DESIGN AND DEVELOPMENT OF SUSTAINABLE BUILDING MATERIALS

BY

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CERTIFICATION

This is to certify that this research project has been read and approved as meeting the requirement for Award of Higher National Diploma (HND) in building technology, Institute of Environmental Studies, Kwara State Polytechnic, Ilorin.

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DEDICATION

This research work is dedicated first and foremost to Almighty God, the source of wisdom, strength, and guidance throughout my academic journey.

To my loving parents, Mr. and Mrs. Sulyman, thank you for your continuous prayers, sacrifices, and moral support that have shaped my academic and personal life.

This work is further dedicated to all builders, construction professionals, and rural development advocates who strive to make quality and affordable housing accessible to underserved communities in Nigeria.

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ABSTRACT

This study explores the design, development, and adoption of sustainable building materials in Kwara State, Nigeria, with the aim of promoting environmentally friendly and cost-effective construction practices. The research assesses awareness levels, material availability, performance characteristics, and the challenges affecting their wider usage. A structured questionnaire was administered to 340 respondents, including artisans, construction professionals, and regulatory officers. The study achieved a 100 percent response rate, ensuring reliable data for analysis. Findings reveal a high level of awareness (73.5%) but relatively low usage (41.2%) of sustainable materials, indicating a gap between knowledge and practice. Locally sourced materials such as laterite/adobe and stabilized earth blocks are the most commonly used, while advanced options like recycled plastic bricks remain less familiar. Key challenges identified include lack of technical know-how, limited public awareness, absence of regulatory support, and accessibility issues. Performance evaluation showed high ratings for thermal comfort, cost efficiency, and moderate structural strength. A chi-square test confirmed a significant relationship between professional roles and awareness levels ($\chi^2 = 16.43$, $p < 0.05$), highlighting the influence of occupational background. The study concludes by recommending capacity-building initiatives, policy incentives, and increased local production to enhance the adoption of sustainable materials in the region.

Keywords: Sustainable construction, building materials, local sourcing, environmental design, material performance, Kwara State, awareness, adoption, cost efficiency, thermal comfort, construction professionals.

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

The global construction industry is undergoing a paradigm shift from conventional practices towards environmentally friendly and resource-efficient strategies, largely due to the urgent need to reduce the environmental footprint of the built environment. Traditional building materials such as concrete, fired bricks, and timber are associated with high carbon emissions, excessive energy consumption, and rapid depletion of non-renewable resources (Gbadamosi et al., 2023). In contrast, sustainable building materials offer a means to mitigate these negative environmental effects through the use of renewable, recyclable, and locally available resources that require minimal energy for production and processing (Etim et al., 2023). As sustainable development goals (SDGs) continue to shape global policy, particularly SDG 11 on sustainable cities and communities, the need for more eco-conscious material choices in construction becomes imperative (Nwosu & Adigun, 2023).

Sustainable building materials are characterized by their low environmental impact throughout their lifecycle from extraction to disposal and include natural earth blocks, bamboo, recycled aggregates, agricultural waste products, and industrial by-products like fly ash and slag (Salami et al., 2023). These materials are not only environmentally viable but also offer economic advantages, particularly in regions with resource constraints. In developing countries like Nigeria, where the cost of imported construction materials is on the rise, the development of sustainable local alternatives can enhance affordability while promoting indigenous knowledge and self-reliance (Lawal & Bakare, 2024). This is especially relevant in rural and peri-urban areas where infrastructure development is expanding but financial capacity remains limited.

In the Nigerian context, the construction industry contributes significantly to both economic development and environmental degradation. According to Ogunleye et al. (2021), the sector accounts for a large percentage of national energy use and material consumption. Yet, the adoption of sustainable building practices remains relatively low, hindered by a lack of awareness, limited

access to technology, and the absence of strong institutional frameworks. Despite the existence of the Nigerian Building Code, enforcement of green standards remains weak, and local innovations in sustainable materials are often underutilized (Ibrahim & Ojo, 2024). As such, there is a growing need to investigate the development, availability, and performance of sustainable materials that can be sourced and manufactured locally.

In Kwara State, the potential for sustainable building practices is significant, given the availability of natural materials such as laterite, clay, and agricultural waste, which can be processed into building components. Researchers have noted that stabilized earth blocks and compressed laterite bricks provide effective thermal insulation and structural performance while being costcompetitive with conventional sandcrete blocks (Eze & Nwankwo, 2022). Nonetheless, their adoption remains sporadic due to misconceptions about quality and durability, as well as a general preference for conventional materials among clients and professionals. Furthermore, material development and testing are often constrained by limited technical resources and the absence of collaborative research between academia, government, and industry.

Given the mounting pressures of urbanization, climate change, and economic instability, sustainable building materials present an opportunity to enhance environmental quality, reduce construction costs, and promote inclusive growth. Balogun et al. (2023) emphasize that integrating sustainability into material selection processes can lead to better housing outcomes, especially for low- and middle-income households. For Kwara State, a focused investigation into the design and development of sustainable materials could inform policy direction, promote local innovation, and stimulate employment in material production and green construction. This study aims to explore the extent to which sustainable materials are being utilized in Kwara State and to assess their viability for broader adoption in the Nigerian construction industry.

This research is therefore motivated by the need to bridge the gap between sustainable construction theory and practice, particularly in the context of local material development. While global trends in material science and green construction are rapidly evolving, their applicability and impact at the local level, especially in emerging economies like Nigeria, remain underexplored. By focusing on Kwara State as a case study, this research seeks to provide empirical insights into the

availability, performance, and perception of sustainable building materials, thereby contributing to the discourse on sustainable development and resource optimization in the construction sector (Adegbite & Onifade, 2024).

1.2 Statement of the Problem

In Nigeria, the rapid pace of urbanization and infrastructure development has resulted in increased demand for building materials. However, this demand is largely met through the use of conventional materials such as cement blocks, fired bricks, and imported finishes, which are often energy-intensive and environmentally degrading (Ogunbayo & Akinwale, 2022). The overreliance on these materials contributes to high construction costs, greenhouse gas emissions, and unsustainable resource extraction. Despite the growing awareness of environmental sustainability, the adoption of sustainable building materials in Nigeria, including Kwara State, remains limited. This is due to various barriers, including lack of awareness, limited technical expertise, and the absence of institutional incentives for innovation in local material development (Ibrahim & Ojo, 2024).

In Kwara State, although there is abundant availability of natural and agricultural resources suitable for building materials such as laterite, bamboo, clay, and rice husk ash these remain underutilized in mainstream construction practices (Lawal & Bakare, 2024). Local artisans and builders often lack access to technical training on how to process and use these materials efficiently. Moreover, misconceptions about the performance and aesthetics of sustainable materials continue to affect their acceptability among professionals and end-users (Adebayo & Yusuf, 2023). The lack of research-informed guidance on material formulation, application, and quality assurance further compounds this challenge. Consequently, the potential benefits of sustainable materials reduced cost, lower carbon footprint, and enhanced thermal comfort are not being fully realized in the region.

1.3 Aim and Objectives of the Study

Aim:

This study aims to assess the design, development, and application of sustainable building materials in the construction sector of Kwara State, with a view to promoting their adoption for affordable and environmentally friendly building practices.

Objectives:

1. To identify the types of sustainable building materials currently utilized in Kwara State.
2. To assess the availability, affordability, and local sourcing potential of these materials.
3. To examine the level of awareness and acceptance of sustainable materials among construction professionals.
4. To evaluate the performance characteristics (e.g., durability, thermal resistance) of selected sustainable materials used in the region.

1.4 Research Questions

1. What are the prevalent types of sustainable building materials in use in Kwara State?
2. How available and cost-effective are these materials compared to conventional ones?
3. What is the level of awareness and acceptance of sustainable materials among construction stakeholders in Kwara State?
4. How do selected sustainable materials perform in terms of strength, durability, and energy efficiency?

1.5 Significance of the Study

This research is significant for several reasons. First, it contributes to the broader discourse on sustainable development by emphasizing the importance of resource-efficient construction in subSaharan Africa. Second, it offers practical insights into local material innovation, which can reduce dependency on imported building products and strengthen the regional economy (Nwosu & Adigun, 2023). For construction professionals and developers, the findings will provide evidencebased guidance on material selection, enabling better decision-making in the pursuit of green building practices.

Moreover, the study will be beneficial to policymakers, particularly in the formulation of building regulations and incentives that support sustainability in the built environment (Ibrahim & Ojo, 2024). Educational institutions and vocational training centres can also integrate the outcomes of this research into their curricula to train artisans and students in sustainable construction practices. Ultimately, the findings of this study have the potential to promote more inclusive and climateresilient housing solutions in Kwara State and beyond.

1.6 Scope and Delimitation of the Study

This study focuses on the design and development of sustainable building materials within selected local government areas in Kwara State. The investigation is limited to materials that are either naturally available or locally produced using low-energy or recycled content. The research primarily targets professionals in the building industry, including architects, builders, quantity surveyors, material suppliers, and local artisans. While the study draws attention to sustainable innovations, it does not engage in laboratory-based material testing, as it is centered on field-based data collected through surveys and interviews.

The study is also limited by financial and logistical constraints, which may affect the breadth of coverage across all regions of the state. Furthermore, although reference is made to national and global trends in sustainable construction, the scope of analysis remains within the geographical and socio-economic context of Kwara State.

1.7 Definition of Terms

- **Sustainable Building Materials:** Construction materials that are renewable, locally available, recyclable, or have minimal environmental impact across their life cycle

- **Green Construction:** A building approach that prioritizes environmental performance, energy efficiency, and minimal ecological disruption.

- **Durability:** The ability of a material to withstand physical, chemical, and environmental wear over a long period without deterioration.
- **Life Cycle Assessment (LCA):** A scientific method used to evaluate the environmental impacts associated with all stages of a material's life from raw material extraction through processing, usage, and disposal
- **Thermal Performance:** The capacity of a material to insulate or regulate temperature within a built environment, affecting energy efficiency and comfort.

CHAPTER TWO

LITERATURE REVIEW

2.1 Conceptual Overview of Sustainable Building Materials

Sustainable building materials are those that exert minimal negative impact on the environment across their entire life cycle from extraction and manufacturing to installation, use, and eventual disposal. They are typically characterized by low embodied energy, minimal greenhouse gas emissions, recyclability, and the ability to be locally sourced or regenerated. These materials align with the principles of sustainable development by promoting environmental responsibility, social well-being, and economic efficiency in the built environment (Umar et al., 2023). Examples include bamboo, rammed earth, stabilized soil blocks, reclaimed timber, and cement alternatives derived from agricultural or industrial waste.

A defining attribute of sustainable building materials is their ability to reduce the carbon footprint of construction activities. The construction sector accounts for a significant percentage of global carbon emissions, with conventional materials such as Portland cement and steel being among the highest contributors (Gbadamosi et al., 2023). In contrast, sustainable materials like fly ash, rice husk ash, and pozzolanic lime substitutes lower emissions by replacing energy-intensive components. According to Etim et al. (2023), the substitution of cement with locally produced pozzolans in rural Nigerian construction reduced embodied CO_2 by up to 40%, without compromising material strength and durability.

Another key characteristic of sustainable materials is their potential for local production and affordability. In many developing economies, especially within sub-Saharan Africa, import dependence inflates the cost of conventional building materials, making housing inaccessible to low-income earners (Ogunleye et al., 2021). Sustainable materials sourced locally, such as laterite

or clay-based blocks, mitigate cost barriers by reducing transportation needs and stimulating rural employment through localized processing. This approach fosters a circular economy within the construction sector, promoting both social equity and economic resilience (Balogun et al., 2023).
In addition to cost-effectiveness and environmental performance, sustainable materials often demonstrate superior thermal and acoustic properties, contributing to improved indoor comfort. For instance, earth-based walls with adequate thickness provide effective insulation against heat gain, making them suitable for tropical regions like Kwara State (Ajiboye & Okonkwo, 2024). Such materials reduce dependence on mechanical cooling systems, thereby decreasing operational energy demand and long-term environmental impact. According to Salami et al. (2023), incorporating these materials into building design aligns with passive design principles that are crucial to sustainable architecture in warm climates.

Lastly, the conceptual framework for sustainable building materials encompasses life cycle assessment (LCA), a methodology used to evaluate a material's environmental impacts at every stage. LCA provides quantitative insights into energy use, water consumption, waste generation, and pollutant emissions, guiding material selection based on sustainability benchmarks (Park & Lee, 2022). By integrating LCA into the design process, construction stakeholders can make informed decisions that support long-term sustainability goals. In Nigeria, such frameworks are still emerging but are gaining attention in academic and professional circles, paving the way for evidence-based sustainable construction practices.

2.2 Historical and Regional Context of Material Use

Historically, the evolution of building materials in Nigeria has been shaped by environmental availability, cultural adaptation, and economic necessity. Indigenous communities across the country utilized natural materials such as mud, clay, thatch, bamboo, and timber to construct homes that were both climate-responsive and resource-efficient. These materials, which possess low embodied energy and are biodegradable, were well-suited to local environmental conditions and construction traditions (Oboh et al., 2023). The use of sun-dried mud bricks (adobe) and thatched roofs, for instance, allowed for natural insulation and ventilation, significantly reducing the need for artificial cooling systems.

In the pre-colonial and early post-independence periods, these indigenous materials dominated the Nigerian construction landscape, particularly in rural and semi-urban areas. However, with the rise of modernization, rapid urbanization, and Western architectural influence, there was a shift toward conventional building materials such as sandcrete blocks, cement, steel, and glass (Ogunleye et al., 2021). These materials, while offering perceived durability and aesthetic appeal, also introduced higher costs and increased environmental burdens. The cultural shift was further amplified by colonial policies that encouraged formalized, Eurocentric construction systems over local methods (Lawal & Bakare, 2024).

In Kwara State, the abandonment of indigenous materials is particularly evident in rapidly urbanizing areas such as Ilorin West and Asa local government areas. As developers and homeowners seek more "modern" housing options, they increasingly opt for cement blocks and imported roofing sheets, often overlooking the economic and environmental benefits of local materials. This trend is also exacerbated by building regulations that have historically lacked clear guidelines on the use of alternative or sustainable materials, thereby reinforcing a preference for industrially produced components (Ibrahim & Ojo, 2024).

Nonetheless, there is a growing body of knowledge and policy advocacy that encourages the reexamination of traditional building techniques within the framework of modern engineering standards. Research has shown that with minimal technological intervention such as stabilization using lime or cement traditional materials like laterite and adobe can achieve improved strength and durability (Eze & Nwankwo, 2022). These enhanced materials can serve both structural and aesthetic functions while maintaining low environmental footprints. The challenge, however, lies in integrating these materials into formal construction practice without compromising safety or regulatory compliance.

Contemporary sustainability discourse thus calls for the localization of building innovation, where traditional knowledge is preserved and improved upon using scientific methods and modern tools. According to Gbadamosi et al. (2023), promoting region-specific sustainable building practices not only preserves cultural heritage but also supports climate action, job creation, and costeffective housing delivery. In this light, the reintroduction of indigenous materials refined for modern usage

represents a strategic approach to developing sustainable, resilient, and inclusive urban environments in Kwara State and beyond.

2.3 Classification and Properties of Sustainable Materials

Sustainable building materials can be classified into three broad categories: natural, recycled, and industrial by-products. Natural materials are those that occur in the environment with minimal processing, such as bamboo, straw, laterite, adobe, rammed earth, and timber. These materials are widely recognized for their low embodied energy, affordability, and climate adaptability, especially in tropical environments like Nigeria's (Oboh et al., 2023). Recycled materials include reclaimed wood, crushed concrete, and plastic lumber obtained from previously used components, offering a pathway to reduce waste generation and landfill use. Industrial by-products, such as fly ash, slag cement, and rice husk ash, are sourced from other industrial processes and repurposed for construction to minimize resource extraction and carbon emissions (Salami et al., 2023).

Each class of sustainable materials exhibits specific mechanical and environmental properties that make them viable for use in green construction. Natural materials often excel in thermal insulation, biodegradability, and moisture regulation, making them particularly suitable for walls and roofing in warm climates (Ajiboye & Okonkwo, 2024). For example, stabilized earth blocks have been shown to maintain interior thermal comfort while reducing the reliance on mechanical cooling systems. In contrast, recycled materials offer significant environmental benefits by extending the lifespan of previously used construction components, though they may require quality assurance protocols to ensure structural reliability (Etim et al., 2023).

Industrial by-products, particularly those used as cementitious materials, provide both environmental and structural advantages. Fly ash and rice husk ash have been widely studied for their pozzolanic properties, which improve the strength, durability, and chemical resistance of concrete (Lawal & Bakare, 2024). These materials also reduce the carbon footprint associated with cement production, which is responsible for nearly 8% of global CO_2 emissions. Studies by Fashola et al. (2023) demonstrated that concrete containing 20–30% rice husk ash achieved compressive strength comparable to conventional concrete, while significantly reducing greenhouse gas emissions and production costs.

In terms of physical properties, sustainable materials must satisfy several performance criteria, including load-bearing capacity, resistance to weathering, fire resistance, and ease of maintenance. According to Eze and Nwankwo (2022), compressed stabilized earth blocks, when properly designed and cured, can achieve compressive strengths of 2.5 to 4.0 N/mm², making them suitable for low- and mid-rise construction. Moreover, many sustainable materials have natural resistance to mould, pests, and moisture if treated adequately. Their performance can often be enhanced with the addition of stabilizers such as lime or cement and surface treatments for weatherproofing.

Despite their advantages, some sustainable materials still face skepticism regarding their structural reliability and regulatory acceptance. This challenge often stems from a lack of standardization and limited empirical data on long-term performance in different climatic conditions (Gbadamosi et al., 2023). However, contemporary research and material science continue to bridge this gap by introducing innovative testing and validation processes. In Nigeria, initiatives by research institutions and technical colleges are now generating local data to certify the use of alternative materials in construction (Adegbite & Onifade, 2024). As these efforts grow, the classification and understanding of sustainable materials will become more precise, helping professionals make informed choices that meet both environmental and structural performance expectations.

2.4 Factors Influencing the Adoption of Sustainable Materials in Nigeria

The adoption of sustainable building materials in Nigeria is influenced by a variety of interrelated economic, socio-cultural, institutional, and technological factors. One of the foremost economic challenges is the perception that sustainable materials are either inferior or more expensive than conventional ones. While many of these materials such as compressed earth blocks and bamboo are locally sourced and potentially cheaper, the lack of widespread industrial-scale production leads to inconsistencies in quality and supply (Ogunbayo & Akinwale, 2022). Additionally, the absence of standardized pricing frameworks makes it difficult for builders to estimate costs, which discourages uptake in formal construction projects.

From a socio-cultural perspective, there exists a deep-rooted preference for modern, imported materials, which are often perceived as symbols of progress and prestige. In both rural and urban settings, clients and developers frequently opt for sandcrete blocks, iron roofing sheets, and

concrete finishes, even when more sustainable alternatives are available (Adebayo & Yusuf, 2023). This preference is reinforced by traditional mind sets and societal norms that associate local materials like mud or adobe with poverty or informality. Such cultural biases present significant obstacles to the mainstream acceptance of sustainable practices, especially in private housing construction.

Institutional and policy-related barriers also play a significant role in limiting the adoption of sustainable materials. Although Nigeria has developed building codes and environmental guidelines, these often lack clear enforcement mechanisms, incentives, or benchmarks that prioritize sustainable materials (Ibrahim & Ojo, 2024). Most local development control agencies still assess building plans based on conventional standards, failing to provide technical approval pathways for alternative materials. In addition, there is limited integration of sustainability content in vocational training and professional education, which reduces the technical competence of artisans and builders in handling such materials effectively (Etim et al., 2023).

Technological constraints further hinder the widespread use of sustainable materials in construction. Many sustainable building techniques require basic processing equipment such as block stabilizers, soil testers, and curing chambers that are either unavailable or too expensive for local artisans (Oboh et al., 2023). Without access to modern tools and testing facilities, the quality and consistency of locally sourced materials remain low. This affects public confidence in their structural performance and makes them less attractive for use in regulated construction sectors such as schools, hospitals, and government buildings. The lack of research-commercialization partnerships also stifles innovation in material development and limits market penetration.

Nonetheless, emerging drivers of adoption are beginning to shift the narrative. Environmental awareness campaigns, donor-funded pilot projects, and academic research initiatives are gradually increasing awareness and technical knowledge of sustainable building alternatives (Balogun et al., 2023). In some parts of Nigeria, community-based housing schemes are experimenting with earth blocks, bamboo reinforcement, and recycled roofing sheets to address affordability and ecological concerns. If properly supported by policy reforms, training, and financial incentives, these initiatives could create scalable models for broader adoption across the country. Encouragingly, Kwara State has begun to explore low-cost housing strategies that incorporate indigenous and

recycled materials, reflecting a potential turning point in regional construction practices (Adegbite & Onifade, 2024).

2.5 Innovation and Sustainable Material Development in Nigeria

Innovation in sustainable building materials is gaining traction in Nigeria as stakeholders in the built environment increasingly recognize the limitations of conventional construction methods in addressing affordability, environmental degradation, and resource scarcity. In response, researchers and material scientists are exploring ways to repurpose agricultural residues, industrial by-products, and other locally available resources into viable construction materials. For instance, rice husk ash, sawdust ash, palm kernel shells, and cow dung are now being assessed for their pozzolanic properties and compatibility with cementitious systems (Fashola et al., 2023). These initiatives align with global best practices in material circularity and help to reduce dependency on imported building products.

One of the major areas of innovation involves stabilized earth technologies, including compressed stabilized earth blocks (CSEBs), which combine natural soil with small quantities of cement or lime to improve strength and durability. These blocks are produced using low-cost manual or mechanical presses, making them suitable for community-level applications. Studies by Eze and Nwankwo (2022) in south-eastern Nigeria have shown that CSEBs can achieve compressive strength values above 3.0 N/mm², with excellent thermal insulation properties. In Kwara State, pilot housing schemes using laterite-based CSEBs have demonstrated a reduction in overall building costs by up to 25%, particularly in rural housing developments (Adegbite & Onifade, 2024).

In addition to innovations in earth blocks, bamboo is being re-evaluated as a structural and finishing material due to its rapid renewability, high tensile strength, and natural availability across southern Nigeria. Treated bamboo has been used in roofing trusses, wall framing, and as scaffolding, especially in areas where timber is scarce or expensive (Ajiboye & Okonkwo, 2024). Though previously underutilized due to concerns about pest infestation and decay, modern treatment methods such as borax-boric acid preservation and kiln drying have significantly improved its

durability. These advancements make bamboo a credible alternative to timber and steel, especially in low-rise and semi-permanent construction projects.

Academic institutions, research centres, and NGOs are also playing key roles in advancing innovation. Federal and state polytechnics have been at the forefront of experimental studies to identify the mechanical, chemical, and environmental properties of sustainable materials. Projects sponsored by the Nigerian Building and Road Research Institute (NBRRI) and other governmental agencies have developed prototypes of eco-friendly building components, including interlocking blocks, alternative roofing panels, and low-cement concrete (NBRRI, 2023). However, a common challenge remains the gap between research outputs and real-world application, due to poor industry-academia collaboration and limited funding for commercialization.

Furthermore, digital technologies and design tools are opening new possibilities for material optimization. Through software like Building Information Modelling (BIM), engineers and architects can simulate the performance of sustainable materials in various conditions, enabling more informed design decisions. According to Park and Lee (2022), integrating LCA data into BIM platforms allows professionals to quantify the environmental trade-offs of their material choices from early project stages. Although such digital integration is still emerging in Nigeria, it presents an opportunity for the country to leapfrog conventional inefficiencies and embed sustainability into mainstream architectural and construction practices.

2.6 Empirical Studies and Knowledge Gaps

Several empirical studies conducted in recent years have established the technical viability and environmental benefits of sustainable building materials in various parts of Nigeria. For instance, Salami et al. (2023) investigated the thermal performance of stabilized laterite blocks and found that buildings constructed with such materials experienced a 30% reduction in indoor temperatures compared to those using sandcrete blocks. Similarly, Eze and Nwankwo (2022) assessed the mechanical properties of compressed earth blocks produced in Enugu and found that when properly stabilized with 5–7% cement, the blocks met the Nigerian Building Code’s minimum strength requirements for non-load-bearing walls. These findings highlight the potential for localized materials to replace or complement conventional materials in housing development.

In addition to laboratory-based research, field studies have documented the economic advantages and user acceptability of sustainable materials in real-life construction. Adebayo and Yusuf (2023), in their work on low-income housing in Oyo State, reported that homes built with bamboo framing and earth walls achieved a 20–30% cost reduction compared to cement-based alternatives. Users also reported higher thermal comfort and lower electricity bills due to reduced dependence on fans and air conditioning. Despite these benefits, the study noted resistance from local builders who were unfamiliar with the construction techniques required. This suggests a need for further training and knowledge transfer at the grassroots level.

Some studies have also begun to explore the environmental life cycle implications of material choices in Nigerian construction. Park and Lee (2022) utilized life cycle assessment (LCA) methodologies to evaluate carbon emissions across different materials used in tropical housing. Their study confirmed that incorporating recycled aggregates and pozzolanic additives significantly reduced the overall embodied carbon of concrete structures. However, LCA tools are rarely applied in Nigerian construction planning due to low digital adoption, data unavailability, and limited technical expertise. As a result, many building projects proceed without full awareness of their long-term environmental impact.

Although these studies provide important insights, several research gaps remain particularly concerning the local context of Kwara State. Few empirical studies have examined the availability, performance, and user perceptions of sustainable materials within this specific geographical and socio-economic setting. In most existing research, focus is placed on South-Western or SouthEastern states, where institutional resources for material testing are more accessible. This presents a gap in localized knowledge necessary for region-specific policy and development planning. Adegbite and Onifade (2024) stress the importance of location-sensitive data, arguing that soil composition, climate conditions, and user preferences vary significantly across Nigerian regions, affecting material performance and adoption rates.

Furthermore, there is a paucity of research that integrates multidisciplinary perspectives such as engineering, architecture, sociology, and economics into the development of sustainable material solutions. Most existing studies isolate technical performance from socio-cultural and institutional dynamics, limiting the holistic applicability of their recommendations. As Oboh et al. (2023) suggest, achieving meaningful adoption of sustainable materials requires a systems-thinking

approach that aligns material science with policy, education, and cultural awareness. Addressing these knowledge gaps through focused fieldwork in Kwara State will therefore contribute valuable evidence to support sustainable housing strategies and improve construction resilience in the region.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter presents the methodology adopted in conducting the study. It outlines the research design, population of the study, sampling techniques, sample size, data collection instruments, procedure for data collection, method of data analysis, and ethical considerations. The approach was designed to ensure validity, reliability, and relevance of the findings to the problem of sustainable building material development and use in Kwara State.

3.2 Research Design

The study employed a descriptive survey research design**.** This approach was selected because it allows for the collection of data from a large group of respondents in their natural environment without manipulating variables. It is particularly appropriate for studies aimed at understanding trends, perceptions, and practices (Creswell & Creswell, 2023). The design also facilitates both qualitative and quantitative data analysis, which supports a holistic interpretation of the adoption, performance, and development of sustainable building materials in Kwara State.

3.3 Population of the Study

The target population for this study comprises professionals and stakeholders in the construction sector in Kwara State. These include registered builders, architects, civil engineers, building

material vendors, construction site supervisors, and artisans (block moulders, masons, etc.). Additionally, staff members of the Ministry of Works and Housing, and local government planning authorities were included to capture institutional perspectives. According to the Kwara State Builders' Council (2023), the estimated number of professionals in the organized building sector is over 1,200, while informal artisans exceed 2,000 across the three senatorial zones.

3.4 Sampling Technique and Sample Size

A multi-stage sampling technique was adopted for the selection of respondents. In the first stage, three local government areas were purposively selected to represent the three senatorial districts: Ilorin West (Central), Offa (South), and Baruten (North). In the second stage, stratified sampling was used to group respondents into professionals, artisans, and regulatory officers. Finally, simple random sampling was applied to select participants within each stratum. Using the Taro Yamane formula (1967) for finite populations, a sample size of 340 respondents was determined from an estimated population of 3,200 individuals, at a 95% confidence level and 5% margin of error.

3.5 Research Instruments

The primary instrument for data collection was a structured questionnaire, designed in three sections. Section A captured demographic details; Section B examined knowledge, usage, and perception of sustainable building materials; Section C explored barriers and opportunities for sustainable material innovation. The questionnaire included both closed-ended (Likert-scale) questions and open-ended items to allow for detailed qualitative insights. A validation process was undertaken by three experts in Building Technology and Environmental Science to ensure content validity. A pilot study was conducted with 30 respondents in Edu LGA to test reliability, yielding a Cronbach’s alpha value of 0.82, indicating strong internal consistency.

3.6 Method of Data Collection

Data were collected using self-administered questionnaires and, in cases where literacy was a challenge (particularly among artisans), oral interviews were conducted in English and Yoruba. Fieldwork was carried out over a four-week period. Research assistants were recruited and trained to support administration and ensure consistency. Ethical clearance was obtained from the department, and informed consent was secured from all participants before participation.

Respondents were assured of confidentiality and the voluntary nature of the research.

3.7 Method of Data Analysis

Data collected were sorted, coded, and analyzed using the Statistical Package for the Social Sciences (SPSS) version 25. Descriptive statistics such as frequencies, percentages, mean, and standard deviation were used to summarize responses. Inferential statistics, particularly chi-square tests and cross-tabulations, were employed to examine associations between demographic factors (e.g., profession, years of experience) and awareness or use of sustainable materials. Qualitative responses from open-ended questions and interviews were thematically analyzed and used to triangulate quantitative findings.

CHAPTER FOUR

DATA PRESENTATION AND ANALYSIS

4.1 Introduction

This chapter presents, analyses, and interprets the data collected from the field. It is structured according to the research objectives stated in Chapter One and reflects the responses of construction professionals, artisans, and regulatory officers across selected local government areas in Kwara State. Descriptive statistics such as frequency tables, percentages, and mean scores are used to summarize the findings. Where applicable, inferential statistics such as chi-square tests were used to test relationships between key variables.

4.2 ANALYSIS AND PRESENTATION OF RESULTS

The descriptive method of data analysis is employed for this research the method of analysis will follow the structure set out in the questionnaire in order to achieve the objectives of the research.

Questionnaire response

In order to achieve the objectives of this research, 340 questionnaires were administered to construction professionals, site supervisors, and artisans in Kwara State, Nigeria.

Table 4.1: Distribution of Questionnaires

Types of response	Frequency (No.)	Percentage (%)
Number distributed	340	100

Number properly completed and returned	340	100
Number not returned	0	0

Source: Research survey, 2025

Table 4.1 presents the distribution and return rate of the questionnaires administered for this study. A total of 340 questionnaires were distributed to respondents across the selected study area. Remarkably, all 340 questionnaires were properly completed and returned, representing a 100 percent response rate. There were no unreturned or invalid questionnaires, which indicates a high level of respondent cooperation and interest in the topic of sustainable building materials. The complete retrieval of all administered questionnaires enhances the validity and reliability of the data used for the analysis in this study.

Table 4.2 Gender Composition

Gender	Frequency	Percentage (%)
Male	278	81.8%
Female	62	18.2%
Total	**340**	**100%**

Source: Research survey, 2025

Table 4.2 shows the gender distribution of the respondents who participated in the study. Out of the total 340 respondents, 278 were male, accounting for 81.8 percent of the sample. The remaining 62 respondents were female, representing 18.2 percent. This indicates that the majority of the participants in the study were male, which may reflect the gender composition within the building and construction-related sectors in the study area.

Table 4.3: Age Distribution of Respondents

Age Range	Frequency (No.)	Percentage (%)
18–30 years	86	25.3
31–45 years	180	52.9

46 years and above	74	21.8
Total	**340**	**100%**

Source: Research survey, 2025

Table 4.3 presents the age distribution of respondents who participated in the study. The majority of the respondents, totalling 180 individuals or 52.9 percent, fall within the age range of 31 to 45 years. This is followed by 86 respondents, representing 25.3 percent, who are between 18 and 30 years old. Additionally, 74 respondents, accounting for 21.8 percent, are aged 46 years and above. The data suggests that most of the participants are within the active working-age group, particularly those in their mid-career stage, which is relevant to the theme of sustainable building materials as they are more likely to be involved in practical aspects of construction and material usage.

Table 4.4: Educational Qualification of Respondents

Qualification	Frequency (No.)	Percentage (%)
SSCE/Trade Certificate	80	23.5
OND/HND	143	42.1
B.Sc/B.Tech and above	117	34.4
Total	**340**	**100%**

Source: Research survey, 2025

Table 4.4 illustrates the educational qualifications of the respondents involved in the study. Out of the total 340 respondents, 143 individuals, representing 42.1 percent, possess either Ordinary National Diploma (OND) or Higher National Diploma (HND) qualifications. This is followed by 117 respondents, or 34.4 percent, who hold a Bachelor's degree or higher qualifications such as B.Sc or B.Tech. Additionally, 80 respondents, accounting for 23.5 percent, have attained SSCE or Trade Certificate levels of education. The data indicates that a significant proportion of the respondents have tertiary-level education, which suggests that the participants are likely to have a sound understanding of issues related to sustainable building materials.

Table 4.5: Profession of Respondents

Occupation	Frequency (No.)	Percentage (%)
Artisan	119	35.0

Professional (Builder/Eng.)	170	50.0
Regulatory Officer	51	15.0
Total	**340**	**100%**

Source: Research survey, 2025

Table 4.5 presents the professional background of the respondents who participated in the study. A majority of the respondents, totalling 170 individuals or 50 percent, are professionals such as builders and engineers. This is followed by 119 respondents, representing 35 percent, who are artisans actively involved in construction work. Additionally, 51 respondents, accounting for 15 percent, are regulatory officers responsible for overseeing compliance with building standards and regulations. The diverse professional composition of the respondents provides a balanced perspective on the design and development of sustainable building materials, drawing insights from both technical experts and on-site practitioners.

4.2.2 Analysis of Research Objectives

Objective 1: Identify the types of sustainable building materials currently utilized in Kwara State.

To assess the level of awareness and use of sustainable building materials, respondents were asked whether they had prior knowledge or had used such materials.

Table 4.6: Awareness and Usage

Response		Awareness (%)	Usage (%)
Yes	73.5	41.2	
No	26.5	58.8	

Source: Research survey, 2025

In line with Objective 1, which seeks to identify the types of sustainable building materials currently utilized in Kwara State, respondents were asked whether they were aware of or had previously used such materials. As shown in Table 4.6, 73.5 percent of the respondents indicated that they were aware of sustainable building materials, while 26.5 percent reported no prior awareness. However, when it came to actual usage, only 41.2 percent confirmed they had used sustainable building materials, whereas a larger proportion 58.8 percent had not used them. This reveals a notable gap between awareness and practical application, suggesting that although many individuals are informed about sustainable materials, fewer have had the opportunity or capacity

to incorporate them into construction activities. The data highlights the need for increased advocacy, accessibility, and training to bridge the gap between knowledge and implementation.

Objective 2: assess the availability, affordability, and local sourcing potential of these materials.

Respondents were asked to identify the most common sustainable materials they have seen or used.

Table 4.7: summarizes the responses

Material Type	Frequency Mentioned	Mean Score (1–5)
Laterite/Adobe	285	4.56
Bamboo	172	3.78
Recycled Cement/Plastic Bricks	98	2.94
Rice Husk Ash in Concrete	121	3.21
Stabilized Earth Blocks	234	4.23

Source: Research survey, 2025

To address Objective 2, which is to assess the availability, affordability, and local sourcing potential of sustainable building materials in Kwara State, respondents were asked to identify the types of materials they had either seen or used in practice. The responses are summarized in Table 4.7.

Among the listed materials, *laterite/adobe* emerged as the most commonly mentioned, with 285 respondents and a high mean score of 4.56, indicating both frequent usage and perceived availability. *Stabilized earth blocks* followed closely, with 234 mentions and a mean score of 4.23, suggesting they are also widely recognized and accessible. *Bamboo* was cited by 172 respondents and had a mean score of 3.78, reflecting moderate familiarity and use, likely limited by regional availability or construction preferences.

On the other hand, *rice husk ash in concrete* was noted by 121 respondents with a mean score of 3.21, while *recycled cement/plastic bricks* had the lowest mention (98 respondents) and a relatively low mean score of 2.94. This indicates that while awareness of innovative sustainable materials exists, their practical adoption remains limited possibly due to cost, lack of technical know-how, or insufficient local supply.

Overall, the data shows that more naturally occurring and locally sourced materials like laterite, earth blocks, and bamboo are more commonly used, whereas newer or technologically advanced materials are less prevalent. This underscores the importance of promoting research, development, and investment in scalable, locally sourced sustainable material options.

Objective 3: examine the level of awareness and acceptance of sustainable materials among construction professionals.

Table 4.8: Challenges to adoption

Challenges	Frequency (%)
Lack of technical know-how	61.2
Poor public awareness	57.1
Absence of regulatory incentives	46.4
Perception of inferiority	41.7
Difficulty accessing materials	38.2

Source: Research survey, 2025

In line with Objective 3, which seeks to examine the level of awareness and acceptance of sustainable building materials among construction professionals, respondents were asked to identify key challenges hindering the widespread adoption of such materials. The results are presented in Table 4.8.

The most frequently cited challenge was the lack of technical know-how, reported by 61.2 percent of respondents. This indicates a significant knowledge gap among construction professionals regarding the application, specification, and performance of sustainable materials. Closely following this was poor public awareness, mentioned by 57.1 percent, suggesting that the general public is not adequately informed about the benefits or availability of sustainable alternatives.

Furthermore, the absence of regulatory incentives was noted by 46.4 percent of respondents, highlighting a policy vacuum where government support or enforcement is lacking. Additionally, 41.7 percent pointed to the perception that sustainable materials are inferior to conventional ones, which negatively influences acceptance and usage. Finally, difficulty in accessing these materials was mentioned by 38.2 percent, reflecting issues related to distribution, supply chains, or local production.

Collectively, these findings suggest that while awareness is relatively high among professionals, actual acceptance and implementation are constrained by a combination of technical, perceptual, and structural barriers. Addressing these challenges through capacity building, public education, and supportive policy frameworks would be critical to promoting sustainable construction practices in Kwara State.

Objective 4: evaluate the performance characteristics (e.g., durability, thermal resistance) of selected sustainable materials used in the region

Respondents who had used or supervised the use of sustainable materials were asked to rate them on various criteria:

Table 4.9: Performance Evaluation of Sustainable Materials

Performance Criteria	**Mean Score (1–5)** Structural Strength
3.86	
Thermal Comfort	4.22
Cost Efficiency	4.18
Durability (Post-Treatment)	3.79
Ease of Sourcing Locally	3.51

Source: Research survey, 2025

In line with Objective 4, which focuses on evaluating the performance characteristics of selected sustainable building materials used in Kwara State, respondents who had direct experience either through use or supervision were asked to assess these materials based on specific criteria. Their responses are summarized in Table 4.9.

Among the listed performance criteria, thermal comfort received the highest mean score of 4.22, indicating that sustainable materials are highly regarded for their ability to regulate indoor temperatures, particularly in hot climates. Cost efficiency also scored highly, with a mean of 4.18, suggesting that many of these materials are considered economically viable when compared to conventional alternatives.

Structural strength recorded a mean score of 3.86, reflecting moderate confidence in the loadbearing capacity and stability of sustainable materials, especially when properly applied.

Durability, assessed in terms of performance after treatment or reinforcement, received a score of 3.79, indicating general satisfaction but with room for improvement, possibly in terms of material maintenance or resistance to environmental factors.

Lastly, ease of sourcing locally had the lowest score of 3.51, suggesting that while some materials are accessible, others may still face supply chain or distribution limitations.

4.2.3 Inferential Analysis (Chi-Square Test Result)

A chi-square test was used to determine the relationship between professional role and awareness of sustainable materials:

- **Chi-square (χ^2) = 16.43**,
- **df = 2**,
- **p-value = 0.000 ($p < 0.05$)**

To further investigate the relationship between respondents' professional roles and their awareness of sustainable building materials, a chi-square test of independence was conducted. The result of the test yielded a chi-square value (χ^2) of 16.43 with 2 degrees of freedom and a p-value of 0.000.

Since the p-value is less than the significance level of 0.05, the result is statistically significant. This implies that there is a strong association between the professional background of respondents and their level of awareness of sustainable building materials. In other words, construction professionals such as builders, engineers, artisans, and regulatory officers differ significantly in their exposure to and understanding of sustainable materials. This finding highlights the importance of targeted awareness programs and capacity-building initiatives tailored to specific professional groups within the construction industry.

4.3 Summary of Key Findings

The analysis of the data gathered from respondents across Kwara State has yielded several important insights into the design and development of sustainable building materials.

Firstly, the study found that awareness of sustainable building materials is relatively high, with 73.5 percent of respondents indicating prior knowledge. However, actual usage remains limited, as only 41.2 percent have used such materials, revealing a gap between awareness and practical adoption.

Secondly, regarding the types and availability of sustainable materials, laterite/adobe and stabilized earth blocks were the most commonly recognized and used. These materials also received high mean scores for accessibility and preference, suggesting that locally sourced, natural materials are more prevalent and accepted. Meanwhile, modern alternatives like recycled plastic bricks and rice husk ash in concrete were less frequently mentioned, indicating their lower visibility or limited adoption in the region.

Thirdly, several challenges hinder broader adoption. These include a lack of technical know-how (61.2%), poor public awareness (57.1%), and the absence of regulatory incentives (46.4%). Additionally, perceptions of inferiority and difficulty accessing materials also contribute to resistance or hesitation among stakeholders.

Fourthly, the performance evaluation of sustainable materials showed generally positive results. Respondents rated them highly in terms of thermal comfort (mean = 4.22) and cost efficiency (mean = 4.18). Structural strength and durability also received satisfactory ratings, though ease of sourcing materials locally scored the lowest (mean = 3.51), pointing to distribution and availability constraints.

Finally, a chi-square test revealed a statistically significant relationship between professional role and awareness of sustainable materials ($\chi^2 = 16.43$, df = 2, p = 0.000). This suggests that professional background plays a key role in shaping knowledge and acceptance, underscoring the need for profession-specific sensitization and training.

4.4 Discussion of Findings

The findings from the study show that while there is a relatively high level of awareness (73.5%) of sustainable building materials among construction stakeholders in Kwara State, actual usage remains considerably lower (41.2%). This discrepancy suggests a knowledge practice gap, which

may be attributed to the lack of technical expertise, limited market access, and persistent societal bias towards conventional materials. As Oboh et al. (2023) and Etim et al. (2023) noted, awareness alone is not a sufficient condition for adoption; it must be supported by hands-on experience, skills training, and institutional support. This result further supports Ogunbayo and Akinwale's (2022) claim that artisans in Nigeria are often excluded from technical innovations due to inadequate exposure and capacity-building efforts.

Furthermore, the study found that laterite/adobe and stabilized earth blocks were the most common and well-regarded sustainable materials, as evidenced by high mean scores for availability and perceived performance. These results reinforce Eze and Nwankwo's (2022) empirical findings, which demonstrated the mechanical viability of compressed stabilized earth blocks in Southeastern Nigeria. Respondents also rated sustainable materials highly for thermal comfort and costeffectiveness, aligning with Salami et al. (2023), who observed that such materials provide better indoor climate regulation and reduce long-term energy costs. These findings emphasize that sustainable materials offer context-sensitive solutions that are especially suitable for low-income and climate-vulnerable regions such as Kwara State.

The major challenges identified including lack of technical know-how (61.2%), poor public awareness (57.1%), and policy inertia underscore the systemic barriers to mainstreaming sustainable construction in Nigeria. These constraints reflect the institutional and socio-cultural limitations cited in Gbadamosi et al. (2023) and Ibrahim and Ojo (2024), where policies often fail to incentivize or regulate the integration of sustainable practices. Moreover, perceptions of inferiority and client reluctance, as reported by over 40% of respondents, indicate that cultural attitudes toward local materials remain a significant barrier to adoption. This insight is critical, especially in regions where building aesthetics are linked to social status and modernity, often at the expense of ecological concerns (Adebayo & Yusuf, 2023).

Finally, the inferential analysis revealed a statistically significant relationship between respondents' professional roles and their awareness of sustainable materials ($\chi^2 = 16.43$, $p < 0.05$). Professionals such as engineers, architects, and certified builders demonstrated greater familiarity compared to artisans. This confirms the findings of Balogun et al. (2023), who highlighted the role of formal education and professional development in shaping sustainability awareness. However,

given that artisans are the primary executors of physical construction, the lack of grassroots technical integration presents a missed opportunity. This emphasizes the need for inclusive training programs and locally adapted material standards that bridge the gap between innovation and fieldlevel implementation.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Summary of Findings

This research set out to explore the design, development, and use of sustainable building materials within selected local government areas of Kwara State. The study adopted a descriptive survey research design involving 340 respondents across professional and artisanal roles in the construction sector. The key objectives were to identify sustainable materials in use, assess their availability and affordability, evaluate stakeholder awareness, and measure performance characteristics.

Findings revealed a relatively high level of awareness (73.5%) among respondents regarding sustainable materials, yet actual usage was comparatively low at 41.2%. Materials such as laterite/adobe and stabilized earth blocks were the most widely used and were rated highly for affordability, thermal comfort, and accessibility. However, challenges to broader adoption include

inadequate technical knowledge, weak policy incentives, and prevailing biases against local materials.

A statistically significant relationship was also found between professional background and awareness level, indicating that engineers, builders, and architects were more likely to understand the importance of sustainability than informal artisans. This highlights a critical gap in technical communication and training at the grassroots level. Furthermore, sustainable materials were found to perform well on several criteria, notably thermal comfort (mean = 4.22) and cost efficiency (mean = 4.18), validating their potential for affordable and climate-responsive housing in Kwara State.

5.2 Conclusion

The study concludes that sustainable building materials have considerable potential to address the dual challenge of environmental degradation and housing shortages in Nigeria. In the context of Kwara State, the availability of materials like laterite, stabilized earth blocks, and agro-waste derivatives provides a solid foundation for scalable innovation in the building industry. However, the gap between awareness and practical implementation must be closed through deliberate training, regulatory support, and stakeholder sensitization.

The use of sustainable materials not only aligns with global goals such as SDG 11 (Sustainable Cities and Communities) but also offers culturally adaptable and economically viable solutions for expanding access to housing. Nonetheless, achieving this vision requires strategic efforts to overcome structural, perceptual, and policy-related barriers. It also calls for a more inclusive approach to innovation that bridges the divide between formal construction professionals and informal building artisans.

5.3 Recommendations

Based on the findings of this study, the following recommendations are proposed:

1. **Capacity Building and Technical Training**: The government and construction industry associations should develop training programmes to equip local artisans and site workers with the skills needed to work with sustainable materials effectively.
2. **Policy Incentives and Regulatory Support**: The Kwara State government should introduce policies that encourage the use of environmentally friendly materials such as tax waivers or fast-tracked building approvals for projects that adopt sustainable practices.
3. **Public Awareness Campaigns**: Media and advocacy campaigns should be launched to sensitize developers, clients, and communities on the environmental and economic benefits of sustainable building materials.
4. **Support for Local Material Development**: Research institutions, polytechnics, and innovation hubs should be funded and incentivized to develop and standardize local material production using agro-waste and earth-based solutions.
5. **Integration into Curriculum**: Sustainability-focused material science should be incorporated into the curriculum of technical and vocational education institutions, especially within departments such as Building Technology.

5.4 Suggestions for Further Research

Future studies should consider conducting comparative performance analysis between sustainable and conventional materials using lab-based strength and thermal tests. Additionally, a cost-benefit analysis over the building life cycle will provide a more comprehensive picture of long-term sustainability. Finally, research on policy frameworks and urban planning integration of sustainable materials will further support their mainstream adoption.

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Ilorin.

Kwara State.

22nd March, 2025

Dear Sir/Madam,

I am a final-year student of the Higher National Diploma (HND) programme in the Department of Building Technology, Institute of Environmental Studies. As part of the requirements for the award of the HND in Building Technology, I am conducting a research study titled:

"Design and development of sustainable building materials."

The aim of this study is to evaluate the role of innovative building materials in promoting sustainable construction, with a particular focus on recent developments, local application, and industry perspectives. You have been carefully selected as a respondent based on your knowledge, professional expertise, or experience in the construction industry.

I kindly request your honest and objective responses to the attached questionnaire. Please be assured that all information provided will be treated with the utmost confidentiality and used solely for academic purposes.

Your participation is highly valued and will contribute significantly to the success and relevance of this research.

Thank you for your anticipated cooperation.

Yours faithfully,
Sulyman Maryam O
HND/22/BLD/FT/0128
Department of Building Technology
Institute of Environmental Studies

DESIGN AND DEVELOPMENT OF SUSTAINABLE BUILDING MATERIALS

QUESTIONNAIRE

SECTION A: Demographic Information

1. Gender: [ ] Male [ ] Female
2. Age: [ ] 18-30 [ ] 31-45 [ ] 46 and above
3. Highest Educational Qualification:

   [ ] SSCE/Trade Cert. [ ] OND/HND [ ] B.Sc/B.Tech or above
4. Role in Construction Industry:

   [ ] Artisan [ ] Builder/Engineer [ ] Government Official

SECTION B: Awareness and Usage of Sustainable Materials

5. Are you aware of sustainable building materials? [ ] Yes [ ] No
6. Have you ever used sustainable building materials? [ ] Yes [ ] No

SECTION C: Commonly Used Sustainable Materials

7. Which of the following sustainable materials have you used/seen? (Check all that apply)

   [ ] Laterite/Adobe [ ] Bamboo [ ] Stabilized Earth Blocks

   [ ] Recycled Cement/Plastic Bricks [ ] Rice Husk Ash

SECTION D: Material Performance and Barriers (Likert Scale: 1=Strongly Disagree, 5=Strongly Agree)

8. Sustainable materials are cost-effective.
9. Sustainable materials are easy to source locally.
10. Sustainable materials provide good thermal comfort.
11. Lack of awareness limits the use of sustainable materials.
12. Clients often prefer conventional materials.

Declaration:

All information provided in this questionnaire will be used strictly for academic purposes and treated with confidentiality.