



Adaptation of Indigenous Material (ISSBs) for Green Façade Design in Sustainable Hotel Architecture: A Case Study from Coastal Lagos

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ABSTRACT

This study examines the architectural integration of Interlocking Stabilized Soil Blocks (ISSBs) and green façade systems to enhance sustainability in hotel design within the tropical coastal context of Lagos, Nigeria. While both technologies have been independently validated for improving thermal performance and reducing environmental impact, their combined application in the hospitality sector remains largely unexplored. Adopting a qualitative multiple case study design grounded in interpretivist philosophy, the research analyzes ISSB-based developments and buildings utilizing green façades through architectural documentation, visual analysis, and comparative evaluation. Findings indicate that ISSBs significantly lower embodied energy and provide high thermal mass, while green façades facilitate passive cooling via shading and evapotranspiration. However, successful integration is hindered by moisture sensitivity, maintenance complexities, technical skill gaps, and socio-cultural perceptions of indigenous materials as "low status". The study proposes a context-responsive framework emphasizing a ventilated double-skin approach, proper surface treatments, and early-stage structural integration. Ultimately, the research contributes to the discourse on Critical Regionalism and Biophilic Design by bridging indigenous material systems with contemporary ecological strategies. It provides practical guidance for architects and developers to reduce the energy intensity of coastal hospitality architecture while fostering a stronger connection between occupants and nature.

Keywords: ISSB, green façade, sustainable hotel architecture, indigenous materials, passive cooling

INTRODUCTION

Background to the Study

Rapid urbanization in coastal Lagos has intensified environmental pressures associated with population growth, infrastructural expansion, and increased energy demand. One of the most critical challenges is the rise in urban heat island effects, which exacerbate already high ambient temperatures in tropical climates (Afolabi et al., 2025). The hospitality sector plays a significant role in this dynamic due to its reliance on energy-intensive cooling systems to maintain indoor comfort (Salami et al., 2024; Enwerem et al., 2025). In response, there has been a growing shift toward sustainable architectural solutions that emphasize passive design strategies and environmentally responsible materials. Indigenous materials have gained renewed attention due to their low embodied energy, affordability, and climatic responsiveness. Among these, Interlocking Stabilized Soil Blocks (ISSBs) have emerged as a promising alternative to conventional sandcrete blocks. ISSBs are produced using locally available soil stabilized with minimal cement, resulting in reduced carbon emissions and improved thermal performance (Danjuma, 2020; Ibitoye et al., 2022).

Parallel to this development is the increasing adoption of green façade systems, which involve the integration of vegetation into building envelopes. These systems provide shading, reduce surface temperatures, and improve microclimatic conditions through evapotranspiration (Aung et al., 2023; Ogunnaiké et al., 2025). In tropical coastal environments, green façades have demonstrated significant potential for enhancing building performance and occupant comfort.

Despite these advantages, the integration of ISSBs and green façade systems in hotel architecture remains limited, particularly in Lagos. This gap highlights the need for empirical architectural investigation

into how these systems can be effectively combined within the constraints of coastal environmental conditions.

Statement of the Problem

Existing research has extensively examined ISSBs and green façades as independent systems. ISSBs have been widely studied for their structural and economic advantages in residential construction (Ibitoye et al., 2023; Nadeem et al., 2023), while green façades have been evaluated for their environmental performance in reducing heat gain (Afolabi et al., 2025; Ogunnaiké et al., 2025). However, there is a lack of integrated studies that explore their combined application in hospitality buildings.

Furthermore, the absence of documented hotel projects utilizing both systems creates a knowledge gap in architectural practice. Designers lack evidence-based guidelines for integrating these systems under coastal conditions characterized by high humidity, salt exposure, and material degradation risks. This limitation hinders the adoption of sustainable design strategies in the Nigerian hospitality sector.

Aim and Objectives

The aim of this study is to examine the architectural integration of ISSBs and green façade systems in sustainable hotel design through case study analysis.

The objectives are to:

- i. analyse selected case studies to identify architectural strategies for integrating ISSBs with green façades;
- ii. evaluate the environmental and material performance of ISSBs and green façade systems in coastal conditions.
- iii. identify practical and contextual challenges affecting the implementation of the integrated system in hotel architecture.

Research Questions

- i. What architectural integration strategies are evident in selected case studies?
- ii. How do ISSBs and green façade systems perform under coastal environmental conditions?
- iii. What challenges limit the adoption of this integrated system in hotel developments?

Scope of the Study

The study focuses on selected case studies within Lagos and comparable tropical coastal environments. It emphasizes ISSB-based buildings and green façade applications relevant to hotel architecture, with particular attention to climatic responsiveness and material performance.

Significance of the Study

This research contributes to sustainable architectural practice by providing empirical insights into the integration of indigenous materials and green façade systems. It offers practical design guidance for architects and developers while supporting policy initiatives aimed at reducing the environmental impact of the hospitality sector.

Limitations of the Study

The absence of fully integrated ISSB-green façade hotel buildings in Lagos necessitates reliance on comparative case studies. Additionally, variations in case study contexts may limit direct generalization of findings.

LITERATURE REVIEW

Conceptual Review

Sustainable hotel architecture has increasingly shifted toward low-energy design strategies that respond to climate, resource efficiency, and occupant comfort. In tropical regions such as Lagos, passive cooling strategies are particularly critical due to persistent high temperatures and humidity levels. Contemporary sustainable hotel design integrates building orientation, shading devices, natural ventilation,

and material selection to minimize reliance on mechanical systems (Enwerem et al., 2025; Salami et al., 2024).

A central concept within this discourse is material sustainability. Building materials contribute significantly to embodied energy and lifecycle environmental impact. Indigenous materials, such as Interlocking Stabilized Soil Blocks (ISSBs), are gaining recognition for their environmental and economic advantages. ISSBs are manufactured using locally sourced laterite soil stabilized with small amounts of cement, resulting in reduced carbon emissions compared to conventional sandcrete blocks (Danjuma, 2020). Their interlocking system eliminates the need for mortar joints, thereby improving construction efficiency and reducing material waste (Ibitoye et al., 2022).

From a performance perspective, ISSBs exhibit high thermal mass, which enables them to absorb and gradually release heat, thereby moderating indoor temperatures. This characteristic is particularly beneficial in tropical climates where diurnal temperature variation can be managed through passive means (Nadeem et al., 2023). Despite these advantages, their application has remained largely confined to low-rise residential buildings, with limited adoption in commercial and hospitality architecture (Ibitoye et al., 2023).

Green façade systems represent another key conceptual component of sustainable architecture. These systems involve the integration of vegetation into building envelopes, either through climbing plants supported on external structures (green screens) or modular planting systems attached directly to façades (living walls). Green façades contribute to building performance through multiple mechanisms, including solar shading, evapotranspiration, and air filtration (Aung et al., 2023).

In tropical climates, green façades are particularly effective due to the synergy between vegetation growth conditions and climatic characteristics. Studies have shown that green façades can reduce exterior surface temperatures and improve indoor thermal comfort, thereby lowering energy consumption (Afolabi et al., 2025; Ogunnaiké et al., 2025). However, the integration of these two systems presents both opportunities and challenges. While ISSBs provide structural and thermal benefits, green façades enhance environmental performance. Their combined application has the potential to create a holistic sustainable façade system, yet this integration requires careful architectural detailing and contextual adaptation.

Theoretical Review

This study is grounded in two key theoretical frameworks: Critical Regionalism and Biophilic Design Theory. Critical Regionalism advocates for an architectural approach that balances global design practices with local cultural and environmental conditions. It emphasizes the use of locally sourced materials and climate-responsive design strategies to create contextually appropriate architecture. Within the Nigerian context, ISSBs embody this principle by utilizing indigenous materials and construction techniques that respond to local climatic conditions (Ibitoye et al., 2023). Biophilic Design Theory, on the other hand, focuses on the integration of natural elements into the built environment to enhance human well-being. The theory posits that exposure to nature can improve psychological health, productivity, and overall quality of life. Green façades exemplify biophilic design by introducing vegetation into architectural spaces, thereby fostering a connection between occupants and nature (Kalu et al., 2025).

The integration of ISSBs and green façades can therefore be understood as a convergence of these two theoretical perspectives. ISSBs address the material and climatic dimensions of sustainability, while green façades contribute to environmental and experiential quality. Together, they form a comprehensive approach to sustainable hotel design.

Empirical Review

Empirical studies on ISSBs have consistently highlighted their economic and environmental benefits. Ibitoye et al. (2022) demonstrated that ISSBs offer significant cost savings compared to conventional sandcrete blocks, while also reducing construction time. Similarly, Danjuma (2020) reported improved energy efficiency in buildings constructed with ISSBs due to their thermal properties.

Research by Nadeem et al. (2023) further confirms the structural viability of interlocking blocks, indicating that they possess sufficient compressive strength for low- to medium-rise construction. However, these studies also note limitations related to moisture absorption and durability, particularly in humid environments.

Studies on green façades have focused on their environmental performance and application in urban contexts. Afolabi et al. (2025) found that green façade systems significantly reduce urban heat island effects by lowering surface temperatures. Ogunnaiké et al. (2025) observed improved thermal comfort in hotel buildings incorporating green façades, with reduced reliance on air conditioning systems.

Aung et al. (2023) highlighted the importance of proper system design and maintenance, noting that poorly implemented green façades can lead to moisture-related issues and structural damage. These findings underscore the need for careful integration of green façade systems within building envelopes.

Despite these contributions, there is a notable absence of studies that examine the combined application of ISSBs and green façades. Existing research tends to treat these systems independently, without exploring their potential synergies or integration challenges within specific building typologies such as hotels.

Conceptual Framework

The conceptual framework for this study is based on an Input–Process–Output model.

- i. Inputs: ISSBs (material properties, thermal mass) and green façade systems (vegetation, support structures)
- ii. Process: Architectural integration strategies, including detailing, material treatment, and structural adaptation
- iii. Moderating Variables: Coastal environmental conditions such as humidity, rainfall, and salt exposure
- iv. Output: Sustainable hotel architecture characterized by improved thermal performance, reduced energy consumption, and enhanced environmental quality

This framework emphasizes the role of contextual factors in shaping the effectiveness of integration strategies.

Research Gap

While ISSBs and green façades have been extensively studied as independent systems, there is a lack of integrated research that examines their combined application in hotel architecture, particularly within coastal Lagos. Existing studies do not provide case-based architectural insights into how these systems can be effectively integrated, highlighting a critical gap in both research and practice.

RESEARCH METHOD

Research Philosophy

This study adopts an interpretivist research philosophy, which emphasizes understanding architectural phenomena through context-specific analysis rather than universal generalization. The interpretivist approach is appropriate for this study because it allows for in-depth exploration of design strategies, material behavior, and environmental performance within real-world settings.

Research Design

A qualitative multiple case study design was employed. This approach enables the investigation of complex architectural systems within their real-life context, making it suitable for examining the integration of ISSBs and green façade systems. The multiple case study strategy allows for comparative analysis across different building types and contexts, thereby enhancing the robustness of findings.

Case Study Selection Criteria

Case studies were selected based on the following criteria:

- i. Relevance to ISSB or green façade application
- ii. Location within tropical or coastal environments
- iii. Availability of architectural documentation and visual data
- iv. Demonstrated performance in terms of environmental response

Three categories of case studies were analyzed:

- i. ISSB-based buildings in Southwest Nigeria
- ii. Buildings incorporating green façade systems in Lagos
- iii. Comparable tropical case studies demonstrating façade vegetation systems

Table 1: Summary of Case Studies.

Case Study	Location	Building Type	Key Features	Relevance to Study
ISSB Residential Estate (Amen Estate Proxy)	Southwest Nigeria	Residential	Use of ISSBs, exposed wall finish, thermal mass performance (Ibitoye et al., 2023)	Demonstrates ISSB material behavior and construction efficiency
Green Commercial Building	Lagos	Commercial	Climbing vegetation, cable support system, passive cooling (Ogunnaike et al., 2025)	Demonstrates façade shading and cooling performance
Tropical Comparative Case	Tropical Region	Mixed-use	Integrated vegetation systems, climate-responsive design (Aung et al., 2023)	Provides comparable insights for integration strategies

Source: Author (2026)

This categorization allows for both within-case and cross-case analysis.

Data Collection Methods

Data were collected using multiple qualitative methods to ensure triangulation:

- i. Architectural Documentation: Drawings, plans, and project reports were analyzed to understand design strategies and material application.
- ii. Visual Analysis: Photographs and site observations were used to assess physical conditions, detailing, and performance.
- iii. Literature-Based Evidence: Published studies and reports provided supporting data on material properties and environmental performance.

Data Analysis Techniques

Data analysis was conducted using a cross-case thematic approach. The process involved:

- i. Within-case analysis to identify key characteristics of each case
- ii. Coding of recurring themes related to integration strategies and challenges
- iii. Cross-case comparison to identify patterns and differences
- iv. Synthesis of findings into broader design principles

This method allows for systematic interpretation of qualitative data while maintaining analytical rigor.

Validity and Reliability

To ensure validity and reliability, the study employed methodological triangulation by combining multiple data sources. Consistency in case selection criteria and analytical procedures further enhanced the credibility of findings. Detailed documentation of the research process ensures transparency and replicability.

Ethical Considerations

The study relies on publicly available data and documented case studies. Proper attribution of sources has been maintained throughout the research to ensure academic integrity.

RESULTS AND DISCUSSION

This section presents a detailed within-case analysis of each case category followed by a cross-case synthesis. The analysis focuses on architectural detailing, material behaviour, environmental performance, and operational implications within coastal conditions.

ISSB Case Study Analysis

The ISSB-based developments examined, including residential estates in Southwest Nigeria used as proxies, demonstrate consistent performance advantages linked to thermal mass and material efficiency.

Thick earthen walls (typically 150–230 mm) were observed to moderate indoor temperature fluctuations by delaying heat transfer from the exterior to interior spaces. This aligns with established findings on the thermal inertia of compressed earth materials (Danjuma, 2020; Ibitoye et al., 2022).

From an architectural standpoint, ISSBs enabled precise alignment due to their interlocking profiles, reducing construction tolerances and improving wall uniformity. This characteristic is particularly relevant for façade integration, where accurate fixing of secondary systems such as trellises is required. Case documentation showed that buildings utilizing ISSBs recorded reduced plastering requirements, thereby lowering embodied energy and construction costs.

However, performance limitations were evident under coastal exposure. Visual assessments indicated surface erosion and efflorescence in areas lacking protective finishes. Moisture ingress was most pronounced at plinth levels and wall bases, especially in flood-prone zones. Buildings that incorporated damp-proof courses and raised foundations performed significantly better, suggesting that moisture management is critical to ISSB durability in Lagos conditions.

Material perception also emerged as a notable constraint. Despite technical advantages, ISSBs were frequently associated with low-cost housing, limiting their application in upscale developments such as hotels. This perception influences client acceptance and design decisions, creating a barrier to adoption in the hospitality sector (Olaleye & Ibitoye, 2022).

Green Façade Case Study Analysis

Buildings incorporating green façade systems, including commercial retrofits in Lagos, demonstrated measurable improvements in thermal performance. Shaded façade surfaces exhibited lower temperatures compared to exposed walls, contributing to reduced indoor heat gain. This effect was particularly evident on west-facing elevations, where solar exposure is highest (Ogunnaike et al., 2025). Two primary typologies were observed: cable-supported green screens and modular living wall systems. Green screens were more prevalent due to their lower cost and adaptability. Climbing species such as *Bougainvillea* and creeping vines were commonly used due to their resilience in tropical climates.

Architectural detailing played a critical role in system performance. Effective installations maintained a separation gap of approximately 50–100 mm between vegetation and the wall surface, creating a ventilated cavity that reduced moisture accumulation. Buildings lacking this separation showed signs of dampness and biological growth on wall surfaces.

Maintenance emerged as a dominant factor influencing long-term viability. Case observations revealed issues such as clogged irrigation systems, plant overgrowth, and structural corrosion of support elements. Buildings with scheduled maintenance regimes performed significantly better, indicating that operational planning is essential for successful implementation.

Table 2: Cross-Case Comparison of ISSBs and Green Façade Systems

Criteria	ISSB Buildings	Green Façade Buildings	Integrated Potential
Thermal Performance	High thermal mass reduces indoor heat gain (Danjuma, 2020)	Shading and evapotranspiration reduce surface temperature (Afolabi et al., 2025)	Combined system enhances passive cooling
Material Efficiency	Low embodied energy, local sourcing (Ibitoye et al., 2022)	Requires additional materials for support systems (Aung et al., 2023)	Balanced sustainability benefits
Moisture Behavior	Susceptible to water absorption if untreated (Nadeem et al., 2023)	Can trap moisture if poorly detailed (Ogunnaike et al., 2025)	Requires ventilated cavity and protection
Maintenance	Low maintenance when properly treated (Ibitoye et al., 2023)	High maintenance (irrigation, pruning) (Ogunnaike et al., 2025)	Maintenance planning is essential
Cost Implications	Cost-effective construction (Ibitoye et al., 2022)	Moderate to high initial cost (Aung et al., 2023)	Long-term savings through energy efficiency

Aesthetic Value	Natural, earthy appearance (Olaleyé & Ibitoye, 2022)	Green, visually appealing façade (Afolabi et al., 2025)	Enhanced architectural expression
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Source: (Author 2026)

Cross-Case Synthesis: Integration Strategies

The synthesis of findings from both case categories highlights several key architectural strategies for integrating ISSBs and green façades:

- i. **Ventilated Double-Skin Façade Approach:** Successful integration requires a separation between the ISSB wall and the vegetation layer. A ventilated cavity of 50–75 mm allows airflow, reduces moisture retention, and prevents direct contact between plant roots and the wall surface.
- ii. **Moisture Protection and Surface Treatment:** ISSB walls require protective coatings such as lime wash or silicate-based sealers to enhance resistance to rainwater and salt exposure. Case evidence shows that untreated walls deteriorate faster under coastal conditions.
- iii. **Structural Integration of Support Systems:** Green façade support systems should be integrated during construction rather than retrofitted. Embedded anchors and corrosion-resistant brackets improve load distribution and system stability, particularly under wind loads common in coastal environments.
- iv. **Material Compatibility and Detailing:** Compatibility between ISSBs and façade systems is essential. Detailing must account for differential movement, moisture behaviour, and thermal expansion to prevent structural and material failure.

Table 3: Identified Integration Strategies

S/N	Strategy	Description	Design Implication
1.	Ventilated Cavity System	Separation between ISSB wall and vegetation layer (Aung et al., 2023)	Prevents moisture buildup and enhances airflow
2.	Protective Surface Treatment	Use of sealers or lime wash on ISSBs (Danjuma, 2020)	Improves durability in coastal conditions
3.	Structural Anchoring	Integration of support systems during construction (Ibitoye et al., 2022)	Enhances stability and load distribution
4.	Plant Selection	Use of climate-resilient climbing species (Ogunnaike et al., 2025)	Ensures long-term performance

Source: (Author 2026)

Cross-Case Synthesis: Performance Outcomes

The integration of ISSBs and green façades demonstrates several performance benefits:

- i. **Thermal Regulation:** Combined systems reduce heat gain through both thermal mass and shading mechanisms.
- ii. **Energy Efficiency:** Lower indoor temperatures reduce dependence on mechanical cooling systems.
- iii. **Environmental Sustainability:** Use of local materials and vegetation reduces carbon footprint.
- iv. **Aesthetic Enhancement:** Green façades improve visual quality and align with biophilic design principles.

These outcomes suggest that the integration of both systems can significantly enhance building performance when properly executed.

Cross-Case Synthesis: Implementation Challenges

Despite the identified benefits, several challenges limit widespread adoption:

- i. **Moisture and Durability Issues:** High humidity and rainfall increase the risk of material degradation. Without proper detailing, ISSBs are vulnerable to water damage.
- ii. **Maintenance Complexity:** Green façades require continuous maintenance, including irrigation management, pruning, and structural upkeep.
- iii. **Technical Skill Gaps:** Limited expertise in ISSB construction and green façade installation leads to inconsistent quality and performance.

- iv. Supply Chain Constraints: Access to specialized materials such as corrosion-resistant components remains limited, increasing costs and project complexity.
- v. Perceptual Barriers: ISSBs are often perceived as low-status materials, discouraging their use in high-end hospitality projects.

Discussion of findings

The findings reinforce the theoretical propositions of Critical Regionalism and Biophilic Design. ISSBs align with regionalist principles by utilizing local materials suited to climatic conditions, while green façades embody biophilic integration through the incorporation of vegetation.

However, the study also highlights a critical gap between theoretical potential and practical implementation. While both systems offer clear environmental benefits, their integration requires a high level of technical coordination and contextual adaptation. The absence of standardized guidelines further complicates adoption. From a design perspective, the study suggests that integration should be approached as a holistic façade system rather than as independent components. This requires early-stage design consideration, interdisciplinary collaboration, and long-term maintenance planning.

The results also indicate that socio-cultural factors play a significant role in material adoption. Reframing ISSBs as sustainable and premium materials may enhance their acceptance in the hospitality sector. Overall, the study demonstrates that while integration is feasible and beneficial, its success depends on addressing both technical and perceptual challenges.

CONCLUSION

This study establishes that the architectural integration of Interlocking Stabilized Soil Blocks (ISSBs) and green façade systems offers a highly effective, ecologically sound pathway for sustainable hotel architecture in tropical climates. By merging the thermal mass and low embodied energy of ISSBs with the passive cooling and shading capabilities of green façades, the resulting hybrid envelope offers a viable pathway to reduce reliance on mechanical cooling systems. Furthermore, this integration successfully operationalizes the theoretical paradigms of Critical Regionalism and Biophilic Design. It demonstrates how indigenous material systems can be elevated through modern ecological strategies to foster a stronger connection between building occupants and nature.

However, the research also reveals that achieving this synthesis is not without substantial practical hurdles. While the theoretical environmental benefits are clear, successful implementation in coastal environments is heavily constrained by moisture sensitivity, the necessity for rigorous architectural detailing, and the demand for ongoing maintenance. Additionally, the socio-cultural perception of earthen materials as "low status" remains a significant barrier to their adoption in upscale hospitality developments. Ultimately, this study demonstrates that while the integration of ISSBs and green façades is highly beneficial, it requires a shift from viewing facades as mere aesthetic skins to treating them as complex, integrated, and actively managed ecological systems.

RECOMMENDATIONS

To bridge the gap between theoretical potential and practical implementation, the following recommendations are proposed across three key domains:

1. For Architectural Practice and Design

- i. **Implement a Ventilated Double-Skin Approach:** Architects must design the integrated system with a deliberate separation gap (e.g., 50–100 mm) between the ISSB wall and the vegetation layer. This cavity is crucial for facilitating airflow, mitigating moisture accumulation, and preventing direct root damage to the earthen blocks.
- ii. **Prioritize Surface Treatments:** Given the vulnerability of ISSBs to coastal humidity and rainfall, exterior walls must be treated with breathable protective coatings, such as lime wash or silicate-based sealers, to prevent surface erosion and efflorescence.
- iii. **Integrate Structural Supports Early:** Green façade support systems, such as corrosion-resistant anchors and brackets, should be embedded directly into the ISSB framework during the initial construction phase rather than retrofitted, ensuring better load distribution against coastal wind pressures.

2. For Hotel Developers and Management

- i. **Reframe Material Perception:** Developers should actively market the use of ISSBs and green façades as a premium, "eco-luxury" feature rather than a cost-saving measure. Highlighting the biophilic wellness benefits and reduced carbon footprint can help overcome the socio-cultural stigma associated with indigenous materials.
- ii. **Invest in Operational Maintenance:** The long-term viability of this system relies entirely on maintenance. Developers must account for the operational costs of automated irrigation systems, structural upkeep, and regular horticultural pruning from the project's inception.

3. For Future Academic Research

- i. **Direct Coastal Testing:** Since current ISSB data heavily relies on inland proxies, future research should conduct longitudinal empirical studies on ISSB degradation specifically in high-salinity, direct-coastal zones to accurately measure the impact of salt-spray.
- ii. **Develop Standardized Guidelines:** There is a critical need for the development of standardized, evidence-based building codes and architectural detailing guidelines specifically tailored for integrating living systems with earthen architecture in the tropics.

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