

An assessment of key indicators for sustainable construction practices in Nigeria: Challenges and opportunities

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Paper History

Received: 06th Feb., 2025

Accepted: 20th Feb., 2025

Published: March, 2025

Abstract:

Sustainable construction practices have gained prominence due to the failure of the traditional means of construction to effectively handle environmental issues. This study therefore, assesses key indicators of sustainable construction practices in Nigeria using a mixed-method approach. A structured questionnaire was administered to 263 construction professionals. Also 3 focus group discussions (FGDs) were also conducted with 28 participants to gain qualitative insights across Abuja, Lagos, and Port Harcourt. The study utilised the mean ranking and relative important index as statistical measures for the quantitative data while the thematic analysis was used to analyse the qualitative data using SPSS version 25 and NVivo version 15 respectively. The study identifies energy efficiency, waste reduction, and preservation of natural resources as the most critical sustainability indicators. Challenges such as high costs, inadequate regulatory enforcement, and limited stakeholder engagement however hinder widespread adoption. The findings highlight the need for policy interventions, capacity-building initiatives, and the integration of key performance indicators (KPIs) to enhance sustainable construction practices. By connecting sustainability awareness with effective implementation, this study contributes to the discourse on green construction and provides recommendations for improving sustainability outcomes in the Nigerian construction industry.

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Keywords: Construction, Indicators, Innovation, Practices, Sustainability, Waste

1. Introduction

Sustainable construction practices have gained global attention as the construction industry significantly impacts the environment, economy, and society. Sustainable construction integrates environmental, social, and economic considerations into building processes to minimise negative impacts while enhancing resource efficiency [1 – 3]. The need for sustainable construction is critical due to rapid urbanisation, population growth, and environmental challenges such as deforestation, carbon emissions, and waste generation has been a source of concern to developing countries [4, 5]. Despite various initiatives promoting sustainability, the level of adoption of sustainable construction practices remains inconsistent across regions and project types [2, 4].

Several indicators have been identified as essential for measuring sustainable construction practices. For instance, Kilbert [6] and Oni [7] categorised these indicators into environmental, economic, and social dimensions, which include energy efficiency, waste management, water conservation, cost-effectiveness, stakeholder engagement, and social equity. Studies by Waziri [8], Usman, *et al.* [9] and Windapo, *et al.* [10] emphasise the importance of green building materials, renewable energy integration, and lifecycle cost analysis as

crucial factors in achieving sustainability. However, there is limited empirical research assessing how these indicators are applied in practice and their effectiveness in driving sustainable outcomes within the Nigerian construction sector [9, 10].

Environmental indicators such as carbon footprint reduction, sustainable material usage, and energy-efficient designs play a fundamental role in sustainable construction [11]. However, the Nigerian construction industry, faces challenges such as inadequate regulatory enforcement, limited awareness, and high costs of sustainable materials, which hinder the widespread adoption of environmentally friendly practices [12]. Additionally, the reliance on conventional construction techniques contributes to excessive resource depletion and environmental degradation, highlighting the need for a structured framework to monitor and enforce sustainability benchmarks.

Economic indicators are equally crucial in assessing sustainable construction. Studies have shown that cost efficiency, return on investment, and long-term financial viability influence stakeholders' willingness to adopt sustainable practices [7, 13, 14]. Furthermore, the high initial costs of green technologies and materials often deter developers from investing in sustainable projects [15,16].

However, research suggests that sustainable buildings offer long-term benefits such as reduced operational costs, higher property values, and improved occupant productivity [17 – 19]. Therefore, understanding these economic trade-offs is vital in promoting sustainable construction practices among industry stakeholders [1, 2, 5, 8]. Social indicators including health and safety, community well-being, and stakeholder involvement are critical in sustainable construction assessment [12, 13, 16]. According to Quang [11] and Gorinpath, *et al.* [13], projects that consider social sustainability tend to achieve better long-term success and user satisfaction.

Studies have shown that the Nigerian construction industry due to issues such as poor working conditions, lack of community engagement, and inadequate housing provisions is faced by gaps in social sustainability [8 - 10]. There is therefore the need to address these issues through holistic approach that integrates policies, capacity building, and public-private partnerships that would foster inclusive and socially responsible construction practices [2, 4, 8]. Given these challenges and opportunities, an assessment of key indicators has therefore become essential for improving sustainable construction practices in Nigeria. Thus, this study evaluates the extent to which these indicators are integrated into current practices as well as identify barriers to their effective implementation. Through this effort, the study aims to contribute to the ongoing discourse on sustainability in the construction industry thereby providing recommendations to enhance the adoption of green and sustainable construction practices in Nigeria.

2. Methods

This study explored the key performance indicators for sustainable construction practices in the Nigerian construction industry. A mixed-methods approach was used, combining both quantitative and qualitative research techniques. For the quantitative aspect, 263 out of 387 targeted construction professionals responded to an online questionnaire, achieving a 68% response rate. Also, three focus group discussions (FGDs), a qualitative technique for gaining in-depth insights, were also conducted with 28 participants. The study population comprised of Architects, Builders, Engineers, Estate surveyors, Town planners, and Quantity surveyors. The study was carried out in Abuja, Lagos, and Port Harcourt, Nigeria. These are three major cities with significant construction activities. To recruit participants for the FGDs, a snowball sampling technique was used, where initial respondents referred others who met the study criteria to gather expert opinions on green innovation in construction.

The quantitative data were analysed using the mean ranking and the relative importance index (RII) using Statistical Package for Social Sciences (SPSS version 25), while qualitative data were examined through thematic (Pattern) analysis using NVivo (version 15). The following formulae were used for the quantitative data analysis [20] where equation 1 is the mean ranking (*MN*) while equation 2 gives the relative importance index (*RII*):

$$MR = \frac{\sum n_i k_i}{\sum N} = \frac{5n_5 + 4n_4 + 3n_3 + 2n_2 + 1n_1 + 0n_0}{N_5 + N_4 + N_3 + N_2 + N_1 + N_0} \quad (1)$$

Where *N* = Total number of respondents, *N₅*, *n₅* = the number of respondents that choose 5, etc, 0 – 5 = the various marks for the ranking of the factors as applicable in each case and, is given in equation 2.

$$RII = \frac{\sum W(0 \leq RII \leq 1)}{A \times N} \quad (2)$$

Where *W* is the weight given to each factor by the respondents and ranges from 1 to 5, (where “1” is “strongly disagree” and “5” is “strongly agree”), *A* is the highest weight (i.e., 5 in this case) and *N* is the total number of respondents

3. Results and discussions

3.1 Questionnaire Responses

Table 1 shows the number of questionnaires administered to each group of construction professionals and the number of responses retrieved per states. Based on the assertion of Creswell [20] and adapted by Waziri [8] the result of a survey could be considered significant if the response rate is not lower than 30 - 40%. Therefore, the percentage of the returned questionnaires is considered adequate for analysis. The Table further presents the study population, the number of questionnaires administered, and the responses received across three states Abuja (ABJ), Lagos (LAG), and Port Harcourt (PH) from various construction professionals. The total population size of professionals surveyed is 12,283 with a sample size of 387 construction professionals. These include: Architects, Builders, Civil Engineers, Estate Surveyors, Planners, and Quantity surveyors forming the sample groups. Out of the 387 questionnaires administered across all states, Civil Engineers had the highest allocation (88), while Quantity surveyors had the lowest (44). Among the responses, Civil Engineers also had the highest return rate (52), followed by Architects (48), and Builders (47), while Quantity Surveyors recorded the lowest number of responses (34). In total, 263 responses were received, with Abuja contributing 103 responses, Lagos 81, and Port Harcourt 86. This distribution highlights variations in engagement levels among professional groups and across the three states.

The plan was to have 12 participants in each of the three focus group discussions (FGDs), making a total of 36 participants. However, only 28 professionals took part resulting in a 78% participation rate. The first group included a mix of professionals: 2 Architects, 2 Builders, 2 Civil Engineers, 1 Estate Surveyor, 1 Quantity Surveyor, and 2 Town Planners. The second group had a similar composition but with only 1 Town Planner. The third group was slightly different, consisting of 2 Architects, 1 Builder, 2 Civil Engineers, 2 Estate Surveyors, 1 Quantity Surveyor, and 1 Town Planner. Table 2 presents the breakdown of the participants for each discussion.

3.2 Quantitative findings

This section identifies various indicators that signify sustainable construction practices in the Nigerian construction industry. Respondents were asked to rate their agreement with each indicator on a 5-point Likert scale, where 1 represents "Not an indicator" and 5 represents "Strong indicator." Table 3 presents the responses of the respondents.

Table 1: Study population, questionnaires administered and questionnaire respondent per state

| Professionals | Population Size | Sample per State | | | Questionnaires Administered | | | | Questionnaires Responses | | | |
|--------------------|-----------------|------------------|-------------|-------------|-----------------------------|------------|------------|-------------|--------------------------|-----------|-----------|------------|
| | | ABJ | LAG | PH | ABJ | LAG | PH | Sample Size | ABJ | LAG | PH | Total |
| Architects | 2300 | 855 | 771 | 674 | 27 | 24 | 21 | 72 | 18 | 14 | 16 | 48 |
| Builders | 1805 | 677 | 597 | 531 | 21 | 19 | 17 | 57 | 20 | 12 | 15 | 47 |
| Civil Engineers | 2803 | 995 | 879 | 929 | 32 | 28 | 29 | 88 | 15 | 16 | 21 | 52 |
| Estate Surveyors | 1755 | 621 | 520 | 614 | 20 | 16 | 19 | 55 | 11 | 16 | 13 | 40 |
| Planners | 2262 | 470 | 452 | 436 | 26 | 23 | 22 | 71 | 18 | 12 | 12 | 42 |
| Quantity Surveyors | 1358 | 825 | 742 | 695 | 15 | 14 | 14 | 44 | 14 | 11 | 9 | 34 |
| Total | 12283 | 4443 | 3961 | 3879 | 141 | 124 | 122 | 387 | 103 | 81 | 86 | 263 |

Table 2: Participants for the Focus Group Discussions per States

| S/No | Professionals | Abuja Participants | Lagos Participants | Port Harcourt Participants | Total |
|------|----------------------------|--------------------|--------------------|----------------------------|-----------|
| 1. | Architects | 2 | 2 | 2 | 6 |
| 2. | Builders | 2 | 2 | 1 | 5 |
| 3. | Civil/Structural Engineers | 2 | 2 | 2 | 6 |
| 4. | Estate Surveyors | 1 | 1 | 2 | 4 |
| 5. | Planners | 2 | 1 | 1 | 4 |
| 6. | Quantity Surveyors | 1 | 1 | 1 | 3 |
| | Total | 10 | 9 | 9 | 28 |

Table 3: Indicators of Sustainable Construction Practices in the Construction Industry

| Code | Item | 1 | 2 | 3 | 4 | 5 | N | Mean | RII | Rank |
|------|---|---|---|----|-----|-----|-----|------|------|------|
| ID1 | Efficient energy measures | 1 | 1 | 5 | 147 | 109 | 263 | 4.37 | 0.87 | 1 |
| ID2 | Renewable energy usage | 0 | 1 | 11 | 103 | 148 | 263 | 4.35 | 0.87 | 5 |
| ID3 | Water conservation strategies | 0 | 1 | 11 | 130 | 121 | 263 | 4.36 | 0.87 | 4 |
| ID4 | Waste reduction and recycling efforts | 1 | 0 | 11 | 117 | 134 | 263 | 4.37 | 0.87 | 1 |
| ID5 | Improve indoor environmental quality | 0 | 1 | 13 | 170 | 79 | 263 | 4.34 | 0.87 | 6 |
| ID6 | Sustainable site development practices | 1 | 9 | 34 | 122 | 98 | 263 | 4.24 | 0.85 | 10 |
| ID7 | Implementation of green building certifications | 1 | 5 | 33 | 154 | 70 | 263 | 4.25 | 0.85 | 9 |
| ID8 | Adoption of low-impact construction methods | 1 | 3 | 10 | 119 | 131 | 263 | 4.27 | 0.85 | 7 |
| ID9 | Incorporation of green infrastructure | 1 | 5 | 27 | 151 | 79 | 263 | 4.26 | 0.85 | 8 |
| ID10 | Preservation of natural resources | 1 | 0 | 9 | 94 | 159 | 263 | 4.37 | 0.87 | 1 |

Table 3 outlines the indicators of sustainable construction practices in the construction industry, with respondents rating each item on a scale of 1 (lowest) to 5 (highest). The mean scores provide insight into the perceived importance and prevalence of these practices. The highest-rated practices include "Efficient energy measures", "Waste reduction and recycling efforts" and "Preservation of natural resources" all with the same mean score and relative important indices of (4.37 and 0.87) respectively. These results suggest that energy efficiency, waste management, and natural resource conservation are regarded as key elements of sustainable construction. Other practices such as "Water conservation strategies" (mean = 4.36; RII = 0.87), "Renewable energy usage" (mean = 4.35; RII = 0.87), and "Improving indoor environmental quality" (mean = 4.34; RII = 0.87) ranked 4th, 5th and 6th and are also highly valued, highlighting the industry's focus on resource-saving techniques and the enhancement of environmental conditions within buildings.

Items like "Sustainable site development practices" with (mean = 4.24; RII = 0.85), "Implementation of green building certifications" (mean = 4.25; RII = 0.85), and "Adoption of low-impact construction methods" (mean = 4.27; RII = 0.85) show the industry's commitment to reducing the environmental impact of construction processes. In the same vein, "Incorporation of green

infrastructure" (mean = 4.26; RII = 0.85) also scored highly, reflecting the importance of integrating eco-friendly infrastructure into construction projects.

3.3 Qualitative findings

Previous studies Dania [4] and Frempong *et al.* [16] have identified several indicators for sustainable construction practices within the construction industry and other sectors of the economy. To address the questions, participants were asked about the indicators their organisations use to promote sustainable construction practices. Specifically, the participants were asked to describe key performance indicators (KPIs) used to measure the success of these practices. The participants were also asked how they track and report environmental impacts of construction projects. They were equally asked to provide examples of successful projects where specific indicators significantly contributed to sustainability outcomes.

In response to the question on KPIs, four main themes emerged from the discussions: energy efficiency and carbon emissions (referred to as Whole Life Carbon Assessment, WLCA), the use of sustainable materials, water conservation, and on-site waste reduction. Insights from participants G₁P₂, G₂P₇, G₃P₆, G₃P₉, and G₂P₄ illustrate these points.

"The organisation uses several KPIs, these include energy savings, water consumption reduction, carbon footprint reduction, and the percentage of waste recycled during construction. It also tracks the certification level of completed buildings through LEED and WELL." – G₁P₂

"The organisation has the policy of measuring success using indicators like energy efficiency, carbon emissions, use of sustainable materials, water conservation, and waste reduction on-site. These are tracked throughout the project lifecycle." – G₂P₇

"The company adopts energy efficiency, renewable energy usage percentage and energy use intensity as well as water conservation such as rainwater harvest via roof designs and water use intensity as key KPIs, it also ensures material sustainability through life cycle assessment and feedback on user satisfaction in terms of occupants' health and wellbeing in our organisation as key indicators to measure success" – G₃P₆

"The organisation assesses success of sustainable construction practices through several key performance indicators (KPIs) that focus on environmental, economic, and operational aspects. These KPIs help ensure that projects not only aligned with sustainability goals but also deliver long-term benefits. One of the main KPIs used is tracking energy consumption reductions, especially when using energy-efficient systems like HVAC, LED lighting, or solar panels. The company compares the building's energy use against baseline standards to ensure that it meets or exceeds expected energy savings" – G₃P₉

"The company monitors the carbon emissions associated with both the construction process and the building's operational phase. This includes assessing the embodied carbon in materials and the operational carbon footprint, ensuring that projects minimise greenhouse gas emissions" – G₂P₄

Participants G₃P₃ and G₂P₂, however, revealed that although their companies do not have KPI to measure sustainable practices at the moment, the companies are making frantic effort to ensure sustainability improvements in projects carried out. This suggests that although such KPIs are not in place at the moment, however, the companies are aware of them and the need for it as well as getting ready while ensuring some level of sustainability in their projects now. This is presented below:

"The organisation does not have such KPI policies measurement for now, but it tries to minimise the effect of carbon emissions through the use of SCMs" – G₃P₃

"Actually, the company do not have such KPIs for now but the company is aware of it as the management have been in contact with some NGOs regarding that, so hopefully soon" – G₂P₂

In response to the question on how companies track and report environmental impact in construction projects. A participant said

"At the moment there is no specific guideline for tracking and reporting in the organisation he works with" – G₁P₂

While themes like measurement of EIA, WLCA, energy consumption, waste generation and material usage emerge. This was the position of 6 participants and documented as follows to buttressed the findings:

"The company uses sustainability tracking tools to measure energy consumption, waste generation, and material usage. These metrics are reported at the end of each project to evaluate environmental footprint." – G₁P₈

"The company has been utilising environmental impact assessment (EIA) tools to track metrics such as energy usage, carbon emissions, and waste production throughout the project lifecycle. These are reported to both internal stakeholders and clients in a transparent manner, often as part of sustainability reports." – G₂P₉

"The organisation employs an Environmental Impact Assessment (EIA) approach to ascertain the impacts of the project before, during, and after construction, the company also monitor indoor quality of the environment these include air and water quality, noise level, waste generation etc using advanced technology. such as GIS and drones." – G₃P₈

"The company ensures the use of whole life carbon assessment to track and report environmental impact of construction projects primarily, following the RICS WLCA professional standards. This allows for evaluation of carbon emissions associated with a project, from the sourcing of materials (embodied carbon) through to the operational carbon footprint of the building over its lifetime." – G₁P₁₀

"The organisation, during the construction phase, adheres strictly to the Bill of Materials (BOM) and the Schedule of Works to ensure that sustainable materials and systems are implemented as designed. This tracking process helps monitor key sustainability goals, such as energy efficiency, use of green materials, and waste management, ensuring that environmental benchmarks are met throughout the project. However, after the completion of the construction phase, the role of the company typically ends". – G₃P₂

"The company has it as policy to carry out, Environmental Impact Assessments before commencement of any projects." – G₃P₅

As regards to examples of successful projects, specific indicators demonstrated significant sustainability achievements. The thematic analysis of the FGDs data on relevant issues related to the study posits as follows:

"The company's team were able to build the Bayero University Kano (BUK) Senate Building, even though, it cannot be said to be completely sustainable, but some

aspect of the building can be qualified as sustainable building". - G₁P₇

"In one commercial building project, the organisation reduced energy consumption by 40% through the use of solar panels and energy-efficient windows. The company also diverted 75% of construction waste from landfills by recycling materials." - G₂P₈

"The company managed to reduce the building's energy consumption by 30% through the integration of passive solar design and efficient HVAC systems via the use of mixed design development. This achievement was tracked using energy consumption data and verified by the building's LEED Gold certification." - G₃P₇

"The organisation constructed residential and commercial buildings, where interlocking Compressed Earth Bricks (CEB) were used as the major building material. The materials use for production were sourced locally" - G₂P₄

"The company team was able to used specific indicators which demonstrate significant sustainability achievements in our projects. For instance, across some Northeastern Nigerian Institutions, the company integrated a solar photovoltaic (PV) system for renewable energy generation, which resulted in the building becoming almost 30% self-sufficient in energy usage. The energy savings were immediately measurable, reducing reliance on grid electricity and lowering energy costs for the client." - G₁P₁

"Recently, the organization designed a building with natural ventilation and optimised orientation to take advantage of the region's abundant sunlight without overheating the interior spaces. The building was aligned to minimise heat gain during the day, which not only improved indoor air quality but also reduced the need for mechanical cooling systems, further contributing to energy savings". - G₃P₅

"The company have worked on retrofitting an educational institute with renewable energy solutions, focusing on solar energy integration recently". - G₁P₄

While two of the participants put in never been part in any successful project where specific indicators where incorporated. The following were their response:

"No, the company have not taken part in such projects" - G₃P₃

"None for now but the company hope to have such worthy experience in a short while" - G₂P₂

3.4 Discussion of Findings

The findings underscore critical indicators for sustainable construction practices within the Nigerian construction industry, derived from both qualitative and quantitative perspectives. Quantitative findings on KPIs revealed "Efficient energy measures", "Waste reduction

and recycling efforts," and "Preservation of natural resources" as rated the highest by 82.9% of respondents (mean = 4.37; RII = 0.87 each). Additional indicators such as "Water conservation strategies" with (mean = 4.36; RII = 0.87) and "Renewable energy usage" with (mean = 4.35; RII = 0.87) demonstrate the industry's focus on resource-saving techniques and environmental sustainability. These findings resonate with the works of Dania [4], Usman *et al.* [9] and Windapo, *et al.* [10], who identified energy and resource efficiency as vital elements for sustainable practices. However, challenges remain, as some participants (28.6%) reported their organisations lacked specific KPIs, reflecting gaps in systematic tracking and reporting.

Qualitative data further supported that indicator like energy efficiency, carbon emissions reduction, sustainable material use, water conservation, and waste reduction are central to measuring project success. For example, G₃P₆ emphasised the organisation he works with uses metrics such as renewable energy usage and lifecycle assessments to track sustainability. Approximately 71.4% of participants identified KPIs related to environmental impact, with G₂P₇ highlighting the importance of monitoring carbon footprints and material sustainability. These insights align with the findings of Quang [11], Bhatia [12], Gorinpath, *et al.* [13], Frempong, *et al.* [16] and Sandakawaye [18], who emphasised tracking environmental metrics for sustainable construction.

The practical application of these indicators was evident in successful projects. For instance, G₃P₇ described achieving a 30% reduction in energy consumption in a mixed-use development by integrating passive solar design and efficient HVAC systems, verified by LEED Gold certification. Similarly, G₁P₁ cited a project where integrating solar photovoltaic systems reduced grid energy reliance by 30%. These examples underscore the transformative impact of adopting sustainability-focused KPIs. Nevertheless, the findings suggest a need for broader industry adoption through training, policy reforms, and the standardisation of sustainability metrics across construction projects as emphasised by Dania [4], Waziri [8], Edomah, *et al.* [15], Frempong, *et al.* [16] and Orsini and Marrone [17].

4. Conclusion

The study underscores the importance of assessing key indicators of sustainable construction practices in Nigeria, revealing that energy efficiency, waste reduction, and resource conservation are critical elements. Despite the increasing awareness of sustainable practices, challenges such as financial constraints, weak regulatory enforcement, and limited industry commitment hinder their effective implementation. The findings suggest that adopting structured sustainability KPIs, integrating green technologies, and strengthening policy frameworks can enhance sustainability outcomes. Furthermore, capacity-building initiatives and stakeholder collaboration are essential for fostering a more sustainable construction industry. This would ensure Nigeria's construction sector transition towards more sustainable and environmentally

responsible practices, hence contributing to long-term economic and social benefits.

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