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Assessment of Low-Carbon Construction Materials in Achieving Sustainable Hospitality Environments in Lagos State

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ABSTRACT

The increasing demand for environmentally responsible construction practices has amplified global interest in low-carbon materials as a viable pathway toward sustainable development. In Lagos State, where rapid urbanization and a growing hospitality industry significantly contribute to carbon emissions and resource depletion, adopting low-carbon construction materials is critical to improving environmental performance. This study assesses the role and effectiveness of low-carbon construction materials in achieving sustainable hospitality environments within Lagos State. It examines the extent of their application in hotels, resorts, and other hospitality facilities, while evaluating their environmental, economic, and operational benefits. The research employs a qualitative approach supported by secondary data review and stakeholder-based analysis to assess perceptions, adoption barriers, and performance considerations of low-carbon construction materials. Key indicators assessed include embodied carbon levels, thermal performance, energy efficiency, durability, and lifecycle costs. Findings are expected to reveal the current level of awareness and use of low-carbon materials, the operational advantages they offer to hospitality buildings, and the barriers affecting their widespread adoption, such as cost implications, limited local availability, and insufficient policy frameworks. The study highlights the significant potential of low-carbon materials in reducing the carbon footprint of hospitality environments, improving indoor comfort, lowering operational expenses, and supporting sustainable urban development in Lagos State. Ultimately, this research contributes to existing knowledge by providing evidence-based recommendations for policymakers, construction professionals, and hospitality developers seeking to align building practices with global sustainability goals and Nigeria's environmental commitments.

Keywords: *Low-Carbon Construction, Low-Carbon Construction Materials, Sustainability, Hospitality Environments, Lagos State*

INTRODUCTION

The global building and construction sector is a major contributor to greenhouse gas emissions, largely through embodied carbon associated with material production, transportation, and construction processes, as well as operational carbon linked to energy use over building life. Reducing embodied emissions through better material choices is now recognised as a core strategy for climate mitigation in the construction industry (Daramola, Ajayi, & Ayodele, 2025). In rapidly urbanising contexts such as Nigeria, where demand for built infrastructure continues to rise, the environmental impacts of conventional, energy-intensive materials are particularly acute. Lagos State, Nigeria's commercial hub with extensive hospitality development, exemplifies this challenge; its construction growth elevates both resource consumption and carbon emissions in the built environment.

Recent life cycle assessment (LCA) research within the Nigerian construction sector highlights the advantages of sustainable building materials over conventional alternatives. A comprehensive LCA study focused on bamboo, low-carbon concrete, and recycled steel found that bamboo exhibits the lowest environmental impacts across global warming potential, eutrophication, and resource depletion categories, while low-carbon concrete reduces greenhouse gas emissions relative to traditional concrete, and recycled steel supports circular economy goals despite higher energy demands in recycling (Unegbu & Yawas, 2025). These results show that material selection can significantly influence the overall sustainability of building projects in Nigeria. In addition to material emissions, climate resilience and building performance under future climate scenarios are critical. Research on building performance in

Nigeria demonstrates that alternative materials and design strategies, such as passive design, thermal mass, and ventilation optimisation, can improve indoor comfort and lower energy use, underlining the need to pair low-carbon materials with climate-responsive design for sustainable buildings (Alegbe & Mtaver, 2023).

Locally produced sustainable construction materials also show promise. Interlocking Stabilized Soil Blocks (ISSBs), produced from laterite soil and stabilisers, are gaining attention in Nigeria as a lower-carbon alternative to fired clay blocks. They require no energy-intensive firing processes, reduce transportation and materials costs, and can enhance construction affordability and environmental sustainability, although challenges such as moisture performance and market uptake remain (Ibitoye, Abiola, & Babamboni, 2023; Olaleye & Ibitoye, 2023).

The hospitality sector, which includes hotels, resorts, and short-stay accommodations, typically involves high material use, continuous energy demand for cooling and lighting, and frequent renovations, all of which contribute to both embodied and operational emissions. Integrating low-carbon construction materials into hospitality infrastructure in Lagos offers a strategic opportunity to reduce environmental footprint, improve energy performance, and enhance climate resilience. However, findings from systematic reviews of sustainable materials and circular economy practices in Nigerian architecture reveal persistent barriers, including limited supply chains, weak policy frameworks, and low practitioner awareness, that inhibit widespread adoption of sustainable materials in the built environment (Daramola et al., 2025). Given Lagos State's rapid urbanisation, booming hospitality market, and environmental vulnerabilities, there is a pressing need for empirical research that moves beyond material performance modelling to examine stakeholder perceptions, institutional constraints, and practical adoption barriers for low-carbon materials. This study adopts a qualitative approach to explore these issues and generate locally grounded evidence that can inform architects, developers, policymakers, and industry stakeholders, thereby promoting sustainable construction practices that align with climate mitigation, resilient urban growth, and enhanced environmental performance in Lagos hospitality developments.

To address these gaps, the study aims to explore the feasibility and potential of low-carbon construction materials for creating environmentally sustainable hospitality buildings in Lagos State, assessing stakeholders' perceptions and the enabling conditions for adoption. The study pursues the following objectives:

1. To examine stakeholders' perceptions, awareness, and acceptance of low-carbon construction materials in hospitality projects in Lagos State, with emphasis on environmental and operational sustainability affordances; and
2. to identify the key socio-economic, institutional, and regulatory barriers and enablers affecting the adoption of low-carbon construction materials in hospitality developments, referencing documented industry-wide constraints in sustainable construction practices in Nigeria.

Corresponding research questions are:

1. What are the perceptions, awareness levels, and acceptance of low-carbon construction materials among key stakeholders (architects, developers, hotel facility managers, and material suppliers) in hospitality projects in Lagos State?
2. What socio-economic, institutional, and regulatory factors facilitate or hinder the adoption of low-carbon construction materials in hospitality developments in Lagos State?

The assessment of low-carbon construction materials for sustainable hospitality environments in Lagos State is justified on technical, economic, policy, and global-development grounds. Technically, the building sector is a major contributor to global greenhouse-gas emissions, not only through operational energy but increasingly through embodied carbon in materials and construction processes. Recent sectoral reviews and global status reports show that material choice is a decisive lever for near-term emissions reductions in buildings. Addressing embodied carbon and promoting low-carbon alternatives, therefore, directly targets the sector's largest remaining mitigation opportunity. This makes an empirical, context-specific study in Lagos timely: city-scale dynamics, including rapid construction, coastal tropical climate, and dense hospitality development, create a distinct local set of material, thermal-performance, and supply-chain conditions that global averages cannot capture (UN Environment Programme, 2021;

International Energy Agency, 2021). Empirical evidence from Nigeria further underscores the importance of sustainable materials: a recent study on housing estates developed with Interlocking Stabilized Soil Blocks (ISSB) demonstrates that alternative construction technologies can reduce environmental footprints, improve durability, and optimize thermal comfort in tropical contexts (Ibitoye, Abiola, & Babamboni, 2023). Economically and institutionally, multiple studies point to non-technical barriers, such as market availability, procurement practices, cost perceptions, and regulatory gaps, as primary constraints to widespread adoption of low-carbon materials in lower- and middle-income countries. A qualitative, stakeholder-centred assessment in Lagos will therefore surface the practical constraints and enabling conditions that quantitative LCAs alone cannot reveal, producing actionable recommendations for policymakers, material suppliers, and hotel developers (Dixit, 2021; Frontiers in Energy Research, 2023). By focusing on the hospitality sector, a building typology with high operational and renovation demands, the study can also link material choices to lifecycle operational outcomes, including comfort, energy use, and maintenance costs, which matter directly to hotel owners and managers.

From a policy and international-development perspective, the study aligns with several Sustainable Development Goals (SDGs). Promoting low-carbon materials and sustainable construction practices contributes to SDG 11 (Sustainable Cities and Communities) by encouraging resilient, low-impact urban infrastructure, SDG 12 (Responsible Consumption and Production) by advancing more circular, lower-impact material use in construction, and SDG 13 (Climate Action) by contributing to national emissions-reduction pathways and international mitigation commitments. Furthermore, by strengthening local supply chains for sustainable materials and building skills, the study supports SDG 8 (Decent Work and Economic Growth) and SDG 9 (Industry, Innovation and Infrastructure) through capacity building and technology diffusion (UN, 2023; UNEP, 2021). In short, a Lagos-focused study that combines verified material performance evidence with stakeholder perspectives will fill an important empirical gap, supplying locally grounded, policy-relevant knowledge on how low-carbon materials can be adopted in hospitality projects, what barriers must be overcome, and where targeted interventions will produce the greatest impact for both emissions reduction and local development.

This study is significant because it addresses a pressing mitigation opportunity in the built environment: embodied and whole-life carbon arising from construction materials. Recent empirical analyses show that material choice, particularly for high-impact materials such as concrete and steel, dominates the embodied carbon profile of buildings and therefore represents one of the most effective levers for near-term emissions reductions in the construction sector (Anderson, 2020; Hart, 2021). By focusing on low-carbon alternatives in Lagos's hospitality sector, the research will supply locally grounded evidence on how material selection can reduce lifecycle emissions in a high-growth urban context where construction demand is intense (Anderson, 2020). Beyond technical carbon accounting, the study has practical significance for industry decision-making and policy. Systematic reviews and sectoral analyses identify persistent barriers to embodied-carbon reduction, data gaps, fragmented supply chains, and limited uptake pathways, yet also emphasize the role of context-specific research in translating global mitigation strategies into local action (Marzouk, 2022; Amarasinghe, 2024). The qualitative insights this study will generate, from architects, developers, facility managers, and suppliers, are therefore crucial: they will reveal supply-chain, regulatory, and perception barriers that life-cycle models alone cannot capture, and will inform targeted interventions to increase adoption of verified low-carbon materials in Lagos hospitality projects (Marzouk, 2022). The research also contributes to resilience and adaptation discourse by aligning material choices with climatic and operational realities in tropical coastal megacities. The IPCC's mitigation assessment highlights that rapid, systemic decarbonisation of infrastructure, including reducing embodied emissions and improving material efficiency, is essential to meet national and global climate goals (IPCC, 2022). By assessing feasible low-carbon materials in Lagos hospitality buildings, this study provides evidence that can be integrated into regional climate action and construction policies, helping to make sectoral emissions reductions both credible and implementable at city and state levels (IPCC, 2022; Amarasinghe, 2024). Ultimately, the study provides practical benefits to the hospitality industry itself. Hotel owners and operators face lifecycle cost and performance trade-offs; identifying low-carbon materials that also deliver acceptable durability, thermal performance, and maintenance profiles can lower operational costs and reputational risks associated with unsustainable construction. The findings will therefore be directly useful to practitioners seeking cost-effective, lower-carbon options that satisfy

guest comfort and regulatory requirements in Lagos (Hart, 2021; Anderson, 2020; Ibitoye, Abiola, & Babamboni, 2023).

LITERATURE REVIEW

The pursuit of sustainability in the built environment has amplified the focus on low-carbon construction materials as essential levers for reducing embodied carbon, the emissions released over the life cycle of building materials. Embodied carbon represents a growing share of total building emissions, particularly as operational energy performance improves through design and technology interventions. A systematic meta-analysis of embodied carbon in buildings confirms that material choice significantly influences environmental outcomes, with traditional materials like concrete and steel accounting for disproportionately high greenhouse gas emissions relative to alternatives (Minunno, O'Grady, Morrison, & Gruner, 2021). This aligns with global calls for innovations in material science and construction practices to achieve sustainable, low-carbon futures.

In the Nigerian context, life cycle assessment (LCA) research provides empirical evidence on the environmental advantages of alternative materials. Unegbu and Yawas (2025) conducted a comprehensive LCA examining bamboo, recycled steel, and low-carbon concrete within the Nigerian construction industry, revealing that bamboo exhibited the lowest impacts in global warming potential, eutrophication, and resource depletion categories, while low-carbon concrete substantially reduced greenhouse gas emissions compared with conventional concrete. Although recycled steel supported circular economy objectives, its benefits were partially offset by higher energy demands in recycling processes (Unegbu & Yawas, 2025). These findings indicate that strategic material selection, supported by LCA evidence, can guide sustainable construction decisions, especially in regions with high construction demand.

Beyond conventional alternatives, locally available and context-specific materials have attracted scholarly interest. Interlocking Stabilized Soil Blocks (ISSBs), for example, are gaining traction as a sustainable alternative in Nigerian construction due to their reduced embodied energy and carbon footprint. ISSBs are made by compacting stabilized soil without energy-intensive firing, thereby eliminating a major source of emissions associated with traditional fired bricks. The blocks also reduce the demand for wood fuel in brick firing, lowering deforestation pressure and further cutting environmental impacts (Ibitoye, Abiola, & Babamboni, 2023; Ibitoye et al., 2023). These attributes make ISSBs particularly relevant for tropical climates like that of Lagos, where materials that improve thermal comfort and lower construction emissions are desirable.

Material sustainability extends beyond embodied carbon reduction to performance under climate variability. Research on climate-responsive construction in Nigeria underscores the importance of pairing low-carbon materials with appropriate design strategies. Studies on future-ready buildings highlight that tropical regions face rising temperatures and shifting climatic patterns, which necessitate materials and designs that improve thermal resilience and reduce operational energy loads (Alegbe, Mtaver, Kalu, & Chukwuemeka, 2025). While this literature focuses primarily on housing, the underlying principles are transferable to the hospitality sector, where reducing operational energy costs and improving thermal comfort directly affect environmental sustainability and user experience.

Barriers to the adoption of sustainable construction practices in Nigeria have also been documented. A mixed-methods study examining sustainable construction barriers confirms that organisational, financial, and regulatory obstacles complicate the implementation of low-carbon practices. Limited availability of sustainable technologies, stakeholder awareness gaps, and weak regulatory enforcement hinder widespread adoption, even when environmental benefits are clear (Adedeji & King, 2025). These barriers are particularly relevant when assessing hospitality developments in Lagos State, where high upfront costs and supply chain constraints may deter developers from selecting low-carbon alternatives despite their potential long-term benefits.

Complementary research on sustainable concrete solutions, such as fly ash-based mixes, further supports the push toward low-carbon materials. Fly ash partial replacements for ordinary Portland cement (OPC) can reduce CO_2 emissions by up to 50% and offer improved durability properties under certain mix proportions (Unegbu & Yawas, 2025). This aligns with broader findings in the literature that supplementary cementitious materials (SCMs), including fly ash and slag, are effective in lowering the carbon intensity of concrete without compromising performance, making them viable options for large-scale construction projects.

Collectively, these studies demonstrate a growing body of evidence supporting low-carbon materials as viable pathways toward sustainable construction in Nigeria. While global and national research highlights multiple material options and frameworks for assessing environmental impact (Minunno et al., 2021; Unegbu & Yawas, 2025), localised material assessments, such as those involving ISSBs, emphasise the need for contextually appropriate solutions that consider both environmental performance and socio-economic realities. For hospitality environments in Lagos State, these insights suggest that combining low-carbon materials with climate-responsive design and supportive policy incentives can significantly advance sustainability outcomes.

Local Case Study: Green Practices in Lagos Hospitality

An example of sustainable construction in the Nigerian hospitality sector is found in the implementation of green building practices in major Nigerian hotels, which, while not exclusively focused on low-carbon materials, provides insights into material use and environmental performance relevant to your study context. A comparative case analysis of four prominent hotels, Transcorp Hilton Hotel (Abuja), Eko Hotel (Lagos), Sheraton Hotel (Abuja), and Radisson Blu Hotel (Lagos), assessed green strategies such as energy conservation, material use, and indoor environmental quality (Abdullahi et al., 2025). Radisson Blu Hotel was reported to incorporate locally sourced and environmentally conscious construction inputs aimed at improving environmental performance compared with conventional practices (Abdullahi et al., 2025). Although renewable energy systems were not widely adopted, the incorporation of energy-efficient lighting, low-VOC materials, and water conservation technologies indicated progress toward more sustainable hospitality spaces (Abdullahi et al., 2025). This case illustrates how sustainable material use, including local and recycled materials, supports environmental performance in Nigerian hotels and aligns with low-carbon construction goals.

International Case Study: Proximity Hotel (United States)

The Proximity Hotel in North Carolina, United States, is widely documented as a green hospitality project demonstrating the application of energy-efficient systems and environmentally responsible building materials (Inwere & Pepple, 2022). Its construction incorporated recycled materials and high-performance building components to reduce environmental impact. The building also uses solar energy systems and geothermal technologies to minimize operational energy consumption. These strategies significantly lower carbon emissions compared to conventional hotel buildings. The project demonstrates how sustainable material selection improves indoor environmental quality and occupant comfort. Lifecycle assessment findings indicate reductions in water consumption and in the overall environmental footprint. The integration of green construction practices enhances long-term building performance and resource efficiency. The hotel's design also reduces operational costs through improved energy efficiency. This indicates that low-carbon construction materials can provide both environmental and economic benefits. The project confirms the feasibility of sustainable construction in luxury hospitality environments. It highlights the role of innovative materials and technologies in achieving sustainable building performance. The case provides empirical evidence supporting low-carbon construction in the hospitality sector. Lessons from the project offer relevant insights for sustainable hospitality development in Lagos State (Inwere & Pepple, 2022).

RESEARCH METHOD

This study adopts a qualitative research design to explore perceptions, barriers, and enabling conditions for adopting low-carbon construction materials in hospitality environments in Lagos State. Qualitative research is appropriate for investigating complex human, organisational, and institutional factors that quantitative methods alone cannot capture, such as stakeholders' beliefs, decision-making processes, and contextual constraints (Kiani Mavi, Hughes, Campbell, & Yates, 2021).

Data collection will be supported by secondary document review of existing policy documents, building standards, project reports, and published life cycle assessment studies on sustainable materials in Nigeria. Secondary analysis of peer-reviewed research, such as studies on life cycle environmental impacts of low-carbon materials, provides contextual benchmarks and enhances triangulation of findings

(Minunno, O'Grady, Morrison, & Gruner, 2021; Unegbu & Yawas, 2025). Data will be analysed using thematic analysis, a rigorous and systematic approach for identifying patterns and themes across qualitative data. Thematic analysis enables the researcher to organise stakeholder perspectives into coherent themes that reflect motivations, barriers, and contextual conditions influencing material adoption (Kiani Mavi et al., 2021; Moshood, Rotimi, & Shahzad, 2025).

RESULTS AND DISCUSSION

The study indicates that low-carbon construction materials such as bamboo, low-carbon concrete, and recycled materials offer significant environmental advantages over conventional materials like standard concrete and hollow blocks. Life cycle assessments show that bamboo has the lowest overall environmental impact, including reduced global warming potential and resource depletion, while low-carbon concrete significantly lowers greenhouse gas emissions throughout the building life cycle (Unegbu & Yawas, 2025). Similarly, alternative materials such as mud bricks and earth-based walls improve indoor thermal comfort and reduce operational energy demand, with studies showing up to 26% lower embodied carbon compared to conventional concrete constructions (Alegbe, 2021). Despite these benefits, the adoption of low-carbon materials in Lagos hospitality projects remains limited due to higher initial costs, limited supply chains, low stakeholder awareness, and weak policy frameworks to incentivize sustainable practices (Daramola et al., 2025). Nevertheless, locally available materials such as laterite blocks, bamboo, and compressed earth blocks provide practical advantages, reduced transportation-related carbon emissions, and improved thermal performance for passive cooling when sourced locally (Ibitoye et al., 2023).

Overall, the findings demonstrate that low-carbon construction materials have substantial potential to enhance sustainable hospitality environments in Lagos State by lowering embodied carbon, improving energy efficiency, and enhancing occupant comfort. However, adoption is constrained by economic, technical, and institutional challenges, indicating that increased policy support, local capacity building, and stakeholder awareness are necessary to encourage broader implementation in the hospitality sector (Adedeji & King, 2025; Daramola et al., 2025).

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