Barriers and Strategies to Achieving Energy Efficient Buildings in Nigeria; Exploring the Perception of Construction Professionals.

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Abstract
Studies have highlighted various challenges to achieving energy efficiency in Nigerian buildings and if Nigeria is to improve its energy supply and lessen the impact of climate change, these energy efficiency measures must be prioritized. However there seems to be a lack of research which highlights possible strategies that can be implemented to curb these challenges. Therefore, this study explores the barriers and strategies for achieving energy-efficient buildings in Nigeria from the perspective of construction professionals. Pilot semi-structured interviews were conducted with 15 Nigerian construction professionals to gain insights into the current barriers and potential strategies and analyse data for this research in preparation for unanticipated issues when conducting future research. Major barriers identified include high implementation costs, inadequate policies and regulations, low awareness levels, limited expertise, lack of stakeholder interest, and theft/vandalism. Recommended strategies involve enacting and implementing robust energy efficiency policies, enhancing public enlightenment and training for professionals, and seeking international cooperation. The findings highlight the possible need for a multi-pronged approach involving government, industry stakeholders, and international collaboration to overcome obstacles and advance energy-efficient building practices in Nigeria. Addressing the barriers and implementing the proposed strategies could yield economic, environmental and social benefits through reduced energy consumption in buildings.

Keywords
Barriers, Buildings, Construction industry, Construction professionals, Energy efficiency, Nigeria, Strategies.

1. Introduction.
Buildings consume more energy than other industries do in many parts of the world, (Ochedi & Taki, 2019; Akhimien, 2022). The energy usage of these structures have a detrimental influence on the environment and the well-being of people. According to International Energy Agency (IEA) (2023) the negative impact of climate change resulting from building industry is widely regarded as a reality and one of the most significant problems that humanity is now facing. Consequently, this has sparked interest throughout the world in finding ways to reduce the amount of energy that the building sector consumes. Ochedi and Taki (2022) went further to say that stakeholders or professionals must make the proper judgements, use the right strategies and make the necessary efforts to achieve energy efficiency in buildings and other sectors. Through laws and industry standards economies are raising the energy performance requirements for both new and existing buildings (IEA 2023). Improvement in economic well-being, reduction in environmental pollution and an over-reliance on energy imports will be reduced in any government that promotes investment and the execution of policies regarding energy efficient structures (Ochedi and Taki 2019).

Despite the benefits of energy efficiency, tangible efforts, and successful implementation in other parts of the world, most sub-Saharan African countries are still in the infancy stage of achieving energy-efficient building development (Ochedi and Taki, 2022). Energy efficiency measures must be prioritized if Nigeria is to improve its energy supply, increase occupant comfort in buildings and lessen the impact of climate change (Nigeria Federal Ministry of Power, Works and Housing (NFMPWH), 2016). Further stating that the Nigerian construction industry has yet to take advantage of existing options, particularly energy-efficient design approaches to dramatically lower energy demand and consumption by buildings, notwithstanding the difficulties with energy supply and distribution in Nigeria and that its construction professionals have not yet fully embraced energy efficient design strategies.

Studies have explored the energy efficiency of buildings in Nigeria (Ejidike et al., 2022; Ochedi & Taki, 2022; Oyedepo, 2014; Hussaini & Majid, 2015) and other studies have comprehended and integrating the expectations of Nigeria construction professionals (Ochedi & Taki, 2019; Aghimien et al., 2018; Vincent-ohizu et al., 2022; Tilde & Fernando, 2022; Ejidike et al., 2022; Muhammad et al., 2020; mato et al., 2023; Oyewole et al., 2021; CCFLA, 2023).

However, most of these studies have either focused on residential, commercial or educational building designs (Ochedi & Taki, 2022; Aghimien et al., 2018; Vincent-ohizu et al., 2022), household challenges (Tilde & Fernando, 2022; mato et al., 2023), awareness levels of professionals (Ejidike et al., 2022; Oyewole et al., 2021) and Financing green buildings (CCFLA, 2023), while quantitative survey was used by Muhammad et al. (2020) to focus on green building development. Only Ochedi & Taki (2019) focused on the challenges towards energy efficient buildings in Nigeria but scarcely highlighted the possible strategies. With this gap in research, the study therefore aims to explore the current barriers and strategies for achieving energy-efficient buildings in Nigeria through semi-structured interviews with construction professionals . The current gap is addressed through the following questions:

1. What are the current approaches to achieving energy efficiency in buildings?
2. What is the current state of energy efficiency in Nigerian buildings?
3. What do Nigerian construction professionals think are the barriers to and possible strategies for achieving energy-efficient buildings in Nigeria?

2. Literature Review

2.1 Current Approach - Energy Efficiency of Buildings

Considerable attempts have been undertaken to introduce pioneering energy-saving building techniques fand develop green building regulations. Specifically, interest in the idea of a net-zero energy building (NZEB) or zero-energy building (ZEB) has grown throughout the last ten years. This concept was first proposed in 2000, and by 2006, it had gained widespread acceptance (Cao et al., 2016). They are regarded as the best option for reducing the adverse effects of future building energy usage. Where the total amount of energy required by the structures each year is roughly equal to the total amount of renewable energy generated on the property (Belussi, et al., 2019) and several nations have passed laws requiring the construction of buildings with the idea of this positive energy concept in Mind. For instance, The EPBD (The Directive on Energy Performance in Buildings) a legislative tool that influences energy use and efficiency, was developed because of the percentage of energy European buildings consume, and it is anticipated that new buildings will need "nearly zero" electricity from the grid by the year 2020 (Moran et al., 2020). Countries like the USA and its Department of Energy's (DOE) Building Technologies Programme have as their strategic objective the completion of "commercial zero energy buildings in 2025 and marketable zero energy homes in 2020 (Cao et al., 2016).

The fundamental idea behind energy efficiency in a building is to consume less energy during design and operations (such as lighting, heating, and cooling) without compromising the wellbeing or comfort of its occupants (Hussaini and Majid, 2015). When all parts of the building process are handled holistically, not just during the concept and design phases but also during construction and operation, a high-efficiency process is attained (IEA 2023).

2.2 Energy Efficiency of Buildings in Nigeria

In Nigeria, the idea of energy efficiency in buildings is relatively recent. The first Building Energy Efficiency Guide (BEEG) for Nigerians was published in 2016 while the first Nigerian Building Energy Efficiency Code (BEEC) was first introduced in August 2017. As a result, little to no effort has been made in the Nigerian building industry to design structures that are energy efficient (Geissler et al., 2018). Also with an increase in urbanisation and population, Nigeria is experiencing a significant amount of housing deficit and as way to lower energy demand and consumption, energy-efficient appliances and sustainable urban and architectural design is needed (Ezeanah, 2021).

The country's building sector accounts for a significant amount of the nation's total energy consumption, with a large portion of this energy being wasted due to inefficient building designs and practices (Tilde Ibrahim and Fernando, 2021; Ochedi and Taki, 2022). One cause for this is the usage of outdated and inefficient equipment and appliances (Adetooto et al., 2020). Inadequate insulation, inefficient lighting systems, and outdated HVAC systems are prevalent in buildings, resulting in excessive energy consumption and higher operational costs (Ezema and Maha, 2022). Other researcher like Elinwa et al. (2021) have also expressed that the high energy consumption is mostly caused by the usage of appliances, lights, and cooling systems, as well as the reliance on traditional biomass fuels for cooking and heating.

Energy efficiency measures are the least expensive way to improve the status of the energy supply, especially in Nigeria where the building sector accounts for roughly 58% of all electricity consumption and a severe lack of electricity generation and transmission capacity (Ochedi and Taki, 2019). Using very effective bioclimatic design techniques and pertinent active systems will significantly lower the amount of energy needed to light and cool

buildings. One of the most energy-intensive and energy-consuming industries in the nation is the building sector (Geissler et al.,2018). For this reason, it is essential to apply energy-efficient design ideas and practices in the industry to achieve energy efficiency and sustainability (Mato et al.,2023).

3. Methodology.

Firstly, a review of extant literature was done to get an overview of the research topic. Grant and Booth (2009) who highlighted a review as a method of identifying what has been accomplished previously, allowing for consolidation, building on previous work, and identifying omissions or gaps. Secondary information such as publications and journal articles, were sourced through scientific databases like Elsevier Scopus. The search used the relevant keywords such as (construction industry, Energy Efficient buildings and Nigeria), as prompts in finding literature. Relevant papers were identified and scrutinised.

Following the review, semi-structured interviews were conducted with building professionals. This qualitative investigation focuses on people's views and their life experiences, it is helpful in revealing cause-and-effect relationships and is appropriate for understudied situations (Pushpamali et al., 2021). The purpose of the semi-structured interview was to get unbiased opinions from a variety of professionals to produce qualitative data for this research. Due to its adaptability and user-friendliness for both individuals and groups, this interview structure is a widely used technique (Pushpamali et al., 2021). Also it was important for this research as it allowed for the exploration of views and experiences of professionals to further inform on the current state of the Nigerian building industry, which was also done in a study by Ochedi & Taki (2019) and Tilde & Fernando (2022). This was a pilot interview, involving 15 Nigerian construction professionals. The purpose of the pilot interviews was to evaluate the effectiveness of the methodology used to gather and analyse data for this study in preparation for unanticipated issues when conducting a more comprehensive future research in line with this study.

Data collection: To choose the participants, purposive sampling was used. This sampling technique refers to a situation where participants are chosen based on their notoriety and subject-matter expertise or years of experience in the field of research (Marshall and Rossman, 2006). Which was a primary criterion for their selection. To gather data, 30 minutes long interviews were conducted. The interview questions were divided into three sections: (a) demographic information, (b) barriers to achieving energy-efficient buildings in Nigeria, and (c) strategies to be implemented to achieve energy-efficient buildings in Nigeria. Initial contacts were made through introductory emails to explain the research, why their participation would be useful and schedule interviews. These participants have 8 to 32 years of experience in the building and energy sectors. All participants were chosen voluntarily and agreed to participate in the study by signing a consent form that described the study's purpose and voluntary nature.

Data Analysis: The analysis of data was done using NVivo software to transcribe, inductively code, and thematically analyse interview material. According to Jackson (2019) NVivo works well with most research designs and analytical methodologies, it also guarantees easy and efficient coding, making retrieval easier and improves the quality of qualitative studies. This inductive method and thematic analysis were utilised to group the interview transcript into recurring ideas and expressions. According to Braun & Clarke (2006), thematic analysis is a technique for qualitative data analysis. Usually, it is used in relation to a collection of texts, such transcripts or interviews. The researcher carefully goes over the data to find recurring themes, subjects, concepts, and meaning patterns.

The following step-by-step procedure was used: Data preparation, labelling research questions, coding strategy, coding data, and creating themes. Firstly, data preparation involves familiarising ourselves with the data, we began analysing individual responses, it was crucial to gain a complete perspective of all the data we had gathered. Audio recording was transcribed, reading of text and make some quick notes, and overall browse through the material to become familiar with it and then transcribed the data into a file and imported it to NVIVO. Secondly, we assigned labels to our interview research questions i.e. (barrier and strategies to achieving energy efficient buildings in Nigeria), which will help us create codes under each research question in Nvivo. Thirdly, a coding strategy was decided. According to Adu (2019) there are two main types of coding strategies namely; descriptive (where you go through your data from interviews, extract significant information and use a code to describe, making sure to put aside preconceived or personal thoughts and not making any type of interpretation to the data) and interpretive, which is the oppositive of descriptive (were relevant information is extracted from interviews and then you interpreted, keeping in mind the nature of the person giving you the response, their believes, preconceived ideas and backgrounds). Therefore, this research makes use of descriptive focused coding because our aim here is to get responses that can directly address

the research questions. The next step is to start the coding process, we look through the transcript file in Nvivo to identify relevant responses that can address the labelled interview research questions, when relevant information is found, a code is then created and attached to the relevant labelled interview question. Related responses are attached to the already created code and if the response is not related but relevant a new code is created and attached to the research question it addresses. We finally moved on to developing our themes, here a phrase, word or short statement is formed to represent the collection of related responses gotten from participant regarding research questions answered. The core themes that emerged from the study are then presented and discussed in the results and discussion section.

During the interview, basic data on the respondents was gathered. To determine the interviewees' capacity to accurately respond to questions and supply pertinent information, factual information about them was required. The demographic information included years of practice, occupation, job title and education level. The participants were labelled with codes (P1 to P15) to protect their identities.

Table 1. Participant demographic data.

Participants	Occupation	Years of Practice	Job Title/Position in organisation	**Highest Level of Education**
P1	Architect	32	Board of Trustees	Master's degree
P2	Electrical Engineer	19	Senior consultant	Bachelor's degree
P3	Civil Engineer	10	Project site coordinator	Master’s degree
P4	Quantity surveyor	19	Senior quantity surveyor	Master’s degree
P5	Mechanical Engineer	13	Quality engineer/Operations manager	Master’s degree
P6	Architect	10	Associate architect	Post graduate diploma
P7	Electrical Engineer	15	Lead electrical engineer	Master's degree
P8	Architect	8	CEO	Master’s degree
P9	Civil Engineer	9	Project coordinator	Bachelor’s degree
P10	Architect	12	Resident architect	Master’s degree
P11	Electrical Engineer	21	Principal consultant	Master’s degree
P12	Civil Engineer	16	Water and habitat team leader	Master's degree
P13	Architect	17	Structural architect	Master’s degree
P14	Lecturer	13	Associate construction lecturer	Doctor of Philosophy
P15	Project Manager	14	Senior project manager	Master’s degree

4. Result and Discussion

The barriers and possible strategies to the realisation of energy-efficient buildings in Nigeria that were expressed by Nigerian construction professionals during the virtual interview are outlined in this section.

Barriers to Achieving Energy Efficiency of Buildings in Nigeria

Cost of Implementation

This was one of the major barriers noted by P1who is an EDGE expert. They said

“I discovered that some of the energy efficient measures that have to be put in place, initially involve a higher cost. Cost is a very big barrier, people want to install pv panels, but the cost may be exorbitant and they just have to return to fuel or diesel generators”. P5, said *“I think cost on the building owner at the time of construction is a problem. If the cost can be postponed or extended I think more people would adopt. Anyone who doesn’t embrace it can't afford it at that time. Generally it’s the cost, I think takes like 70% of what is holding people back”. “Then*

client want to achieve more with very little, so if you're going to make an office building and you want to make full use of daylighting it means you're going to have to invest a lot of money on glazing and clients are not interested in spending. People are thinking investment when a building is concerned, how much do I put in this building and when do I get my money back", according to P6. This result is similar to Ibrahim and Fernando (2021), who discovered the huge financial burden faced by the Nigerian economy and the lack of funds to provide the requisite infrastructure for a more sustainable energy-saving culture. They noted high cost of more reliable energy-efficient equipment is an impediment to achieving sustainable energy savings.

Inadequate Policy and regulation

The policies, regulations and standards regarding the design and construction of energy-efficient buildings in Nigeria was another barrier noted by participants. According to P2,

"*The government policy is not helping and does not take energy efficiency measures into consideration. Their policies are not geared towards strict measures that will make sure energy efficiency practices are complied with"*. P4 who commented on the poor regulations regarding energy efficiency of Nigerian buildings said *"regulatory bodies usually have a plan in place regarding mandatory procedure that enable them check building to see if they meet standards, but you don't see them implementing these procedures"*. In a study done by CCFLA (2023), they highlighted policy barriers such as poor standards and regulations, saying that the current regulations are not suitable for the implementation of the shift to net zero buildings and also stated that city led net zero initiatives are unfeasible in Nigeria, citing impractical policies and projects.

Level of Awareness

P3 said that *"the level of awareness of energy efficiency in Nigeria is quite low. People just know they need energy and don't consider the kind of equipment to use. They don't consider design requirements that will reduce the amount of energy they require in their homes and buildings"*. P7 also said that "*the level of awareness of energy efficiency in Nigeria is quite low. People just know they need energy and don't consider the kind of equipment to use. They don't consider design requirements that will reduce the amount of energy they require in their homes and buildings"*. According to P9 *"not up to 20% of the population knows about energy efficient measures, apart from places like Lagos, Abuja, Enuju and the main hubs of the country and I don't think that would even form up to 20%. These areas are enlightened, and they have it at the back of their mind to implement energy efficient measures when building. But widely in Nigeria no, I don't think the individual is enlightened enough on energy efficient measures"*. This result agrees with that of Ochedi andTaki, (2019), who asserted that the lack of awareness is one of the major challenges to achieving energy efficiency of buildings in Nigeria.

Limited Expertise

In a response from P5, they said that *" a lot of people in the industry still have poor skills, firstly even most Nigerian buildings don't use architects they employ the services of foremen, and these people are not experienced in sustainable measures to buildings and it is evident in the kind of buildings that you see"*. P10, said that *"Professionals don't have enough knowledge about the concept of energy efficient building and make ill-informed comments, so how can they convivence their client"*. According to P1 *"majority of professionals have a poor background regarding sustainable building practices, practitioners often practice what is the easiest thing to do, so when designers are not trained directly of course it becomes difficult to implement energy efficient practices".* This result was corroborated in a study done by CCFLA (2023), who stated that due to the low maturity, limited supply of required technical solutions and the lack of skilled professionals, the concept of net zero building deployment is slowed down in the Nigerian building industry.

Lack of interest from stakeholders

P1 said that *"some clients are so much interested in aesthetics and international style of building and end up spending so much on the operation of the structures. They forget local materials and traditional buildings styles have energy efficient advantages and can cut their energy bills, also because some professionals are trying to please clients they go with what the client wants as long as it benefits their pockets".* P13 said that *"clients are not interesting in hearing about energy efficient materials because they might take a while to source and complete projects and they pressure professionals to meet deadlines and then these professionals are put in a difficult position, were they are pressured to meet deadlines and end up sourcing for alternative materials which most times could be inefficient"*

This result is similar to research done by (GIZ & NESP, 2014), where they discovered that traditional building materials and concepts responding to local climatic conditions are usually considered unprogressive. In contrast,

modern materials and building designs from abroad are preferred, leading to designs that consume a lot of energy, especially for cooling and lighting.

Theft / Vandalism

According to P3 *"in some rural areas you hear news of agbero boys vandalising and stealing some of these energy efficient materials or equipments, claiming government didn't not give them job or big cooperations taking advantage of their land, and claiming they do not welcome any form of change unless you settle them".* P15 *said that "even stealing of equipment's is a problem". "I have come across a client who was afraid of buying solar panels because they are scared of it been stolen because of how unsafe the area of their business is"*. This result are similar to Ikejemba et al. (2018), who stated that the absence of protection of the infrastructure from theft and vandalism are factors that affect the sustainability of energy efficient and renewable projects in Sub Saharan Africa.

Strategies to Achieving Energy Efficiency of Buildings in Nigeria

Adequate Policies and Implementation

According to P5*"We should try implementing what we already have as a plan. strategies have been formulated in the past on paper, but these strategies are being adopted at a very slow pace or in some cases non-existent"*. P3 said that *"there should be strong policies that focus on providing security to regions or areas that are undergoing some form of energy development to help reduce the rate of vandalism and theft"*. According to P11, "*The government should play a leading role. Their policy will be very impactful because everything here in Nigeria is backed by government policy, a private sector can drive it but it is not going to be as impactful if the government was involved and if the government say we are going to fine you for not complying with energy efficient building standards people will be forced to comply".* Mushafiq et al. (2023) highlighted the importance of the right policies geared towards improving energy efficiency of buildings and that government policies help to advance energy-efficient technologies and building designs.

Public Enlightenment

P4 said that *"Enlightenment is very important, stakeholders in the building industry who are not pushing for sustainable buildings have to be enlightened. School curriculums have to make sure sustainable building design practices are part and parcel of what is been taught"*. P14 said *"sensitization should be given to the public. There should be giggles about not leaving your light on before you leave the house".* P10 believes the general public are not well aware and expressed this by saying *"increased awareness on the cost benefit of energy efficient buildings is needed in Nigeria. In my home I used to use conventional AC system and my utility bills were so high, so considering that, you realise there are some energy efficient AC systems like inverters, which I make use of presently and the savings on my electricity bill is evident, so I think if a lot more people knew, they would behave accordingly".* This result is similar to a study by Ejidike et al. (2022) who asserted on the need for gaining the required awareness and knowledge which is essential since improper adoption and use of new technology is impeded by ignorance. Additionally, Ade-Ojo and Awodele, (2020) recommended that the general public and built-industry experts throughout the nation be educated on the concepts of green buildings and its environmental benefits.

Training of Professionals

P1 stated that *"I think a lot more architects, engineers and what have you in the building industry need to be trained on sustainable building measures and how to add them to their construction designs"*. P12 also said *"building industry professionals should consult with international organisations to provide training for workers. There are some international organisations in Nigeria that conduct training for architects, but more works needs to be done, because the percentage of professionals without the skill to implement such measures outweighs does who know how to".* This result is in line with, Toyin and Bassey (2020), who recommended that all the professional bodies in the built environment should mandate their members to acquire adequate skills and knowledge required for green building for effective green building design

International Cooperation

P2 expressed his concern by saying

"Nigerian construction industry should seek the advice of foreign bodies. They can help with providing the right approach or plan on how the industry can incorporate more energy efficient buildings to their stock. They have a lot more experience on the various measures, and we can learn a lot from that. Yes, organisations like Edge and GIZ are doing what they can, but a lot more needs to be done compared to other countries". This result is again similar

to CCFLA (2023), who has stated the need for industry collaboration between developed and developing nations to find solutions that offer environmentally sustainable buildings

Use of Smart Meters.

A Participants is of the notion that the use of smart meters would influence building occupants to use adopt energy saving behaviours. P15 said *"building owners need to form the habit of getting meters, they can monitor their energy consumption levels, for example, they can make use smart meters, it will automatically inform them on their energy consumption patterns and show they them the activities that consume most of their energy, when they begin to see this, I believe they will be forced to make adjustments".* This response is corroborated in studies like that of Echezona et al. (2018) on the design and construction of a smart electric metering system in Nigeria. They discovered the usefulness of smart meters in addressing the problem of anticipated billing and unpaid electricity consumption to tackle the task of metering Nigeria's over 170 million electricity users.

Smart Buildings.

P13 also believes in the adoption of smart buildings into Nigerian building designs as a way to showcase the industries technological growth and goal of achieving a sustainable industry. Saying *"although the Nigerian construction industry doesn't have the adequate resources to advance automated buildings and you can count the number of smart buildings in Nigeria, this is a concept that has to be further looked into in Nigeria for better efficiency of buildings. You can see that smart technologies are taking over globally, and industries are moving towards that direction, because of its environmental and economic benefits''*. This response is similar to studies done by Kumar et al. (2022), who stated that there has been an increased interest in IoT (Internet of things) applications in buildings to improve energy efficiency and reduce environmental impacts.

5. Conclusion

This pilot study explored the barriers and strategies for achieving energy efficient buildings in Nigeria from the perspective of construction professionals. Main barriers identified include high implementation costs, inadequate policies and regulations, low awareness levels, limited expertise, lack of stakeholder interest, and theft / vandalism issues. Key possible strategies recommended by the professionals include enacting and implementing adequate policies, increasing public enlightenment campaigns, providing training for construction professionals, and seeking international cooperation and knowledge sharing. Overcoming these barriers and implementing the suggested strategies could help unlock the great potential for enhancing occupant well-being and reducing carbon footprints in Nigerian buildings. The insights from this qualitative study provide valuable information that the Nigerian building industry can leverage in their efforts towards realizing energy efficiency in their building sector. Addressing the challenges and capitalizing on the recommendations is crucial for promoting sustainable construction practices nationwide.

The study was conducted with 15 professionals, which limited generalizability for the Nigerian building industry. However, the utilisation of a wider range and increased number of construction professional could have produced a more comprehensive result. Moreover, it is recommended that approaching from a different angle of primary data collections like case studies or a mixed method approach could offer more in-depth analysis and understanding of the subject. For future research, given the rapid evolution of energy efficiency and its applications in the built environment, it would be good to compare the information presented in this study to other future studies on the same issue.

Additionally, the strategies recommended by professionals in the study, such as enacting robust policies, increasing public awareness, providing training, and seeking international cooperation, can serve as a roadmap for other developing countries looking to improve energy efficiency in their building sectors. The emphasis on the need for adequate policies and proper implementation can guide policymakers in other countries to develop and enforce effective regulations promoting energy efficient building practices.

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References

Adu, P. (2019). A step-by-step guide to qualitative data coding. Oxford: Routledge

2.

Adetooto, J.D., Ijigah, E.A., Oseghale, G.E. and Oseghale, B.O., 2020. Evaluation of Energy Efficiency in Residential Buildings in Akure, Nigeria. J. Basic Appl. Res, 53, pp.85-96

Ade-Ojo, C. O., & Awodele, O. A. (2020). Awareness of Green Building Prerequisites for Skill Development Among Built-Industry Professionals in Nigeria. The Construction Industry in the Fourth Industrial Revolution, pp.188–196. https://doi.org/10.1007/978-3-030-26528-1_19

Aghimien, D. O., Awodele, O. A., Oke, A.E., & Aghimien, E.I. (2018). View of Stakeholders' Perception of Sustainability in Educational Buildings in Nigeria. International Journal of Sustainable Construction Engineering & Technology, Vol.9 No.1, pp.2180-3242.

Akhimien, N. (2022) A framework for incorporating circular economy in the design of energy efficient residential buildings in Nigeria. PhD Thesis, Cardiff University. Available at: https://orca.cardiff.ac.uk/id/eprint/154475/ (accessed 26 May 2023)

Belussi, L., Barozzi, B., Bellazzi, A., Danza, L., Devitofrancesco, A., Fanciulli, C., et al. (2019). A review of performance of zero energy buildings and energy efficiency solutions. Journal of Building Engineering, Vol.25, p.100772. https://doi.org/10.1016/J.JOBE.2019.100772

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. Qualitative Research in Psychology, Vol.3 No.2, pp.77–101. https://doi.org/10.1191/1478088706QP063OA

Cao, X., Dai, X., & Liu, J. (2016). Building energy-consumption status worldwide and the state-of-the-art technologies for zero-energy buildings during the past decade. Energy and Buildings, Vol.128, pp.198–213. https://doi.org/10.1016/J.ENBUILD.2016.06.089

Cities Climate Finance Leadership Alliance (CCFLA). (2023). Financing Net Zero Carbon Buildings in Nigeria. Online. Available at; https://citiesclimatefinance.org/publications/financing-net-zero-carbon-buildings-in-nigeria/#_ftnref1 (Accessed 16 December, 2023).

Echezona, U., E., King, A., A., & Tolulope, O., A. (2018). Design and construction of a smart electric metering system for smart grid applications: Nigeria as a case study. International Journal of Scientific & Engineering Research, Vol.9 No.7. http://www.ijser.org

Ejidike, C. C., Mewomo, M. C. & Anugwo, I. C. (2022). Assessment of construction professionals' awareness of the smart building concepts in the Nigerian construction industry. Journal of Engineering, Design and Technology. https://doi.org/10.1108/JEDT-05-2022-0263/FULL/PDF

Elinwa, U. K., Ogbeba, J. E., & Agboola, O. P. (2021). Cleaner energy in Nigeria residential housing. Results in Engineering, 9, 100103. https://doi.org/10.1016/J.RINENG.2020.100103

Ezeanah, U. (2021). Housing Challenges in Nigeria. Sustainable Housing. https://doi.org/10.5772/INTECHOPEN.99263

Ezema, I. C., & Maha, S. A. (2022). Energy Efficiency in High-rise Office Buildings: An Appraisal of its Adoption in Lagos, Nigeria. IOP Conference Series: Earth and Environmental Science, 1054(1), 012037. https://doi.org/10.1088/1755-1315/1054/1/012037

Geissler, S., Österreicher, D. & Macharm, E. (2018) Transition towards Energy Efficiency: Developing the Nigerian Building Energy Efficiency Code. Sustainability, Vol.10 No.8, p.2620. https://doi.org/10.3390/SU10082620

Gesellschaft für Internationale Zusammenarbeit (GIZ) & Nigerian Energy Support Programme (NESP). (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. http://www.energyplatformnigeria.com/index.php/library/energy-efficiency

Grant, M. J., & Booth, A. (2009). A typology of reviews: an analysis of 14 review types and associated methodologies. Health Information & Libraries Journal, Vol.26 No.2, pp.91–108. https://doi.org/10.1111/J.1471-1842.2009.00848.X

Hussaini, I. U., & Majid, N. H. A. (2015). Energy development in Nigeria and the need for strategic energy efficiency practice scheme for the residential building sector. Management of Environmental Quality: An International Journal, Vol.26 No.1, pp.21–36. https://doi.org/10.1108/MEQ-10-2013-0117/FULL/XML

Ibrahim, A. T., & Fernando, N. G. (2021). The obstacles to energy saving in residential buildings in Nigeria: stakeholders' perspectives. World Construction Symposium, pp.528–539. https://doi.org/10.31705/WCS.2021.46

Ikejemba, E. C. X., & Schuur, P. C. (2018). Analyzing the Impact of Theft and Vandalism in Relation to the Sustainability of Renewable Energy Development Projects in Sub-Saharan Africa. Sustainability 2018, Vol. 10 No.3, p.814. https://doi.org/10.3390/SU10030814

International Energy Agency (IEA). (2023). Buildings. Available at: https://www.iea.org/energy-system/buildings (accessed 19 December 2023)

Jackson, K., Bazeley, P., & Bazeley, P. (2019). Qualitative data analysis with NVivo. Sage.

Kumar, T., Srinivasan, R. and Mani, M. (2022) 'An Emergy-based Approach to Evaluate the Effectiveness of Integrating IoT-based Sensing Systems into Smart Buildings', Sustainable Energy Technologies and Assessments, Vol.52, pp.102225. Available at: https://doi.org/10.1016/J.SETA.2022.102225

Marshall, C. and Rossman, G.B. (2006), Designing Qualitative Research. Availabel at: https://books.google.co.uk/books?hl=en&lr=&id=-zncBQAAQBAJ&oi=fnd&pg=PP1&dq=Designing+Qualitative+Research,+4th+ed.,+Sage,%0D%0AThousand+Oaks,+CA.&ots=Lgn7oL0z8V&sig=sUXOdMFeTZzNOftC_e7J7NYfHXY#v=onepage&q=Designing%20Qualitative%20Research%2C%204th%20ed.%2C%20Sage%2C%20%20Thousand%20Oaks%2C%20CA.&f=false (accessed 16 October 2023)

Mato, H., Labaran, Y. H., Mukherjee, D., Saini, G., & Farouq, M. M. (2023). Achieving Sustainability in Nigerian Households: Investigating Factors Impacting Energy Efficiency Practices. Journal of Sustainable Construction Materials and Technologies, Vol.8 No.3, pp.180–191. https://doi.org/10.47481/JSCMT.1261384

Moran, P., O'Connell, J., & Goggins, J. (2020). Sustainable energy efficiency retrofits as residential buildings move towards nearly zero energy building (NZEB) standards. Energy and Buildings, Vol. 211, p.109816. https://doi.org/10.1016/J.ENBUILD.2020.109816

Muhammad, A. Y., Ibrahim, S. K., & Dalibi, S. G. (2020). Barriers and Drivers Facing Architects in Adopting Energy Efficiency and the use of Zero-carbon Technologies in Nigerian Built Environment. IOP Conference Series: Earth and Environmental Science, 588(2), 022046. https://doi.org/10.1088/1755-1315/588/2/022046

Mushafiq, M., Arisar, M. M. K., Tariq, H., & Czapp, S. (2023). Energy Efficiency and Economic Policy: Comprehensive Theoretical, Empirical, and Policy Review. Energies 2023, Vol. 16 No.5, p.2381. https://doi.org/10.3390/EN16052381

Nielsen, A. N., Jensen, R. L., Larsen, T. S. and Nissen, S. B. (2016) 'Early stage decision support for sustainable building renovation – A review', Building and Environment, Vol.103, pp.165–181. Available at: https://doi.org/10.1016/J.BUILDENV.2016.04.009

Nie, H., Vasseur, V., Fan, Y., & Xu, J. (2019). Exploring reasons behind careful-use, energy-saving behaviours in residential sector based on the theory of planned behaviour: Evidence from Changchun, China. Journal of Cleaner Production, Vol.230, pp.29–37. https://doi.org/10.1016/J.JCLEPRO.2019.05.101

Nigeria Federal Ministry of Power, Works and Housing (NFMPWH). 2016. Building Energy Efficiency Guideline for (Housing). Online. https://energypedia.info/images/c/c7/Building_Energy_Efficiency_Guideline_for_Nigeria_2016.pdf (accessed 16 October 2023).

Noorollahi, Y., Khatibi, A., & Eslami, S. (2021). Replacing natural gas with solar and wind energy to supply the thermal demand of buildings in Iran: A simulation approach. Sustainable Energy Technologies and Assessments, Vol.44, p.101047. https://doi.org/10.1016/J.SETA.2021.101047

Ochedi, D. E. T., & Taki, P. A. (2019). Towards Energy Efficient Buildings in Nigeria: Challenges and Opportunities. JOURNAL OF ENGINEERING AND ARCHITECTURE, Vol.7 No.2. https://doi.org/10.15640/JEA.V7N2A14

2.

Ochedi, E. T. & Taki, A. (2022). A framework approach to the design of energy efficient residential buildings in Nigeria. Energy and Built Environment, Vol.3 No.3, pp.384–397. https://doi.org/10.1016/J.ENBENV.2021.07.001

Oke, A. E., Arowoiya, V. A., & Akomolafe, O. T. (2020). Influence of the Internet of Things' application on construction project performance. Vol.22 No.13, pp.2517–2527. https://doi.org/10.1080/15623599.2020.1807731

Oyedepo, S. O. (2014). Towards achieving energy for sustainable development in Nigeria. Renewable and Sustainable Energy Reviews, Vol.34, pp.255–272. https://doi.org/10.1016/J.RSER.2014.03.019

Oyewole, M. O., Komolafe, M. O., & Gbadegesin, J. T. (2021). Understanding stakeholders' opinion and willingness on the adoption of sustainable residential property features in a developing property market. International Journal of Construction Management, Vol.23 No.2, pp.358–370. https://doi.org/10.1080/15623599.2021.1874676

Pillay, P., & Mafini, C. (2017). Supply chain bottlenecks in the South African construction industry: Qualitative insights. Journal of Transport and Supply Chain Management, Vol.11, p.12. https://doi.org/10.4102/JTSCM.V11I0.307

Pushpamali, N. N. C., Agdas, D., Rose, T. M., & Yigitcanlar, T. (2021). Stakeholder perception of reverse logistics practices on supply chain performance. Business Strategy and the Environment, Vol.30 No.1, pp.60–70. https://doi.org/10.1002/BSE.2609

Tilde, A. I., & Fernando, N. (2022). The Drivers to Energy Saving in Residential Buildings in Nigeria: Stakeholders Perspectives. EasyChair. Online. Available at: https://easychair.org/publications/preprint/ngpP (accessed 1 December 2023)

Toyin, A., & Bassey, S. (2020). Assessment Of Cost Implication Of Green Building In Nigeria. Available at: https://www.ijesi.org/papers/Vol(9)i2/Series-1/F0902013844.pdf (accessed 10 December 2023).

Vincent-Ohizu, B. C., Akande, I., & oke, T. I. (2022). Design Strategies for Energy-Efficient Commercial Buildings in Nigeria - IRE Journals. IRE Journals, Vol.6 No.4, pp.110–115. https://www.irejournals.com/

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