SUSTAINABLE ARCHITECTURE AND CONSTRUCTION IN SOUTH - SOUTH GEO POLITICAL REGION OF NIGERIA

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ABSTRACT

The study assessed sustainable architecture and construction in the south-south geopolitical region of Nigeria, exploring the strategies, challenges, components, cases, and opportunities for promoting sustainable architecture and construction in the south-south region. The study highlighted the importance of architecture and sustainability in minimising the negative environmental impact and enhancing resilience in built environments. It also gave an overview of building construction, building collapse, and a further breakdown of the components of sustainable architecture. The study further delves into the cases of building collapse in the south-south geopolitical region and its challenges, such as limited awareness and education, inadequate infrastructure and resources, and also the strategies to maintain sustainable architecture and construction in Nigeria, which include the use of eco-friendly materials, energy-efficient designs, and water conservation practices. The study concluded that embracing sustainable approaches fosters economic growth, enhances social equity, and preserves cultural heritage. One of the recommendations was that there is need to encourage the use of locally sourced, renewable materials such as bamboo, adobe, and timber to reduce reliance on environmentally harmful imported materials and support local economies.

Keyword: Sustainable Architecture, Construction, South-South Geo Political Region and Nigeria.

INTRODUCTION

Environmental preservation, social justice, and economic feasibility are given top priority in sustainable architecture and construction, which encompasses a comprehensive approach to building design, construction methods, and urban planning. The adoption of sustainable principles acquires more relevance in the South-South area of Nigeria, which is marked by different ecosystems, growing urbanization, and cultural diversity. The area represents a patchwork of potential and difficulties that highlight the need of adopting sustainable development techniques, from the expansive metropolis of Port Harcourt and Warri to the serene landscapes of Bayelsa and Akwa Ibom.

The imperative for sustainable architecture and construction in the South-South region is underscored by a confluence of factors. Environmental degradation, exacerbated by deforestation, pollution, and climate change impacts, threatens the region's ecological balance and resilience. Moreover, rapid urbanization, fueled by

population growth and industrial expansion, strains existing infrastructure, exacerbates socio-economic disparities, and poses formidable challenges to sustainable development (Udeh 2019).

However, amidst these challenges lie opportunities for innovation, collaboration, and transformative change. The South-South region boasts abundant natural resources, including oil and gas reserves, fertile agricultural land, and rich biodiversity, which can be harnessed sustainably to drive economic development while preserving ecological integrity (Olotuah 2019). Moreover, the region's cultural heritage, characterised by vibrant traditions, indigenous knowledge systems, and community cohesion, provides fertile ground for integrating traditional wisdom with modern sustainability practices.

An emphasis on comprehensive planning, resource efficiency and community involvement is fundamental to South-South sustainable architecture and construction. Using regionally appropriate design elements may reduce a building's environmental impact and increase its resistance to the effects of climate change. Examples of these elements include green infrastructure, vernacular architecture, and passive cooling systems. In addition, encouraging the use of low-carbon concrete, bamboo, and recycled materials in building may lower embodied carbon emissions and advance the ideas of the circular economy. As stated by (Oti & Emeti, 2015) cited in (Usanga, 2023) these strategies not only contribute to environmental sustainability but also align with the sociocultural fabric of tropical communities.

CONCEPT OF ARCHITECTURE

Architecture is defined as the thought, idea, or notion that serves as the foundation of a design project as well as the engine that propels it forward. However, curiosity is essential for creativity as it becomes the power and identity of an architectural project's development, and it is regularly consulted at all stages (Fidanci 2022).In the architecture journey, the very first step is to understand the concepts, as some of these concepts include typography, vernacular, historic, form and volume, physical features, views, public and private, accommodation, use, mass, journey and movements, adding and subtraction, materials, atmosphere, grid, culture and society, protection and shelter, structure and technology, users, light, and orientation. Architecture is created only to fulfil the specifications of an individual or group. Architectural designs are evolutionary, as it is best to start by collating project data, project briefs, requirements, site information, and many more, as it helps architects orient the design context themselves (Snaptrude 2021). Architecture serves as the foundational idea and core identity of a project and guides its design throughout the entire process. Architecture is also the translation of a non-physical design problem into a physical building product.

Architecture is both the process and product of planning, designing, and constructing buildings and other physical structures. It's an art and a science that shapes the environments in which we live, work, and play. When architecture is grounded in depth and meaning, it becomes more coherent, relevant, successful, and interesting as it brings richness to the design. Additionally, Babylib (2023) explained that architecture has various types and roles they play in shaping and building our environments. Architecture is the art and technique of designing and building, as it is distinguished from the skill of construction. The practice of architecture is employed to

fulfil both practical and expressive requirements, and thus it serves both utilitarian and aesthetic ends (Collins & Ackerman, 2024). Abdel-Aziz (2021) defined architecture as the concept of an idea or thought that provides identity and direction for a project, as the concepts can come from a site, programme, culture, or influence.

CONCEPT OF SUSTAINABLE ARCHITECTURE

Up until now, the majority of discussions surrounding the word "sustainability" in design have focused on building technology and how it is changing. The goal of sustainability, also known as ecological design, is to make sure that the resources that are now accessible are used in a way that will not negatively impact the well-being of future generations or make future resource acquisition unfeasible. The term "sustainable architecture" refers to design that aims to reduce a building's negative environmental effects by using resources more wisely and with more efficiency, including less energy, less materials, less development area, and the ecosystem as a whole. Sustainable architecture designs the built environment with consideration for both ecological and energy conservation.

According to Hohenadel (2024), sustainable architecture is a general term that refers to buildings designed to limit humanity's impact on the environment. Sustainable architecture defines a building designed and built to significantly reduce the damages inflicted on the health of its inhabitants and the environment. A sustainably designed building is important because it uses substantially less energy and water long-term, and it's built using fewer chemically toxic materials. Bowen (2023) explained that sustainable architecture is an architecture that emphasises environmental sustainability in all aspects of planning and construction. Sustainable architecture's definition involves designs that leverage its materials, methods, and systems to reduce its impact on the environment of the future while also meeting the current needs of those that inhabit it. As mentioned by Tadao Ando (2012) cited in Usanga (2024) it is important to integrate certain building elements into the architectural design. Building elements integrable into architectural design for optimization of the relationship between the building and the adjourning landscape.

Sustainable architecture and environmental issues are now a part of the agenda for businesses as well as local and international communities. Garafola (2018) noted that sustainable architecture means being able to satisfy consumers' requests, taking the time and natural resources needed into consideration from the very early stages of the project, entering the context in the most natural way possible, and planning ahead by making the space and materials employed completely reusable. Moreover, sustainability in architecture does not only mean reducing energy use and waste. It cannot be segmented into various subcategories because it represents a fundamental and intrinsic combination of factors related to our existence on this planet.

CONCEPT OF BUILDING CONSTRUCTION

A building is generally thought of as a structure made up of floors, walls, and roofs that is erected to provide covered space for different uses such as residence, business, entertainment, a workshop, and many more. While construction is defined as anything made by man for one purpose or another, it can also refer to a road, path, bridge, dam, dwelling place, airport, or building, among many other things. Most constructions are the result of designs for better living conditions. The process of

constructing or erecting structures—usually residential, commercial, or industrial buildings—from separate parts or components is known as building construction. It involves a combination of design, planning, and execution to create a functional and safe built environment. Building construction is the process of adding structures to real property through various techniques.

However, the vast majority of building construction projects are small renovations, such as the addition of a room to a building, the renovation of bathrooms, and many more. It also involves the demolishing of buildings, the construction of new buildings, the construction of additions to existing buildings, and the necessary alteration of existing buildings to conform to any new additions. Nuzha & Gass (2023) defined building construction as the process where contractors build structures that serve a certain purpose. Construction requires engineers to design them and contractors to build them. It is also an ancient human activity.

According to Proest (2022), building construction is the physical activity on a construction site that contributes to building or structure construction. However, this process involves uploading plants, machinery, materials, cladding, fixing and fitting of the installation, formwork, and external finish. Ali (2023) explained that building construction is the structure designed to provide shelter, house activities, and accommodate human needs, as it typically consists of walls, floors, a roof, and various systems to ensure functionalities and comfort. Buildings are integral to civil engineering, as the construction of buildings not only fulfils the basic human need for shelter but also facilitates economic growth by creating employment opportunities in the construction industry. According to ZeroDocs (2023) as cited in Usanga (2024) architectural specifications play a crucial role in the construction process by furnishing comprehensive details on the items, materials, and techniques that will be employed in the building of a project. Buildings are normally constructed according to drawings and specifications prepared by architects or civil engineers. It is the process of putting structures together for the purpose of human settlement, amongst others. In addition, building construction is the technique and industry involved in the assembly and erection of structures, primarily used to provide shelter.

CONCEPT OF BUILDING COLLAPSE

Collapse is a state of complete failure when the structure has literally given way and most members have caved in, crumbled, or buckled; the building can no longer stand as originally built. It can therefore be seen that collapse is the very extreme state of failure (Akinyemi, Dare, Anthony, & Dabara, 2016). Structures known as buildings provide homes for people, their belongings, and their activities. To achieve the appropriate level of enjoyment from the surroundings, they need to be carefully planned, created, and constructed (Usanga, 2024). Building collapse, on the other hand, refers to a building's abrupt structural failure, either completely or partially, endangering people's lives and health. A building will collapse into itself when internal load-bearing structural elements fail, drawing outside walls into the collapsing structure. This situation might result in a dense debris field with a tiny footprint and be brought on by construction, an earthquake, or a fire. Alternatively, the structure may fall outward, creating a less dense and more dispersed debris cloud, if an explosion or natural factors like weather induce structural failure.

Building collapse is defined as a partial or progressive failure of one or more components of a building structure that leads to the inability of the building to perform its primary functions of comfort, satisfaction, safety, and stability (Ariye, 2020). On the other hand, there are several types of structural failure, each exhibiting a distinct level of damage or severity. It could have a fracture, disintegration, or loss of use. Building collapses are oftentimes the consequence of some other occurrence or disaster, such a tornado or fire.

Sharma (2020) highlights that building collapse refers to the failure of the structure or component. The failure of a building depends on the materials, designs, methods of construction, environmental conditions, and building use. Furthermore, attributed causes of building collapse include defective building design, faulty construction, failure of the foundation, soil liquefaction, and demolition through explosives. A building collapse is a defect, imperfection, deficiency, or fault in a building element or component. It may also be a result of an omission of performance.

COMPONENT OF SUSTAINABLE ARCHITECTURE

Sustainable architecture is the process by which buildings are designed to be environmentally conscious and energy-efficient. According to Tobias (2024), sustainable architecture aims to incorporate structural and MEP systems into building designs that engage positively with their surroundings. It encompasses various components aimed at minimising the negative environmental impact of buildings by enhancing efficiency and moderation in the use of materials, energy, and development space. The components of sustainable architecture are as follows:

- **Energy efficiency and renewable energy:**

Energy efficiency is a cornerstone of sustainable architecture. Renewable energy systems are only becoming more popular as technological innovations drive costs down. Solar panels have never been more affordable, and building owners are eager to explore the cost-saving possibilities of renewable energy. When used in combination with passive design strategies like well-insulated building envelopes, natural lighting, and ventilation, renewable energy systems can go a long way in providing reliable, cost-effective energy performance (Foreman, 2022). However, buildings consume a significant amount of energy, and it is important to ensure that this energy use is optimised while minimising waste.

- **Sustainable materials:**

The use of sustainable materials is critical in sustainable architecture. Sustainable architecture depends on using as many eco-friendly materials as possible. Newer concrete technologies can also reduce one's ecological footprint in places where cement and concrete are necessary. More effectively, one can use recycled materials in order to keep the natural environment from being torn down (Samuel, 2024).

- **Water management:**

Water management is another essential component of sustainable architecture. Water is a vital resource that is consumed in various ways. Sustainable apartments employ water-saving measures like rainwater harvesting, dual flush toilets, low-flow

fixtures, and so on (Webdura, 2024). By minimising water consumption, sustainable buildings help preserve this precious natural resource and prevent pollution of water sources (Hutter architects, 2022).

- **Waste management:**

Sustainable architecture considers the entire lifecycle of a building, from design and construction to operation and eventual decommissioning. Any product that is reusable and reconfigurable contributes to waste reduction because less material is required to upgrade or reconfigure to accommodate future changes. It is also important that building products match the lifecycle of a building to avoid frequent replacement. This helps reduce the demand for virgin materials associated with the replacement products and reduces the waste associated with disposal of the products being replaced (Grainger, 2024).

- **Smart growth and sustainable development:**

Sustainable buildings will continue to develop their sustainability and environmental impact over time. This could include dealing with storm water runoff or even occupant waste in a new, sustainable way. Green buildings will need to adapt over time to changing and ever-tightening regulations.

CASES OF BUILDING COLLAPSE IN SOUTH –SOUTH NIGERIA

The south-south region of Nigeria is not immune to the menace of building collapse. Building collapses in south-south Nigeria have become a distressing issue, often resulting in significant loss of life, property damage, and economic disruption. One notable incident that happened sometime in 2015 was that an ongoing structure for indoor games close to U.J. Esuene Stadium in Calabar, Cross River State, collapsed. A visit by the Nigerian Society of Engineers to the scene revealed that polystyrene was incorporated in some structural members; the resultant effect was the failure of the structure under its own weight. (Ewa, 2018).

Furthermore, another tragic event was the the collapse of an appendage of a two-story hotel in the Ada-George area of Port Harcourt, Rivers State. Four people injured in the incident have received treatment at the hospital. The News Agency of Nigeria (NAN) gathered that the two-story building belonging to the 1708 Hotel, Rumuoke, by Okilton Junction, off Ada George, collapsed at about 6.15 a.m. on Thursday, 2023. The incident occurred when some residents of the area were still asleep and the occupants of the building, who were mainly site workers, were getting ready to resume their day's work. However, the collapse was due to foundation failure or failure of the structure itself (Agency Report, 2023). On December 10, 2016, a church in Uyo-Akwa-Ibom State collapsed during a mid-Saturday service, killing over 200 people, with the State Governor among the lucky survivors. This tragedy highlighted the consequences of structural failures and the importance of adherence to building regulations.

In a similar incident, a section of a two-story building currently under construction in Asaba, Delta State, collapsed yesterday, leaving about eight people injured. The building, situated opposite ShopRite in the state capital, sources said, collapsed about 5 p.m. as workers were working on the site. After inspecting the building, the state commissioner for urban renewal, Mr. Michael Anoka, said the

incident was the result of a building defect (Akuopha, 2023).The situation in Bayelsa State is no different, with a notable case in Yenagoa in March 2020 when a three-story residential building collapsed, resulting in several deaths and injuries. The incident raised serious concerns about the structural integrity of many buildings in the area, particularly those in flood-prone zones. Investigations pointed to poor foundational work and waterlogged soils as major contributing factors.

Comprehensive reforms in the construction sector have been called for as a result of the numerous building collapses in south-south Nigeria. Experts contend that the focus should be on enhancing the certification and training programmes for building professionals rather than just upholding the current laws. Furthermore, a thorough examination of current structures is necessary to guarantee their structural soundness, particularly for those constructed before to the implementation of contemporary building rules.

STRATEGIES TO MAINTAIN SUSTAINABLE ARCHITECTURE AND CONSTRUCTION IN NIGERIA

Nigeria's fast urbanization, population increase, and environmental problems make sustainable architecture and building imperatives. In order to attain sustainability in the built environment, many approaches that tackle the economic, social, and environmental aspects can be utilized. These tactics include waste management, regulations that support sustainability, water conservation techniques, energy-efficient design, and the use of environmentally friendly products. By putting these solutions into practice, Nigerian urban areas may become more resilient and sustainable.

- **Use of Eco-Friendly Materials:**

Adopting eco-friendly materials is critical to sustainable construction. These materials have a low environmental impact during production, use, and disposal. In Nigeria, promoting the use of locally sourced materials such as bamboo, laterite, and rammed earth can reduce the carbon footprint associated with transportation and manufacturing. These materials are abundant and have been traditionally used in construction, making them cost-effective and culturally acceptable. Research shows that using such materials can significantly reduce the environmental impact of buildings (Olaniyan & Olatunde, 2019).

- **Energy-Efficient Designs:**

Energy-efficient design is another crucial strategy for sustainable architecture. This involves optimizing the building's orientation, insulation, and ventilation to reduce energy consumption for heating, cooling, and lighting. In Nigeria, where temperatures can be high, incorporating passive cooling techniques such as natural ventilation, shading devices and green roofs can minimize the reliance on air conditioning (Nduka & Ogunsanmi, 2018). Additionally, integrating renewable energy sources like solar panels can provide a sustainable energy supply for buildings.

- **Water conservation practices:**

Water conservation is essential in areas with limited water resources. Sustainable architecture in Nigeria should include systems for rainwater harvesting, greywater

recycling, and the use of low-flow fixtures. These practices help reduce water consumption and promote the efficient use of water resources. Rainwater harvesting, for instance, can provide a supplementary water source for non-potable uses such as irrigation and toilet flushing, easing the pressure on municipal water supplies (Adedeji & Fadamiro, 2018).

- **Sustainable urban planning:**

Sustainable urban planning integrates environmental, social, and economic factors to create livable and resilient urban environments. In Nigeria, this involves designing compact, mixed-use developments that reduce the need for long commutes and encourage walking, cycling, and the use of public transport. Urban green spaces, such as parks and community gardens, play a crucial role in enhancing urban biodiversity, improving air quality, and providing recreational opportunities for residents (Aluko & Ajala, 2019).

- **Education and awareness:**

Raising awareness and educating stakeholders about the benefits and techniques of sustainable construction is essential. This includes training architects, engineers, builders, and developers in sustainable design principles and construction practices. Public awareness campaigns can also inform homeowners and communities about the advantages of sustainable buildings, driving demand for eco-friendly construction (Oluwatayo & Amole, 2020).

- **Waste Management:**

Effective waste management strategies are vital for sustainable construction. This includes reducing, reusing, and recycling construction waste. In Nigeria, construction and demolition activities generate significant amounts of waste, much of which ends up in landfills. Implementing site waste management plans and promoting the use of recycled materials can help mitigate this issue. Encouraging the adoption of prefabricated construction methods can also minimise waste generation by producing building components off-site under controlled conditions (Ogunbiyi, Goulding, & Oladapo, 2019).

CHALLENGES TO SUSTAINABLE ARCHITECTURE IN SOUTH –SOUTH NIGERIA

The utilization of environmentally conscious design and construction techniques is a hallmark of sustainable architecture, which is essential for reducing the negative impacts of urbanization and fostering adaptability to climate change. Nonetheless, there are a number of obstacles preventing the broad use of sustainable design concepts in South-South Nigeria. The following are the difficulties facing sustainable architecture in southern Nigeria:

- **Limited Awareness and Education:**

In South-South Nigeria, there is a lack of awareness and education about sustainable architectural practices among stakeholders, including architects, builders, and policymakers (Oluwagbemi, 2020). Without a proper understanding and appreciation of the benefits of sustainable architecture, traditional building methods persist, leading to increased environmental degradation and energy consumption.

- **Economic factors**:

Economic factors play a significant role in inhibiting the adoption of sustainable architecture. High initial costs associated with green building materials and technologies deter many developers and homeowners from investing in sustainable construction (Oni, 2019). Additionally, the lack of access to financing options tailored to sustainable projects further exacerbates this challenge.

- **Inadequate Infrastructure and Resources:**

The South-South region of Nigeria faces infrastructural deficiencies, including unreliable power supply and limited access to water and sanitation services (Babatunde, 2021). These shortcomings pose significant obstacles to the implementation of sustainable architectural solutions, such as renewable energy systems and water-efficient designs.

- **Regulatory and Policy Framework:**

The absence of stringent regulations and incentives for sustainable construction hampers progress in this field. Without supportive policies mandating sustainable building practices or providing incentives for compliance, developers may prioritise cost-saving measures over environmental considerations.

- **Cultural and Social Factors:**

Cultural norms and societal preferences often prioritise aesthetics and immediate comfort over sustainability in building design. Moreover, traditional building practices deeply rooted in local cultures may resist innovation, making it challenging to introduce sustainable architectural concepts.

CONCLUSION

In conclusion, sustainable architecture and construction hold immense promise for the South-South Geopolitical Region of Nigeria. Through innovative design, renewable materials, and energy-efficient practices, these initiatives can mitigate environmental impact and promote resilience to climate change. Furthermore, embracing sustainable approaches fosters economic growth, enhances social equity, and preserves cultural heritage. However, successful implementations require collaborative efforts among stakeholders, including government bodies, industry professionals, and local communities. By prioritizing sustainability, the region can not only address pressing environmental challenges but also lay the foundation for a more prosperous and resilient future.

RECOMMENDATIONS

- There is need to encourage the use of locally sourced, renewable materials such as bamboo, adobe, and timber to reduce reliance on environmentally harmful imported materials and support local economies.
- There is dire to implement energy-efficient designs incorporating passive solar techniques, natural ventilation, and high-performance insulation to minimize energy consumption and lower carbon emissions in buildings.

- Integrate water-saving technologies like rainwater harvesting, greywater recycling, and low-flow fixtures to reduce water usage and mitigate the impact of water scarcity in the region.

REFERENCES

Abdel-aziz D. (2021) Architectural concepts available at: https://www.slideshare.net/slideshow /concept-244672043/244672043

Adedeji, Y. M. D., & Fadamiro, J. A. (2018). Water conservation techniques in Nigerian buildings: Towards sustainable practices. *Journal of Sustainable Development in Africa*, 20(1), 103-117.

Agency report (2023). Building collapses in Port Harcourt. Available at: https: //www.premiumtimesng.com/regional/south-south-regional/607355-building-collapses-in-port-harcourt.html?tztc=1

Akinyemi, P. A, Dare. G. M, Anthony, A. Dabara, D. I. (2016) &I. Building Collapse in Nigeria: Issues and Challenges. *Conference of the International Journal of Arts & Sciences*.09 (01):99–108.

Akuopha, O. (2023). 8 injured as multiple-storey building collapses in Delta. Available at: https://www.vanguardngr.com/2023/09/8-injured-as-multiple-storey-building-collapses-in-delta/

Aluko, O. E., & Ajala, O. (2019). Sustainable urban planning in Nigeria: Challenges and opportunities. *Urban Planning*, 4(3), 75-86.

Ariye, Y. (2020). Building Collapse in Nigeria. Available at: https://www.linkedin.com /pulse/building-collapse-Nigeria-yemi-ariye

Babatunde, A., Oluwatobi, S., & Odusina, A. (2021). Infrastructure Deficit and Economic Growth in South-South Nigeria. *International Journal of Economics, Commerce and Management,* 9(4), 1-13.

Babylib (2023) what are types of architectural concepts? Available at:https://thearchitopics.com /what-are-types-of-architectural-concepts/

Bowen, K. (2023). Sustainable Architecture | Overview & Examples. Available at: https://study.com/academy/lesson/what-is-sustainable-architecture-definition-examples.html

Collins P. & Ackerman J. S. (2024) Architecture available at: https://www.britannica.com /topic/architecture

Ewa, E. D. (2018). *Building Collapse in South-South Nigeria*. Standards Organization of Nigeria (Son). Calabar.

Fidanci E. A. (2022) Understanding architectural concept available at: https://illustrarch.com /articles/9525-understanding-architectural-concept.html #:~:text=An%20architectural%20concept%20is%20a,regularly%20consulted%20 at%20all%20stages.

Foreman M. (2022) 8 key sustainable building design practices available at: https://www.rowlandbroughton.com/guide-to-sustainable-building-design/

Garafola, F, (2018). What is sustainable architecture: definition, concept and famous examples? Available at: https://www.lifegate.com/sustainable-architecture-definition-concept-projects-examples

Grainger (2024) focus on three components for effective sustainable building design available at: https://www.grainger.com/know-how/safety-health/sustainability/kh-sustainable-building-design

Hohenadel, K. (2024). What Is Sustainable Architecture? Available at: https://www.thespruce.com /what-is-sustainable-architecture-4846497

Hutter designs (2022) what are the four elements of a sustainable building. Available at: https://hutterarchitects.com/what-are-the-4-elements-of-a-sustainable-building/

Nduka, D. O., & Ogunsanmi, E. O. (2018). Energy-efficient building practices in Nigeria: Barriers and recommendations. *Energy Policy*, 123, 39-46.

Obi, L., &Okonkwo, V. (2018). Sustainable Urbanization and Environmental Challenges in Nigeria: A Case Study of Port Harcourt Metropolis. *Journal of Sustainable Development in Africa,* 20(2), 24-41.

Ogunbiyi, O., Goulding, J. S., &Oladapo, A. (2019). Construction waste management practices in Nigeria: Drivers and barriers. *Waste Management & Research,* 37(4), 342-354.

Olaniyan, O. S., & Olatunde, S. F. (2019). Eco-friendly building materials in Nigeria: A review. *International Journal of Environment and Sustainability*, 8(1), 12-21.

Olotuah A., Oluwatayo A. & Ede A. (2019). The Role of Architects in Sustainable Building in Nigeria. *International Journal of Engineering Research & Technology,* 8(3), 327-334.

Oluwagbemi, O. O. (2020). Sustainable Construction Practice in the Nigerian Building Industry: Challenges and Prospects. *International Journal of Building Pathology and Adaptation,* 38(1), 68-84.

Oluwatayo, A. A., & Amole, D. (2020). Education and awareness in promoting sustainable construction practices in Nigeria. *Sustainability,* 12(15), 6005.

Oni, A. O., Ede, A. N., & Opoko, A. P. (2019). Barriers to the Adoption of Sustainable Construction Practices by Nigerian Quantity Surveyors. *Journal of Engineering, Design and Technology*, 17(4), 803-821.

Samuel N. (2024) 9 best sustainable architecture design ideas available at: https: //foyr.com/learn/sustainable-architecture/

Sharma, N. (2020). What are the reasons of Building Collapse? Available at: https: //theconstructor.org/question/what-are-the-reasons-of-building-collapse

Snaptrude (2021) simple guide to architectural concepts for the architectural students available at:https://www.snaptrude.com/blog/simple-guide-to-architectural-concepts-for-the-architecture-student

Tobias M. (2024) Elements of sustainable architecture available at: https://www.ny-engineers.com/blog/elements-of-sustainable-architecture.

Udeh, K. A., & Aduwo, E. B. (2019). Sustainable Building: A Review of Policies, Initiatives and Certification Systems in Nigeria. *International Journal of Civil Engineering and Technology*, 10(1), 141-151.

Usanga, P. S. (2023). Tropical Kitchen Construction: Assessing the Prospects and Challenges. *Journal of Architectural Design.* 24: 12-23.

Usanga, P. S. (2024). Architectural Specification and Thermal Comfort in Residential Bungalows. *The artist journal* (taj). (7)1: 72-81.

Usanga, P. S. (2024). Cracks in walls: investigating the causes and remedies for building sustainability in our society. *Journal of Engineering, Mechanics and Modern Architecture*. 3(1): 34-43.

Usanga, P. S. (2024). Optimization of the relationship between the architect's designed building and the adjoining landscape. *The artist journal* (taj). (7)1: 66-71.

Webdura (2024) sustainable apartments: top key components of sustainable architecture for apartments available at: https://www.confident-group.com/blog/sustainable-apartments/