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Innovative Sustainable Materials and Professional Practice Reforms for Nigeria's Global Built Environment Competitiveness

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Abstract **Original Research Article**

Nigeria's built environment faces a twin pressure of a large housing deficit and a high carbon and cost burden from conventional materials, even as global construction shifts toward low-carbon and certified systems. This study aims to synthesize the evidence on innovative and sustainable construction materials and professional practice in Nigeria, to diagnose the barriers to their mainstream adoption, and to propose the professional-practice and policy reforms required for global competitiveness. Its objectives are, first, to map the materials with demonstrated technical and cost performance in the Nigerian context; second, to classify and interpret the barriers to adoption; third, to identify the professional-practice changes that adoption requires; and fourth, to set out the standards and policy reforms that would mainstream adoption. The study adopts a structured literature synthesis, complemented by documentary policy analysis, and interprets the evidence through the technology-organisation-environment framework and diffusion-of-innovations theory, modelling adoption as a three-layer system of materials, practice, and enabling environment. The findings show that the binding constraints are not technical but organisational and environmental, lying in professional capacity, regulatory inclusion, client perception, and the scarcity of demonstration projects. The study concludes that the professional-practice layer, the domain of the Council of Registered Builders of Nigeria and the Nigerian Institute of Building, is the under-addressed pivot on which the transition depends, and it recommends a sequenced reform pathway of standards inclusion, certified practice capacity, and procurement-led demonstration. The findings carry implications for materials policy, professional development, and Nigeria's positioning in a decarbonising global construction market.

Keywords: sustainable construction; innovative building materials; professional practice; global competitiveness; housing delivery; Nigeria.

1. Introduction

Two pressures bear on Nigeria's built environment at the same time. The first is a deep housing deficit set against the cost and carbon burden of conventional construction, which depends heavily on cement-rich sandcrete and imported systems. The second is competitiveness, because as the global construction industry moves toward low-carbon and certified building, a sector that remains tied to high-emission materials and informal practice falls behind on cost, on climate performance, and

on the professional standing required to compete beyond national borders (Babalola & Harinarain, 2024). These pressures point in the same direction, toward a more sustainable and more professional model of delivery, yet the sector has been slow to move.

The slowness is not for want of alternatives. Innovative and sustainable materials are documented in the Nigerian setting, and their performance is real rather than aspirational. Compressed stabilised earth blocks, compressed adobe bricks, bamboo, rammed earth, laterite-based and interlocking blocks reduce embodied carbon, improve thermal behaviour in a tropical climate, and can lower whole-life cost. A Nigerian simulation study found that an adobe-walled dwelling carried an annual heat load roughly eleven per cent lower than an equivalent sandcrete building (Olaniyan, 2023), consistent with the established thermal advantage of earth-based walling, and national research institutions have produced guidance and lower-impact materials such as laterite and interlocking blocks (NBRRI, 2021).

Despite this evidence, adoption in mainstream housing delivery remains marginal. Recent peer-reviewed work on the Nigerian construction industry identifies the obstacles concretely. Mogaji et al. (2025), surveying 282 construction professionals, found that the barriers to innovative building materials cluster around cost, awareness, availability, and the policy environment rather than around any failure of the materials themselves. Tunji-Olayeni and David (2024) similarly identified perception, cost, and weak institutional support as the barriers hindering green building materials adoption in Nigeria, and Babalola and Harinarain (2024) traced the constraints to policy barriers embedded in the enabling environment. Adebowale et al. (2025), examining a developing economy, reached the same conclusion that the binding constraints lie beyond the material itself. The problem this study addresses is therefore not whether sustainable materials work, since the evidence indicates that they do, but why a country with the materials, the climate case, and the cost case cannot move them from pilot to mainstream, and what reforms in professional practice and policy would close that distance.

The gap in the literature follows directly from the pattern of these studies. Material performance has been established in one body of work, and adoption barriers have been catalogued in another (Mogaji et al., 2025; Tunji-Olayeni & David, 2024; Adebowale et al., 2025), yet the two strands run in parallel without meeting. None articulates the integrated pathway that links materials to professional capacity and to the enabling environment, and thence to competitiveness, or identifies which of these layers is the decisive lever. The aim of this study is to build that pathway. Its objectives are to map the materials with demonstrated performance, to classify the barriers, to identify the professional-practice changes that adoption requires, and to set out the policy reforms that would mainstream adoption. It asks which materials are credible, which barriers bind, what professional competencies are needed, and which reforms would shift the sector.

2. Literature Review and Theoretical Framework

2.1 The sustainability and competitiveness imperative

The case for sustainable construction in Nigeria rests on three converging drivers. The climate driver follows from the high embodied carbon of cement-based construction and from national commitments under the global sustainable development agenda (United Nations, 2015). The cost driver follows from the volatility and import dependence of conventional materials. The competitiveness driver follows from the direction of the global market, in which certification and low-carbon performance increasingly condition access to finance and to cross-border work. Windapo and Rotimi (2012) connected the sustainability of the built environment to the broader development trajectory, situating material choice within a sustainability frame rather than treating it as a narrow technical question. Competitiveness in this context has a concrete meaning: international green-building certification schemes and the growing expectation that projects disclose embodied carbon are reshaping how quality is judged and how finance is allocated. A sector able to demonstrate certified,

low-carbon performance can attract climate finance and satisfy the requirements of international clients and lenders, whereas a sector that cannot make that demonstration is progressively shut out of those markets, regardless of the unit cost of its labour. Sustainable practice is therefore increasingly a precondition for competitiveness rather than a moral supplement to it.

2.2 Innovative and sustainable materials in the Nigerian context

The performance evidence for sustainable materials in Nigeria and comparable settings is favourable. Earth-based walling systems offer lower thermal conductivity than sandcrete and so improve indoor comfort while reducing cooling demand, a benefit confirmed in the Nigerian simulation evidence cited above (Olaniyan, 2023). Compressed stabilised earth and interlocking blocks reduce cement content and can be produced close to site, lowering both cost and transport emissions, and national research guidance supports their use (NBRRI, 2021). Bamboo and other rapidly renewable materials extend the palette further. The technical viability of these options is, on the present evidence, not seriously in dispute.

The options are not interchangeable, however, and a realistic account must distinguish them. Compressed stabilised earth and interlocking blocks suit load-bearing and infill walling in low- to medium-rise housing, where their thermal mass and reduced cement content are most valuable, though their performance depends on disciplined soil selection and stabilisation. Bamboo offers a high strength-to-weight ratio for framing, scaffolding, and reinforcement in appropriate detailing, but requires treatment against decay and pests to perform over a building's life. Rammed earth and adobe deliver strong thermal comfort in hot climates yet demand protection from driving rain and careful structural design at height. The practical implication is that each material carries a specification and supervision burden that a competent professional must manage, which returns the discussion from the material itself to the practitioner who must deploy it.

2.3 Barriers to adoption

A separate and growing literature catalogues why viable materials are not adopted, and its findings are strikingly consistent. Mogaji et al. (2025) grouped the barriers around cost, awareness, availability, and the policy environment. Tunji-Olayeni and David (2024) identified client perception, high initial cost, and weak institutional and market support as the leading obstacles to green building materials in Nigeria. Babalola and Harinarain (2024) located the constraints specifically in policy, showing through exploratory factor analysis that the absence of enabling regulation and incentives is a distinct barrier dimension. Adebowale et al. (2025) confirmed, for a developing economy more broadly, that the obstacles are organisational and environmental rather than technical, and that overcoming them requires coordinated action across regulation, capacity, and demand. Studies of compressed earth and adobe systems add that the scarcity of demonstration projects and the perception that earth-based materials are cheap or structurally unfit are persistent constraints. The barrier literature, in short, points consistently away from the laboratory and toward the institutions, capacities, and perceptions that surround the material.

2.4 Professional practice and capacity

The professional dimension is comparatively underdeveloped in this literature. Specifying and supervising a sustainable material reliably requires competencies that differ from those for conventional construction, and the builder is the actor positioned to hold that competence and to educate the client. CORBON's recognition as a sector skills council under the national skills framework provides an institutional route to build and certify this capacity, and NIOB's continuing professional development mandate provides another, yet neither is currently organised around sustainable practice at scale. The consistent appearance of professional capacity and awareness among the leading barriers (Mogaji et al., 2025; Tunji-Olayeni & David, 2024) indicates that this

underdevelopment is not incidental but central to the adoption problem.

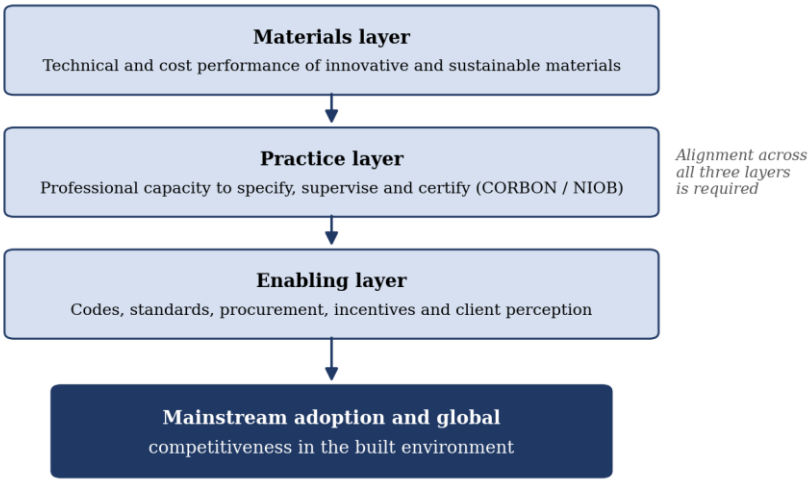
2.5 Research gap

The two strands of evidence, on performance and on barriers, therefore run in parallel without meeting. What is missing is an integrated account that treats adoption as a system in which materials, professional practice, and the enabling environment must align, and that connects that alignment to competitiveness. The barrier studies stop at diagnosis and general recommendation (Mogaji et al., 2025; Babalola & Harinarain, 2024), while the performance studies stop at the material (Olaniyan, 2023). Neither identifies which layer is the decisive lever, nor sequences the reforms accordingly. This study supplies that integrated account.

2.6 Theoretical framework

The analysis combines two established theories. The diffusion-of-innovations perspective explains the slow uptake of a proven technology in terms of its relative advantage, compatibility, complexity, trialability, and observability; the documented barriers map closely onto compatibility, through social perception, and onto observability, through the demonstration-project deficit. The technology-organisation-environment framework structures the barriers across technological, organisational, and environmental dimensions. These are integrated in the three-layer adoption model shown in Figure 2, which treats a materials layer, a practice layer, and an enabling layer as jointly necessary, such that a strong materials case still fails to diffuse if the practice and enabling layers lag.

Figure 2: *A Three-Layer Model of Sustainable-Material Adoption for Competitiveness*



Note. Developed by the author from the technology-organisation-environment framework and diffusion-of-innovations theory.

3. Methodology

3.1 Research design and its justification

The study uses a structured literature synthesis, a narrative-systematic review, complemented by documentary policy analysis. The design is deliberate. The research question is integrative, asking how materials, professional practice, and the enabling environment together shape adoption and competitiveness, and such a question is answered by systematically assembling and interpreting the dispersed evidence rather than by generating new primary data on a single variable. Alternative designs were considered. A primary questionnaire survey, as used by Mogaji et al. (2025) and Tunji-Olayeni and David (2024), can rank barriers within one sample but cannot integrate

performance evidence, barrier evidence, and policy instruments into a single pathway. A Delphi study would build expert consensus on priorities but would not establish the documentary and empirical base that the synthesis draws together. The structured synthesis was therefore selected because it matches the integrative aim, and its limitations are stated in Section 3.4.

3.2 Search and selection procedure

The route from literature to findings followed four explicit steps. First, the search targeted peer-reviewed databases and reputable publishers, together with authoritative institutional and policy sources, using combinations of the terms sustainable materials, innovative building materials, green building materials, compressed earth blocks, adoption, barriers, and Nigeria. Second, inclusion criteria were applied: sources had to address sustainable or innovative materials and their adoption in Nigeria or a directly comparable developing-country context, be published largely from 2015 onward to satisfy the requirement for current evidence, and be either peer-reviewed or issued by a recognised institution. Third, the retained sources were screened for relevance and quality, with preference given to recent empirical studies and away from unindexed or non-peer-reviewed material. Fourth, the material-performance findings and the barrier findings were extracted into a structured matrix to allow systematic comparison.

3.3 Analytical procedure

The extracted evidence was analysed in three stages. First, the barriers were classified using the technology-organisation-environment framework, assigning each to its technological, organisational, or environmental dimension, and were interpreted through the diffusion attributes to explain their effect on uptake. Second, the performance evidence and the classified barriers were mapped onto the three-layer adoption model to identify which layer constitutes the decisive constraint. Third, the resulting diagnosis was triangulated against current Nigerian policy instruments, namely the National Building Code (2006) and the National Housing Policy (2021), to locate the reform gaps and to sequence the recommended interventions. The classification is reported in Table 1 and the model in Figure 2.

3.4 Trustworthiness and limitations

The credibility of a synthesis depends on the coverage and quality of its corpus, and this was supported by prioritising recent, peer-reviewed, and institutionally authoritative sources and by the convergent findings across independent studies, which strengthens confidence in the diagnosis. Dependability rests on the explicit search, inclusion, and classification steps, which another reviewer could follow. Two limitations are acknowledged. First, reported cost and performance figures vary by study and setting and are therefore reported with their provenance rather than aggregated into single values. Second, a synthesis reflects the existing literature and cannot substitute for primary demonstration data; the study accordingly recommends primary and demonstration-based research to validate the pathway proposed here.

4. Results and Discussion

4.1 Materials perform; adoption lags

The synthesis confirms a consistent pattern. On the materials layer the evidence is favourable, with earth-based and interlocking systems offering thermal and environmental advantages and competitive whole-life cost despite, in some cases, a higher upfront cost. On the adoption side the picture is the reverse, with uptake remaining marginal in mainstream delivery. The contradiction between demonstrated performance and limited use is the central empirical finding, and it directs attention to the layers above the material itself.

4.2 The barriers, classified

Table 1 classifies the dominant barriers using the technology-organisation-environment framework, and its interpretation is the analytical core of the study. Reading down the table, only two of the seven barriers, namely higher upfront cost and limited local availability, sit primarily in

the technological dimension, and even the cost barrier is as much a matter of communication and financing as of the material. The remaining barriers, namely weak professional capacity, client perception, the absence of tested standards and regulatory inclusion, the scarcity of demonstration projects, and the absence of a procurement preference, sit in the organisational and environmental dimensions. In diffusion terms, the constraints are concentrated in compatibility, through social perception, and observability, through the demonstration deficit, which are precisely the two attributes most amenable to professional and policy intervention. The table therefore shows that the binding constraints lie not in the material but in the institutions, capacities, and perceptions that surround it, and this reading is consistent across the recent Nigerian evidence (Mogaji et al., 2025; Tunji-Olayeni & David, 2024; Babalola & Harinarain, 2024).

Table 1: *Barriers to Sustainable-Material Adoption Classified by the Technology-Organisation-Environment Framework*

Barrier	TOE dimension	Nature and evidence
Higher upfront cost and uncertain costing	Technological / economic	Initial cost can exceed conventional systems; whole-life advantage poorly communicated (Mogaji et al., 2025)
Limited local availability and supply	Technological	Thin supply of certified green materials raises cost and procurement risk
Absence of tested standards and regulatory inclusion	Environmental (policy)	Materials not embedded in codes, so specifying them remains exceptional (Babalola & Harinarain, 2024)
Weak professional capacity to specify and supervise	Organisational	Few builders trained or certified for these systems; the practice layer is underdeveloped
Client perception and social prejudice	Organisational / social	Earth-based materials perceived as cheap or unfit, reducing compatibility (Tunji-Olayeni & David, 2024)
Scarcity of demonstration projects	Environmental	Low observability slows diffusion; clients cannot witness performance directly
No procurement preference or incentive	Environmental (policy)	Public demand signal absent; adoption left to voluntary goodwill (Adebowale et al., 2025)

4.3 The practice layer as the pivot

Reading the barrier classification against the three-layer model in Figure 2 yields the study's central argument. The figure represents adoption as three stacked and dependent layers, in which mainstream adoption and competitiveness at the base can be reached only when the materials, practice, and enabling layers above it are aligned. The materials layer is sound and the enabling layer is the subject of most existing policy talk, but the practice layer is the pivot that the discourse neglects. Standards inclusion and procurement preference will not produce safe, competitive delivery if builders cannot specify and supervise the materials and cannot carry clients with them. Because the practice layer is the domain of CORBON and NIOB, the professions are not bystanders to the sustainability transition but its decisive enablers.

4.4 Discussion

This study set out to diagnose why proven sustainable materials remain marginal in Nigerian housing delivery and to identify the reforms that would mainstream them. Synthesising the recent evidence and classifying the barriers through the technology-organisation-environment framework, it found that the binding constraints are organisational and environmental rather than technical, and that the professional-practice layer is the under-addressed pivot on which adoption depends. In brief, the material works; the system around it does not yet support it.

The study has clear strengths and weaknesses. Its principal strength is integration: by drawing performance evidence, barrier evidence, and policy instruments into a single three-layer model, it moves beyond the diagnosis-and-list format of much of the barrier literature and identifies a decisive lever and a sequence for acting on it. A second strength is the currency and convergence of its evidence base, which draws on several independent recent Nigerian studies that reach compatible conclusions. Its principal weakness is that, as a synthesis, it reflects the existing literature and cannot substitute for primary demonstration data, and that reported cost and performance figures vary by source and are not aggregated. These weaknesses define the agenda for the primary and demonstration-based research recommended below.

Read against the current literature, the findings agree closely with the recent Nigerian evidence while adding an organising structure it has lacked. Mogaji et al. (2025), Tunji-Olayeni and David (2024), and Babalola and Harinarain (2024) each conclude that the obstacles are matters of cost communication, awareness, capacity, perception, and policy rather than of material performance, and Adebowale et al. (2025) reaches the same conclusion for developing economies more broadly. The present study concurs and goes further by locating these barriers within a layered model and arguing that the practice layer, rather than the enabling layer that attracts most policy attention, is the decisive constraint. The findings also agree with the performance literature (Olaniyan, 2023; NBRRI, 2021) that the materials themselves are viable, which is precisely why the study directs reform effort away from the material and toward the practice and enabling layers. The point of disagreement with the prevailing policy discourse is one of emphasis: where that discourse tends to treat sustainable construction as a matter of standards and incentives alone, this study contends that standards and incentives will underperform unless the professional capacity to specify and supervise the materials is built first.

5. Conclusion and Recommendations

This study has argued that the obstacle to sustainable and competitive construction in Nigeria is not the performance of sustainable materials, which the evidence supports, but the alignment of professional practice and the enabling environment around them. By classifying the barriers and reading them through a three-layer adoption model, it has shown that the binding constraints are organisational and environmental, and that the professional-practice layer is the under-addressed pivot on which the transition depends.

For professional builders, the recommendation is to build specification and supervision competence in sustainable materials through CORBON and NIOB continuing professional development, treating that competence as a competitiveness skill rather than a niche interest, and to lead the client education on which adoption depends. For regulators and standards bodies, the priority is to develop and publish tested performance standards for innovative materials, to establish a builder-certification track using CORBON's sector-skills mandate, and to certify sustainable products so that specifiers and clients can trust their quality. For policymakers, the recommendation is to embed sustainable materials in the National Building Code and state codes, to introduce a sustainable-materials preference in public housing procurement, to fund visible demonstration housing that attacks the observability barrier directly, and to link sustainable-construction reform to climate-finance access and to a stated competitiveness target. Two safeguards should accompany this pathway: standards inclusion

must be paired with tested and enforceable performance standards, so that a drive for sustainability does not become a route for poor-quality earth construction, and demonstration and procurement preference should reward verified performance rather than mere labelling. Pursued as a sequence rather than as isolated measures, and validated by the primary and demonstration-based research recommended here, these reforms would move sustainable construction from the margins of Nigerian housing delivery toward its mainstream, and would position the country to compete in a global market that increasingly rewards building both competitively and responsibly.

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