



Exploring the Sustainable Use of Wood and Brick in Institutional Buildings in Nigeria

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ABSTRACT

The construction industry is a major contributor to environmental degradation, with conventional materials like concrete and steel accounting for nearly 40% of energy-related CO₂ emissions. While sustainable alternatives such as wood and brick offer significant environmental benefits, their application within the Nigerian institutional building sector remains marginal. This study employs a systematic literature review (SLR) of 25 scholarly publications (2015–2025) to evaluate the environmental, structural, and economic feasibility of integrating wood and brick into Nigeria's public infrastructure. The findings indicate that engineered timber and stabilized earth bricks significantly reduce a building's carbon footprint through sequestration and lower embodied energy. Technically, the study highlights that fast-growing tropical wood species can be successfully engineered for multi-story construction, while the high thermal mass of brick improves indoor comfort in Nigeria's hot-humid climate. Economically, earth-based materials offer a data-proven cost advantage over sandcrete blocks. However, widespread adoption is hindered by technical knowledge gaps among professionals, negative cultural perceptions regarding material prestige, and a lack of standardized building codes. The study concludes that transitioning to these materials requires a shift in public procurement policy, specialized professional training, and the establishment of local material standards to ensure long-term structural and environmental sustainability in Nigeria's built environment.

Keywords: Brick masonry, Institutional buildings, Sustainable building materials, Sustainable construction, Wood construction.

INTRODUCTION

The built environment plays a critical role in global environmental sustainability, accounting for a substantial share of energy consumption, resource depletion, and greenhouse gas emissions. The construction and operation of buildings contribute significantly to global carbon emissions, with the sector responsible for nearly 40% of energy-related CO₂ emissions worldwide (IEA, 2020). Cement production alone contributes approximately 7–8% of global carbon dioxide emissions due to energy-intensive manufacturing processes and clinker production (Scrivener, John, & Gartner, 2018). As global climate targets become increasingly ambitious, the need to transition toward low-carbon construction materials has become urgent. In response to these environmental concerns, research has increasingly focused on renewable and low-embodied-energy materials such as timber and earth-based products. Engineered wood, such as Cross-Laminated Timber (CLT), has emerged as a formidable alternative to conventional concrete and steel due to its capacity for carbon sequestration and lower lifecycle emissions (Chen, Pierobon, Jones, Maples, Gong, & Ganguly, 2022). Comparative life cycle assessment (LCA) studies demonstrate that timber-based structures can significantly reduce embodied carbon compared to reinforced concrete buildings (Rinne, Ilgin, & Karjalainen, 2022).

Similarly, brick and earth-based construction systems have been identified as environmentally beneficial alternatives in both developed and developing contexts. Stabilized earth blocks, compressed interlocking earth blocks, and clay bricks are characterized by lower embodied energy, local material sourcing, reduced transportation impacts, and improved thermal mass performance in hot climates (Obianyo et al., 2021). In urban centers like Lagos, this reliance on heat-retaining materials contributes to the Urban Heat Island (UHI) effect, highlighting the need for sustainable facades and materials that can mitigate urban heat and improve microclimates (Afolabi, Ibitoye, Kalu, & Olaoye, 2025). Beyond

environmental performance, the adoption of sustainable materials like wood and brick is deeply intertwined with the socio-cultural fabric of Nigerian architecture. The form and meaning of buildings in Nigeria are often influenced by liturgical and cultural practices, which dictate material preferences and architectural expression (Olaoye, Iweka, Adejumo, & Ajayi, 2023). However, the transition to sustainable materials is also a matter of governance; the effectiveness of administrative frameworks and voluntary compliance within the state internal revenue and regulatory services plays a secondary but vital role in how new building standards and sustainable practices are enforced (Adesemowo, Dada, & Adegbe 2022). While numerous studies have investigated sustainable building materials in Nigeria, the majority focus on low-cost residential housing. There remains a limited synthesis of research specifically examining the environmental performance, lifecycle implications, and adoption barriers of wood and brick in institutional building contexts. Given Nigeria's rapid population growth and the corresponding demand for public infrastructure (Nations, 2019; National Bureau of Statistics, 2022), evaluating material pathways that balance environmental performance with contextual feasibility is critical. This study aim to explore the sustainable use of wood and brick in institutional buildings in Nigeria and assess their potential to enhance environmental performance, energy efficiency, and resource optimization.

The objectives of the study are to;

- i. To investigate the current extent of wood and brick usage in institutional buildings in Nigeria.
- ii. To evaluate the sustainability benefits and limitations of these materials compared to conventional alternatives.
- iii. To assess the lifecycle performance of wood and brick in Nigeria's climatic and environmental context.

LITERATURE REVIEW

Sustainable Building Materials in the Construction Sector

The construction industry is widely recognized as one of the most resource-intensive sectors globally, consuming significant quantities of raw materials and energy while contributing substantially to greenhouse gas emissions. Building materials such as cement, steel, and concrete dominate modern construction but are associated with high embodied energy and environmental impacts (Scrivener et al., 2018). Consequently, sustainable building materials are generally defined as materials that minimize environmental impacts throughout their lifecycle, from extraction and processing to construction, operation, and disposal (Kibert, 2016). These materials are often considered environmentally beneficial due to their lower embodied carbon, renewability, and potential for local sourcing. The adoption of such materials is particularly relevant in developing countries where locally available resources can reduce construction costs and transportation impacts (Obianyo et al., 2021). Studies on life-cycle assessment (LCA) have demonstrated that structural material choices significantly influence the environmental impact of buildings, especially during the construction phase (Rinne, Ilgin, & Hameed, 2022). Consequently, researchers and policymakers are increasingly encouraging the use of renewable and low-carbon building materials in both residential and institutional buildings.

Sustainability Potential of Wood in Building Construction

Wood has been widely identified as one of the most sustainable structural ue to its carbon sequestration capacity; it stores atmospheric carbon during growth, effectively acting as a carbon sink when integrated into buildings. Advancements in engineered wood products, such as Cross-Laminated Timber (CLT), Glulam, and LVL, have revolutionized timber's structural reach, allowing for multi-story institutional construction with enhanced fire resistance and load-bearing capabilities (Fasasi & Ogunmilua, 2024). Recent studies indicate that timber structures can reduce embodied energy by 20–30% compared to steel and concrete systems (Rinne et al., 2022). However, applying these systems in tropical regions like Nigeria presents specific technical hurdles. The risk of biodeterioration and moisture susceptibility necessitates advanced wood preservation techniques to ensure longevity in hot-humid climates (Gabriela Lotufo Oliveira & Brazolin. 2018). Furthermore, while CLT offers passive house benefits, its application in tropical zones must account for specific material risks related to humidity and high temperatures (Strang & Leardini, 2019). Addressing these concerns through improved treatment methods and engineering practices is essential for expanding the use of timber in sustainable building construction.

Brick and Earth-Based Materials in Sustainable Construction

Brick and earth-based masonry materials have historically been used in building construction across many regions of the world. In recent years, these materials have regained attention as sustainable alternatives due to their low embodied energy, thermal performance, and compatibility with local construction practices. These materials utilize locally available laterite soil stabilized with minimal cement, making them far more sustainable than energy-intensive fired bricks or conventional sandcrete blocks (Walker, Heath, Lawrence, & Maskell, 2018).

Beyond structural integrity, the high thermal mass of earth-based materials is a critical advantage in tropical climates. These walls absorb heat during the day and release it at night, naturally regulating indoor temperatures and reducing the reliance on energy-consuming air conditioning systems (Sharma, Kumar, & Verma, 2020). Research conducted in Nigeria has demonstrated the technical feasibility of these bricks, confirming they meet the required compressive strength for durable construction (Alagbe, 2022; Musa, Zannah, Sani, & Lawan, 2021). This characteristic makes brick and earth construction particularly suitable for tropical regions such as Nigeria, where thermal comfort is a major design consideration.

Sustainable Building Materials in Nigeria

In Nigeria, building construction has traditionally relied on sandcrete blocks and reinforced concrete as the primary structural and walling materials. However, the environmental and economic challenges associated with these materials have led researchers to explore alternative building materials that are both affordable and sustainable. Studies in regions like Jos have successfully demonstrated the use of stabilized earth to address housing crises (Daniel, Benjamin, & Tali, 2018). Additionally, the demographic characteristics of housing estates developed with ISSB technology suggest that while the technology is viable, its adoption is often limited by external factors (Ibitoye, Abiola, & Babamboni, 2023). Significant barriers to adoption persist in the Nigerian market. These include technical knowledge gaps among professionals, a lack of standardized building codes, and a pervasive public perception that earth-based materials are "materials for the poor" (Adebayo & Ojo, 2020; Agboola & Odewale, 2022). Design experts highlight that these inhibitors, ranging from supply chain unreliability to regulatory gaps, frequently prevent sustainable materials from being specified in urban housing and institutional projects (Nwaki, Sofolahan, & Eze, 2023; Olusola & Ogunbiyi, 2021). Furthermore, the drivers and barriers for interlocking blocks are often tied to the level of institutional support and professional awareness available in the local industry (Douglas, Makanjuola, & Adegbebo, 2016). Despite these findings, the majority of research on alternative building materials in Nigeria has focused primarily on residential housing. Limited attention has been given to the application of sustainable materials in institutional buildings such as universities, hospitals, and government facilities. Institutional buildings typically require higher structural performance standards, durability considerations, and larger construction scales, which may influence material selection decisions.

Research Gap

Although numerous studies have examined the environmental performance and technical properties of timber and earth-based materials, there remains a lack of comprehensive synthesis focusing specifically on their application in institutional buildings within the Nigerian context. Existing research tends to concentrate on either timber construction in developed countries or earth-based materials for low-cost housing in developing regions. This study addresses this gap by providing a systematic review of how wood and brick can be integrated into the Nigerian institutional sector to balance environmental performance with socio-economic and structural demands.

RESEARCH METHOD

This study adopts a qualitative research approach, utilizing a systematic literature review (SLR) to examine the sustainable integration of wood and brick in Nigerian institutional buildings. A qualitative methodology was deemed appropriate as the study focuses on synthesizing multifaceted environmental performance data, structural feasibility, and socio-cultural adoption barriers rather than generating primary numerical data. A comprehensive review of 20 scholarly articles and technical reports published between 2015 and 2025 was undertaken, with 7 core papers selected for deep thematic analysis based on their specific relevance to life-cycle assessment, tropical wood engineering, and the Nigerian construction context. These sources were accessed through global academic databases, including ScienceDirect and

Scopus, as well as local institutional repositories. By adopting this method, the study ensures a rigorous, evidence-based assessment of sustainable material pathways, drawing on empirical insights and scholarly consensus to situate findings within the unique climatic and regulatory framework of Nigeria.

RESULTS AND DISCUSSION

A total of 25 studies were systematically reviewed, providing a multi-dimensional perspective on the sustainable integration of wood and brick within both global and Nigerian construction sectors. Out of this comprehensive pool, 7 core papers were selected for deep thematic analysis to provide empirical evidence for the findings.

From the reviewed literature, 7 key articles were selected for detailed analysis and are presented in Table 1. The table summarizes the research objectives and key details of each study, including the author(s), year, country, title, and study area. These structure offer critical insights into the environmental, structural, and economic performance of these materials, while further elucidating the socio-regulatory challenges that currently hinder their adoption in Nigerian institutional building projects.

Table 1: Research Findings

S/N	Authors	Year	Country	Paper Title	Study Area
1	Rinne, Ilgin, & Karjalainen.	2022	Finland / Europe	Life cycle assessment of timber structures and their carbon footprint	Timber construction sustainability
2	Tupenaite, Kanapeckiene, Naimaviciene, Kaklauskas, & Gecys	2023	Lithuania / Europe	Timber construction as a solution to climate change: A systematic literature review	Sustainable timber construction
3	Okuda, Corpataux, Muthukrishnan, & Kua	2018	Japan / Tropical Regions	Technical feasibility of tropical wood species for cross-laminated timber (CLT)	Engineered wood products
4	Aghimien, & Aghimien	2015	Nigeria	Assessment of stabilized earth blocks in the Nigerian construction industry	Earth-based building materials
5	Ibitoye, Alagbe, & Dare-Abel	2022	Nigeria	Comparative cost advantages of interlocking stabilized soil blocks and sandcrete blocks	Construction cost analysis
6	Agboola & Odewale.	2022	Nigeria	Perception of alternative building materials in Nigerian institutional construction	Institutional construction sector
7	Onyenokporo & Nduka	2021	Nigeria	Policy and regulatory challenges affecting sustainable construction materials	Sustainable building policy

Environmental Sustainability of Wood and Brick Materials

A primary finding across the literature is the superior carbon profile of timber systems compared to mineral-based materials. Rinne et al. (2022) provide empirical evidence through Life Cycle Assessments

(LCA), demonstrating that timber-based apartment buildings significantly reduce embodied carbon and overall carbon footprints when compared to hybrid or concrete structures. This is further supported by Tupenaite et al. (2023), whose systematic review positions timber construction as a cornerstone solution for climate change mitigation, specifically highlighting its role in long-term carbon sequestration. In the Nigerian context, the environmental benefits extend to earth-based bricks. Aghimien and Aghimien (2015) conduct an empirical assessment of Compressed Stabilized Interlocking Earth Blocks (CSIEB), finding that their production drastically reduces energy consumption compared to conventional sandcrete blocks. By utilizing local laterite and minimal cement, these materials align with global sustainability benchmarks while addressing local resource efficiency.

Structural and Mechanical Performance

The structural viability of wood in large-scale institutional projects is often questioned due to tropical climate risks. However, Okuda et al. (2018) provide technical proof that fast-growing tropical wood species can be successfully engineered into Cross-Laminated Timber (CLT). Their research confirms that with proper processing, these species meet the mechanical requirements for multi-story construction, challenging the notion that high-performance timber is exclusive to temperate regions. Similarly, the structural reliability of earth blocks in Nigeria has been validated. Aghimien and Aghimien (2015) demonstrate that stabilized interlocking blocks provide sufficient compressive strength for load-bearing applications in institutional settings, provided that stabilization techniques are standardized. However, the structural performance of earth-based materials is influenced by factors such as soil composition, stabilization techniques, and production quality. Consequently, proper standardization and quality control are necessary to ensure the reliability of these materials in building construction.

Table 2: Analysis of Research

S/N	Methods Used	Advantages Highlighted	Limitations Identified	Key Findings
1	Life Cycle Assessment (LCA) analysis and comparative carbon footprint modeling	Reduced embodied carbon, carbon sequestration potential, lower lifecycle emissions compared to concrete	Limited applicability in regions without sustainable forestry supply chains	Timber structures significantly reduce lifecycle carbon emissions and contribute to climate change mitigation in the construction sector.
2	Systematic literature review of global studies	Renewable material, carbon storage capacity, reduced environmental impact of buildings	Requires sustainable forest management and improved regulatory frameworks	Timber construction can play a critical role in reducing greenhouse gas emissions in the building sector.
3	Experimental structural testing and material performance analysis	High strength-to-weight ratio, potential for engineered timber construction using tropical species	Durability concerns and the need for treatment against biological degradation	Tropical hardwood species can be technically viable for CLT production with proper processing and treatment.
4	Empirical survey and material performance analysis	Low embodied energy, local material availability, reduced construction cost	Limited public acceptance and lack of technical knowledge	Stabilized earth blocks provide a sustainable alternative to conventional sandcrete blocks in Nigeria.
5	Quantitative cost comparison	Reduced construction cost, lower mortar	Limited awareness among developers and builders	Stabilized soil blocks can significantly reduce building costs compared to sandcrete blocks in Nigeria.

	and field data analysis	requirements, faster construction process		
6	Survey research and perception analysis	Identifies opportunities for sustainable materials adoption	Negative perception toward non-conventional materials and lack of technical expertise	Professional perception and limited technical knowledge remain major barriers to adopting sustainable materials.
7	Policy analysis and regulatory review	Highlights importance of policy support and institutional frameworks	Absence of clear building codes and standards for alternative materials	Regulatory gaps and lack of policy support hinder the adoption of sustainable building materials in Nigeria.

Economic and Cost Benefits

Economic considerations are central to material selection in Nigeria's developing economy. Ibitoye et al. (2022) provide critical data-driven cost comparisons, revealing that Interlocking Stabilized Soil Blocks (ISSB) offer substantial cost advantages over conventional sandcrete blocks. These savings stem from reduced mortar requirements, faster labor cycles, and the elimination of expensive external plastering. Furthermore, Tupenaite et al. (2023) highlight that the prefabrication potential of timber can further drive down costs in the long term by reducing on-site construction timelines. Despite these advantages, the economic viability of timber construction in Nigeria may be influenced by the availability of properly processed timber products and the level of technical expertise required for engineered wood construction.

Barriers to Adoption in Nigeria

Despite technical and economic benefits, adoption remains hampered by human and regulatory factors. Agboola and Odewale (2022) provide primary evidence regarding the perception of these materials in Nigerian institutional projects. Their findings reveal a "prestige gap," where decision-makers often view timber and brick as inferior or temporary compared to the perceived "modernity" of concrete. This is exacerbated by significant policy failures. Onyenokporo and Nduka (2021) identify critical policy gaps and capacity constraints, noting that the absence of specific building codes for timber and earth-based materials creates a legal vacuum. This lack of standardization prevents architects and engineers from confidently specifying sustainable materials in high-stakes public contracts.

Synthesis and Implications

The integration of these findings suggests that while the technical and environmental case for wood and brick is robust (Rinne et al., 2022; Okuda et al., 2018), the Nigerian path to adoption is blocked by a lack of institutional will and regulatory frameworks (Onyenokporo & Nduka, 2021). However, realizing this potential requires improvements in technical knowledge, professional training, and regulatory frameworks. Increased research, demonstration projects, and policy support could help promote the integration of wood and brick materials in the design and construction of institutional buildings such as universities, schools, and public facilities.

Encouraging the use of locally available materials could also contribute to sustainable development goals by reducing construction costs, supporting local industries, and minimizing environmental impacts associated with material production and transportation.

CONCLUSION

This study conducted a systematic review of the sustainable application of wood and brick in institutional buildings, synthesizing data on environmental, structural, and economic performance within the Nigerian context. The findings provide robust evidence that both materials offer significant sustainability advantages over conventional reinforced concrete and sandcrete blocks. Timber, particularly engineered products, serves as a high-performance renewable resource capable of substantial carbon sequestration. Meanwhile, brick and earth-based masonry demonstrate excellence in lowering embodied energy and enhancing thermal regulation, making them ideally suited for Nigeria's tropical climate

Despite these advantages, the transition toward these materials in Nigeria is stalled by the systemic dominance of cement-based construction, a lack of technical expertise, and deep-seated negative cultural perceptions regarding earth-based materials. Furthermore, the existing research gap concerning large-scale institutional projects, as opposed to low-cost housing, remains a barrier to high-impact adoption. Ultimately, while wood and brick possess the technical and environmental credentials to transform Nigerian architecture, realizing this potential requires a shift from fragmented research to coordinated industry and policy action.

RECOMMENDATIONS

Based on the findings of this study, several recommendations are proposed to encourage the sustainable use of wood and brick materials in institutional buildings in Nigeria.

- 1. Development of Building Codes and Standards:** Government agencies and regulatory bodies should develop clear building codes and standards for the use of timber and stabilized earth materials in construction. Standardization would improve confidence among architects, engineers, and developers and ensure the structural safety and durability of these materials.
- 2. Professional Training and Capacity Building:** There is a need to strengthen technical knowledge among built environment professionals regarding sustainable building materials. Universities, professional organizations, and training institutions should incorporate courses and workshops on timber construction, earth-based materials, and sustainable design practices.
- 3. Promotion of Local Material Production:** Encouraging the local production of stabilized bricks and processed timber materials can enhance material availability and reduce construction costs. Supporting local industries involved in sustainable material production would also contribute to economic development and job creation.
- 4. Demonstration Projects for Institutional Buildings:** Pilot projects that incorporate wood and brick materials in institutional buildings should be promoted to demonstrate their feasibility and performance. Such projects could serve as practical examples for architects, policymakers, and developers.
- 5. Increased Research on Sustainable Building Materials:** Further research is needed to explore the long-term durability, structural performance, and environmental benefits of wood and brick materials in the Nigerian context. Future studies should also examine their application in different types of institutional buildings such as educational facilities, administrative buildings, and public infrastructure.

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