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Context-based Design Framework for Promoting Sustainable Housing Development in Nigeria: The Case of Lokoja, Kogi State

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ABSTRACT: *An intelligent design of buildings through strong collaboration with relevant stakeholders is key to achieving sustainable housing development in Nigeria.Housing development efforts in the past were without long-term viable initiatives. This study emerged to promote sustainable housing in Nigeria through the development of a context-based design framework. This is intended to downsize future retrofit of residential dwellings that may be constructed in the years to come without adopting sustainable design practices. The study was conducted through a literature review and qualitative approach involving interviews with architects and engineers who are directly responsible for the production of drawings for building projects in the area of investigation. The data collected were analyzed through content analysis and the results showed an urgent need for the proposed framework in the study area to promote sustainable housing development. Moreover, it emphasized strong collaboration among project stakeholders, especially at the design stage, and the involvement of at least a sustainability expert in the current design team to promote sustainable housing development. The proposed framework was developed based on the findings of the interviews and a review of pertinent literature. The framework involves four stages, predesign and conceptual design, schematic design, design development, and construction documents stage, and verification stage. The framework is expected to eliminate possible challenges at the design stage of the building project and promote collaboration and efficient communication among stakeholders, especially the design team towards establishing a responsive design approach for sustainable housing development in Nigeria.*

KEYWORDS: framework, sustainable housing development, design professionals, design stage, Lokoja/Nigeria

INTRODUCTION

Housing development presents a huge opportunity to achieve Sustainable Development Goals (SDGs) 11, which seeks to provide among other things, access to safe, adequate, and affordable housing, upgrade of slums, and other basic services for all [1]. Many African cities lack access to quality housing, which is among the most basic human needs. Achieving sustainable urban development starts from a home, which grows into a city. Hence, architecture which focuses on the design of buildings for homes at different scales is key to achieving a sustainable urban environment. However, the traditional strategy for building design is now becoming ineffective to meet the requirements and standards of sustainable housing. The responsibilities of design professionals have now moved from just the provision of buildings that is functional, structurally stable, and aesthetically appealing to include factors such as thermal comfort and energy demand. Proper architectural design can serve as a strong tool for downsizing energy bills in homes towards overcoming energy poverty and improving people's well-being. Moreover, it is crucial to consider how buildings are designed because a significant part of the campaign for sustainable buildings is for building designers to come up with strategies for creating structures that have little to no negative impact on the environment and people's well-being. Cowan et al. [2] suggested that to accomplish the UK's aim to reduce greenhouse gas (GHG) emissions by as much as 80 percent by 2050, building design must be optimized. A thoughtful approach to building design may substantially decrease energy demand, consumption, and the building sector's contribution to GHG emissions. Akande et al. [3] said that many residential structures in particular climates were unsuitable for occupants due to poor design that doesn't take local factors into consideration. Sustainable design principles as well as knowledge transfer can help designers accomplish the ultimate objective of sustainable development, which is for both humans and the environment to coexist in harmony [4]. Adegun [5] posited that issues related to social and environmental sustainability have not been adequately addressed in previous housing interventions in Africa. Previous studies showed that major considerations were on economic issues like job creation and economic development [6,7].

The argument above shows that sustainable design approach is key to achieving sustainable housing development in Nigeria, especially in Lokoja, Kogi State. In line with this, this study aims to develop an approach to housing development that does not only seek to address immediate housing challenges but the provision of sustainable housing development towards improving people's well-being and environmental quality. Hence, this research seeks to promote sustainable housing development in Nigeria through the development of a context-based design framework.

The basis for the proposed framework

Urbanization

The process of urbanization is an important factor of "economic development" which significantly affects the consumption of human resources. Over the next 40 years, it is projected that the urban

population of "less developed countries" will increase from approximately 2.6 to 5.3 billion. This indicates that between 2010 and 2050, the average urban population growth rate in the so-called "least developed countries" is expected to rise by 3.3% per year. It has been estimated by the United Nations that nearly 83% of people on Earth will live in “less developed regions”. The growth rate prospects show that African and Asian cities are projected to experience faster rates of urbanization. On the reverse side, it is anticipated that within the same time frame, the urban growth rate in "more developed regions" of America and Europe will fall to zero [8].

Cities, accounting for nearly 2% of the World’s land mass consume about 75% of human resources. This shows that global energy demand is mainly a reflection of urbanization. Cities account for “two-thirds” of the World and 70% of CO_2 emissions. Considering the rapid growth of cities in developing countries, the urban energy demand and CO_2 emissions of cities are expected to rise to 73% and 76% respectively by 2030 [9].

On average, in terms of energy consumption by cities, North America ranked first with an energy consumption of (51, 000MJ), followed by Oceania (21, 500MJ) and Western Europe (16, 000MJ). Asian and African cities currently consume less due to some reasons. However, if nothing substantial is done to reduce energy use in Asian and African cities, energy consumption in these regions may reach that of Northern American cities [10].

Lokoja is a model of a fast-urbanizing city. This may be because Kogi State (Lokoja as the capital city) is contiguous to nine states in Nigeria, a transit route to about sixteen states, and its nearness to the Federal Capital Territory, Abuja. The increase in population that Lokoja has witnessed in recent times led to a corresponding increase in the rate at which buildings are constructed, an increase in GHG emissions, and an increase in the temperature of the microclimate [11]. The increase in temperature has contributed to some health issues resulting from the weather, such as meningitis, heatstroke, and heat rashes [13]. Increasing energy demand may be attributed to the need for the teeming population of building occupants to overcome the effects of increasing temperature through the use of cooling systems. Efforts to meet housing demand due to urbanization resulted in a significant modification of the microclimate. Hence, the land use pattern of Lokoja has undergone significant changes since becoming the seat of government [13, 14].

Studies have confirmed that the transformation of the environment through human activities and the corresponding effects are often attributed to urbanization and accelerated economic growth [15]. Furthermore, an increase in temperature has a link with high population density and the alteration of biodiversity due to the removal of natural vegetation for construction purposes [16]. Urbanization contributes significantly to the alteration of local climates leading to heat islands [17]. Lokoja has witnessed a gradual change in the microclimate over the years owing to the increase in the built-up area [11].

Building stocks, commercial as well as residential, are responsible for 61% of overall energy usage. Measures aimed at reducing energy demand and consumption have been suggested notably

the use of energy-efficient appliances and environmentally conscious urban and building design [18, 19]. Hence, these actions must be taken immediately in Lokoja, Nigeria to promote sustainable housing development.

Housing needs and possible future retrofits

Housing need due to population growth has become a primary concern in most developing countries, especially in Nigeria [20]. Since Lokoja became the capital city of Kogi State in 1991, one of the major challenges has been the need to provide more housing to meet the demands of the teeming population. Successive governments made several efforts to provide accommodation for the people, especially civil servants [21]. Table 1 shows selected housing schemes in Lokoja. Despite the various housing interventions, housing deficits are still an issue that requires appropriate methodology in Lokoja, Kogi State. An effort to reduce housing deficits in Kogi State in the past involved a memorandum of understanding between the Kogi State Government and CRCI Nigeria Limited signed in January 2015 to the tune of 8 billion dollars to develop a modern city in the East Senatorial District. The memorandum of understanding was aimed at the construction of 10,000 houses for middle-income earners in the state civil service [22]. This memorandum is yet to have any positive impact on housing development in Kogi State.

Table 1. Selected Housing Schemes in Lokoja

Location	Name of housing scheme	Age of buildings	Number of housing units
Adankolo	Phase 1	10	200
Ganaja	Phase 2	8	100
Lokongoma	Phase 3	8	150
GRA	Commissioners' Quarters	8	100
Workers'	Phase 4	7	100
Lokongoma	Secretariat Housing Estate	6	200
Ganaja	House of Assembly Quarters	6	50
GRA	DG Quarters	4	20
Gadumo/Ganaja	Workers Housing Units	1	200

Source: Adapted from Olawepo, [21]

Existing dwelling units were constructed with minimal to no environmentally friendly procedures. This study aims to provide guidance and raise awareness throughout Nigeria, and more specifically Kogi State, on the necessity of employing sustainable design and construction methods for subsequent housing development interventions. This is essential to prevent dwellings from being retrofitted in the years to come if they get built without using sustainable construction practices.

The goal of addressing the housing shortage must include environmentally friendly methods to avoid further negative impacts of buildings on the environment and people's well-being.

The current strategy used for building design

The current strategy used for building design in Lokoja has no significant sustainable design features. Alabi [11] corroborated this when he revealed that practices and policies of the built environment in Lokoja do not consider GHG emissions. Post-modern building characteristics influenced by the importation of foreign materials, particularly from China, are characteristic of Nigerian architecture [23]. The building envelope can be designed sustainably to significantly increase energy efficiency and help achieve heating and cooling requirements [24]. Poor building design, on the other hand, may substantially raise a building's energy usage. Akande [25] argued that because of bad designs that are unresponsive to the local environment, a variety of residential buildings in a few climatic regions of the world were not suitable for their occupants. Challenges with such design include poor orientation, improper shading solutions on exterior windows, and inadequate ventilation of functional spaces. Hence, there is an urgent need to encourage sustainable housing demand through the inclusion of sustainable building design experts and appropriate frameworks. Alabi [11] suggested that thermal discomfort in Lokoja could be minimized through intelligent design that incorporates passive cooling strategies. These strategies include the use of vegetation, reflective paving, cool roof, building configuration, and orientation. Owolabi et al. [26] maintained that innovative design is key to the successful implementation of affordable housing delivery in developing countries. This study evolved to produce a framework for performance and a context-based design approach for sustainable housing development in Nigeria.

Building project design team

Because the design phase is key to sustainable building development, the selection of design team members is critical to sustainable project delivery. This selection should be informed by the intended project output. It may be extremely difficult for the traditional design team that lacks the involvement of a sustainability expert to deliver sustainable housing. We strongly hope that to achieve sustainable housing development, competent design teams that involve at least an expert that is conversant with sustainable housing demand are required. Hence, it has become necessary to move from the general approach to the design of buildings to involving specific design requirements, especially in the area of sustainable design.

The traditional approach to the building sector in Nigeria is to handle the entire building process in two separate phases by two separate teams of design and construction. The design team members include Consultant Architects, Consultant Engineers (structural, Electrical, Mechanical), and Quantity Surveyor. The main contractor and the subcontractors make up the construction team in Nigeria [27].

The demand for sustainable housing development has necessitated the expansion of design professionals to include relevant design experts/specialists. These include sustainable building

design experts, valuation/appraisal experts, real estate and marketing experts, site design specialists, and systems specialists. This is important as changes in clients' needs due to sustainable building requirements place additional demands on project areas like cost, time, and quality. Hence, to promote sustainable housing design, the design team should involve members with relevant skills in sustainable housing design.

Jayasel [28] maintained that an appropriate design team must possess relevant skills that match the client's requirements. In line with this to promote sustainable housing development in Nigeria, and specifically Lokoja, it is imperative to include the services of a sustainable design expert in the design team. This is important as the traditional building design team may not have the relevant skill to meet the client's demand in this regard. Moreover, climate change and its resulting challenges call for climate-responsive design approaches.This study aims to involve the services of a sustainable design expert in the current design team towards achieving sustainable housing development.

The design stage of a building project

The design stage of a building project is key to the success or failure of any building project. A study by Svalestuen et al. [29] maintained that although building design accounts for a negligible portion of the entire cost of construction projects, it has a significant influence on both construction and operation costs. Design errors have been blamed as one of the human factors that are responsible for cases of building collapse in Sub-Saharan Africa [30]. According to previous studies, unsound structural design is a major contributing component responsible for building collapse in Nigeria [31-35]. Mbamali and Okotie [27] who corroborated the relevance of the design phase of the project, argued that important decisions that influence the performance of buildings take place at the design stage. The design phase of building projects is where most decisions that affect the construction, performance, and operation of buildings are taken toward value optimization for the Client or users [36]. Over four decades ago, BRE [37] argued that about 50% of construction faults are attributed to design deficiencies.

Other studies have shown that the design stage of projects has a great influence on delivering quality building projects [38-42]. Considering the relevance of the design stage of building projects, Oyedele et al. [43] revealed that all design professionals must be committed to quality project delivery right from the design stage.

About two-thirds of construction costs due to design changes can be avoided through well-managed projects [44], especially at the design stage. Hence, proper control of the design process can help to minimize project costs towards achieving project objectives. Cockshaw [45] confirmed that the design stage is vital to project success. In line with this, modern design approaches using modeling and analysis tools that simplify the building design process are recommended at the early stage of building design to provide an opportunity for checking the efficiency and sustainability of proposed design solutions [46].

The argument above goes to confirm that the design phase of a building project is crucial to the quality of building output. Bearing in mind the relevance of the design phase of the building project, this study set out to produce a framework to promote sustainable housing in Nigeria through the development of a framework for performance and context-based design approach. This is aimed at overcoming project challenges arising from the design stage of projects toward sustainable housing development in Nigeria and the study area in particular.

Sustainable building and architecture

The concept of sustainable building as an offshoot of sustainability and sustainable development is difficult to pin down in terms of a suitable definition. Nevertheless, a common framework has been identified from different measurement tools presented by sustainability assessment systems to intensify efforts on awareness regarding the criteria and objectives of sustainability. Sustainable building has been defined based on these systems as any building that is built ecologically with reduced impact on the environment [47]. Efforts towards achieving this in the study area are still rudimentary. This framework is aimed at promoting sustainable building development in Lokoja, Nigeria.

Sustainable architecture, on the other hand, aims to mitigate the adverse effects of buildings on the environment by using building materials, energy, and development space effectively. It also involves the production of buildings based on the site microclimate and establishing harmonious and enduring relationships between building occupants and the building-surrounding environment [48, 49]. Sustainable architecture focuses on satisfying the broad aim of sustainability, which is to maintain ecological balance and offer opportunities to various life forms to survive and flourish. It is an effort towards reducing the contribution of buildings to the world's total GHG emissions. Additionally, it emphasizes appropriate design approaches that might lessen the damaging effects of building development on the natural environment without sacrificing the comfort of building inhabitants [50].

Sustainable building and architecture can be achieved through the adoption of both passive and active technologies by design professionals towards achieving the ultimate objective of sustainable development in the housing subsector. This is crucial since the basic objective of sustainable development is for people and nature to coexist peacefully, and design professionals can help achieve this aim by using sustainable design techniques and sharing their knowledge [4].

Sustainable building design

The level of response to sustainable building design and construction in developing countries especially in Nigeria is still very low [11, 51]. Since buildings utilize almost 40% of all energy consumed worldwide and emit one-third of all greenhouse gases [52], there is an urgent need to embark on sustainable approaches to housing delivery in Kogi State, Nigeria. This is important as the traditional building design approaches are becoming ineffective and will not be able to meet the requirements of sustainable building design and construction.

To achieve sustainable building design, it is important to move from the contemporary building design process and redefine the roles of the participants involved [46]. The proposed framework is aimed and promoting sustainable housing development through sustainable design approaches.

The Study Area

The location

A study has revealed that Lokoja is located between latitude 7º 45'N, 7º 51'N of the equator, and on longitude 6º 41' E 6º 45'E of the Greenwich Meridian [11]. Lokoja is characterized by different sizes of hills and mountains among which is the popular Mount Patti. Figure 1 is the map of Nigeria showing Kogi State.

Figure 1: Map of Nigeria showing Kogi State
Source: Kogi State Ministry of Works and Urban Development, Lokoja (2018) as in **Olorunfemi [53]**

Lokaja, Kogi State is a city in "the North-central geopolitical zone" in Nigeria. Lokoja is among the oldest settlements in Nigeria [21]. History has it that Lokoja was the administrative city of the British colonial government in Nigeria in 1914. Lord Lugard who was the Governor General ruled Nigeria as a unified nation from Lokoja, which is now the present capital city of Kogi State [54]. Other reasons, which make Lokoja a significant city in Nigeria, include serving as a center for the slave trade in the 18th and 19th centuries and a center for distance learning in the 1800s. Moreover, Lokoja became famous in Nigeria due to its position on the bank of the river Niger bordering the confluence of two great waterways in West Africa, River Niger and Benue [55]. The map of Nigeria revealed that Lokoja, Kogi State is contiguous to nine other states and is a transit route to several cities in Nigeria. Figure 2 shows the location of Lokoja on the map of Kogi State.

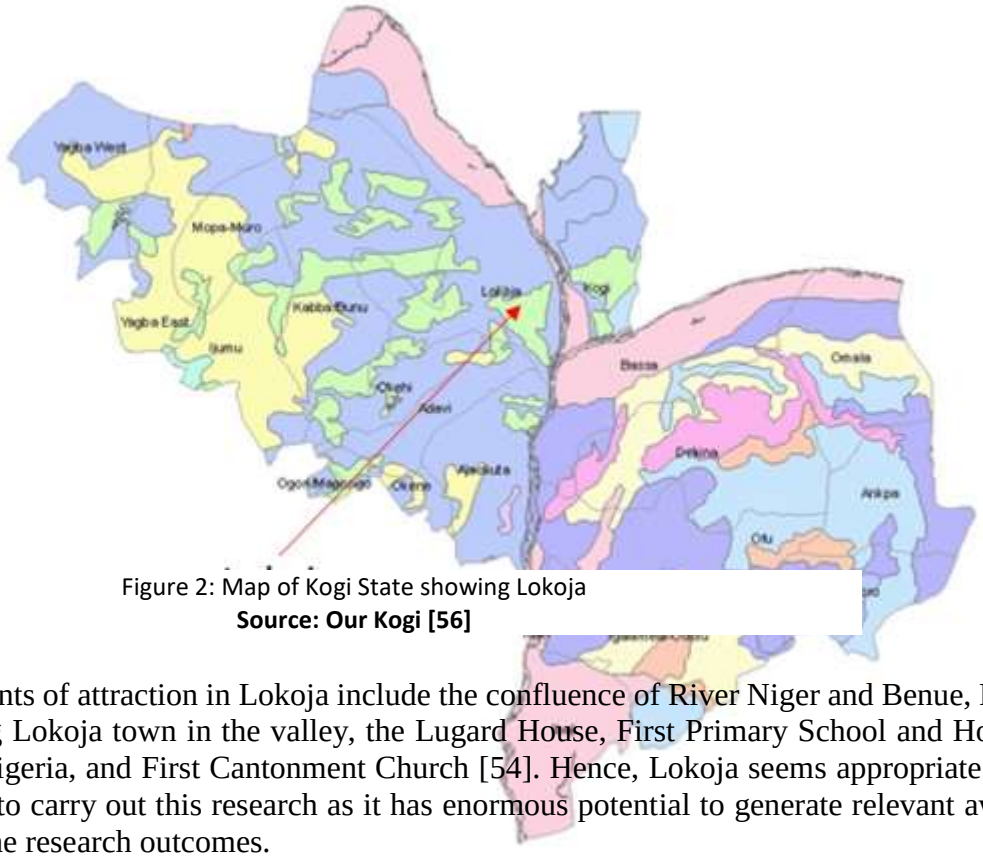

Figure 2: Map of Kogi State showing Lokoja
Source: Our Kogi [56]

Famous points of attraction in Lokoja include the confluence of River Niger and Benue, Patti Hill overlooking Lokoja town in the valley, the Lugard House, First Primary School and Hospital in Northern Nigeria, and First Cantonment Church [54]. Hence, Lokoja seems appropriate in terms of location to carry out this research as it has enormous potential to generate relevant awareness regarding the research outcomes.

The climate

Lokoja and its environs belong to the Koppen-Aw climate classification [57]. The climate of Kogi State is categorized into two major seasons, which are the "wet and dry" seasons. The wet season begins towards the end of March and stops towards the end of October. In some years, the wet season will start in April. The dry season, on the other hand, starts in November until late February. The beginning and end of both seasons are controlled by when the rain starts and stops. The maximum temperature takes place during the hot season and its average annual rainfall is 1000mm

[11]. The daily mean temperature during the rainy (wet) season is about 28^0C while the average temperature during the hot (dry) season is about 35^0C [58]. The average annual temperature in Lokoja hardly drops below 30.7^0C with February and March being the hottest in the year [12]. Relative humidity in the city during dry and wet seasons are nearly 30% and 70% respectively [59].

RESEARCH METHOD

Interview with design professionals

This study adopted qualitative structured and semi-structured interviews to collect data from design professionals in Lokoja, Nigeria to determine how to promote sustainable housing development through the development of a context-based framework. The qualitative research approach was chosen because it is explanatory and aims to provide answers to how and why questions [60, 61]. Moreover, Miles and Huberman [62] posited that it is a constant and iterative process, which entails a simultaneous flow of activities involving data reduction and display, making conclusions, and verification.

The interview instruments for the design professionals comprises sections A and B: section A contained structured questions on demographic data while section B involved semi-structured questions aimed at generating data to support the development of the proposed framework to promote sustainable housing development in Lokoja, Nigeria. The areas covered in the latter include the current members of the design team in the study area, the need to involve a sustainable building design expert in the current design team, the need for project design team meetings at strategic stages of the design process, and verification of performance requirements of the proposed design before construction. Considering the need for face validity of the survey instrument as advocated by Bryman and Bell [63], two design professionals in Lokoja were contacted and they validated the design instrument. The initial interview instrument was revised based on the suggestions made by the design professionals.

A pilot interview was necessary to test the structure, clarity, flow, and suitability of the questions raised regarding the research focus. Hence, two architects and an engineer in Lokoja, the study area were selected for the pilot interview. After the pilot interviews were conducted, shortcomings, which were discovered in the interview instruments, were corrected awaiting the main interviews. For the purpose of choosing respondents for the interviews, non-probability sampling was adopted. When compared to probability sampling, this sampling method is less costly in terms of both time and money [64]. Furthermore, because of the nature of the inquiry, it was impossible to apply the probability sampling method because not all of the intended respondents would be equally likely to be chosen.

Architects and engineers (structural, electrical, and mechanical) are directly responsible for the production of drawings for building projects in the study area. Hence, architects, and engineers were sampled to provide relevant data to the production of the proposed framework. The Nigerian

Institute of Architects (NIA) in Lokoja, Nigeria, has roughly 40 members on its roster. Finding trustworthy information on the overall population of engineers in the study area proved to be challenging for the researcher. A total of 10 architects and 5 engineers who were chosen from government ministries and parastatals, academics, and private practice participated in the interview for this study. Both engineers and architects were chosen based on their level of expertise and involvement in building development procedures in the study area. It was difficult to interview more design professionals due to the research duration, cost implication, and other limitations.
Using content analysis, a structured and objective method for finding and describing phenomena [65, 66], the interview material was examined. This approach was used to reduce the lengthy contextual data collected from the respondents into smaller categories using coding [67]. In this study, content analysis was performed to condense and organize the vast amounts of data collected from all respondents. A deductive approach to content analysis was applied to the interview data leading to the research findings.

DISCUSSION OF MAJOR FINDINGS

This section summarizes the results from the analysis of the interview data that were collected for this study to guide the development of the framework for performance and context-based design approach for sustainable residential development.
For identifying the interview data based on the different respondents and settings, an audit trail was created. To accomplish this, identifiers were created with the objective to provide context [68]. These identifiers were required to uphold the respondents' anonymity in accordance with research ethics. The design professionals were identified as DP01, DP02 …DP15.

Members of a standard project team

All the respondents agreed that architects are part of the design team for building projects. Of the 15 respondents, 11 maintained that structural engineers are also part of the design team. For electrical and mechanical engineers 10 respondents agreed that both are members of the design team. Other members of the design team listed by the respondents are builders, quantity surveyors, landscape architects, interior designers, clients, estate valuers/surveyors, contractors, town planners, and surveyors.

There seem to be divergent views on the members of the design team based on the literature review and the interview data. A study by Mbamali and Okotie [27] revealed that the design team members include Consultant Architects, Consultant Engineers (Structural, Electrical, Mechanical), and Quantity surveyors. The responses from the interviewees above showed other members of the design team beyond this view. However, in the study area Architects, Engineers (Structural, Electrical, and Mechanical) are responsible for producing drawings for building projects. The Client, Contractor, and other allied professionals only provide advice that will aid the production of drawings toward achieving project goals.

Involvement of a sustainable building design expert

Apart from the respondent (DP07), all others agree that a sustainability expert should be included and gave their reasons. Considering the rate of unsustainable housing development in Nigeria, a respondent (DP03) was of the view that it is imperative to include sustainability experts in the design team. He added that this is important as it might be difficult to attain sustainable building design without the involvement of an expert in the team. Other respondents who were in support of this view argued that the involvement of the sustainability expert will aid the realization of the project requirements in terms of the adoption of sustainability measures.

Respondent (DP07) argued that there is no need to include a sustainability expert. In his words, "The current members of the design team should update their knowledge on sustainable building design and delivery". This may be possible when an architect or a member of the team is licensed in the area of sustainability and can play this role in addition to the design responsibilities. However, where the architect or any of the design team members lacks training in sustainable housing design, it becomes necessary to involve a sustainable expert to achieve sustainable housing design. These were the views of other respondents who were asked to comment on this line of thought. Hence, we can deduce from this argument that using whatever approach, a sustainability expert is required to be a member of the design team.

Project design team meetings

Respondents were asked to state whether the design team must meet at the pre-design and conceptual design stage and the design development and construction documents stage. All respondents agreed that it is necessary for the design team to meet at these stages of the design process and listed benefits of these meetings to include: time management, a proper understanding of project requirements, proper cost management, alignment of ideas, efficient communication, quality assurance, and proper planning. For instance, respondent DP03 maintained that meetings at predesign and conceptual design stage can help the design team to work within the budget limit for the proposed project. Some interviewees were of the view that the design team meetings can help to reveal aspects of the project which the client may not have envisaged thus enabling him to have a rethink before proceeding with the project. Moreover, it can be an avenue for the design team to align divergent views to prevent conflict of ideas and interests which can have negative effects on the project.

Verification of project performance requirements.

All respondents agreed that the performance requirements of the project proposal should be verified by carrying out the necessary tests before the construction stage. Respondent (DP15) stressed that verification of performance requirements will help to make sure that the project is on the right track, especially at the design stage which is critical to the realization of the project objectives. Another respondent (DP07) that corroborated this view maintained that it will help the design team to determine how the design meets the project requirements like comfort and energy performance. Moreover, it will help to confirm certain assumptions that led to the production of the design proposal (DP03). Other reasons outlined by respondents include prevention of possible

failure of the building during construction or post-construction, resolution of grey areas in the project, minimizing revision of drawing at the construction stage, keeping construction costs within expected targets, and making sure that the proposed design satisfies client's expectation. Further questions revealed that the majority of the respondents were not familiar with appropriate software and standards for verifying the performance of buildings at the design stage.

The framework

The framework was developed based on the literature review of relevant data on the research area and the interview with design professionals. The framework involves the current design process in the study area and the introduction of the verification stage, which is intended to validate the project performance requirements. The review of existing literature provided data that form the basis for the proposed framework. The interview with design professionals provided information on the current design team in the study area, the need for the involvement of sustainable building design experts to promote sustainable residential housing development, the need for the official team meeting at critical stages of the design process, and the need to verify the design documents to make sure they meet project performance requirements.

The proposed framework for performance and context-based design approach for sustainable housing development in Nigeria, especially in Lokoja, comprises four stages. These stages are the predesign and conceptual design stage, schematic design stage, design development and construction documents stage, and verification stage.

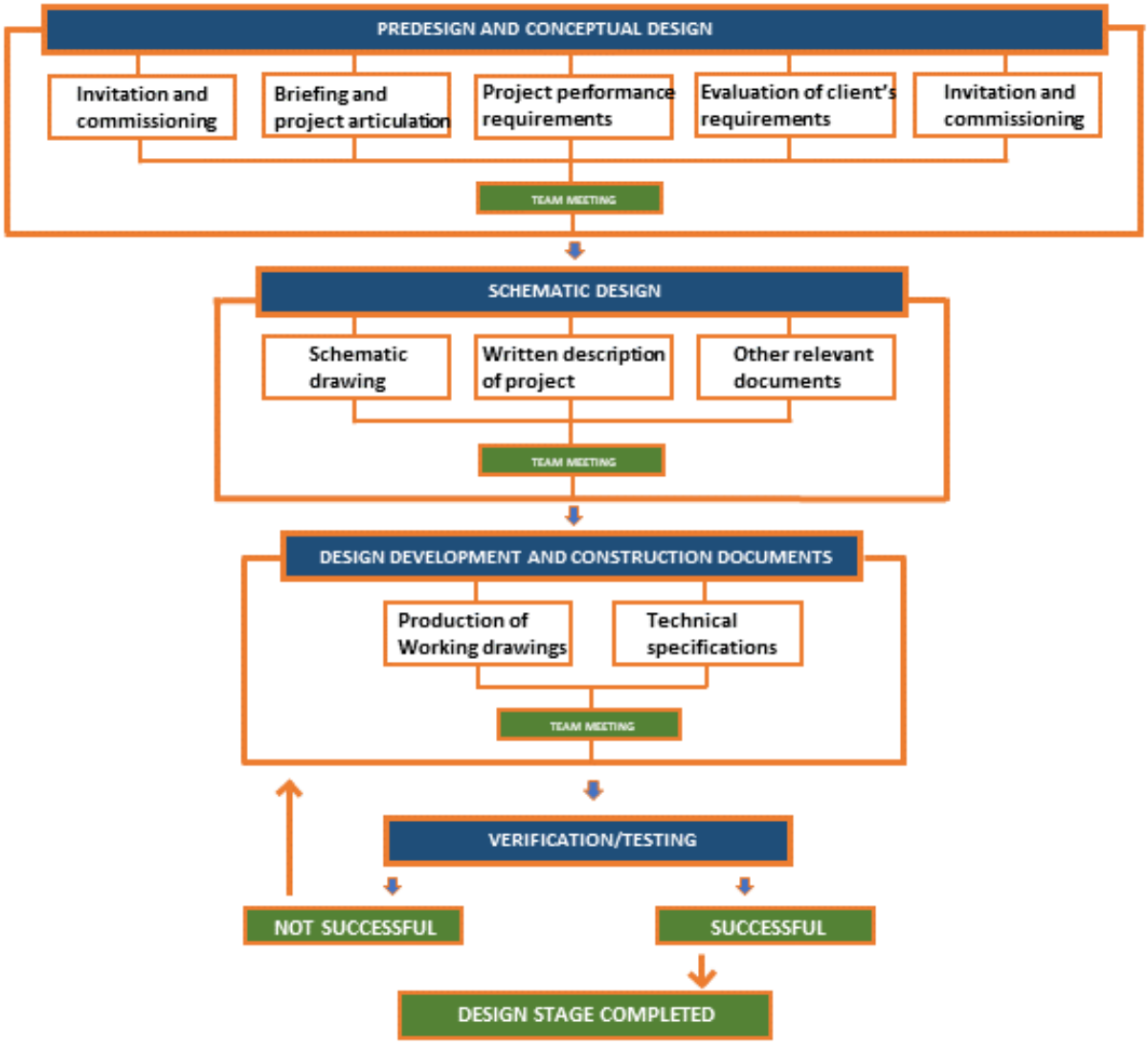

Figure 3: The proposed framework

Predesign and conceptual design stage

This stage forms the foundation of the entire design process. Involves the invitation and commissioning of the architect, who is expected to work with the sustainable design expert and the client to produce the project brief that defines the project performance requirements.The client can now be assisted by the architect or other designated team leader in defining the project's scope and the number of services that will be provided by each team member. Services that can be performed at the predesign stage based on agreement with the leader of the team include site

selection, site analysis, consideration of building code and zoning requirements, feasibility studies, programming, and environmental impact analysis and report.

Another important action to be taken at this stage, especially by the architect is the production of the conceptual design based on the aforementioned activities. The architect is to develop an alternative design considering the evaluation of the client's requirements. After the client has taken a decision on the preferred alternative design, other design team members will be introduced subject to the approval of the client. The final activity at this stage of the proposed framework is a meeting with all the members of the design team for final briefing and dissemination of relevant information regarding the project. At this meeting, all the allied professionals will be given the go-ahead to proceed to the next stage of the project. This meeting is important as it is expected to provide proper guidance for all the design team members, especially, in terms of their duties.

Schematic design stage

This stage is crucial to the design stage of projects. At this phase, the entire design team members are saddled with the responsibility of producing schematic design papers based on the conceptual design alternative for which the client instructed to continue with the project. The documents to be prepared at this stage include the schematic drawings, a written description of the project detailing all the aspects involved, and other relevant documents that are necessary to guide the quantity surveyor to produce a preliminary estimate for the project. After the preparation of the schematic design documents, the design team members will meet again to review the progress of the design process, to determine if there are challenges, and discuss the way forward. This stage is key to the design stage as possible challenges are to be identified and overcome before proceeding to the next stage.

Where necessary, some design documents as output from this stage, especially renderings and finished scale 3Ds and models can be used for promotional purposes. This, among other benefits, can generate positive feedback to guide the design team. At the end of this stage, the client will give final approval for the design team to proceed to the next stage, the design development, and construction documents stage.

Design development and construction documents stage

At this stage, the architect and other design team members are expected to produce design development and construction documents. The design development documents are necessary to enable the relevant members of the design team to provide additional information on the project. This information, which includes applicable specialty systems, materials, and furniture will form the basis for the preparation of construction drawings. When the design development documents are approved by the clients, the design team will proceed to the next section in this stage, which is the preparation of construction documents. The documents to be produced include all working drawings and technical specifications. All the documents that are to be produced at this stage will guide the QS in the production of detailed estimates for construction and bidding purposes.

Verification stage

The process of designing a building is iterative, moving from the conceptual design stage to the construction development stage. The best design elements and methods must be achieved during this phase. The focus of this stage is to verify project performance requirements based on the design elements and approaches adopted.

The final proposed design can be verified using virtual modeling and simulation software, which include DesignBuilder and Building Information Modeling. Using this software, building design, materials, and construction specifications are tested to make sure they satisfy project requirements. When it is confirmed that they meet the relevant requirements and standards, based on the simulation and verification results, the final design will be accepted as the proposed design bringing the design stage of the project to an end. Where the modeling and simulation outcomes did not meet the project requirements, the design will be optimized and the procedure repeated until it satisfies the project criteria.

CONCLUSIONS AND RECOMMENDATIONS

This study centered on promoting sustainable housing development in Nigeria through the production of a design framework. This is done in an effort to limit the number of residential structures that might eventually be constructed without using sustainable design principles. The proposed framework was developed using data gathered from design professionals in Lokoja through qualitative structured and semi-structured interviews.

The study showed that Lokoja, the study area is a model of an urbanizing city owing to its location, which is contiguous to nine states in Nigeria and Abuja, the Federal Capital Territory. The level of urbanization has led to an increase in temperature, energy demand, and GHG emissions. This has necessitated the development of the proposed framework aimed at overcoming these challenges. Moreover, this study revealed that the current approaches to building development in Lokoja are not sustainable as existing buildings lack relevant sustainable design features. This may be attributed to the lack of involvement of sustainable design experts in the design team of projects as revealed by the research findings. This study confirmed that the demand for sustainable housing development requires the expansion of the project design team to include relevant sustainable design specialists.

The study emphasized the relevance of the design stage to the success of the building. Considering this, the study maintained that proper control of the design process can aid the realization of project objectives. Hence, the proposed design framework for promoting sustainable housing development in Lokoja, Nigeria.

This study provides pertinent information that both commercial and public entities can utilize to formulate and put into practice efficient strategies to support sustainable housing development in Nigeria. The proposed framework will increase understanding of sustainable construction projects,

particularly at the crucial design stage where the achievement of project goals is dependent. The inclusion of sustainable experts in the design team will no doubt promote sustainable building development in the study area. Official team meeting at all the design stages is hoped to promote proper communication and collaboration among the team members leading to quality project delivery. Moreover, the verification stage, which aims to validate the suitability of design based on the performance requirements will help to overcome design challenges that may be carried over to the construction stage.

The study recommends that, to promote sustainable housing development in Nigeria in general and in Lokoja in particular, the design team of building projects should include sustainable design experts. Moreover, provisions should be made for proper verification of the final design of buildings to make sure it satisfies project objectives before the commencement of the construction stage. Furthermore, building stakeholders should encourage strong collaboration between the members of the design team to prevent conflict of interest, communication gaps, and possible challenges that may arise from the design stage.

REFERENCES

[1] El-hadj, M.B., Faye, I. and Geh, Z.F., 2018. The political economy of housing development in Africa. In *Housing Market Dynamics in Africa* (pp. 23-55). Palgrave Macmillan, London.
[2] COWAN, D., MAIDMENT, G. and CHAER, I., 2015. Understanding total emissions from cooling systems in urban buildings. *Proc. Institute of Refrigeration*.
[3] AKANDE, O.K., FABIYI, O. and MARK, I.C. (2015) Sustainable Approach to Developing Energy Efficient Buildings for Resilient Future of the Built Environment in Nigeria. *American Journal of Civil Engineering and Architecture*, 3 (4), pp. 144-152.
[4] IYENGAR, K., 2015. *Sustainable architectural Design: an overview.* Routledge.
[5] ADEGUN, O.B., 2019. Social and environmental aspects of housing developed for 'slum' dwellers in Africa. *Proceedings of the Institution of Civil Engineers-Urban Design and Planning*, *172*(5), pp.176-184.
[6] MAJALE, M., 2008. Employment creation through participatory urban planning and slum upgrading: The case of Kitale, Kenya. *Habitat International*, *32*(2), pp.270-282.
[7] FRENCH, M.A. and Lalande, C., 2013. Green cities require green housing: Advancing the economic and environmental sustainability of housing and slum upgrading in cities in developing countries. In: *The Economy of Green Cities* (pp. 257-284). Springer, Dordrecht.
[8] MADLENER, R. and SUNAK, Y., 2011. Impacts of urbanization on urban structures and energy demand: What can we learn for urban energy planning and urbanization management? *Sustainable Cities and Society*, vol. 1, no. 1, pp. 45-53.
[9] KAROUSAKIS, K. and BIROL, E., 2008. Investigating household preferences for kerbside recycling services in London: A choice experiment approach. *Journal of Environmental Management*, vol. 88, no. 4, pp. 1099-1108.

[10] MADLENER, R. and ALCOTT, B., 2009. Energy rebound and economic growth: A review of the main issues and research needs. *Energy*, vol. 34, no. 3, pp. 370-376.
[11] ALABI, M.O., 2012. The Built-up Environment and Micro-Climate Variation in Lokoja, Nigeria. *American International Journal of Contemporary Research*, vol. 2, no. 12, pp. 151-158.
[12] IFATIMEHIN, O.O., ADEYEMI, J.O. and SALIU, O.A., 2013. The Impact of Urban Micro–Climate Change on Human Comfort in Lokoja, Nigeria.
[13] AMUJABI, F., 2006. The use of remote sensing data in monitoring the urban growth of Lokoja town in Kogi State. *Unpublished B.Sc. Project, Department of Geography and Planning, Kogi State University, Anyigba*.
[14] IFATIMEHIN, O.O. and UFUAH, M.E. (2006) An analysis of urban expansion and loss of vegetation cover in Lokoja, using GIS techniques. *Zaria Geogr*, 17 (1), pp. 28-36.
[15] IFATIMEHIN, O.O., 2007. An assessment of Urban Heat Island of Lokoja Town and surroundings using LandSat ETM data. *FUTY Journal of the Environment*, vol. 2, no. 1, pp. 100-108.
[16] GIDLEY, J.M., FIEN, J., SMITH, J., THOMSEN, D.C. and SMITH, T.F., 2009. Participatory futures methods: towards adaptability and resilience in climate-vulnerable communities. *Environmental Policy and Governance*, vol. 19, no. 6, pp. 427-440.
[17] ZHOU, L., DICKINSON, R.E., TIAN, Y., FANG, J., LI, Q., KAUFMANN, R.K., TUCKER, C.J. and MYNENI, R.B., 2004. Evidence for a significant urbanization effect on climate in China. *Proceedings of the National Academy of Sciences of the United States of America*, vol. 101, no. 26, pp. 9540-9544.
[18] PACIONE, M., 2009. *Urban geography: A global perspective.* Taylor & Francis.
[19] TOMBAZIS, A.N. and PREUSS, S.A., 2001. Design of passive solar buildings in urban areas. *Solar Energy*, vol. 70, no. 3, pp. 311-318.
[20] ADESHINA, T. and IDAEHO, R., 2019. Analysis of Nigeria's policies on housing. *JEE Sector Thought Leadership Series*, pp. 1-10.
[21] OLAWEPO, R.A., 2009. Evaluating Housing Problems through Participatory Rural Appraisal in Lokoja Nigeria. *African Research Review*, vol. 3, no. 1.
[22] KOGI REPORTS., 2015. *Kogi Govt Signs $8billion MoU on Power, Housing.* Available from: http://www.kogireports.com/kogi-govt-signs-8billion-mou-on-power-housing/.
[23] GIZ, N., 2014. *Energy Efficiency in Buildings (EEB) in Selected Sub-Sectors of the Nigerian Building Sector: Development of recommendations for interventions to promote energy efficiency in buildings.*
[24] SOZER, H., 2010. Improving energy efficiency through the design of the building envelope. *Building and Environment*, vol. 45, no. 12, pp. 2581-2593.
[25] AKANDE, O.K., 2010. Passive design strategies for residential buildings in a hot dry climate in Nigeria. *WIT Transactions on Ecology and the Environment*, vol. 128, pp. 61-71.
[26] OWOLABI, J., AIGBAVBOA, C., OGUNBAYO, B. and OGUNDIPE, K., 2022. *Proceedings of the Construction Business and Project Management Conference, Cape Town, South Africa, June, 2022.*

[27] MBAMALI, I. and OKOTIE, A., 2012. An assessment of the threats and opportunities of globalization on building practice in Nigeria. *American International Journal of Contemporary Research*, vol. 2, no. 4.
[28] JAYASEL, R.P., 2006. Development of Civil and Structural Consultant's Performance Evaluation, Master of Science Construction Management, Universiti Teknologi Malaysia, Jahor, Malaysia.
[29] SVALESTUEN, F., FRØYSTAD, K., DREVLAND, F., AHMAD, S., LOHNE, J. and LÆDRE, O., 2015. Key elements to an effective building design team. *Procedia Computer Science*, vol. 64, pp. 838-843.
[30] WORLD BANK, (2015) Building Regulation for Resilience: Managing Risks for Safer Cities, Author, Washington, DC, 2015.
[31] FOLAGBADE, S.O., 2001. Case studies of building collapse in Nigeria. *Proceedings of a Workshop on Building Collapse, Causes, Prevention and Remedies, The Nigerian Institute of Building, Ondo State*, 2001.
[32] AYENI, D. and YMD, A.A., 2015. Strategies for mitigating building collapse in Nigeria: Roles of architects and other stakeholders in the building industry. *Strategies*, vol. 7, no. 8.
[33] OSEGHALE, G.E., IKPO, I.J. and AJAYI, O.D., 2015. Causes and effects of building collapse in Lagos State, Nigeria. *Civil and Environmental Research*, vol. 7, no. 4, pp. 34-43.
[34] OKAGBUE, H.I., IROHAM, C.O., PETER, N.J., OWOLABI, J.D. and OPANUGA, A.A., 2018. Systematic review of building failure and collapse in Nigeria. *International Journal of Civil Engineering and Technology*, vol. 9, no. 10, pp. 1391-1401.
[35] ODEYEMI, S.O., GIWA, Z.T. and ABDULWAHAB, R., 2019. Building collapse in Nigeria (2009-2019), causes and remedies–a review. *USEP: Journal of Science and Engineering Production*, vol. 1, no. 1, pp. 123-135.
[36] BOURN, J., 2001. Modernising construction: Report by the Comptroller and Auditor General, HC 87 Session 2000 2001, 11 January 2001. *Stationery Office, London Null*.
[37] BRE, 1982. Quality in Traditional Housing.
[38] SOWERS, G.F., 1993. Human factors in civil and geotechnical engineering failures. *Journal of Geotechnical Engineering*, vol. 119, no. 2, pp. 238-256.
[39] ARDITI, D. and GUNAYDIN, H.M., 1997. Total quality management in the construction process. *International Journal of Project Management*, vol. 15, no. 4, pp. 235-243.
[40] HIYASSAT, M.A.S., 2000. Applying the ISO standards to a construction company: a case study. *International Journal of Project Management*, vol. 18, no. 4, pp. 275-280.
[41] MINATO, T., 2003. Design documents quality in the Japanese construction industry: factors influencing and impacts on construction process. *International Journal of Project Management*, vol. 21, no. 7, pp. 537-546.
[42] LOVE, P.E. and IRANI, Z., 2003. A project management quality cost information system for the construction industry. *Information & Management*, vol. 40, no. 7, pp. 649-661.
[43] OYEDELE, L., JAIYEOBA, B. and FADEYI, M., 2003. Design factors influencing quality of building projects in Nigeria: Consultants' perception. *Construction Economics and Building*, vol. 3, no. 2, pp. 25-32.

[44] MORRIS, J., ROGERSON, J. and JARED, G., 2000. *A tool for modelling the briefing and design decision making processes in construction.* Citeseer.
[45] COCKSHAW, S.A., 2001. Changing construction culture. *Interdisciplinary Design In*.
[46] LAPINSKIENE, V. and MARTINAITIS, V., 2013. The framework of an optimization model for building envelope. *Procedia Engineering*, vol. 57, pp. 670-677.
[47] BERARDI, U., 2013. Clarifying the new interpretations of the concept of sustainable building. *Sustainable Cities and Society*, vol. 8, pp. 72-78.
[48] ABIDIN, N.Z., YUSOF, N. and AWANG, H., 2012. A foresight into green housing industry in Malaysia. *World Academy of Science, Engineering and Technology*, vol. 67, pp. 440-448.
[49] KEITSCH, M., 2012. Sustainable Architecture, Design and Housing. *Sustainable Development*, vol. 20, no. 3, pp. 141-145 ISSN 1099-1719. DOI 10.1002/sd.1530.
[50] GHIDA, D.B., 2019. Heat recovery ventilation for energy-efficient buildings: design, operation and maintenance. *International Journal of Innovative Technology and Exploring Engineering*, vol. 9, no. 1, pp. 3713-3715.
[51] BARON, N. and D. DONATH. Learning from Ethiopia–A discussion on sustainable building. *Proc. of SBE16 Hamburg International Conference on Sustainable Built Environment Strategies–Stakeholders–Success factors, Held from 7th to 11th March in Hamburg, Germany*, 2016.
[52] PEARCE, A. and AHN, Y.H., 2013. *Sustainable buildings and infrastructure: paths to the future.* Routledge.
[53] OLORUNFEMI, S., 2021. Performance assessment of the state of road infrastructure in selected urban centers in Kogi State in Nigeria. *Prace Komisji Geografii Komunikacji PTG*, vol. 24, no. 1, pp. 31-43.
[54] FUL., 2014. *Lokoja at a glance.* Available from: https://www.fulokoja.edu.ng/lokoja-at-a-glance.php.
[55] TNV., 2013. *The importance of Lokoja in Nigerian History.* Available from: https://www.thenigerianvoice.com/news/113990/the-importance-of-lokoja-in-nigerian-history.html.
[56] Our Kogi., 2015. *About Kogi State.* Available from: http://ourkogi.com/about-kogi/.
[57] OLATUNDE, A.F. and ADEJOH, I., 2017. Intensity, duration and frequency of rainstorms in Lokoja. *Science World Journal*, vol. 12, no. 2.
[58] KOGI ADP., 2011. *Kogi State ADP Annual Report.* Lokoja: Planning Monitoring and Evaluation Department.
[59] OLIVERA, F., D.C. MCKINNEY, D.R. MAIDMENT, Y. ZICHUAN and S. REEDS. Predicting the water balance of surface and groundwater resources over large areas. *Proceedings of the Symposium on Runoff Computations for Water Projects, UNESCO, St. Petersburg, Russia*, 1995.
[60] WALKER, D.H., 1997. Choosing an appropriate research methodology. *Construction Management and Economics*, vol. 15, no. 2, pp. 149-159.
[61] CRESWELL, J.W., 2003. A framework for design. *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*, pp. 9-11.

[62] MILES, M.B. and HUBERMAN, A.M., 1994. *Qualitative data analysis: An expanded sourcebook.* sage.
[63] BRYMAN, A. and BELL, E., 2015. *Business research methods.* Oxford university press.
[64] BABBIE, E.R., 1990. Survey research methods Wadsworth Pub. *Co Belmont, California*.
[65] KRIPPENDORFF, K., 1980. Validity in content analysis.
[66] SANDELOWSKI, M., 1995. Qualitative analysis: What it is and how to begin. *Research in Nursing & Health*, vol. 18, no. 4, pp. 371-375.
[67] STEMLER, S., 2001. An overview of content analysis. *Practical Assessment, Research & Evaluation*, vol. 7, no. 17, pp. 137-146.
[68] DUFFEE, L. and AIKENHEAD, G. (1992) Curriculum change, student evaluation, and teacher practical knowledge. *Science Education,* 76 (5), pp. 493-506.