ASSESSING THE SUSTAINABILITY OF TRADITIONAL ARCHITECTURE IN NIGERIA: INSIGHTS FROM IGALA TRADITIONAL BUILDING PRACTICES

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ABSTRACT

Nigeria's rich cultural diversity is reflected in its different traditional building practices, each representing a unique cultural identity. However, modernization poses significant challenges to these traditional building practices. Contemporary architectural practices in Nigeria often neglect the local traditions and conditions that historically shaped building design and construction, particularly failing to consider crucial factors such as local culture, environment, and climate. This research focuses on the architectural heritage of the Igala people, with particular emphasis on their sustainable building practices. The study aims to examine the features and values inherent in Igala traditional building practices, and seeks to promote their preservation and integration in contemporary Nigerian architecture. The research employed narrative research approach, incorporating archival and historical data, field surveys, and interviews with local building professionals, traditional elders, and environmental experts. Data analysis was conducted through thematic content and descriptive analysis. The findings revealed key aspects of Igala indigenous building practices, including the use of courtyard layouts, hierarchical spatial configurations, organic growth patterns, and specialized food storage facilities. These features reflect a deep integration of socio-economic and socio-cultural functions. The research highlights how these traditional features contribute to sustainability by emphasizing valuable aspects such as security, privacy, communal living, cultural identity, energy efficiency, resource conservation, rainwater harvesting, passive solar design, and environmental conservation. The study underscores the importance of preserving these traditional building practices, not only to preserve cultural heritage but also to promote sustainable architectural practices in Nigeria by integrating indigenous knowledge into modern building design and construction.

Keywords: Sustainability, Igala, Traditional Architecture, Culture, Building Practices

1.0 INTRODUCTION

The concentration of economic activities and population in urban areas significantly impacts the environment. The construction industry, in particular, is responsible for high energy consumption and the emission of substantial amounts of toxic waste, contributing to global warming and climate change (Balaban and Oliveira, 2017). This climate crisis introduces challenges such as extreme weather conditions, rising sea levels, and heat waves to the built environment. Buildings, as the largest human-made structures, are major contributors to carbon emissions and account for 40% of total global energy consumption (Sandanayake et al., 2022; Luo et al., 2022). Consequently, reducing the life cycle carbon emissions and energy consumption of buildings is essential to mitigating environmental, economic, and social impacts and achieving sustainable development goals (SDGs).

Nature plays a vital role in sustainability by enabling efficient designs that generate minimal waste. In response to rising global warming, along with the high cost and limited availability of fossil fuels, it has become essential to adjust energy consumption in buildings and prioritize the use of natural resources (Kiasif and Tas, 2023). For example, traditional earth buildings emit fewer greenhouse gases, consume less energy, and maintain high internal thermal comfort, even in the face of intense exterior solar radiation. Sustainable housing development can be realized through collaboration among building professionals to create green buildings that are designed, constructed, renovated, operated, or repurposed in an environmentally responsible and resource-efficient manner. Green architecture focuses on integrating buildings into both local ecosystems and the global environment. This practice enhances energy efficiency while minimizing the impact of buildings on human health and the environment by implementing improved planning, design, construction, operation, and maintenance strategies (Wang et al., 2018).

In tropical countries like Nigeria, where solar radiation is intense, contemporary building designs are often influenced by concepts and practices imported from Western cultures. This has led to the development of architectural forms that frequently neglect critical environmental factors. As a result, many residential buildings are compact and airtight, relying heavily on mechanical systems and electricity to create comfortable indoor environments. Consequently, air-conditioners have become the standard solution for achieving thermal comfort during the day in such enclosed spaces (Uzuegbunam et al., 2018). Sadly, maintaining a conducive indoor environment through active

measures is hindered by frequent electricity outages and exacerbated by costly and scarce fuel supplies for private generators (Emusa and Idakwoji, 2023).

Therefore, this study aims to assess the sustainability of traditional architecture in Nigeria with specific focus on the distinctive features and imperatives of the Igala traditional building practices. The study seeks to examine how these indigenous architectural practices can inform and enhance the sustainability of contemporary architecture in Nigeria, contributing to more environmentally responsive and culturally relevant building designs. The objectives of the study are to: (i) identify the Igala traditional building pattern and technology; (ii) identify the Igala traditional building materials; and (iii) examine the key values of the Igala traditional building practices.

2.0 LITERATURE REVIEW

2.1 The Study Area

This study focuses on Igala land, situated in Kogi State, North Central Nigeria. The region's boundaries lie between latitudes 6°30' and 8°40' N and longitudes 6°30' and 7°40' E, covering approximately 13,665 km². Demographically, the Igala community boasts an estimated 1.5 million inhabitants, according to the 2006 National Population Census. They occupy nine Local Government Areas (LGAs) out of the 21 LGAs in Kogi State, specifically: Ankpa, Bassa, Dekina, Ibaji, Idah, Igalamela-Odolu, Olamaboro, Omala, and Ofu (Fig. 1) (Owoicho et al., 2024).

Fig. 1 Map of Kogi State Showing the Local Government Areas Occupied by the Igala People. Source: Owoicho et al. (2024)

2.2 Sustainability of African Traditional Architecture

African traditional architecture, rooted in rural culture, was shaped by practical decisions influenced by sustainability factors such as social, economic, climatic, and environmental considerations, as well as energy efficiency (Emusa and Idakwoji, 2023). This emphasis on sustainability is not unique to African traditional architecture, as research has shown that traditional buildings globally have stronger environmental ties compared to modern ones (Esin and Yüksek, 2008). For instance, traditional Turkish architecture reflects the region's cultural heritage, with designs shaped by environmental factors to create a balance with the surroundings (Hidayatun et al., 2015).

The sustainable design elements of traditional architecture are achieved through the use of local materials and techniques, fostering a harmonious connection between people and their environment. Specifically, African traditional architecture exemplifies this sustainability approach. It adapts to the cultural needs of the people, employing locally available materials such as earth, timber, straw, stone, and thatch to construct simple yet functional dwellings (Onyegiri and Ugochukwu, 2016). By leveraging these natural resources, African traditional architecture seamlessly integrates cultural, social, and environmental considerations.

Without relying on modern Western technological innovations, African traditional architecture has demonstrated exceptional architectural advantage by effectively addressing thermal comfort, aesthetics, and sustainability. Constructed from abundant natural materials, these structures are gaining recognition for their viability in modern applications, with earth increasingly accepted as a suitable material for contemporary buildings. Africa's rich architectural heritage, spanning over 5,000 years, boasts notable examples such as the ancient cities of Kano and Zaria in Nigeria. These enduring structures showcase affordability, comfort, and environmental harmony, having stood the test of time for centuries. Central to African traditional architecture are earth-based materials like adobe bricks, mud, and earth, often complemented by locally sourced timber, palm trunks, thatch, and straw. These readily available resources have been sustainably utilized across African settlements, preserving ecological balance and supporting agrarian lifestyles (Onyegiri and Ugochukwu, 2016).

3.0 METHODOLOGY

3.1 Research Design

This study employed a mixed-method research design, incorporating both quantitative and qualitative research methods. The research approaches utilized include Archival/Historical Research, Structured Questionnaire, Physical Observation and Focus Group Interview.

3.2 Sampling Technique

The study area included all nine local government areas of Kogi State occupied by the Igala people. A purposive sampling approach selected 450 traditional compounds. Questionnaires were distributed resulting in 386 valid responses which represent 85.8% response rate.

3.3 Method of Data Analysis

The collected data was analyzed to identify sustainable practices in building techniques and materials as well as their significance. Interview data underwent thematic analysis, highlighting patterns and correlating them with structured classifications from the surveys. The findings were synthesized into a narrative, integrating the historical context, cultural significance, and building practices, with a focus on sustainability.

4.0 DATA PRESENTATION AND ANALYSIS

4.1 Igala Traditional Building Practices

The circular curvilinear building pattern represents the Igala traditional building pattern. The houses were constructed with circular plans, mud walls, and thatched roofs covering wooden supports or mud domes, and sometimes wattle and daub walls. The buildings stood independently, and typically enclosed a courtyard that housed a reception house natively known as ‘atakpa’. The courtyard operates as the heart of the compound, linking all the spaces and activities. The courtyard, along with the reception house, played a crucial role in the socio-cultural and socio-economic life of the immediate compound and the general community. Shrines were also incorporated into the compound to facilitate religious practices. The Igala traditional building practice is predetermined by tradition, the builders’ knowledge according to the culture of the people and the building materials available. This study identified the Igala traditional building techniques adopted in the construction of various elements of the Igala traditional homestead.

4.1.1 Foundation Construction

In Igala traditional architecture, foundations were constructed by digging shallow trenches (250-400 mm deep, 450 mm wide) along planned wall positions, relying on the natural load-bearing soil. Laterite earth was puddled and compacted into the trenches to form the footing for the wall. This eco-friendly approach, using locally sourced clay and conserving energy, reflects sustainable building practice in Igala building tradition.

4.1.2 Wall Construction

The Igala people used two methods for wall construction: wattle and daub, and monolithic wet wall construction. In the wattle and daub technique, vertical posts and sticks, secured with natural fibers, formed a sturdy framework covered in mud. The monolithic method involved creating walls from kneaded mud (called 'otubęli') mixed with water, clay, straw, and sedimentary rock. For multi-story structures like the old ‘odogo’ in the Attah Igala Palace in Idah, mud mixed with palm oil provided weather resistance. These eco-friendly techniques promoted durability, distributed structural forces evenly, and minimized environmental impact by using renewable materials.

4.1.3 Floor Construction

Igala traditional floors were constructed from compacted anthill mud, firmly rammed with wooden beaters or palm fronds for strength and water resistance. Floors were elevated 50 cm above ground level, and finishes included palm oil, cow dung, or ashes for smoothness and sheen. This method produced durable, cement-like floors capable of withstanding pressure. The technique reflects a deep understanding of local materials, offering a simple and cost-effective construction solution.

4.1.4 Lintels

Lintels in Igala traditional buildings were made from timber or bamboo. Timber posts were used for monolithic mud constructions, while bamboo stems reinforced wattle and daub walls, sometimes with timber posts. These materials reflect the Igala people's understanding of sustainable building practices, utilizing timber and bamboo for eco-friendly and effective construction.

4.1.5 Ceiling, Window and Door

Igala traditional buildings often omitted ceilings due to low headroom and the heat-insulating properties of thatch roofs. When ceilings were used, they were constructed with crisscrossed bamboo or date palm joists, covered with natural materials like 'ichala' (long stem grass), 'adugbo'

(millet or guinea corn stems), or 'uloko' (woven mats). These materials provided insulation and aesthetic appeal. Ceilings were often used as platforms for storing food and utensils. Doors and windows were small and limited in number, and occupants had to stoop to enter through the door which had low height, a design that regulated indoor temperature by minimizing solar radiation. This aligns with studies indicating that larger windows increase indoor temperatures (Liangdong et al., 2015). In addition, the use of small windows reflected cultural beliefs, offering protection from malevolent spirits, emphasizing the integration of climate awareness and cultural practices in Igala architecture.

4.1.6 Roof Construction

Roof construction began after the walls were completed. The roof's skeletal framework was made from bamboo stems, timber sticks, and palm frond midribs, with conical hipped roofs covered in thatch. The roof truss included wall plates, tie-beams, king posts, purlins, and sometimes struts. Roofs were supported by four strategically placed timber posts and fastened together with ropes made of palm frond fibre. For larger roofs, a central wooden pillar was used for support. The thatched layers were not only functional in terms of heat regulation but also decorative, enhancing the aesthetic appeal of the structure.

4.1.7 Plastering/Painting

Plastering was done using thin earth covering, which was regularly replaced. To improve strength and durability, materials like animal dung, which deterred pests such as jiggers, and palm oil production waste water were added. Decorative patterns were created on the walls using sweeping arm movements, and later, color pigments from substances like chalk, camwood, and indigo were used for painting. This method was largely cost-efficient and environmentally friendly.

4.1.8 Decoration and Ornamentation

Decorative elements were carefully placed, particularly at high-stress points like door and window lintels. Entrances, seen as transitional spaces, were especially adorned to create a lasting impression. Interior spaces, including floors and walls, also received decorative attention, with woven mats commonly used on floors. Decoration was seamlessly integrated with finishes, using materials like pebbles and wood ash pressed into wet mud or plaster. While the Igala people did not have specific cultural motifs, their artisans blended functional and aesthetic elements to create a unique architectural identity, reflecting creativity and cultural significance.

4.1.9 Maintenance

Proactive maintenance was crucial in Igala traditional building practice due to the low durability of local materials. Regular upkeep included patching cracks in walls and floors with mud or red earth, washing and polishing floors, and replacing roof coverings after each rainy season. Fence materials were also refreshed periodically, with maintenance tasks scheduled around the rainy seasons. This diligent practice reflects the Igala people's sustainable approach to preserving the longevity and functionality of their buildings.

4.2 Igala Traditional Building Materials

4.2.1 Earth / Mud (Ikẹtẹ)

In Igala land, clay or laterite soil is the most abundant local building material. It is prepared by digging, mixing with water, and puddling to create mud, known locally as 'ikẹtẹ,' which is commonly used for walls and is available even from poor agricultural soil. The best quality results from a mix of clay, sand and sedimentary aggregates, with clay enhancing strength and plasticity. Mud is versatile, allowing for various shapes and structures, including rectilinear and curvilinear forms. When stabilized and maintained, it is durable and regulates indoor temperature, contributing to thermal comfort. From a hygrothermal perspective, raw earth acts as a thermal and humidity regulator, mitigating heat waves and stabilizing indoor humidity more effectively than other materials. Historically, interiors made from raw earth have been described as 'cool in summer and warm in winter', reflecting the material's ability to maintain comfortable living conditions through its unique thermal and hygrometric properties.

4.2.2 Vegetable Fibre / Bush Twine (Rope) (Ikwu)

The mid-stems of palm fronds were cut and stripped of leaves to create stiff, coarse fibers used as ropes for tying frameworks. While these fibers can withstand tensile stress, they may become brittle if left exposed for too long. Bush twines served as alternative binding materials. Vegetable-based building materials are considered reusable, biodegradable, and ozone-friendly, highlighting their sustainability in traditional building practices.

4.2.3 Timber (Oli)

Igala land has a rich rainforest that provides various types of timber for construction, with Iroko and Mahogany being abundant and strong choices for beams and posts in traditional buildings.

These timbers serve essential roles as columns and fork posts, which support the roof framework and transmit loads to the ground. Fork posts typically measure around ten centimeters in diameter, with gable roof carriers being taller, while their height varies depending on the roof slope. A study by Abimaje and Baba (2014) comparing the environmental impact of timber to other building materials found that rough sawn timber requires only 750 MJ/m³ of fossil fuel, compared to 266,000 MJ/m³ for steel, 4,800 MJ/m³ for concrete, and 1,100,000 MJ/m³ for aluminum. The burning of fossil fuels releases harmful greenhouse gases, negatively impacting the environment. This study highlights timber's lower fossil fuel requirements for manufacturing, making it a more environmentally friendly and sustainable building material.

4.2.4 Bamboo Stem (Ọtachọ)

The thick vegetation of the guinea savannah provides Igala land with abundant bamboo, which is commonly used in its natural state as longitudinally split strips, halved culms, or solid culms. In Igala traditional building construction, bamboo is primarily utilized for wall and roof frames, as well as general structural frameworks. Its strength, resilience, and lightweight properties enable it to bear both dead and live loads, making it suitable for various weather conditions. Vertical strips of bamboo are placed between horizontal framing members to complete the walls, providing protection against weather and animals, ensuring privacy, and enhancing the overall stability of the building against horizontal forces. The bamboo roof structure includes purlins, rafters, and struts. A study by (Auwalu and Dickson, 2019) encouraged the use of bamboo as a sustainable building material in Nigeria due to its environmental sustainability, aesthetic qualities, workability, and cost-effectiveness. Its versatility allows it to be used in foundations, floors, walls, partitions, doors, windows, scaffolding, trusses, roofing, and even in disaster mitigation and bridge construction.

4.2.5 Grass (Egbe)

The primary thatching material used in Igala traditional roof construction is pill-grass (Imperata cylindrica), locally known as iwọ. This long-growing grass thrives in the fine humus soil of Nigeria's guinea savannah, reaching heights of 0.6 to 3 meters. The leaves, which are about 2 centimeters wide at the base and narrow towards the top, have finely toothed edges and are tipped with sharp silica crystals. Pill grass is valued for providing effective roof coverage and enhancing indoor thermal comfort in Igala traditional buildings. Studies indicate that thatch is the most

environmentally friendly roofing option. A comparative analysis of the embodied energy of various materials, including galvanized steel, thatch, and concrete tiles by (Snell, 2004) revealed that thatched roofs require only 398.55 million joules of energy, whereas galvanized sheet metal needs 26,790.46 million joules and concrete tiles require 9,478.76 million joules. This makes thatched roofs the most sustainable choice based on environmental impact assessments.

4.2.6 Palm Frond (**Im'ękpę**)

Igala land is rich in palm trees, which are a primary source of local building materials. Palm fronds are utilized in various construction aspects: the leaves are used for thatching, while the midribs, after the leaves are removed, serve as rafters in roofing. These midribs are key materials in both wall and roof construction, where they can be split and used as crossbars and purlins. Palm fronds share similar characteristics with thatch regarding embodied energy and are readily available, reusable, biodegradable, and ozone-friendly. This makes palm frond a sustainable traditional building material, reinforcing their integral role in Igala architecture.

5.0 KEY VALUES OF THE IGALA TRADITIONAL BUILDING PRACTICES

5.1 Cultural Identity

Igala traditional mud houses, reminiscent of cave shelters, are organized to reflect the community's activities and cultural identity. Through a process of trial and error, the Igala people developed their building technology, utilizing locally abundant materials to create a unique and culturally rich architectural style. This housing pattern is seamlessly integrated into the traditional Igala village layout, with the 'Ceremonial Square', just like the courtyard, serving as a socio-cultural hub for various social and ceremonial events.

5.2 Spatial Organization and Cultural Hierarchy

The traditional building practice of the Igala people is structured around the principle of zoning, encompassing three major zones:

1. **Domestic Zone**: This area includes the dwelling space for leisure activities such as sleeping and resting, along with functional areas for domestic tasks like cooking preparation (obuka), waste disposal (ojęta), and open defecation (ugwęręchę).
2. **Socio-Cultural Zone**: This zone comprises the courtyard, reception house, and shrine, which serve as venues for socio-cultural and religious activities. These spaces are used for gatherings, ceremonies, plays, chores, and worship, highlighting the community's rich cultural practices.

3. Socio-Economic Zone: This area includes the animals' pen, garden, and barns, dedicated to essential activities such as food crop storage, gardening, and animal husbandry. Furthermore, the spatial arrangement of individual houses reflects the cultural roles and responsibilities within the family. The man’s house, situated at the entrance of the compound, symbolizes his protective role and authority over the family. The wives' and females' houses are positioned on either side of the man’s house, while the males' houses are located at the rear. This configuration allows adult sons to access farmland easily through the rear exit, while the women are securely positioned between their husband and male children. By adhering to these zoning principles, the Igala traditional building pattern efficiently organizes and optimizes space within the compound, accommodating diverse aspects of daily life and cultural practice.

5.3 Communalism and Organic Expansion

The Igala traditional building practice promotes organic growth, accommodating family expansion through axial and radial arrangements of houses. Extended families live together in one compound, reflecting communal association, crucial in Igala society. In an agrarian context, a man's economic status is linked to the number of wives and children, as this increases farming manpower. As families grow, compounds expand, and intergenerational living arrangements support strong familial ties. New houses are built as needed, allowing for flexibility and dynamic growth within the Igala community.

5.4 Security and Privacy

The Igala traditional compound is surrounded by a perimeter fence, with the man's house positioned to control visitor access. This fence enhances privacy for family members, with guests received only in the reception house. To further ensure security and privacy, the windows and doors of Igala houses are intentionally small, reflecting the community's belief in the presence of malevolent spirits at night.

5.5 Spiritual Symbolism

The Igala man is deeply religious, viewing his deity as a mediator with ancestors, offering protection and guidance. The deity is central to family affairs and moral values, making shrines integral to Igala traditional housing. However, with the rise of religious pluralism in Nigeria and the acceptance of foreign religions, the significance of these shrines has waned. Many Igala people now feel disconnected from their ancestral practices, relying on foreign religions.

5.6 Environmental Adaptation

Igala traditional building materials and construction techniques prioritize sustainability and environmental friendliness. Key elements include mud walls, mud floors, timber posts, bamboo struts, and thatch roofs. Interior furnishings often consist of bamboo frame beds and clay water pots. These materials are abundant, economically viable, reusable, biodegradable, flexible and easy to maintain, ensuring that the buildings are well-adapted to the local climate and contribute to environmental sustainability.

5.7 Rainwater Harvesting and Water Storage

During the colonial period, the introduction of corrugated roofing sheets, which replaced traditional thatch on rectangular earth buildings, prompted the construction of impluviums in courtyards. These impluviums functioned as rainwater harvesting systems, collecting and storing rainwater from the corrugated iron roofs. To supplement rooftop runoff, water was also sourced from nearby streams and stored in impluviums, iron drums, and clay pots. An impluvium typically consisted of a deep pit, approximately 3-4 meters deep and 3 meters in diameter, constructed using sandcrete blocks and concrete. Dug into the earth, these structures provided an alternative source of water for domestic use, enhancing water security in colonial-era households among the Igala people.

6.0 CONCLUSION AND RECOMMENDATIONS

The study on sustainable practices in Igala traditional architecture highlights the sustainability of the circular curvilinear building pattern. The Igala traditional housing embodies essential features and values that reflect sustainable building practices. Preserving this architectural heritage is vital for ensuring sustainability for future generations. By understanding and assimilating the principles entrenched in Igala traditional building practices, we can harness the wealth of knowledge accumulated over generations. This knowledge is crucial for informing contemporary architectural practices, allowing us to create spaces that are functional, culturally relevant, and sustainable.

Therefore, it is imperative to continue studying and documenting traditional building practices in Nigeria. This research serves as a bridge between the past and present, preserving the invaluable wisdom of our ancestors. By integrating these traditional practices into modern architecture, we can promote a harmonious coexistence between tradition and innovation. This synthesis enriches our cultural heritage and paves the way for sustainable architectural practices, ensuring a legacy

for future generations. In doing so, we contribute not only to the preservation of architectural heritage in Nigeria but also to the creation of a sustainable future grounded in the foundations of our past.

REFERENCES

Abimaje, J. & Baba, A. N. (2014). An Assessment of Timber as a Sustainable Building Material in Nigeria, *International Journal of Civil Engineering, Construction and Estate Management*. 1(2), 39-46.

Auwalu, F. K. & Dickson, P. D. (2019). Bamboo as a Sustainable Material for Building Construction in Nigeria. *Civil and Environmental Research*, 11(8), 30-36.

Balaban, O. & Puppim de Oliveira, J.A. (2017). Sustainable Buildings for Healthier Cities: Assessing the Co-Benefits of Green Buildings in Japan. *J. Clean. Prod*., 163, S68–S78.

Emusa, H. & Idakwoji, W. A. (2023). Sustainability of Traditional Building Practices in Nigeria: The Case of Igala Traditional Architecture. *International Journal of Science and Research Archive*, 10(02), 041–055.

Esin, T., & Yüksek, İ. (2008). A Study on Ecological Properties of Building Materials Used in Traditional Buildings (in Turkey). *Facilities*, 26 (5/6), 229-241.

Hidayatun M. I., Prijotomo J. & Rachmawati M. (2015). Sustainability as Important Part of the Identity in the Dimension of Regionalism Architecture. *Applied Mechanics and Materials*. 747:145-148. Doi: 10.4028/www. scientific.net/amm.747.145.

Kiasif, G. C. & Taş, Y. D. (2023). The Effect of the Construction Industry on Global Warming and Solution Suggestions. Paper presented at the 11th Global Conference on Global Warming, Istanbul, Turkey.

Liangdong, M., Nina S., Jili Z. & Tianyi Z. (2015). The Influence of Doors and Windows on the Indoor Temperature in Rural House. *Procedia Engineering*, 121, 621 – 627.

Luo,W., Sandanayake, M., Hou, L., Tan, Y. & Zhang, G. A. (2022). Systematic Review of Green Construction Research Using Scientometrics Methods. *J. Clean. Prod*., 366, 132710.

Onyegiri, I. & Ugochukwu, I. B. (2016). Traditional Building Materials as a Sustainable Resource and Material for Low Cost Housing in Nigeria: Advantages, Challenges and the Way Forward. *Int'l Journal of Research in Chemical, Metallurgical and Civil Eng*. 3(2), 248-249.

Owoicho, B. C., Idakwoji, W. A, Audu, J. D. & Emusa, H. (2024). Cultural Influence on Architectural Evolution in Nigeria: A Case Study of Igala Indigenous Homestead. *World Journal of Advanced Research and Reviews*, 21(01), 1325–1343.

Sandanayake, M., Zhang, G. & Setunge, S. (2022). Impediments Affecting a Comprehensive Emission Assessment at the Construction Stage of a Building. *Int. J. Constr. Manag*., 22, 453–463.

Snell, C. (2004) *The Good House Book: A Common-sense Guide to Alternative Homebuilding*. New York: Lark Books.

Uzuegbunam, F. O., Ezezue, A. M., & Nwalusi, D. M (2018). *Evaluation of the indoor air quality of residential buildings in the hot-humid tropical environment of Enugu. Nigeria*: Pushba Publishing House.

Wang, H., Chiang, P. C., Cai, Y., Li, C., Wang, X., Chen, T.L., et al. (2018). Application of Wall and Insulation Materials on Green Building: A Review. *Sustainability*, 10, 3331.