for the built up area was the google Earth Pro, software. The google Pro imageries were overlayed and classified using ArcGIS 10.2 software to determine the extent of the spatial expansion of built up area from the different classified images for the different years (2000 - 2019). This method is often used for establishing the spatial growth and expansion of settlement areas. This also helped in determining the direction of physical expansion of the area and deducing the urban implications.

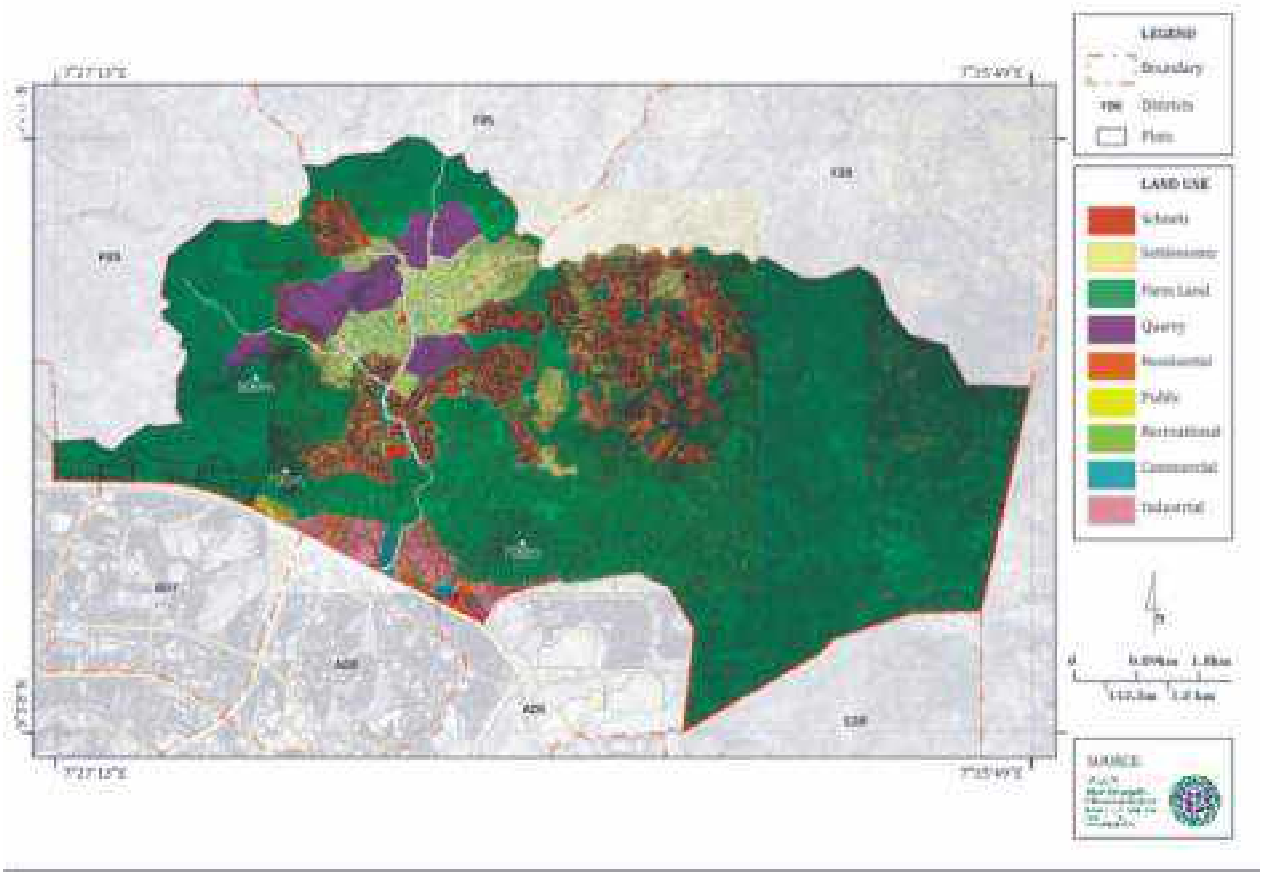

Figure 1.3: Map of Mpape

Results and Discussion

Nature of Expansion in Mpape town:

Data on the nature of expansion in Mpape were examined from 2000 to 2019. These covered Area Spatial Coverage, Spatial Rate of Change, Percentage of Spatial Change and Total Area Spatial Coverage. Plates 1 – 5 shows Satellite Imagery of Mpape from 2000 – 2019 while Table 4.1shows an estimated change in built up area of Mpape from 2000-2019 among the communities in Mpape.

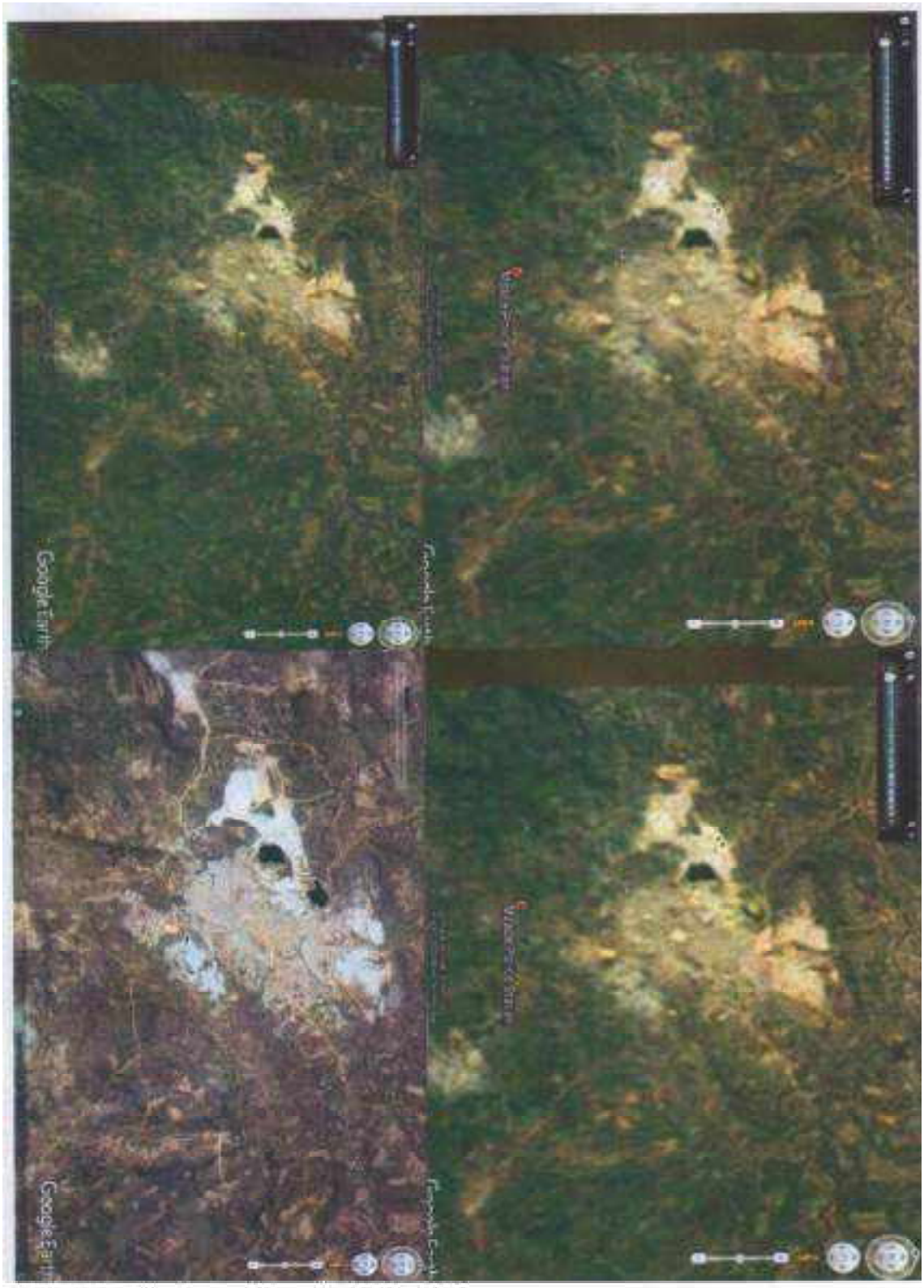

Plate 1: Satellite Imagery Mpape from 2000 - 2003

Plate 2: Satellite Imagery Mpape from 2004 - 2007

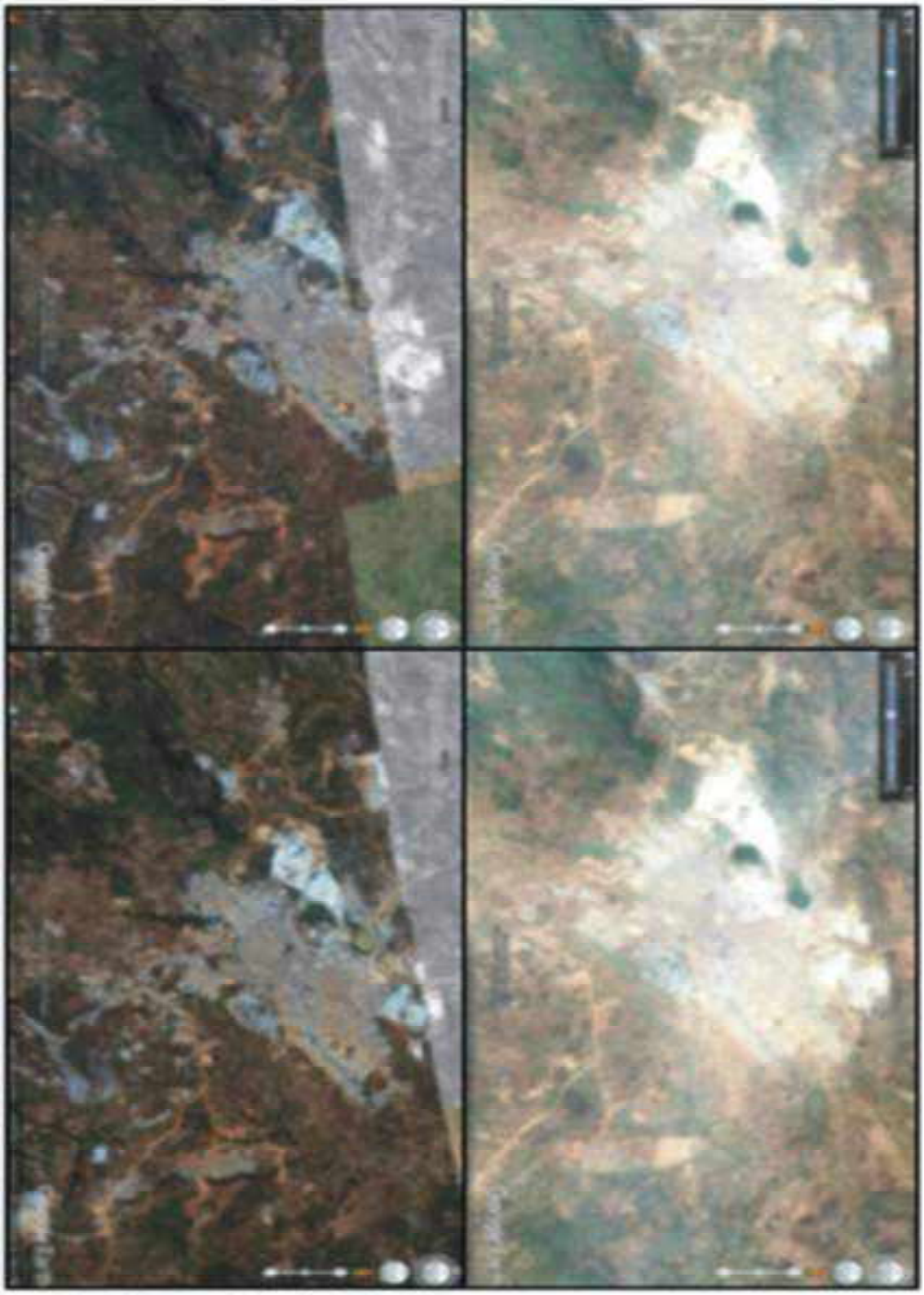

Plate 3: Satellite Imagery Mpape from 2008 - 2011

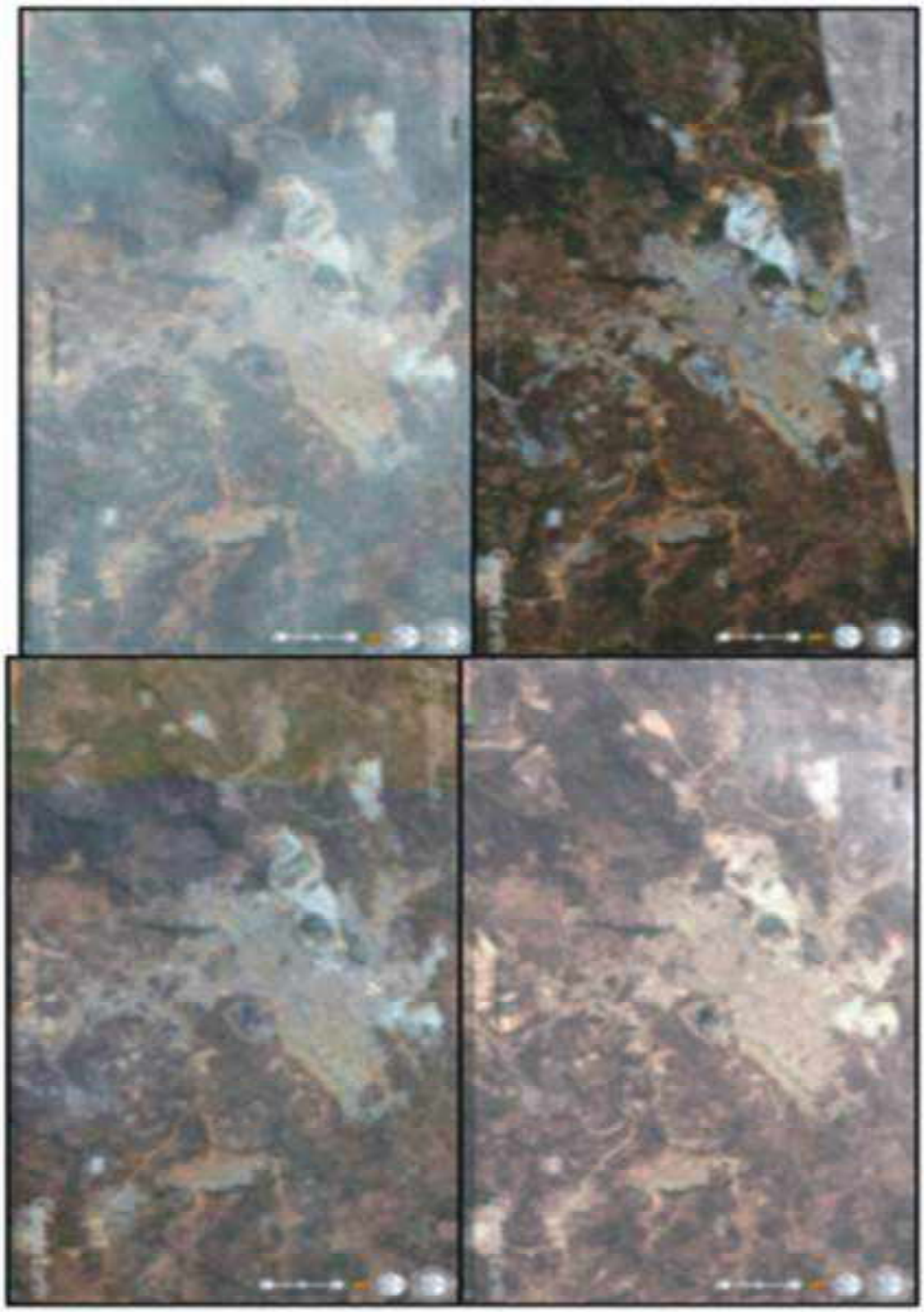

Plate 4: Satellite Imagery Mpape from 2012 - 2015

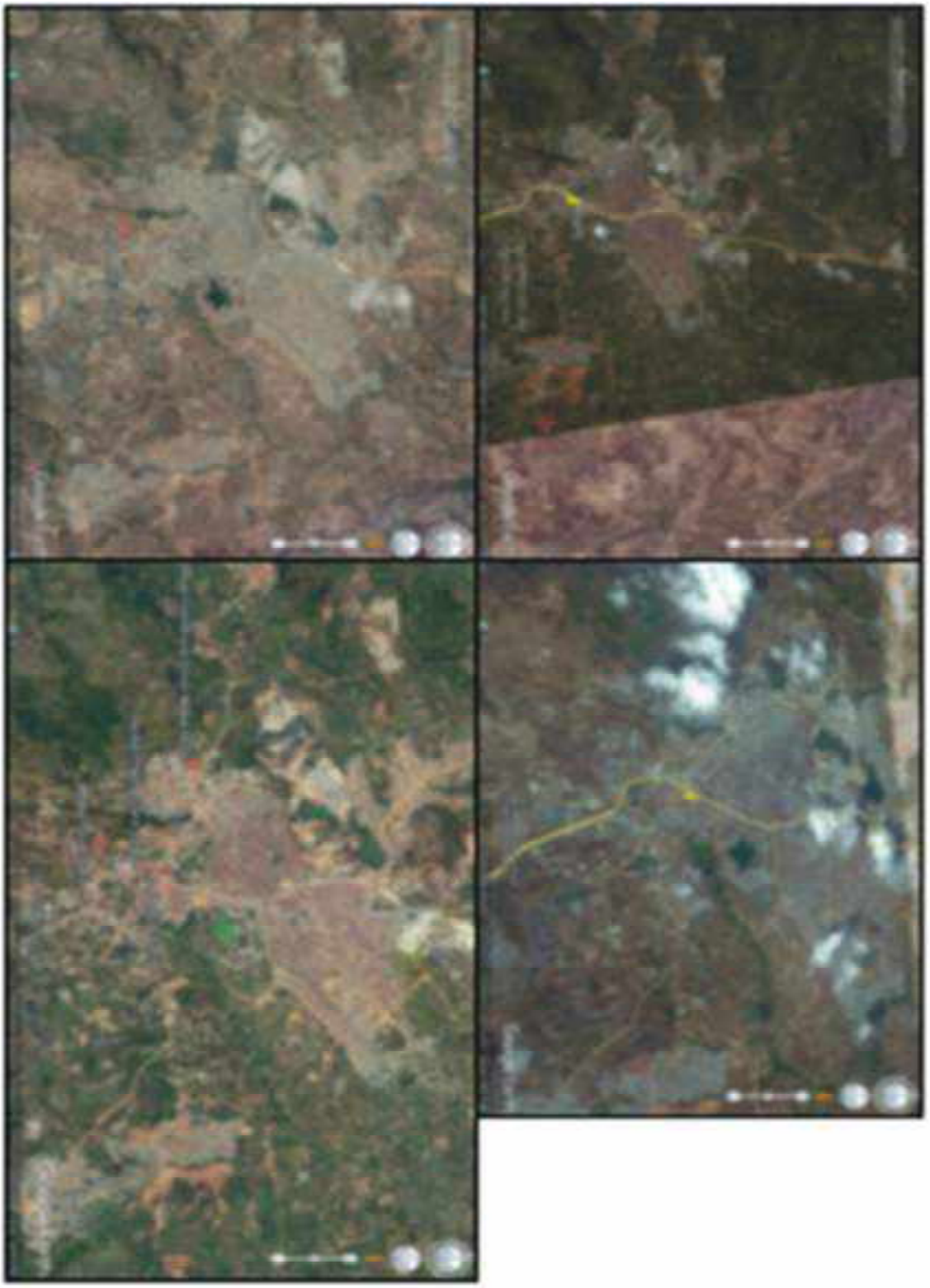

Plate 5: Satellite Imagery Mpape from 2016 - 2019

Table 1: Estimated Change in Built up Area of Mpape between 2000-2019

DESCRIPTION																				
Year	Gwadiko ward			Kachimo ward			Takumo			Mashampe ward			Gwatampe ward			Katagari ward				
	ASC (km^2)	SRC (km^2)	PSC (%)	ASC (km^2)	SRC (km^2)	PSC (%)	ASC (km^2)	SRC (km^2)	PSC (%)	ASC (km^2)	SRC (km^2)	PSC (%)	ASC (km^2)	SRC (km^2)	PSC (%)	ASC (km^2)	SRC (km^2)	PSC (%)	Tasc (km^2)	Annual change(km^2)
2000	0.53	-	10.93	0.57	-	13.05	0.43	-	10.72	0.35	-	7.14	0.29	-	6.17	0.31	-	5.88	2.48	-
2001	0.58	0.05	11.96	0.58	0.01	14.34	0.50	0.07	12.47	0.70	0.35	14.29	0.40	0.11	8.51	0.60	0.29	11.39	3.36	0.88
2002	0.60	0.02	12.37	0.61	0.03	15.06	0.65	0.15	16.21	0.83	0.13	16.94	0.60	0.2	12.77	0.92	0.32	17.46	4.21	0.85
2003	0.63	0.03	13.0	0.68	0.07	16.79	0.75	0.10	18.70	0.90	0.07	18.37	0.80	0.2	17.02	1.50	0.58	28.46	5.26	1.05
2004	0.69	0.06	14.22	0.73	0.05	18.02	0.80	0.05	19.95	1.10	0.2	22.45	0.91	0.11	19.36	1.60	0.10	30.36	5.83	0.57
2005	1.03	0.34	21.24	0.82	0.09	20.24	0.81	0.01	22.20	1.40	0.3	28.57	1.50	0.59	31.92	1.79	0.19	33.97	7.35	1.52
2006	1.35	0.32	27.34	0.93	0.11	22.96	0.98	0.17	24.44	1.60	0.2	32.65	1.60	0.10	34.04	1.88	0.09	35.67	8.34	0.99
2007	1.53	0.18	31.55	1.10	0.17	27.16	1.21	0.23	30.18	1.89	0.29	38.57	1.92	0.32	40.85	2.38	0.50	45.16	10.03	1.69
2008	2.38	0.85	49.07	1.25	0.15	30.86	1.55	0.34	36.65	2.01	0.12	41.02	2.20	0.28	46.81	2.49	0.11	47.25	11.88	1.85
2009	2.95	0.57	60.87	1.43	0.18	35.30	1.68	0.13	41.90	2.40	0.39	48.98	2.30	0.10	48.94	2.68	0.19	50.85	13.44	1.56
2010	3.10	0.15	63.92	1.93	0.5	47.65	1.89	0.21	47.13	2.70	0.3	55.10	2.41	0.11	51.28	3.38	0.70	64.14	15.41	1.97
2011	3.21	0.11	66.11	2.70	0.77	66.66	2.30	0.41	57.36	2.90	0.2	59.18	2.60	0.19	55.32	3.58	0.20	67.93	17.29	1.88
2012	3.31	0.1	68.25	2.95	0.2	72.83	2.50	0.2	62.34	3.00	0.1	61.23	2.90	0.30	61.70	3.93	0.35	74.57	18.59	1.30
2013	3.45	0.14	71.26	3.00	0.05	74.07	2.71	0.21	67.58	3.50	0.5	71.43	3.00	0.10	63.83	4.28	0.35	81.21	19.94	1.35
2014	3.65	0.2	78.92	3.08	0.08	76.04	2.98	0.27	74.31	3.60	0.1	73.47	3.20	0.20	68.09	4.38	0.10	83.11	20.89	0.95
2015	3.83	0.18	82.06	3.32	0.24	81.97	3.15	0.17	78.55	3.70	0.1	75.51	3.40	0.20	72.34	4.68	0.30	88.80	22.08	2.09
2016	3.98	0.15	85.57	3.37	0.05	83.20	3.30	0.15	82.29	3.89	0.19	79.39	3.67	0.27	78.09	4.77	0.09	90.51	22.98	0.90
2017	4.15	0.17	87.54	3.58	0.21	88.39	3.51	0.21	87.53	4.01	0.12	81.84	3.92	0.25	83.40	4.87	0.10	92.41	24.04	1.06
2018	4.81	0.66	99.18	3.87	0.29	95.55	3.80	0.29	94.76	4.20	0.19	85.71	4.30	0.38	91.44	4.99	0.12	94.69	25.97	1.93
2019	4.85	0.04	100.0	4.05	0.18	100.0	4.01	0.21	100.0	4.90	0.7	100.0	4.70	0.40	100.0	5.27	0.28	100.0	27.78	1.81

Source: Author's field analysis (2020) ASC=Area Spatial Coverage; SRC=Spatial Rate of Change; PSC=Percentage of Spatial Change; TASC= Total Area Spatial Coverage

Table 1 shows the spatial area change of Mpape district, FCT Abuja for the year between 2000 and 2019. The study shows that between 2000 and 2019, the area grew by 0.93km^2 (from 0.88km^2 to 1.81km^2)representing 48.6%. This expansion rate is similar with 48.8% reported by Adeboyejo and Olajoke in a study on the built up area of Ogbomosho in Osun State but surpasses that by Hemba et al (2017) who reported 10% expansion rate in his study in Makurdi. In terms of net change among the communities or wards, the built up area for Katagari grew faster (5km^2) within the time span as shown in Table 1, this is followed by Gwatampe (4.41km^2) while Gwadiko followed with 4.32 km^2 respectively in that order. The highest rate of expansion among the wards however occurred in Gwadiko (ward I) with 0.85km^2 in the year 2008.The study further shows Kachimo in 2011 with growth rate of 0.77km^2, in 2010, the rate of expansion in Katagari (ward V) was 0.70km^2 and Gwadiko in 2018 was 0.66km^2 . On the other hand Gwatampe grew by 0.59 km^2 in 2005. In terms of annual net expansion in the study area, the highest annual net expansion within the time period took place between 2014 and 2015 (2.09km^2) followed by 2009 and 2010 (1.97km^2) while the year 2017 and 2018 recorded net expansion of 1.93km^2. The least annual expansion in the study area took place between 2003 and 2004 (0.57km^2).

Socio-Economic Characteristics of Respondents:

Data on the socio-economic characteristics of respondents of Mpape were examined. This covered five major characteristics namely; age, level of education, income, occupation and marital status. Tables 2 – 6 therefore present the socio-economic characteristics of the respondents contributing to the expansion.

Table 2: Age Group of Respondents

Age Group	Gwadiko		Kachimo		Takumo		Mashampe		Gwatampe		Katagari		Total	
	F	%	F	%	F	%	F	%	F	%	F	%	F	%
1 – 20	0	0.0	1	2.4	1	1.7	0	0.0	3	3.9	2	2.1	7	1.8
21 – 40	31	63.3	22	52.4	41	69.5	40	60.6	42	54.5	58	59.8	234	60.0
41 – 60	18	36.7	15	35.7	15	25.4	22	33.3	30	39.0	34	35.1	134	34.4
61 – 80	0	0.0	4	9.5	2	3.4	4	6.1	2	2.6	3	3.1	15	3.8
Total	49	100	42	100	59	100	66	100	77	100	97	100	390	100

Table 3: Level of Education of Respondents

Level of Education	Gwadiko		Kachimo		Takumo		Mashampe		Gwatampe		Katagari		Total	
	F	%	F	%	F	%	F	%	F	%	F	%	F	%
FSLC	1	2.0	2	4.8	0	0.0	0	0.0	2	2.6	0	0.0	5	1.3
SSCE	13	26.5	12	28.6	21	35.6	26	39.4	27	35.1	39	40.2	138	35.4
OND/NCE	17	34.7	17	40.5	22	37.3	31	47.0	28	36.4	37	38.1	152	39.0
HND/B.Sc	18	36.7	11	26.2	15	25.4	7	10.6	19	24.7	19	19.6	89	22.8
M.Sc/PhD	0	0.0	0	0.0	1	1.7	2	3.0	1	1.3	2	2.1	6	1.5
Total	49	100	42	100	59	100	66	100	77	100	97	100	390	100

Table 4: Occupational Distribution of Respondents

Occupation	Gwadiko		Kachimo		Takumo		Mashampe		Gwatampe		Katagari		Total	
	F	%	F	%	F	%	F	%	F	%	F	%	F	%
Farming	4	8.2	4	9.5	1	1.7	3	4.5	7	9.1	3	3.1	22	5.6
Traders/ Business	12	24.5	8	19.0	6	10.2	17	25.8	14	18.2	20	20.6	77	19.7
Civil Servant	24	49.0	23	54.8	30	50.8	22	33.3	37	48.1	38	39.2	174	44.6
Consultant	1	2.0	1	2.4	6	10.2	2	3.0	0	0.0	7	7.2	17	4.4
Artisant	4	8.2	3	7.1	16	27.1	14	21.2	9	11.7	15	15.5	61	15.6
Applicant	4	8.2	3	7.1	0	0.0	8	12.1	10	13.0	14	14.4	39	10.0
Total	49	100	42	100	59	100	66	100	77	100	97	100	390	100

Table 5: Annual income of Respondents

Annual Income (N)	Gwadiko		Kachimo		Takumo		Mashampe		Gwatampe		Katagari		Total	
	F	%	F	%	F	%	F	%	F	%	F	%	F	%
1–500,000	23	46.9	18	42.9	36	61.0	24	36.4	40	51.9	41	42.3	182	46.7
500,001 – 1,000,000	16	32.7	15	35.7	14	23.7	26	39.4	18	23.4	32	33.0	121	31.0
1,000,001 – 1,500,000	2	4.1	1	2.4	2	3.4	3	4.5	5	6.5	3	3.1	16	4.1
1,500,100 – 2,000,000	3	6.1	2	4.8	1	1.7	2	3.0	8	10.4	4	4.1	20	5.1
2,000,001 – 2,500,000	5	10.2	6	14.3	6	10.2	11	16.7	6	7.8	16	16.5	50	12.8
2,500,001+	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	1.0	1	0.3
Total	49	100	42	100	59	100	66	100	77	100	97	100	390	100

Table 6: Marital Status of Respondents

Marital Status	Gwadiko		Kachimo		Takumo		Mashampe		Gwatampe		Katagari		Total	
	F	%	F	%	F	%	F	%	F	%	F	%	F	%
Single	12	24.5	7	17.0	20	33.9	14	21.2	18	23.4	24	24.7	95	24.4
Married	37	75.5	32	76.0	37	62.7	50	75.8	58	75.3	71	73.2	285	73.1
S/D	0	0.0	1	2.0	1	1.7	0	0.0	0	0.0	2	2.1	4	1.0
Widowed	0	0.0	2	5.0	1	1.7	2	3.0	1	1.3	0	0.0	6	1.5
Total	49	100	42	100	59	100	66	100	77	100	97	100	390	100

Source: Field Data and Analysis (2020) S/D= Separated / Divorce

Tables 2–6 illustrate the socio-economic characteristics of respondents. The age group 21-40years has the highest percentage (60.0%) of respondents followed by that of 41-60years as shown in Table 4.3. Age group 1-20years has the lowest number of respondents. Similarly, Table 3 shows data on the level of education of the respondents. The highest level of education for most respondents in the area were those with either ordinary national Diploma (OND) or Nigeria certificate in Education (NCE) represented by 39.0%. This is closely followed by those with senior school certificate (SSCE) holders, the least qualification (1.3%) was observed among school leavers. This suggests that the area is predominantly resident by those with intermediate qualifications. Data in Table 4 also shows that the occupational distribution of the respondents contributing to the expansion of Mpape were mostly civil servants as indicated by 44.6% which represented the highest proportion of the population with farming been the least (5.6%) occupation of the residents. Furthermore, Table 5 and 6 represents the annual income and marital status of the respondents respectively. Data obtained from this study shows that majority (46.7%) of people residing in Mpape depended on an annual income of between ₦1-500,000 and that most of them were married. This is indicative of the potential for further population increase and spatial expansion of the area which may arise due to natural increase hence the need for effective planning of the area a head of the anticipated expansion.

Physical Planning Implications of the Expansion of Mpape:

Findings about the nature of expansion and socio-economic characteristics of respondents in the study area revealed a number of physical development planning implications on the prospect of Mpape. The nature of expansion in Mpape like in other studies portends social, economic and environmental effect. Firstly, the rate of expansion (0.93km^2) suggests an increase in the spatial growth and population concentration of residents in the area within the period under review. This implies the need to plan for the provision of more social infrastructure such as schools, transportation facilities, health care facilities, water supply, waste management services and other utilities necessary for the wellbeing of the people and for sustainable development. In other wards it implies that this development requires more services which means the city must increase its budget to cope with the provision of these basic services. An interaction with some of the officials of the planning agencies in Bwari further revealed that some of the challenges being faced as a result of the expansion of Mpape include traffic challenges, overcrowding, illegal development and increasing social ills among others. The pace of expansion of the communities within the time span therefore places an increase in responsibility on the planning agencies to develop better appropriate regulatory and monitoring approaches to cope with the pace of development in the study area with a view to enhancing orderly development and sustained quality development. In addition, the rate of expansion suggests rapid encroachment into fringe lands. This has implication on rural agricultural lands as well as administrative boundaries and or governance issues which portends management or regulatory problems or conflicts. All

these suggest that the physical development planning agencies needs to brace up for effective development control and monitoring of development activities so as to protect the quality of life of urban residents as well as rural communities. Authorities responsible for physical development planning activities in the area acknowledged that the use of demolition, resettlement of indigenes, lay out and allocation of plots and charges on contraventions currently in use to control physical development planning alone is not yielding the desired results. They opined that population inflow is actually being higher than what is planned and that some of this approaches are too rigid and not in the interest of developers.

The socio-economic characteristics of those driving development in the study area also presents a number of implications. For instance ,the preponderance of the active and productive age group (21-40years), mostly married and characterized by intermediate level of education, mostly middle income earners implies planning development considerations for these attributes for the future good of the place. In other words, basic services that are within the affordable realm of this category of people should be considered including public housing.

Conclusion and Recommendations

The study has uncovered the nature of expansion in Mpape FCT, Abuja and that this expansion has social, economic and environmental implications. This up to date data therefore lend itself to planning decisions and policies. In view of all these therefore the study recommends effective monitoring of the physical development of Mpape in line with the expansion rate identified using appropriate regulatory planning instruments for sustainable livable quality life in Mpape. Policy measures should also be put in place to avert hike in rent to continue to accommodate this low income earners

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FLOOD VULNERABILITY ASSESSMENT AND RISK MANAGEMENT OF GREATER YOLA, ADAMAWA STATE, NIGERIA.

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Abstract
This work is a problem diagnosing and solving research. It employs Remote Sensing and GIS to assess Flood Vulnerability and risk management by proposing residential development suitable sites that are not vulnerable to flooding. Data employed included elevation data, sentinel-2 image and soil map of the study area. For assessing the flood, the factors inculcated in the multi criteria evaluation process included proximity to water body, elevation, slope, flow accumulation, soil and land use. The resultant flood vulnerability map yielded areas most vulnerable, vulnerable, less vulnerable, very less vulnerable, and not vulnerable and vulnerability free. The most vulnerable areas were observed to be located close to water body, on low elevation and gentle slope. Areas with past occurrence of flood were overlaid on the flood vulnerability map produced to validate the model which includes Jambutu, a part of Modire, 80 units, NEPA and other areas. Multi criteria evaluation was again adopted to obtain the most suitable areas (free from flood) for residential development. The factors considered included, proximity to build up areas, elevation, slope, land use and soil. The resultant suitability map yielded the most suitable, more suitable, moderately suitable, and not suitable and risk zone areas. The suitable areas were seen to be located North Eastern and South Western of the study area mostly in Girei and Yola South part of the study area. The research work recommends that, Residential Suitability mapping should be performed before development to avoid encroachment into areas prone to Natural Hazards.
Keywords: Vulnerability, Flood, Elevation, Slope, Residential.

Introduction

The global disaster database from EM-DAT for the last three decades (1982-2012) revealed that climate events (flood, storms, extreme temperatures and drought) accounts for about 69% of total economic losses globally with flood events causing 25% of all the total losses. A 35% increase in flood risk was also reported by the United Nations which is driven by the increasing exposure of people and economic assets to the menace in the past decades (Akinola *et al*, 2015). It is understood that flood will not subside in the future, and the onset of climate change, flood intensity and frequency will threaten many regions of the world as it is gradually becoming a common phenomenon around the world caused by rise in global temperatures resulting in torrential rains and rise in sea level that overflowed their banks and flood surrounding coastal areas. Factors influencing flooding in Nigeria are basically excessive rainfall, drainage blockages and dam failures causing destruction of houses, markets, bridges and washing away of farmlands which have heaped the craving for proper flood vulnerability and risk management by government and nongovernmental organizations and individuals to curtail this menace and seek remedy to the damages caused by this phenomenon (Jonkman and Dawson, 2012; Essien *et al*, 2018; Chukwudi *et al*, 2018).

Flood being one of the most destructive acts of nature is mostly caused by over spilling of banks of rivers, inadequate water way at rail, road crossing, and encroachment into floodplain. A knowledge on the causes of this disaster helps in selecting factors to be employed in modeling flood vulnerability. In Nigeria for instance, flood is majorly caused by natural and anthropogenic causes. The natural causes include; heavy rainstorm and ocean storms along the coastline. Human causes include; result of rapid urban expansion encroaching into flood plains, agricultural activities in river beds, poor solid disposal habits, and burst of water main pipes, inadequate drainage system, dam failures and spills with closeness to water bodies being the causes of flooding in most cases. Population outburst has also led to increased urbanization. Flood vulnerability and risk management consist of all processes captured in flood events. These processes can be observed in three phases namely; preparedness phase, prevention phase, mitigation and response/reaction phase. The preparedness phase involves prediction and identification of areas vulnerable and at risk of flooding. This phase of flood vulnerability and risk management is the most performed by scientists. It involves generation of models to predict possible occurrence and areas possibly vulnerable and at risk of the menace. The prevention phase involves activities like forecasting, early warning, observation, monitoring and plan for an eventuality. The mitigation and response/reaction phase consist of activities after the disaster which includes damage assessment and relief management of affected areas. Particularly in Nigeria, the

second phase is been skipped and that has led to massive loss of lives at flood events in various parts of the country (Essien *et al*, 2018).

The area under Study (Greater Yola), consist of three local government areas and hosts the great river Benue. The study area has consistently encountered the problem of flood with high vulnerability of lives and properties. It had a great deal of share in the 2012 flooding which led to loss of lives and properties and since then, the issue of flooding has been a thin of fear and worry in the study area. This study will seek to perform a complete Flood Vulnerability and Risk Management (FVRM) which will consist of flood vulnerability mapping, site suitability analysis for residential development and least cost path analysis. The Multi-criteria Evaluation (MCE), Analytical Hierarchy Process (AHP) and Least Cost Path Analysis (LCPA) Methods will be adopted.

The aim of this research is to perform flood vulnerability and risk management on greater Yola, Adamawa State, Nigeria. The aim will be achieved by meeting the following objectives:

i. Creation of Land use/Land cover maps of the study area;
ii. Derivation of flood vulnerability and risk criteria (Proximity to water body, Soil type, Fill sink/Elevation, Slope, Flow Accumulation);
iii. Development of flood vulnerability and risk model of the study area (Using Multi-criteria Evaluation);
iv. Development of optimal sites for residential development in the study area (Using Multi-criteria Evaluation).

Study Area & Methodology

The study area consists of three local government areas in Adamawa state and these are, Yola North, Yola South and Girei Local Government Areas. It is located between longitudes 189248.409mE to 247059.983mE and Latitudes 1005417.434mN to 1065477.971mN. The area is bounded by Fufore Local Government Area to the East and South, Demsa Local Government Area to the West and Song Local Government Area to the North as seen on Figure 1. It has a total estimated population of 699,385 persons in 2016.

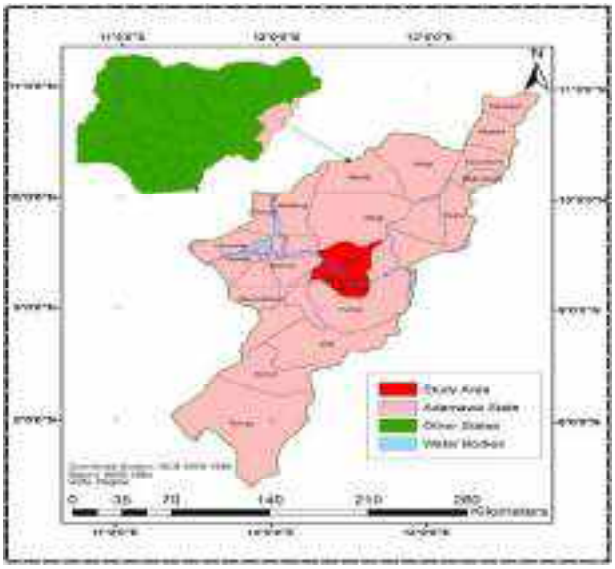

Figure1.Map of the Study Area

This research basically inculcated two major analysis; flood vulnerability mapping and site suitability analysis. Both were carried out using remote sensing and GIS hence the need for remote sensing data. Basically, Sentinel 2 Imagery, ASTER DEM and Soil data of the study area were acquired and digitally processed to model flood vulnerability and risk management model in the study area. The data acquired was used to derive criteria for all the analysis in-view, followed by a standardization process (reclassification),

AHP for weighting criteria and overlay to produce results. There are basically three (3) set of data used in this research; Sentinel 2 Imagery, ASTER DEM and Soil Map. The description of the data to be used is shown below.

i. Sentinel 2 Imagery with resolution 10x10 which was obtained from libra.developmentseed.org
ii. ASTER DEM with a resolution of 30x30 which was obtained from http://srtm.usgs.gov/mission.php
iii. Soil Map will be obtained from the Geoinformatics Department, National Center for Remote Sensing, Jos.

Data preprocessing: The data preprocessing stage inculcated various processes ranging from checking data acquired, clipping out extent of study from wholesome data. Other preprocessing activities included geometric and radiometric corrections were necessary. All this processes was undertaken to enhance the usability of the data acquired.

Band composition: The composite band function allows you to combine raster to form a multiband image. This function was used in this research to combine Landsat bands to produce a multiband image. The bands combined for this project were the near infrared, red and green band. The composite band tool under data management tools in ArcGIS 10.3 was employed for this process.

Image classification: The goal of classification is to assign each cell in a study area to a category or class. Example of a class or category includes land use type, bare preference locations and others. There are three types of classification; supervised, unsupervised and hybrid. Since the study area is known very well by the researcher, the supervised classification was adopted in this research. Supervised classification was performed on the Landsat images as the features on the study area are known. In a supervised classification, there should be a sampling of features.

Training samples: To perform an image classification, a sample set has to be created. Then, you can sample training pixels; assign class names to groups of pixels with similar spectral values and that are supposed to represent a known feature on the ground.

Signature development: In ArcGIS Spatial Analyst, one can create a classification by grouping raster cells into classes or clusters. A class is usually a known category such as vegetation, settlement or water bodies; while a cluster is a grouping of cells based on the statistics of their attributes. A signature is a subset of cells that are representatives of a class or cluster. The statistics of signatures are stored in a signature file that will be used to classify all cells in the raster. One of the most significant of signature development will help in the whole process of work.

Maximum likelihood classification: The maximum likelihood classification tool considers both the variances and covariance of the class signatures when assigning each cell to one of the classes represented in the signature file, with the assumption that the distribution of a class sample is normal, a class can be characterized by the mean vector and the covariance matrix. Given these two characteristics of each cell value, the statistical probability is computed for each class to determine the membership of the cell to the class. When the default equal a priori option is specified, each cell is classified to the class to which it has the highest probability of being a member.

Modified normalized difference water index (MNDWI): The Modified Normalized Water index (MNDWI), is an index been applied on satellite images to delineate water bodies. The index employs the green band and shortwave infrared band in the formulae. The formula for MNDWI is seen below.
MNDWI = (Green band – SWIR 2 band) / (Green band + SWIR 2 band)
For Sentinel 2 data, the formula can be literarily interpreted as: MNDWI = (Band 3 – Band 12) / (Band 3 + Band12).

Proximity to water body: Proximity or nearness to source of hazard in most cases necessitates the responsive need and management practice to be launched to combat the hazard. Buffers are usually used to delineate protected zones around features in this case, river or to show area of influence. In this case, we have the extracted water bodies from the indices in raster format, therefore the Euclidean Distance too from spatial analyst, distance in ArcGIS 10.3 to produce the proximity to water body factor.

Results and Discussion

LULC Classification of the Study Area: The Land use/land cover map of the study area was generated from the Sentinel data obtained for this research. The Supervised classification was adopted to produce the LULC map. The theme employed for training sample selection and subsequent LULC categories were the Built up Areas, Bare Surface, Vegetation, Forest and Water Body. This selection was made possible with the help of spectral characteristics of the various features on the image and a very good prior knowledge of the study area. Figure 2.Shows the resultant LULC map produced from the processes enumerated above. Accompanying the LULC map is Table1.Which gives vivid information on the area covered by the various LULC Categories recognized in the study area? This information exposes us to the magnitude of each LULC category in the study area.

Distance to Water Body: As previously established in the course of this research, the distance to water body is considered to be one of the major factors to flood vulnerability, hence the need for proper processes to be followed in deriving the above factor. To minimize the risk of human error, the Modified Normalized Difference Water Index (MNDWI) was employed to derive the water bodies in the study area which is a recognized index in water body generation.. Furthermore, the Euclidean distance tool was employed to generate a graduated distance away from water body generated in the study area so as to mark out vulnerability due to closeness to water body in the study area. Figure.3 shows the map representing distance from water body in the study area.

Elevation: The ASTER DEM as earlier stated was employed for the purpose of this research to map out elevation. A filled copy of the data was used to signify variation in elevation in the study area which is a major factor in flood vulnerability too.

Slope: Despite the fact that elevation is inculcated in this research to map vulnerability, it was also considered that though a high elevation may not be vulnerable to flood but with a very gentle slope, the area may still be flooded. This strongly proves the vitality of slope in flood vulnerability mapping hence the adoption of slope for this model.

Flow Accumulation: Flow accumulation is a process in hydrological analysis that indicates the accumulation of water drained in a particular location. This factor performs a big role in indicating the possible areas to accommodate flow in the study area.

Soil: Soil though sometimes neglected in flood mapping also plays a role in flood vulnerability as the drain capacity of a soil can determine it water retaining capacity. The soil data in this research was adopted with respect to its capacity to retain and drain. The soil variations with respect to its capacity to retain and drain are illustrated to serve as a factor in flood vulnerability in the study area.

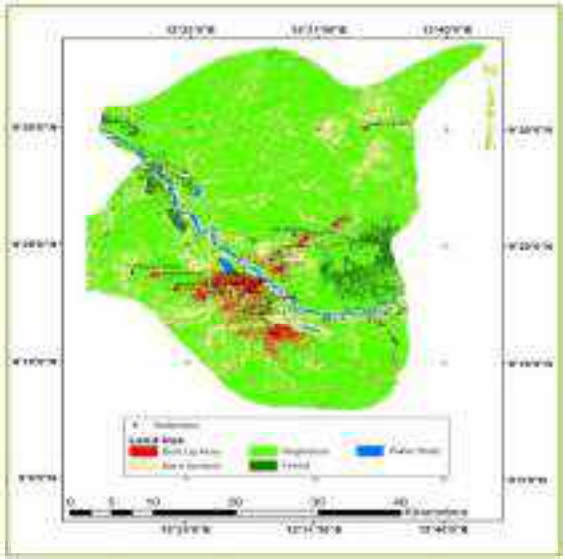

Figure 2: Land use/Land cover map of the Study Area

Table.1: Land use land cover distribution table

S/No	Land use Category	Area in Hectares	Area in Percentage
1	Built Up Area	5329.78	3.00
2	Bare Surface	38819.63	21.86
3	Vegetation	122143.2	68.78
4	Forest	8723.25	4.91
5	Water Body	2571.53	1.45
	TOTAL	177587.36	100

Reclassification (Standardization): As earlier stated in the course of this research, due to the fact that the factors employed for the research come in various units, there is a need to standardize the inputs into one unit based on intensity so as to make all the factors comparable. As noted, the factors employed for this research are LULC, Distance to Water Body, Elevation, Slope, Flow Accumulation and Soil.

Analytical Hierarchy Process: The pairwise comparison and weight generation table is represented as Table 2. The table gives a description of the pairwise comparison of factors, leading to the generation of weights for each factor with respect to its influence to the flood vulnerability map derived.

Flood Vulnerability Modeling Using Multi Criteria Evaluation: As earlier stated, the Multi Criteria Evaluation (MCE) for flood vulnerability mapping in this research inculcates LULC, Distance to Water Body, Elevation, Slope, Flow Accumulation and Soil as factors. The standardized data were adopted for this process to make the factors comparable. The resultant Map shows Flood Vulnerability in the study area.

Built Up Area Vulnerable to Flood: Using spatial query and LULC map, the Buildup Areas fall within the vulnerable zone of the Flood vulnerability map generated; and were extracted to indicate the elements at risk in the study area. The result of the above process represents the built up areas vulnerable to flood in the area under study.

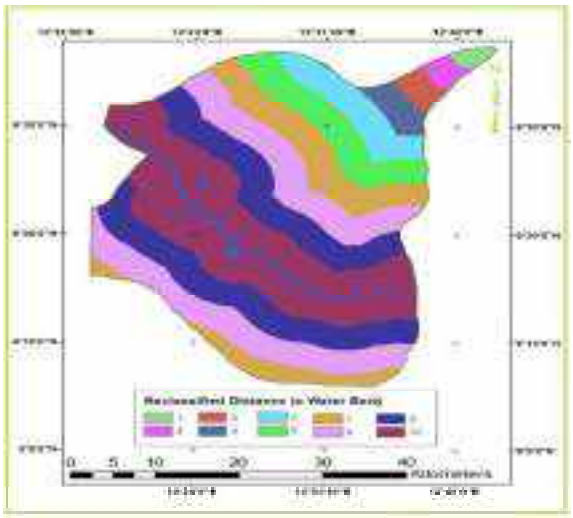

Figure 3: Reclassified to water body

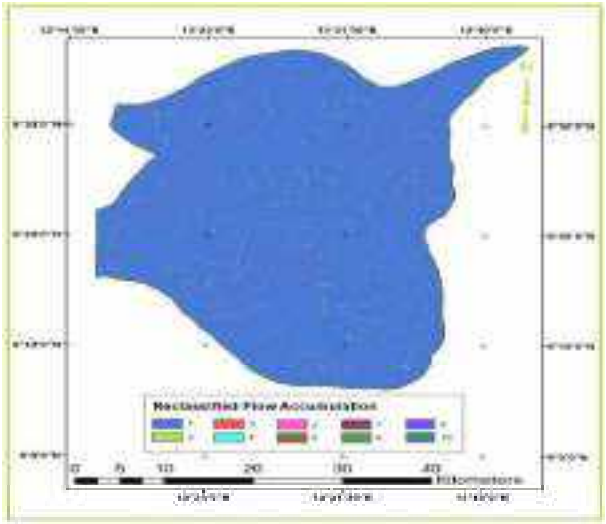

Figure 4: Reclassified flow Accumulation

Table 2: Analytical Hierarchy Process for Flood Vulnerability Modelling

	Slope	Flow Acc	Elevation	Water Dist	Landuse	Soil	
Slope	1	0.5	0.25	0.2	0.33	1	
Flow Acc	3	1	0.33	0.25	3	3	
Elevation	2	3	1	1	3	4	
Water Dist	5	3	1	1	4	4	
Landuse	3	0.33	0.33	0.25	1	1	
Soil	1	0.33	0.25	0.25	1	1	
	15	8.16	3.16	2.95	12.33	14	
	Slope	Flow Acc	Elevation	Water Dist	Landuse	Soil	Weight %
Slope	0.07	0.06	0.08	0.07	0.03	0.07	6.22
Flow Acc	0.20	0.12	0.10	0.08	0.24	0.21	16.16
Elevation	0.13	0.37	0.32	0.34	0.24	0.29	28.09
Water Dist	0.33	0.37	0.32	0.34	0.32	0.29	32.78
Landuse	0.20	0.04	0.10	0.08	0.08	0.07	9.70
Soil	0.07	0.04	0.08	0.08	0.08	0.07	7.06
							100.00

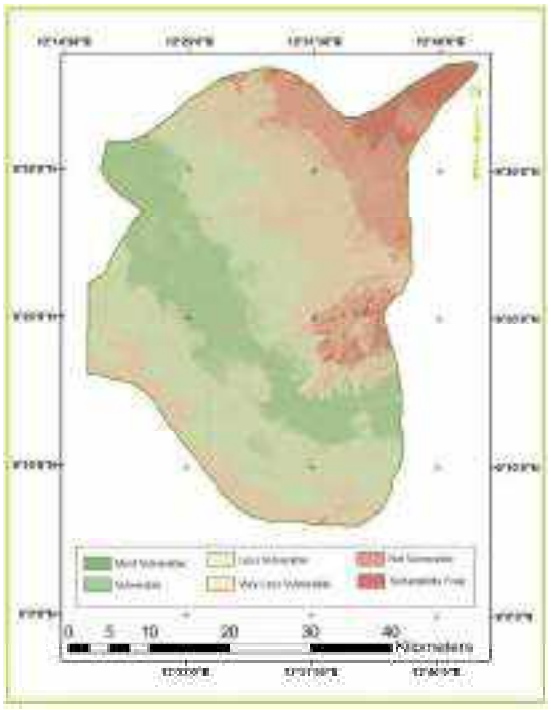

Figure 5: Flood Vulnerability Map of the Study Area

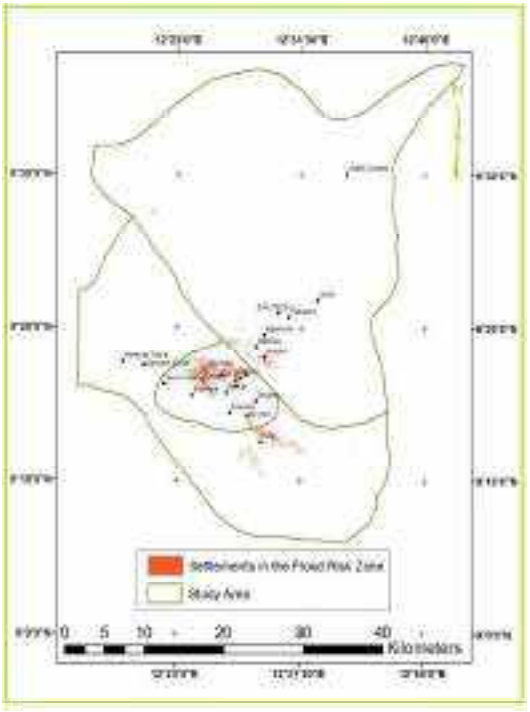

Figure 6.Built up Area Vulnerable to Flood

Residential Suitability

To probe the encroachment of built up areas into flood vulnerable areas, an alternative area must be recommended that suites residential development, hence the need for a site suitability analysis for residential development. The factors considered included Closeness to Build Up areas, Land use, Flood Vulnerability, Soil, Slope and Elevation. Spatial query was employed to extract out the built up areas in the study area so as to derive the proximity to built up area factor. Figure 6 shows the built up areas in the study area as the Land use, Flood vulnerability map, Soil Map, Slop and Elevation map have been presented above. The suitability factors were also standardized as in the flood vulnerability model. Figure 5 and 6 show the standardized Proximity to Buildup Area and Flood Vulnerability Maps as the Standardized Soil, Slope and

Elevation maps have been presented above. Table 3 shows the Analytical Hierarchy Process to allocate weights to the factors in the MCE process identifying the most Suitable and flood free zones for residential development in the study area.

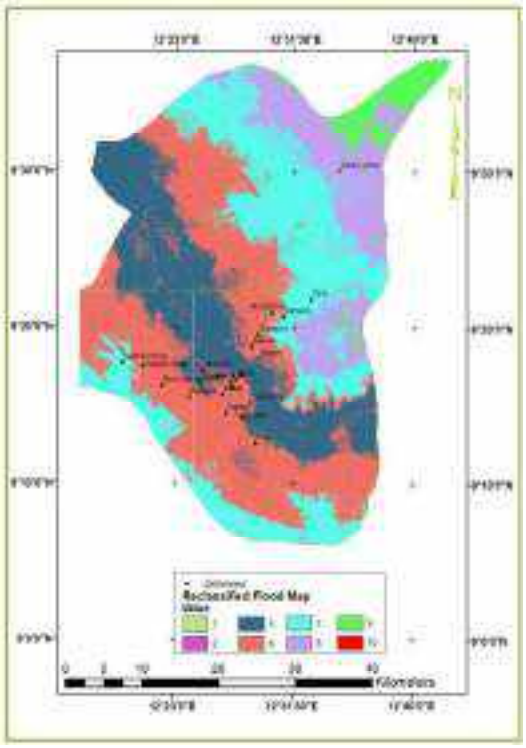

Figure 7: Reclassified Flood Vulnerability Map

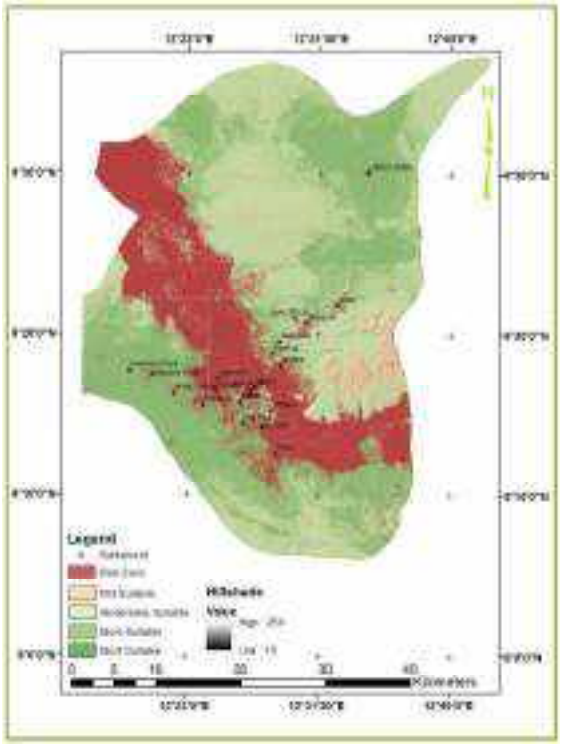

Figure 8: Residential Suitability Map of the Study Area

Table 3: Analytical Hierarchy Process for Residential Site Suitability

	Landuse	Flood Map	Soil	Slope	Settlement Dist	Elevation	
Landuse	1	0.33	1	1	1	1	
Flood Map	3	1	4	4	3	1.5	
Soil	1	0.25	1	1	0.33	0.25	
Slope	1	0.25	1	1	0.33	1	
Settlement Dist	1	0.33	3	3	1	1	
Elevation	1	0.6	4	1	1	1	
	8	2.76	14	11	6.66	5.75	
	Landuse	Flood Map	Soil	Slope	Settlement Dist	Elevation	Weight %
Landuse	0.13	0.12	0.07	0.09	0.15	0.17	11.14
Flood Map	0.38	0.36	0.29	0.36	0.45	0.26	36.74
Soil	0.13	0.09	0.07	0.09	0.05	0.04	8.55
Slope	0.13	0.09	0.07	0.09	0.05	0.17	8.55
Settlement Dist	0.13	0.12	0.21	0.27	0.15	0.17	17.63
Elevation	0.13	0.22	0.29	0.09	0.15	0.17	17.38

Discussion of Results

Land use/Land cover

As illustrated in Figure 2, the land use/land cover map of the study area can be seen with Built up area in Red, Bare surface in Topaz, Vegetation in Lemon Green, Forest in Dark Green and Water Body in Blue color. Table 1 gives detail on the magnitude of each land use category in the study area. Built Up area occupied 3% of the study area, Bare Surface 22%, Vegetation 69%, Forest 5% and Water Body 1%. From

the location of built up areas on the map, vulnerability to flooding can be sensed as majority of the built up areas tend to be located close to the water body. Areas in Northern Yola North, Southern Girei and Eastern Yola South tend to be vulnerable by proximity to water body. This problem was also observed by Aderoju *et al* (2014) as was noted in 7 local government areas that natural floodplain was not exceeded but encroachment into floodplains increased vulnerability.

Elevation and Slope

Elevation in the study area was observed to range from 113 to 668m. The study area is observed to possess a slightly flat terrain south west while Girei and North West are characterized by mountains and undulating terrain. Assessing this observation, a line is drawn to possible vulnerability in the southward part of the study area as it possesses a low relief and gentle slope. Emmanuel and Aniekan (2017) confirmed these factors to adversely contribute to vulnerability in their assessment of flood in Edo State Nigeria.

Flow Accumulation and Soil

Flow accumulation in the study area is observed to cluster close to the water bodies; this validates the proximity to water body factor. Soils on the other hand in the study area are relatively well drained except for areas at the river banks that are clayey and possess high water retentive capacity. This makes the two factors a bit less weighted as proximity to water body and elevation.

Flood Vulnerability Model

The Flood Vulnerability Model derived from the MCE processes undergone with the above factors is seen presented as Figure 5. The model clearly validates all suspicions on the vulnerable areas. The most vulnerable areas are observed to be located in the southward part of the study area. This can be boldly attributed to the closeness to water body, low relief and gentle slope nature of the study area as areas of high elevation and distance away from water body are seen to be less vulnerable. The map indicates green areas as more vulnerable and the brown areas as not vulnerable to flood.

The above result justifies studies made by Aderoju *et al* (2014), Emmanuel and Aniekan (2017) and a host of other authors that confirmed Proximity to water body and elevation to be the major factors influencing Flood Vulnerability.

Validating the Model

In trying to validate the model, the settlements that were situated within the areas vulnerable to flood by the model were extracted using spatial query. The settlements were identified and coincidentally, most of these settlements have had events of flood in time past some even consistently. The settlements include, Part of Modire, Jambutu, 80 Unit, NEPA, Damilu, WurroJebbe and Dougirei. This observation validates the model created with a high level of confidence

Residential Suitability Model

A lot of studies have been performed on flood vulnerability in various part of the country and reasonable results obtained but it is not just enough to confirm the presence of a problem. Occurrences in the past have proved the presence of flood vulnerability in a lot of the areas studied. This research is not just a move towards Flood Vulnerability Assessment and Identification alone but also risk management. In a way, it can be observed that if the public is alerted to not reside in an area termed to be vulnerable to flood, and alternative area that is free from that risk must be recommended. With the vulnerable areas been mapped already, 50% percent of the job can be said to be done already then the question arises; where is the alternative area of residence? In his research as earlier stated, we considered 5 factors, Proximity to built up areas, Elevation, Slope, Flood Vulnerable areas Land use and Soil. Table 3 shows the allocation of weights for the above factors. Avoiding the Flood Vulnerable areas was weighted more than all the other factors as it is the main factor being avoided in this research.

Residential Suitability Map

Figure 8.shows the resultant map showing areas of residential suitability. The flood vulnerable areas and built up areas were restricted in the model to avoid flood and already built up areas. From the model, the most suitable areas are represented in Green and located mostly in the North Eastern and South Western part of the study area as they fit all the required factors and inputs. Lastly, there would have been a need for least

cost path analysis to create least cost path to suitable sites but most of the suitable sites have been observed to be accessible therefore, turns down the need for that analysis but in a case were the sites are in-accessible, this is highly recommended.

Conclusion

This research have proved the ability of remote sensing and GIS to be employed in curbing the menace of flood as analysis can be made to observe areas vulnerable to the event and alternative relocation areas recommended. There are other options of curbing the menace as seen around the world which include building barricades around floodplains, dredging of the water Bodies and others which have in years back proved to be an exuberantly cost hyped project to our governmental bodies. With constant research, scientist should be able to come up with methods, and ways to curb most of these natural disasters as they affect us all in one way or the other.

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SOCIAL COMMENTARIES IN SCULPTURE: THE INNOVATIVE TEXTURAL WOOD CARVINGS OF JOHN SMART

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Abstract
Owing to human nature - the inclination to flaws, errors, arguments and contrarianism, the world is flooded with issues which call for comments and reactions in attempt to correct the ills therein. So many people have expressed their feelings and opinions in diverse ways employing different means of communication - verbal, nonverbal and visual. In some cases, innovation is introduced to the medium, style or technique employed, to make for a sense of newness for a greater impact in comments and reactions made. This paper takes a look at one of such expressions, a visual means of communication - textural cubic carvings in wood produced by John Smart, with a view of x-raying their contents. It sought to highlight visual art as an effective tool for social commentaries; and elucidate the commentaries in the textural cubic carvings. The paper employed desk research method and analytical research approach wherein the novel textural cubic carvings were analysed to reveal the artist's comments. It concludes that visual art, as a visual means of communication, is a viable tool for social commentaries as evident in the textural cubic carvings analysed.
Keywords: textural cubic carving, social commentaries, visual means of communication, innovation.

Introduction

Human beings, by nature, do not have the capacity to live and operate in a perfect state given their individual differences biologically, socially, educationally, morally, spiritually, culturally, physically, and the like. Their lives are characterized by flaws, disagreements, errors, failures, envy, arguments and contrarianism which are woven into the fabric of their nature. Although these are negative tendencies, they are however tolerated when exhibited on a moderate scale, for instance, Adrian (2019) observes that "sometimes it feels intuitively right to object towards other people's idea." It is only in extreme cases that those negative tendencies are condemned and rejected which call for comments and reactions. These are expressed in various forms of communication - orally through the media and other information communication equipment. They are also expressed in written format through print media and bill boards, and visually through the visual art. When a particular visual means of communication is employed to communicate a message to the public overtime without recourse to innovation, such message can possibly be characterized by boredom which may lead to reduction in the expected impact. To make for greater impact, therefore, there is need to inject innovation into such means of communication for it to yield a better result, in line with Ukim's (2006)assertion that visual art should be dynamic to meet the challenges of the time. Evolving new styles and techniques remains the only plausible means of providing fluidity in visual documentation of the economical, political, religious and other mundane experiences of our time without becoming insipid". This paper x-rays innovative art of sculpture - textural cubic wood carvings by John Smart with a view of revealing the commentaries therein. It sought to highlight visual art as an effective tool for social commentaries, elucidate the processes and products of John Smart's novel textural cubic carvings. The paper benefitted from desk research method and analytical research approach.

Theoretical Framework

Leo Tolstoy's art theory of communication, as propounded by Jahn (2000), is the framework which this paper is modeled after. Tolstoy's position on the definition of art lies in its function rather than in the concept of beauty, given that there is no objective way of defining beauty. For him, art is a means of communication and a means of expression of any experience, or any aspect of human condition. Communication connotes two concepts - expression and infection. By expression, it is the process through which what is subjective in the artist becomes objective for the audience. Art is a means of communication by which a person communicates his or her thoughts to another. In art, what is transferred is not rational thought but feelings. Just as verbal communication makes people convey their thoughts and experiences to others, art in Tolstoy's view, is a means of conveying a person's feelings to others.

By infection, it means understanding. The viewer of a work of art is infected when the work is intelligible and comprehensible to him. He must understand what is expressed in the work. If a work of art is only

intelligible to a particular audience, it would be obscure to others outside that particular audience. To make for access to felt experience of the artist (feelings), what is expressed in a work of art must be understood by the public. Tolstoy buttressed this by drawing the analogy of procession and jests. A procession may be art as it expresses the feelings of solemnity and grandeur on those who behold it. A jest likewise may be art given that it expresses a feeling of levity to those who hear it. Tolstoy, therefore, submits that "art begins when a man, with the purpose of communicating to other people a feeling he once experienced, calls it up again within himself and expresses it by certain external signs." The purpose of creating art is to communicate to others a feeling once experienced. Our society is flooded with social issues of concern which breeds feelings in people's minds. Such feelings need be expressed using any communication medium of choice. In this paper, the feelings of the artist are expressed through innovative textural cubic carvings as the artist's social commentaries. The works are further analyzed to make them very much intelligible and comprehensible to the audience. Through this, he communicates to others his feelings on crucial social issues.

Visual Art as a Language for Social Commentaries

Language, a vehicle for expression of thoughts, is very central to communication, in that, without it communication cannot occur. It can take the form of verbal, nonverbal or visual. Sculpture, like any other visual art, falls under visual form of communication. It is made up of three basic components which are interwoven - subject, form and content. Subject is the topic, focus or image. Form refers to the development of the work or composition while content has to do with the artist's intention; what he is communicating and meaning in his work. It is the emotional or intellectual message in a work of art, a statement, expression or mood developed by the artist (Ocvirk *et al*, 2006). This component (content) is responsible for the communicative power there is in a work of art. For the artist to communicate effectively through his work, the content in his work must be a reflection of his inner mind. He does not give in to chance as the message he is communicating is his personal feelings. He tailors the work to suit his felt experience as his work is a means with which he makes known his inner mind, as affirmed by Schaeffer (1971) that "whatever form art takes, it gives outward expression of what otherwise would remain locked in the mind."

Art, by nature, is known to possess aesthetic qualities. Beyond serving aesthetic purpose, it also serves functional purpose as it is created to communicate the artist's feelings to the audience. Its ability to communicate is very primary to it being considered as art, for instance, there are works of art that are grotesque and therefore are ordinarily not pleasing to the sense of sight but are considered as art works provided they have artistic messages in them. In the same vein, there are pieces which are aesthetically appreciated but are not considered as art given that they were not created to communicate any artistic message - objects like cutleries, scissors, bolts and nuts and the like, although such objects can be repackaged by the artist to create a work of art if he had the intention of passing a visual message to the public. This, therefore, implies that not all aesthetically appealing objects are works of art. There has to be a meaning; a message to communicate to the public for any aesthetic object to be art. Thus, visual art is a language of communication.

Art is didactic. It is often used to convey information in both literate and non-literate societies all over the world. In the Middle Ages in Europe, visual art was used to teach Bible stories to an illiterate population, (Prebble, 1994). This makes it not just a language but one with the capacity of cutting across barriers of ordinary languages. With it, communication can effectively be carried out without any need for translation, as art can be read and understood by all, making it a universal language. Art has the capacity to communicate effectively, even unconventional message(s) that ordinary words cannot explain well, can best be explained in visual language. It does not merely exist to entertain and gratify the senses; it must equally serve a functional purpose of edifying the public by the message(s) it communicates. Art, therefore, must play a crucial role of improving the collective existence of the public much as there are ethnic, religious, political and economic wrongs to be righted, given its ability to express human ideas, feelings and thoughts in ways that are clearly understood. More so, visual messages in art are usually more accessible and memorable than other forms of communication. This makes it an effective tool suitable for social commentaries.

Textural Cubic Carvings in Wood: Process and Products

Art is made up of process and product. There cannot be art as a product without a process. It must pass through a process. The artist is given to influencing the society anew with his creation which he uses to express his views about the society. In the process of coming up with a new reality, he may end up evolving a new style, medium or technique thereby making his product innovative. In the course of producing the sculptures this paper is dealing with, the artist evolved a novel technique of producing wood carvings. This involved carving of wood with cubic style, using only gouge from start to finish. Like Vincent Van Gogh who is known to have made use of impasto technique of applying paint to canvas using palette knife to achieve the swirling textural work he became famous for, (Taggart, 2019), John Smart explored the production of textural wood carving with the use of only gouge from start to finish, to arrive at a unique textural effects that is all over the carvings, making the works novel in a way. As earlier stated, the products' contents are messages the artist is communicating which form the thrust of this paper. The artist focused on a number of social issues which caught his attention as he airs out his mind visually.

Fig.1
Title: "Coronation"
Artist: John Smart
Medium: Wood Carving
Year of Production: 2018
Size: 30cm x 60cm

The figure in the work, "Coronation", is a king who wears a crown rendered in cubic abstraction. It suggests coronation, a ceremony for crowning of a king. It is usually a joyous and merry making event. Underneath it, however, is a price to pay by the person coroneted, which makes for the popular expression "uneasy lies the head that wears the crown". This implies that anyone who leads, such as a king, is constantly apprehensive. The expression comes from Shakespeare's Henry IV, Part II. In the work, Henry is bemoaning his position as king in that he, unlike even the most humble cabin-boy, cannot find a moment of peace and repose (Barnes, 2019). This means that great power comes with responsibility. The figure created appears more of an onlooker than a celebrant. He appears lost in thoughts as he looks into the future rather than the present. He focuses on the stress he would go through as a king, rather than the immediate merriment every other person sees. It is an admonition; a caution to those who are in power and others who aspire to be there, that they should not only look at the exalted position and the goodies in there but equally see the price they have to pay while being there. Quite unfortunate in Nigeria, numerous politicians see political positions as bed of roses, as they are not ready to face the stress which the office also carries. This breeds negligence, nepotism and corruption which form the cankerworm that eats into our polity and economy.

Fig. 2
Title: "The Masker"
Artist: John Smart
Medium: Wood Carving
Year of Production: 2018
Size: 30cm x 60cm

The Masker" is a textural cubic relief carving rendered in wood. It depicts a mask which is used for face covering as obtainable in some traditional African cultures Like Ibibio in Nigeria, where it was employed for religious, cultural and entertainment purposes. It is an established fact that behind every mask worn, there is a masker, even in traditional Ibibio culture earlier mentioned where everyone, except initiates of ekpo cult, were made to believe that masquerades were not humans but spirits of their departed ancestors. This fact forms the springboard for the artist's visual expression; an expression which bothers on a prevailing political malady in Nigeria - 'godfatherism; a situation where political office holders are fronted by political godfather(s) with the former doing the biddings of the latter, even when such biddings are against the progress of government and that of the masses. The masses do not see the political godfathers (the maskers) but the political office holders (the masks) who are usually blamed and criticized whenever situation arises, without recourse to the fact that the political office holders are mere actors of scripts written by the political godfathers. Rather than made the mask to have the usual grotesque look, the artist created it to have an appearance of an innocent, spotless and sincere person - an appearance these politicians carry which is meant to deceive the masses while being extra loyal to their corrupt godfathers (maskers). For the artist, this is indeed a development that has strongly weakened our economy and democracy.

Fig. 3
Title: "Expectation"
Artist: John Smart
Medium: Wood Carving
Year of Production: 2018
Size: 26cm x 62cm

It is very noticeable that Nigerian politicians are given to employing any available means to either convince or confuse the masses to win their support especially when there is an upcoming election. They are given to pretence and deceits, hiding under any umbrella to gather support for themselves. Meanwhile, the populace on their part is given to accepting anything once it is clothed with religious garment regardless of whether or not that thing itself is religious. Such is the case where political campaigns are organized under the disguise of solemn assemblies by politicians in order to win the hearts of gullible religious members of the public. These politicians would engage themselves with the populace in prayers but had already laid down their plans of action to do and undo, like how to rig election, who to place where, how to forcefully implement their decisions and the like. The artist drew inspiration from this fact to come up with a new visual idiom entitled "Expectation. For the artist, such an act is incapable of yielding any positive result as anyone who expects anything from God should be sincere, desirous and hopeful rather than hide under the cloak of being prayerful just to confuse people to win their support. To this end, he makes a visual statement on this in a textural cubic carving. He captures a female figure with her head gazed upward which portrays expectation. The figure looks up to God just as David did in the Holy Bible when he declared "I will lift up mine eyes unto the hills, from whence cometh my help. My help cometh from the Lord which made heaven and earth (Psalms 121:1-2). She is deeply enveloped in spiritual euphoria such that she is completely lost to mundane concerns. Her eyes are closed to earthly things as she looks into the future in faith using her mind's eye. The emphasis of the work is shifted away from the head, which is the centre of thought, to the neck, which is elongated, portraying desire and hope. This shift of emphasis from the head to the neck is to drive home the message that anyone who expects anything from God should be sincere, desirous and hopeful rather than cloth oneself in thoughts of his or her ability to get that same thing done without God.

Fig. 4
Title: "The Watchman"
Artist: John Smart
Medium: Wood Carving
Year of Production: 2018
Size: 30cm x 64cm

The forms on the cubic relief carving are bold. This connotes strength - a true characteristic of a viable watchman. Given this fact and the title of the work, one would expect to see an agile looking figure that is fully awake and alert as a competent watchman. The artist rather looks at it from the perspective of irony, as he goes Biblical in his interpretation of the title "The Watchman". He drew inspiration from the Holy Bible in Psalms 127:1 "...if God does not guard a city, the night watchman might as well nap." To this end, he renders the figure (the earthly watchman) as an old and weak person who is already asleep. More so, rather than project the figure above the background, the artist had it buried in the background. This is to suggest that the figure (the earthly watchman) is speechless and withdrawn as he is enveloped in fear. For the artist, no human is capable of watching over another as humans are limited in both knowledge and strength. The ultimate watchman is the invisible God who is omnipotent and does not sleep. Much as visual art is a means of communication, the artist can employ any figure of speech to communicate visually. In the piece "The

Watchman", John Smart has successfully made use of irony - a figure of speech in his visual expression of who truly is the Watchman. This, therefore, makes the sculpture a visual irony.

Fig.5
Title: "Virtue"
Artist: John Smart
Medium: Wood Carving
Year of Production: 2018
Size: 30cm x 60cm

Virtue is an excellent trait of character that is well entrenched in its possessor (Hursthouse and Pettigrove, 2016) which makes a person to be held in high esteem in the society, such as cited in the Holy Bible Proverbs 30:10 "who can find a virtuous woman? For her price is far above rubies." This implies that it is not that easy to find a woman who is virtuous given that it takes so much to be one. The sculptor reechoes this visually, to enlighten the public by rendering a good looking female figure in a relief cubic wood carving. She is rendered as a humble and submissive girl, showing her gestural, inestimable value and the priceless character of a virtuous woman that she is. The contra posing position she is captured at showcases her stylish look, which connotes that virtue is not synonymous with inferiority or illiteracy, as someone who is exposed, educated and up to date can still be virtuous. This is perhaps the hallmark of the artist's expression as he focuses more on enlightening the public than criticize the ills of the society.

One unique characteristic of a visual artwork is its ability to communicate, as such, the artist takes advantage of it to communicate his feelings to the public. With his works, the artist plays the role of a watchdog in the society by speaking to reconcile the shambles of the society, as he lays open visually his position on societal issues of concern, given that artworks have the capacity of sinking deep into the viewers' minds instantaneously, as observed by Preble cited in Ochigbo (2006) that "the most direct avenue to the mind is through the eyes." The artist does not just creates, whatever form his creation takes, it is the outward expression of what is in his mind; his feelings which are based on the occurrences in his environment. The public, upon viewing his visual idioms of expression, gets infected by the artist's feelings, in line with Tolstoy's position that art is a means of conveying a person's feelings to others. The textural cubic wood carvings analysed are John Smart's feelings expressed visually. They are his commentaries on crucial societal issues meant to impact the public positively.

Conclusion

The world we live in is flooded with social issues which generate diverse feelings in individuals. These feelings call for comments and reactions which are communicated using any means of communication - verbal, nonverbal or visual. Visual art, as a visual means of communication, is a universal language as it is understood by all regardless of language affiliation. More so, it is more accessible and memorable than other languages of communication. It is, therefore, a viable tool for social commentaries as evident in the textural cubic wood carvings analysed.

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URBANIZATION: THE NEED FOR ADHERENCE TO TOWN PLANNING AND HOUSING STANDARDS IN NEW SETTLEMENTS IN KADUNA STATE

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Abstract
Since the surge of insurgence and religious upheavals in the northern part of Nigeria started in the early 2000s, it has been causing an alarming rate of urbanization in the region drawing global attention. New settlements are fast emerging in many cities without master plan. This study seeks to find out the environmental conditions of the new settlements in Kaduna metropolis in conjunction with town planning standards vis-a-viz its effects on the community in order to forestall occurrence in future cities. The study assessed the conformity of housing standards at plot level and the community facilities level. A total of 175 copies of questionnaire were distributed to occupants of five settlements. The data collected were analyzed using SPSS tools such as averages, ratios and percentages. The results show that the cities are not planned, no good road network, non-adhering to standards criteria thereby making the areas mere modern slums. The study recommended that for sustainable development government should ensure adherence to building standards, provide master plan and provide infrastructure, amenities and needed facilities for future cities, so as to ensure conformity to building standards for sustainable development.
Keywords: City, Housing Standards, Master Plan, New Settlements, Urbanization.

Introduction

The aim of urban settlement according to Olawale (2009) is "providing a more satisfying environment in which urban inhabitants can live, work and pursue their goals that would enhance human dignity and lead to the attainment of a richer and fuller life". Yet the dynamics of the Nigerian city growth according to Olokesusi et al (2011) have been accompanied by enormous deficiencies in modern basic facilities such as potable water, hospitals, roads, electricity, market and recreational areas, among other municipal and community facilities. There are glaring evidences that the growing rate of urbanization in Nigeria is not without concomitant problems of planning, adequate provision of basic amenities and infrastructures. There are more new settlements emerging in many cities in Nigeria in the past decade than probably were since independent in 1960. For instance, in Kaduna State the results of 2000 and 2003 crises led to the polarization of the metropolis. Christians from the northern part are now migrating to the south. The recent insurgence by Boko haram in the northern states has further worsen the situation because many people are now moving to the perceived safety zones and these zones are experiencing population pressure every day and due to this according to Zaki *et al* (2013) accommodation is now provided mostly in form of inadequate houses lacking in major amenities necessary for comfortable living. A quick look at these new settlements portray them as emergency area where so many people build houses in so limited spaces with nearly no regards for established housing standards. This results to over-crowding, bad drainage system, jeopardizing the safety and health being of the people living in the area.

In the developed western world it takes them many decades to go through urbanization process, gradual emergence of economic, social and political systems to tackles the problems of transformations, ironically it is not so in Nigeria's situations. The patterns of urbanization or urban development are occurring very rapidly, which according to Agbola (2008) is occurring against a background of higher population growth but less developed economic, social and political systems. In the year 1992, the Nigerian urban and Regional Planning Act No.88 (URP Act No. 88) was promulgated by the Federal Government of Nigeria which clearly defines the roles of the three tiers of government in the planning process aiming at overhauling the old laws. The URP Act No.88 stipulates a wide range of plans and scope of services for professional planners to contribute to the planning of human settlements. Unfortunately it has been observed by scholars at different times (Zaki, 2015 and Agbola, 2008) that no government at all levels in Nigeria has fully implemented all tenets of the Act. It is more than two decades now after the passage of this law, the many dividends of good planning that are expected to come from it are yet to be seen. The Act was amended by

Act 18 of 1999 that ushered in new millennium developments, which include the creation of an independent ministry for Housing and Urban Development resulting from the two in one; 2002 government policy on Housing and Urban Development. The policy was seen as a lucid exposition of all that is bad and ugly on and about Nigerian cities and urban agglomerations with well thought out strategies on how to make the cities work again. Surprisingly, new settlements have continued emerging at a rapidly and at a greater rate than the capacity and capability of urban managers thereby creating modern slums which the inhabitants call homes. Although, urbanization in Nigeria has been in existence since 18th century, it has been observed by Suleiman (2013) that it was largely under colonial rule that the major cities and urban systems that exist today were defined. Most of the cities grew modestly in population and size. However, today through political changes and administrative development of the country, many of the towns and cities have continued to grow at a rate faster than the capacities of the initially installed facilities. Thus, linkages exist between deficient infrastructure and poor health outcomes of urban residents. Arimah (2012) posited that "major implication of the pattern of towns and cities development concern the head to provide adequate infrastructure".

This study presupposed there are existing standards and building codes guiding housing delivery in urban settlements whether they are old or new. It therefore worked on the hypothesis that: "most of the Nigeria's urban settlements especially the new ones are modern slums". So the underpinning problems associated with lack of city-wide administration in the system of cities governance, the non-effective and efficient urban governance in Nigeria, how and who should govern the towns and cities development as found in the norms of developed countries urban administration were not the concern of this study.

The primary concern of this study is to provide answers to the following questions:

i. Are these settlements developed in line with standard criteria?
ii. Are there existing policies relating to urban development process?
iii. How much of these are being conformed to in the built environment?
iv. What are the effects of non-conformity experiencing by these communities?
v. What should government do to solve the problems for the sustainability of the built environment and future urban settlements?

To provide answers to these questions the study carried out an investigation of the environmental conditions of some of the new settlements and assessed their conformity to housing standards development at plot level and urban development planning process at community facilities level. The reason for this is to ensure that standard houses are built, political requirement and aesthetics are met and community facilities that ensure health and safety of the inhabitants are provided. Housing standards, as observed by Zaki (2013) are the established rules and norms of behaviors by the government rather than individual or private groups with regards to housing which is necessary to maintain the man-shelter-environment relationship at a save level. Hence, the need to establish the general planning and site requirements is necessary.

Table 1: General Planning and site requirements

Category of Plot	Maximum plot coverage as % of the total plot area	Minimum set back (M)		
Residential	%	Front	Back	Side
Low density	35%	-	-	-
Medium density	40%	5.0	3.0	3.0
High density	50%	4.5	2.5	3.0

Source: KASUPDA

The above (Table 1) defined building lines and stipulates that no structure such as porch veranda, steps and so on shall project beyond the specified building lines. For ventilation and health related reasons it is stipulated that where two buildings are to be built on the same plot or site the distance between the two buildings should not be less than the mean of the heights of the two buildings. The maximum height of hedge fence or walls around plots shall not be more than 1.5m in front and 2.0m at the back. Where any hedge, fence or walls parts appears to the authority to be likely to obstruct the view of a passage at road traffic the authority should ensure it is altered.

Types of Standards

The first step in a review like this is to consider the various types of standards which are meant to perform in shelter provision. In general according to UNHSP (2012), three broad groups of functions can be identified, which provide a basis for classifying the standards themselves. First, there are space standards, which specify not only the amount of space to be made available in shelter provision but also the rights of individuals to that space and the manner in which it is to be used. More specifically; these standards define the level of intensity at which the activity of shelter provision can be conducted. The units in which standards are expressed vary, and include minimum lot sizes, number of buildings per unit area, building bulk per unit area, number of persons per room (occupancy ratio) or number of persons per acre (density). Second, there are technologies or performance standards which define the quality of environment, particularly in terms of the quality of construction, the type of materials that must be used, the quality of services that can be offered, or tolerable levels of toxicity. Building bye-laws, codes of construction, and regulations on water, fire, noise, waste and industrial effluent all belong to this category.

Third, there are threshold and range standards. These define the lower and upper limits of the size of population, area of distance to be serviced by a particular amenity or community facility. They include standards regarding the per capita supply of water, the desirable number of potential patients per hospital bed, or the amount of recreation land required to serve a specific number of people. Range standards define the maximum area serviced by a facility, whilst threshold standards define the respective minima.

Looking at the later on the basis for examining the environmental aspects of shelter provision, it has been argued by Arimah (2012) that this typology of standards is not completely useful as it stands, and needs to be slightly modified. To review the standards for shelter provision in the developing regions of the world, according to Olayemi (2000) the following threefold division is, therefore, offered:

i. Space – use and density standards
ii. Health and sanitation standards
iii. Community facilities and services standards.

Based on these stipulated criteria the study assessed the provisions obtainable in Kaduna state urban development.

Table 2: Kaduna State Housing Standards

Categories of Plot	Plot Size	Plot Coverage	Setback of Boundary	Back to Road centre
Residential High Density	30m x 15m (100 x 50)ft	50%	1.80m	12m
Medium Density	30m x 20m (100 x 75)ft	40%	2.50m	15m
Low Density (GRA)	30m x 40m (100 x 150)ft	35%	3.5m	15m

Source: KASUPDA

Methodology

The study carried out an in-depth literature review about the subject area upon which two (2) sets of structured questionnaire were designed and distributed to the developers and public agencies on one hand; and residents in five settlements within Kaduna State in the western political zone of Nigeria on the other. Interviews were held with community leaders and some government officials. This was done to seek their various opinions on the perceived established policies and standards and what effect the lack of or their provisions have on the environment and the inhabitants. In all, 238 questionnaire were distributed and out of which 100 copies were distributed to developers and government agencies; 95 copies were returned and analyzed.

For the residents the sample distribution was determined from a representative sample for population greater than 10,000. The following standard formula was used to determine the sample size (IWSD, 2003; Stanley, 2014)

$n= Z^2pq /d^2$

Where:

n = the desired sample; z= the standard deviate, usually set 1.96 which correspond to the 95 percent confidence level; p= the proportion in the target population estimated to have particular characteristic (normally set between 0.1 and 1.05); q=1.0-p; d= degree of accuracy desired usually set at 0.05

For the study area, the household population was estimated to be 314,066 (FRN, 2009, NPC 2007; Based on average of 5 per household of census 2007). Therefore the proportion of the population that was tested was 32.406 which is 10% of the whole population. Therefore P = 0-1
Sample size n= $(1.96)^2$ x 0.1 x 0.9 / $(0.05)^2$ = 138.2976
The study therefore randomly administered 138 questionnaires to the residents of the study areas on the ratio of 1:5 houses. The 138 copies were correctly filled and returned.

Table 3: Questionnaire Distribution

Categories	Total Number	Responses
Developers	50	49
Public Authorities (PA)	50	46
Residents	138	138
Total	238	223
Areas	Total Number	Returned
Mahuta Kaduna	25	25
UngwanBoro	25	25
Kamanzo	45	45
Janruwa	38	38
Karji	35	35
Total	138	138

Developers consists of contractors and consultants of construction firms who are responsible for actualizing the construction work; the public authorities (PA) are government health officers, local government building department agents, town planners and housing authorities (in this case Kaduna State Urban Planning Development Authority – KASUPDA) who are responsible for ensuring the conformity to housing standards and adherence to building codes. Considering the analysis of the data, the strength and weaknesses of data triangulation are: Standing on the fact that triangulation is a borrowed term from the study of experimental methods and refers to any attempt to investigate a phenomenon using more than one method; and that it was developed to counteract the threats emanating in the validity that each experimental method contained. The strength of the data triangulation is that effective data analysis was done through triangulation. This is based on the fact that each experimental method is 'best' for certain applications, scenarios and populations, but none is best for all. Using them will combine their respective advantages. The weakness lies in the fact that all information may be mixed up in data analysis as researchers are seldom skillful in the two methods and cost of using multiple methods may be expensive. Some of the variables that are impediment to triangulation are response rates, size and complexity of survey, sensitive questions, implementation time, etc.

Results and Discussion

Table 4: Ranking of Facilities Perceived to be provided in a Decent Settlement

Facilities	Number	Mean	Std.Dev	Std. Error	Ranking
Water	138	2.60	.595	.051	2nd
Roads	138	2.74	.441	.038	1st
recreation	138	1.72	.551	.047	7th
Drainage	138	2.25	.465	.040	3rd
Hospital	138	2.08	.568	.048	4th
Set back	138	1.47	.707	.060	9th
Sewage	138	1.13	.338	.029	10th
Market	138	1.48	.642	.055	8th
Schools	138	2.08	.695	.059	4th
Electricity	138	1.84	.697	.059	6th

The literature review shows the standards required of a settlement and community service facilities that should be provided to make any settlement satisfactory. Table 4 presents the residents' ranking of the facilities. They ranked Road 1st with a mean score of 2.7, water was ranked 2nd with 2.60 mean as main facilities to be provided in a new settlement. The residents also ranked Drainage 3rd and by this they proved

the philosophical saying that a city must be adorned with good roads for accessibility, water for life and drainage for the discharge of waste water. Hospitals and Schools were ranked 4th showing that society needs health and education at the same time. Electricity, Recreation, Market, Setback and Sewage were ranked 6th, 7th, 8th, 9th and 10th with the mean scores of 1.84, 1.72, 1.48, 1.47 and 1.13 respectively. When interviewed what informed their ranking decision, the majority of the respondents said they based their ranking on the necessity of life.

Table 5: Ranking of the existing Facilities provided for the settlements

Facilities	Number	Mean	Std.Dev	Std. Error	Ranking
Electricity	138	2.44	.705	.060	3rd
Road network	138	2.27	.700	.060	5th
Water	138	2.27	.760	.065	6th
Recreation	138	2.46	.641	.055	2nd
Schools	138	2.70	.459	.039	1st
Market	138	1.96	.671	.057	9th
Setback	138	2.09	.714	.061	8th
Drainage	138	2.17	.868	.074	7th
Hospital	138	2.34	.560	.048	4th
Sewage	138	1.48	.642	.055	10th

Environmental assessment was done within the constraints of a lack of information as such the study saw the measures as being practical. Therefore, the study took a practical measurement of setback of the areas of study and the results presented as follows: Table 5 shows the residents' ranking of what is provided in their settlement. The analysis of the responses shows school ranked 1st with the mean 2.70, Recreation facilities 2nd with the mean 2.46. This was followed by Electricity3rd with the mean score of 2.44 and Hospital was ranked 4th with the mean of 2.34. The result in this table shows that priority is not given to what matters most in the communities even when these facilities are grossly inadequate. What is alarming is the ranking of Roads and Water provision 5th and 6th respectively. The implication of the result with Water, Drainage, Setback and Market being ranked 6th, 7th, 8th and 9th respectively is that no easy accessibility to the areas when it rains because of flooding cause by lack of no drainage. On market days is even worse because trading take place on the pavement called roads, motorists take longer distances to find alternative routes. Water that is the source of life is only provided in Governments Reserved Areas (GRAs) as commonly known. The majority take the alternatives of drilling boreholes if they are capable or digging a well according to their financial power. The ranking of setback shows no conformity which means the areas are mostly congested and unplanned.

Table 6: Averages of plot coverage and setback obtainable in the areas

Location	Plot Coverage (average)	Setback of Boundary (average)	Back to Road centre (average)
Mahuta	76 %	1.2 m	10.**0m**
UngwanBoro	84 %	1.0 m	6.0m
Kamanzo	87 %	0.9 m	6.0m
Janruwa	85 %	0.9 m	5.7m
Karji	90 %	0.9 m	6.0m

Table 6 is a result of plot coverage, boundary setback and back to road center presenting the average of the total obtained in the areas. The table shows Karji covering up to 90% of the plot, Kamanzo covers 87%, Janruwa 85%, UngwanBoro covers 84% while Mahuta covers 76%. This can be noted as a serious noncompliance when compared to the stipulated standards in tables 1 and 2. The implication is that the areas quickly become congested especially with the stipulated setback not being conformed to. What is worth noting is the Mahuta, which inspite of being a layout still did not conform to the stipulated standards. This is an indication that as long as building of houses or housing developments is left in the hands of individuals who purchase land for their own use and not the government doing it for the citizens then they will always try to maximize the use of space within the constraint of their financial capability.

Table 7: Perception of who should be responsible for implementation of policies

Description	Number	Percentage
Land owners (sellers)	10	21.8
Village Heads	7	15.2
Developers	3	6.5
Public Authorities (PA)	26	56.5

Table 7 shows the opinions of the PA who responded to the question 'who is responsible for the implementation of the building standards policies? About 56.5 percent indicated that it is the responsibility of PA to ensure compliance, 21.8 percent indicated that it is the land owner who is selling the land while 15.2 percent indicated that it is the village head that should be responsible and only 5.5 percent indicated developers. In an interaction (interview) those that are of the opinion that it should be the PA said only government formulates policies and it is the government that has the power to enforce policies within its jurisdiction. Those that said land owners argued that since it is not government land those selling land should always ensure that plots are demarcated and provision of roads made before selling their land. Those who indicated village heads said that village heads are the government representatives in their communities and they have the authority to implement government's policies. Those who opined that it should be the developers based their argument on the fact that since developers consist of professional who are no novices to the standards policies they are in the better position to implement policies.

Table 8: Factors Responsible for Poor Implementation of Standards policies

Description	Number	Percentage
Stringent policies	10	20.4
Lack of awareness	2	4.1
No government presence	6	12.2
Lack of enforcement by government agents	31	63.3

Table 8 shows the responses of the developers on what could be the factors responsible for poor implementation of standards policies. About 63.3 percent believed it is lack of enforcement by the PA while 20.4 percent indicated that it is due to stringent policies, 12.2 percent indicated that no government presence is the reason for poor implementation of policies and 4.1 percent indicated lack of awareness.

Conclusion

The literature reveals that there are existing policies, stipulated building codes for standards and established agencies to enforce their implementation. From the analysis of the primary data shown above, the study findings are:

i. *At plot level the stipulated setback and building codes standards that make a settlement a healthy environment for people to live in and carry out their activities are not conformed to;*
ii. *The community facilities are not adequately provided;*
iii. *The standards are not conformed to because PA are not enforcing their implementation;*
iv. *Sales of land is left in the hands of Individuals who do not comply with stipulated policies because they want to maximize their gains;*
v. *Individuals are left to build without being properly checked therefore they do not observe the plot coverage allowable for flow of ventilation in and around our dwellings; and*
vi. *The result of these is overcrowding thereby, causing health problems, air and noise pollution.*

From the findings it is safe to say that our new settlements are not planned and building developments are just going haphazardly. This is not a good development for the present day situation where sustainability is the watch word in developing our environments. To achieve sustainable development and sustain our built environment the government must make concerted effort to plan and provide the facilities required for community service before plots are sold out to individuals as noted in the case of Mahuta layout area.

Government should not compromise in the discharge of its responsibility in the built environment as this has direct bearing on health and safety of the inhabitants of such communities.

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TABLE OF CONTENTS

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