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Evaluating the Criteria for Selecting Green Building Materials in Nigeria's Construction Industry: A Case Study of Anambra State

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ABSTRACT

This study aimed to evaluate the criteria for selecting green building materials in the construction industry in Anambra State, Nigeria. The research involved 312 construction professionals, including Architects, Engineers, Builders, and Quantity Surveyors, practicing in both public and private organizations. Data was collected through a structured questionnaire, titled "Criteria for Selecting Green Building Materials in Construction Industry Questionnaire" (CSGBMCIQ). The questionnaire was divided into two sections, A and B, with A containing demographic information and B divided into three clusters. Descriptive statistics were used to analyze the bio-data, while mean scores were used to answer the research questions. A benchmark of 2.50 mean score was set for decision-making, with scores below this score indicating disagreement and scores above 2.50 indicating agreement. The finding revealed that construction professionals agreed on the efficiency of the existing criteria in promoting sustainable construction practices. It was found out that green building materials are utilized in construction projects to a low extent as rated by construction professionals. Based on the findings, it was recommended amongst others that Anambra State government should provide subsidies and tax incentives for projects that utilize green building materials. This can help offset the higher initial costs and encourage more builders to adopt sustainable materials.

KEYWORDS

green building; materials; construction industry; sustainable construction practices

INTRODUCTION

The activities of human being on the environment, regarding meeting his daily needs, exert pressure on the environment. For instance, construction activities which are regarded as the heart of every development constitute a powerful influence on the environment. The construction industry consumes a major share of resources and produces a lion's share of waste. According to Nnaemeka, Fadumo and Okolie (2021), the industry is often referred to as the 40 per cent industry as it is responsible for the consumption of approximately 40 percent of natural resources and about 40 per cent of all waste produced. Patil and Patil (2017) observed that human habitats (buildings) contribute to environmental crises through resources depletion, energy consumption, air pollution and creation of waste. Alohan and Oyetunji (2021) outlined up to ten different adverse effects of construction activities on the environment. These include, among others, land misuse, existing site dereliction, habit destruction, misuse of natural resources, and so on. In addition, the on-site construction practices result in a number of health and comfort disturbances, especially to people living where construction activities are taking place.

One problem which is of great concern is the observation made by Schmidt cited in Alohan and Oyetunji (2021) that building activities are responsible for approximately one-third of ecological disasters. Thus, it can be seen, clearly, that construction activities, have direct impact on man and his environment, in that, it leads to the change on the state or condition of such environment in terms of not only the quality but also the stock of natural resources.

One important question that is always asked is: how can we ensure that these activities (construction activities) do not compromise the ability of future generation in achieving their needs. According to Alam and Haque (2016), the friendliest way to handle the environment is not to build. However, without construction, life can be miserable and threatening. For shelter is needed, amongst other things, for protection against the inclement weather and for healthy living. Chan, Darko and Ameyaw (2017) stated that what is needed is a dynamic equilibrium. In other words, production process that is friendly to the ecosystem, yet competitive and possess no any form of threat. Environmentally friendly buildings, popularly called Green Buildings (GB), sustainable or high-performance buildings, seem to satisfy the above-mentioned requirements.

A green material is one that simultaneously does the most with the least, fits most harmoniously within ecosystem processes, helps eliminate the use of other materials and energy, and contributes to the attainment of a service-based economy (Okeke & Chinwe, 2018). Green materials can be used in different places such as environmental area, chemical industry as well as building materials. Though we cannot avoid affecting the environment, the green buildings will aim and contribute towards minimizing the environmental impact. According to Abolare (2013), green buildings do not only contribute towards a sustainable construction and environment but it also brings lots of benefits and advantages to the building owners and the users. It contributes towards lower development costs lower operating costs, increased comforts, healthier indoor environment quality, and enhanced durability and less maintenance costs (Gidado, Feng, Shuangqin, Sadiq, Bello & Danja, 2017).

Green Building (GB) is a holistic approach to programming, planning, designing, and constructing (or renovating) buildings. It is part of the larger concept of sustainable development as it enhances the environment against the negative side effect of construction activities. Besides, that all liabilities of materials, water and energy waste, and pollution emissions are converted into economic opportunities through the realization of environmentally sound, healthier and cost-effective project (Chan, Darko, Olanipekun and Ameyew, 2018). It has been described as a clear answer to health, economic and environmental challenges. Chan et al. (2018) stressed that construction of green building entails tailoring a building and the site to the local climate, site conditions, cultural and community in order to reduce resource consumption, augment resource supply, and enhance the quality and diversity of life. This is achieved through analyzing important and interrelated issues, such as, the site and climate, building orientation and form, lighting and thermal control system, and materials, while optimizing all these in an integrated design.

Green Building (GB) is a total quality management approach to building that involves involving all key people involved in the project from the beginning to ensure synergistic design through interdisciplinary teamwork. GB is not an assemblage of environmental components or a piecemeal modification of a standard building, but a philosophy that incorporates natural and resource-efficient features while enhancing the surrounding environment (Dalibi, Fend, Shuangqin, Sadiq, Bello & Danja, 2017). It is a building philosophy that involves professionals involved in planning, design, and construction from the beginning to achieve synergy. In GB, not only architects, builders, engineers, and quantity surveyors participate in the project execution, but also a land surveyor who is responsible for custodian of land information. This approach aims to enhance the surrounding environment and promote sustainable development.

In this study, the researchers aim to identify and categorize the key criteria currently employed in the selection process of green building materials in the region. This categorization allows for a structured evaluation of the various factors influencing material selection decisions. The study also seeks to assess the efficiency of the existing criteria in driving sustainable construction practices within Anambra State. By evaluating the effectiveness of these criteria, the researchers can provide insights into the current state of sustainable construction efforts in the region. This evaluation may involve analyzing the impact of the criteria on environmental performance, energy efficiency, cost-effectiveness, and overall sustainability of construction projects. Furthermore, the researchers aim to evaluate the extent to which green building materials are being utilized in construction projects in Anambra State. This involves quantifying the adoption of sustainable materials and identifying any potential barriers or challenges hindering their widespread use. By understanding the uptake of green building materials in the local construction industry, the study can provide valuable data on the current trends and practices in sustainable construction in Anambra State.

STATEMENT OF THE PROBLEM

The criteria for selecting green building materials in the local construction industry may be lacking, ambiguous, or not effectively implemented. This could result in a suboptimal use of green materials, leading to missed opportunities for sustainability improvements in construction projects. Researchers such as Alohan and Oyetunji (2021), Chan et al. (2017), remarked that various stakeholders involved in the construction industry are not be fully aware of the benefits of green building materials or may face challenges in implementing sustainable practices due to factors such as cost considerations, lack of awareness, and limited availability of green materials. The evaluation of the extent to which green building materials are being utilized in construction projects in Anambra State will help identify gaps in adoption rates. The study aims to address barriers hindering the widespread use of green materials, such as cost implications, lack of awareness, or limited availability. This backdrop therefore informed the study. Specifically, the study sought to:

1. identify and categorize key criteria used for selecting green building materials in the construction industry in Anambra State
2. determine the efficiency of the existing criteria in promoting sustainable construction practices
3. evaluate the extent to which green building materials are being utilized in construction projects in Anambra State

RESEARCH QUESTIONS

1. What are the key criteria used for selecting green building materials in the construction industry in Anambra State?
2. What is the efficiency of the existing criteria in promoting sustainable construction practices?
3. What is the extent to which green building materials are being utilized in construction projects in Anambra State?

LITERATURE REVIEW

Criteria for selecting Sustainable Building Material

According to Patil and Patil (2017) For Selection of Sustainable building materials the following criteria are commonly used;

Local availability of Materials: The availability of construction materials has a strong impact on costs as well as on the construction time of a building. Thereby, on the one hand, a high availability reduces purchasing effort and on the other hand leads to quick lead times, even if orders are made on short notice. Low availability would present an obstacle for construction contractors to use these materials. Furthermore, the availability refers to local aspects. It might be beneficial to use local materials rather than materials which have to be delivered from far distances, with respect to transportation effort and costs which in turn is beneficial for the environment due to reduced emissions during transport (Halliday, 2008) As far as possible locally sourced materials are to be preferred so as to minimize the energy spent in transportation of the building materials. Energy consumed in transportation should be considered as total energy spent on transporting materials starting from the place of manufacturing.

Embodied Energy of Materials: Embodied energy is an assessment of the energy required to manufacture any building material. This include energy required to extract raw materials from nature, energy used to transport raw materials to manufacturing unit and the energy used in manufacturing activities to provide a finished product. Every building is a complex combination of many processed materials, each of which contributes to the building's total embodied energy. Embodied energy is a reasonable indicator of the overall environmental impact of building materials, assemblies or systems. (Jagdish, Ventkarama & Nanjunda, 2003).

Percentage of Recycled/Waste Materials Used: Building materials can be manufactured using recycled materials or using waste materials. Use of recycled materials helps the environment and the economy in several ways. A significant effect is that of lessening the need for manufacture with virgin, non-renewable resources, which saves precious resources, energy and cost. Waste materials that would have ended in landfills after its useful life instead can be reprocessed for use in other products. Use of various types of waste materials such as fly ash, blast furnace slag, red mud, waste glass, marble dust, cinder, rice husk, coconut husk, banana leaves, jute fibers, rubber from automobile tires, etc. is demonstrated by research.

Use of Rapid Renewable Resources: Materials manufactured with resources that are renewable (i.e. wood or solar power) rather than non-renewable (i.e. fossil fuels) shall be preferred. Depletion of the earth's resources is occurring at an alarming rate. Entire ecosystem is affected due to continuous extraction of raw materials from the earth. As stock of fossil fuel is limited, it may get exhausted very soon. By utilizing renewable energies, such as wind, solar, tidal, as well as renewable materials, such as wood (certain certified species which are rapidly renewable), grasses or sand, impact on biodiversity and ecosystems can be lessen.

Durability: Materials which are long lasting and needing little maintenance are preferred. Material replacement puts a strain on the earth, its resources and inhabitants. In making materials more durable and easier to maintain, manufacturers can help in eliminating a costly, damaging and time-consuming process of replacement. Although high life time expectancy might as well be an ecological requirement in terms of reduced material use due to longer replacement intervals, construction materials and components with a long-life cycle and low maintenance effort reduce investments for maintenance, replacement and renovation (Sunke & Schultmann, 2008).

Environmental Impact and Indoor Air Quality: All materials used for construction of buildings must not harm the environment, pollute the air or water, or cause damage to the earth, its inhabitants and its ecosystems during manufacturing process, and also during use or disposal after end of life. Material should be non-toxic and contribute to good indoor air quality. Worldwide industrial production uses billions of tons of raw materials every year. Pollution caused in excavation, manufacturing, use or disposal of a product can have far reaching consequences on the Earth's ecosystem. Poor indoor air quality caused by VOC emission costs billions in medical bills and lost productivity to companies every year (Jagdish *et al.,* 2003).

Recyclability: The recyclability of the materials can be judged from quantity of materials recovered for re-use after the useful life of materials/products or after demolition of the building. The construction industry is the second largest consumer of raw materials after the food processing industry (Halliday, 2008). Construction materials are highly diversified and accumulate in huge amounts at the end of the life cycle either of the material or of the building or its components. In Germany, the Waste Management and Recycling Act defined a hierarchy for waste treatment as the highest priority assigned to the avoidance of waste. Second ranked is recovery or recycling of materials. However, construction materials can still not lead back into the material cycle without any processing, or even have to be disposed of. Hence, the ability of recycling of a construction material is a prerequisite for the establishment of closed-loop material flows.

Contamination from Gases and Toxic Emissions: The aspect of contamination refers to the environmental burden caused by construction materials but also to its impact on the wellbeing and health of the living environment. In the past, construction materials were used for interiors without giving cause to possible negative effects. However, nowadays, several of the construction materials used in the past is now known to be hazardous to health and environment. The use of numerous substances is already interdicted, however, the number of negative symptoms caused by indoor Algren's and toxins in the interior of buildings has risen significantly (Jorissen, Coenen & Stelzen, 2005).

Manufacturing and Price: In addition to a high availability, construction materials and components ought to be cheap in production, hence, should not be significantly or even cheaper than its less sustainable substitutes. Keeping the idea of closed-loop material cycles in mind, subsidies for the use of recycled or renewable raw materials should be encouraged, whereas the price for primary resources should be increased, which however, has a positive impact on the environment (Sunke & Schultmann, 2008).

Cost of Transportation: Transportation of materials is a major factor in the cost and energy of a building. Bulk of the building materials in urban and semi-urban centers are transported using trucks in India. The transportation distance may vary depending upon the location of construction activity (Jagdish *et al.,* 2003). The cost of transporting building materials depends on its distance from the place of production to where it is to be used.

METHODOLOGY

Area of the Study: This study was carried out in Anambra State, Nigeria.

Research design: The descriptive survey research design was adopted for this study.

Population of the Study: The population of this study comprised 312 construction professionals in Anambra State. These professionals are registered Architects, Engineers, Builders and Quantity Surveyors practicing in both public and private organizations in Anambra State, Nigeria.

TABLE 1: Population Frame of the Respondents.

S/N	Respondents	Population
1	Architects (NIA)	81
2	Builders (NIOB)	106
3	Engineers (NSE)	95
4	Quantity Surveyors (NIQS)	30
	Total	**312**

Sample Size: For this study, the sample size was gotten with the formula from Morgan and Krejcie (1970) with a confidence level of 95%, and it found to be 172

$$S = \frac{X^2 NP\,(1-P)}{d^2\,(N-1) + X^2 P\,(1-P)}$$

where:

s = sample size

p = estimated variance of the population (i.e 0.5 for this study)

X = based on confidence level (i.e 1.96 for 95% confidence level was used for this study)

N = total population

d = precision desired, expressed as a decimal (5% used for this study)

$$S = \frac{1.96^2 \times 312 \times 0.5 \times (1-0.5)}{0.05^2\,(312-1) + 1.96^2 \times 0.5 \times (1-0.5)}$$

$$S = \frac{299.6448}{0.7775 + 0.9604}$$

$$S = \frac{299.6448}{1.7379}$$

$$S = 172$$

Based on the sample size gotten, a total of 172 questionnaires were circulated as the study progressed, and all copies were retrieved.

Data Collection Instrument: Data for this study were collected by means of structured questionnaire developed by the researcher. The questionnaire is titled "Criteria for Selecting Green Building Materials in Construction Industry Questionnaire" (CSGBMCIQ). The questionnaire is sub-divided into two sections; A and B. Section A contains information on the demographic profile of the respondents while section B is sub-divided into three clusters: I – III in line with the research questions. The response option for cluster I and II was structured on a 4-point Likert scale of Strongly Agree (SA); Agree (A); Disagree (D); and Strongly Disagree (SD) with values 4, 3, 2 and 1 respectively.

The response option for cluster III was structured on a 4-point scale of Very High Extent (VHE), Great Extent (GE), Low Extent (LE), and Very Low Extent (VLE) with values 4, 3, 2 and 1 respectively.

Method of Data Procedure and Analysis: The direct delivery strategy was utilized to administer the questionnaire. Using this method, the researcher, assisted by two research assistants, personally delivered copies of the questionnaire to the respondents. Descriptive statistics of frequency counts and percentages was employed to analyze the bio-data of the respondents while mean score was used to analyze the data to answer the research questions. The benchmark of 2.50 mean score was set for the decision rule for the mean scores. Any mean score below 2.50 is adjudged disagreed while any mean score above 2.50 is rated agreed.

RESULTS

Demographic Profile of the Respondents

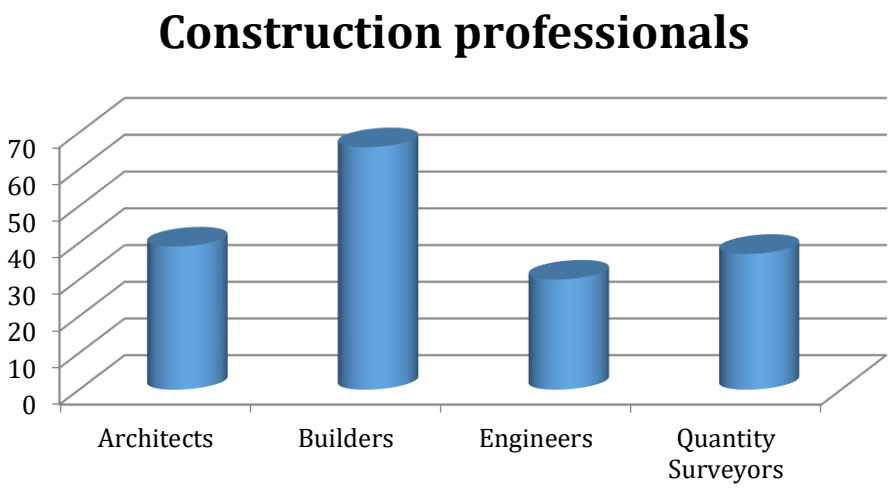

FIGURE 1: Distribution of Respondents by Professionals.

Data presented in Figure 1 show the percentage distribution of the respondents on construction professionals. Table 2 reveals that 39 of the respondents (representing 23%) were Architect; 66 of the respondents (representing 38%) were Builders; 30 of the respondents (representing 18%) were Engineers; and 37 of the respondents (representing 22%) were Quantity Surveyors.

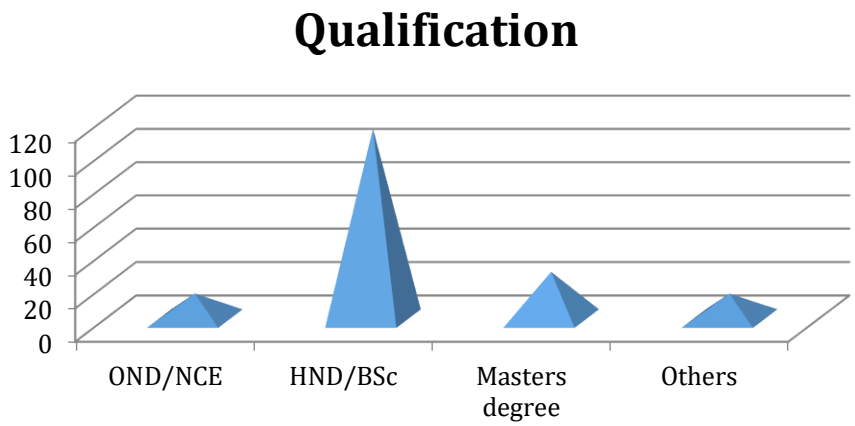

FIGURE 2: Distribution of the respondents by Educational Qualification.

Data presented in Figure 3 show the percentage distribution of the respondents by professional qualification. The result revealed that 15 of the respondents (representing 9%) possessed OND/NCE; 114 of the respondents representing 66% were HND/BSc holders; 28 of the respondents representing 16% were masters' degree holders; and 15 of the respondents representing 9% had other qualifications.

RESULTS AND DISCUSSION

TABLE 2: Respondents' mean and standard deviation ratings on the key criteria used for selecting green building materials in the construction industry in Anambra State.

S/N	Items	X	SD	Decisions	Ranking
1	Green building materials should have a low environmental impact	2.58	0.87	Agree	5th
2	Green building materials should be recyclable or biodegradable	2.66	1.14	Agree	4th
3	The selection of green building materials should prioritize energy efficiency	2.53	0.86	Agree	7th
4	Green building materials should offer long-term financial savings	3.33	1.03	Agree	1st
5	Availability of green building materials in the local market is essential	2.55	1.02	Agree	6th
6	Green building materials should enhance occupant health and well-being	3.31	0.96	Agree	2nd
7	The performance of green building materials should meet industry standards	2.95	1.06	Agree	3rd
	Grand Mean	**2.84**		**Agree**	

Data in Table 2 revealed that all items (1 – 7) with their respective mean scores of 2.58, 2.66, 2.95, 3.33, 2.55, 3.31 and 2.53 were rated agreed. The cluster mean of 2.84 summarized that construction professionals agreed on key criteria used for selecting green building materials in the construction industry. The respondents identified and ranked item 4 first position, this means that one key criteria for selecting green materials is that it offers long-term financial savings, followed by item 6, 7 and 2. The least identified and ranked item is 3. This finding aligns with Alam and Haque (2016) that consistency in material selection can lead to better project outcomes, as materials are chosen based on their proven benefits and alignment with sustainable construction practices. This can result in buildings that are more energy-efficient, environmentally friendly, and cost-effective over the long term. More so, Dahiru, Dania amd Adejoh (2014) remarked that key criteria such as ability to recycle green building materials and energy efficient can help in establishing industry best practices. This can lead to the development of guidelines, policies, and standards that promote the use of green building materials across the industry.

TABLE 3: Respondents' mean and standard deviation ratings on the efficiency of the existing criteria in promoting sustainable construction practices.

S/N	Items	X	SD	Decision	Ranking
8	The criteria promote the use of materials with low environmental impact	2.78	1.01	Agree	4th
9	The criteria ensure significant reductions in carbon emissions	2.79	1.04	Agree	3rd
10	The criteria facilitate the conservation of natural resources	2.67	1.03	Agree	6th
11	The criteria provide cost-effective solutions for sustainable construction	2.86	0.96	Agree	2nd
12	The criteria lead to long-term financial benefits for construction projects	2.66	0.99	Agree	7th
13	The criteria enhance the health and well-being of building occupants	2.72	1.02	Agree	5th
14	The criteria promote social sustainability within the community	2.57	1.03	Agree	8th
15	The criteria ensure the durability and longevity of construction materials	3.01	0.73	Agree	1st
	Grand Mean	**2.76**		**Agree**	

Data in Table 3 revealed that all items (8 – 15) with their respective mean scores of 2.78, 2.79, 2.67, 2.86, 2.66, 2.72, 2.57 and 3.01 were all rated agreed. The cluster mean of 2.76 summarized that construction professionals agreed on the efficiency of the existing criteria in promoting sustainable construction practices. The respondents ranked durability and longevity of construction materials as the most efficient followed by cost-effective solutions for sustainable construction, then significant reductions in carbon emissions as the most efficient. The respondents ranked social sustainability within the community as the least efficient. This finding supported that of Mehta, Mehta and Sharma (2014) that the criteria for selecting green building are successfully promoting environmentally-friendly, socially-responsible, and economically-viable construction methods within the construction industry. The finding of Simpeh and Smallhood (2018) buttressed that the current criteria are deemed effective in guiding the selection and use of materials and practices that contribute to sustainable construction. This suggests that the criteria are well-designed and align with the goals of sustainability.

TABLE 4: Respondents' mean and standard deviation ratings on the extent to which green building materials are being utilized in construction projects in Anambra State.

S/N	Items To what extent are/do:	X	SD	Decision	Ranking
16	green building materials used in residential construction projects	2.41	0.54	Low extent	3rd
17	green building materials used in commercial construction projects	2.28	0.69	Low extent	4th
18	locally sourced materials utilized in construction projects	2.92	0.99	High extent	1st
19	energy-efficient materials utilized in construction projects	2.07	0.88	Low extent	7th
20	clients demand the use of green building materials in their projects	2.18	0.89	Low extent	5th
21	green building materials used during the construction phase	1.98	0.91	Low extent	8th
22	green building materials incorporated during the procurement phase	2.48	1.04	Low extent	2nd
23	contractors prefer green building materials in their projects	2.14	0.79	Low extent	6th
	Grand Mean	**2.29**		**Low extent**	

Data in Table 6 revealed that item 18 with mean score 2.92 was rated high extent. It means that respondents to a high extent utilized locally sourced materials utilized in construction projects. Items 16, 17, 19, 20 21, 22 and 23 with their respective mean scores of 2.41, 2.28, 2.07, 2.18, 1.98, 2.48 and 2.14 were rated low extent. The grand mean of 2.29 summarized that green building materials are utilized in construction projects to a low extent as rated by construction professionals. The finding agreed with that of Tathagat and Dod (2015), Uwaize, Igwenma and Okonkwo (2015) that there is limited use of green building materials in construction projects. This suggests that traditional materials are still predominantly being used over environmentally friendly alternatives. Nwokoro and Onukwube (2011) remarked that the cost of green building materials might be a deterrent. If these materials are perceived as more expensive, budget constraints can lead to choosing cheaper, less sustainable options.

CONCLUSION

It is evident that there is a growing awareness and importance placed on sustainable construction practices. The criteria identified in the study, such as environmental impact, cost-effectiveness, availability, and quality, are crucial factors influencing the selection of green building materials. It was concluded that construction professionals agreed on the efficiency of the existing criteria in promoting sustainable construction practices. More so, the study concluded that sustainability might not be a primary focus for many construction projects. If other factors such as cost, speed, and traditional practices take precedence, the use of green building materials may be deprioritized.

RECOMMENDATIONS

Based on the findings of this study, the following recommendations were made:

1. The Nigerian institute of estate surveyors and valuers should organize regular workshops and seminars for construction professionals to deepen their understanding of green building materials and their benefits. This should include practical sessions on material selection and application.
2. The Nigerian institute of estate surveyors and valuers should encourage local production of green building materials to reduce costs and increase availability. This can be supported through incentives for local manufacturers.
3. Anambra State government should provide subsidies and tax incentives for projects that utilize green building materials. This can help offset the higher initial costs and encourage more builders to adopt sustainable materials.

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