Assessing the Effectiveness of the Green Building as a ways of Sustainability in the Construction Industry

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Abstract
Green building is a practice that focuses on designing, constructing, and operating buildings in a way that minimizes their and enhances the health and well-being of occupants. This research examines the effectiveness of the green building sustainability in the construction industry in Nigeria. Data were collected through a eighty (80) structured questionnaire administered to a purposive of construction professionals, including architects, builders, civil engineers, quantity surveyors, and town planners. Descriptive statistics such as frequencies, percentages, and mean scores were employed to analyze the collected data. Findings showed that *environmental concerns* ranked first with RSI value of 0.855 (85.50%), *economic benefits* ranked second with RSI value of 0.84 (84%) and the need for sustainable development ranked third with RSI value of 0.83 (83%) among factors influencing the effectiveness of green building adoptions in Nigeria construction industry among others. Conclusion and recommendations are drawn from the factors influencing the effectiveness of green building adoptions, its challenges in implementing the green building and environmental sustainability influences of green building adoptions in Nigeria.

Keywords: Green building, environmental impact,sustainable,development, effectiveness

I.Introduction
Green building is the process of creating, erecting, and maintaining buildings in a way that is resource-efficient and considerate of the environment over the course of their whole existence. Green building is a practice that focuses on designing, constructing, and operating buildings in a way that minimizes their environmental impact and enhances the health and well-being of occupants. This strategy, which emphasizes the efficient use of energy, water, and materials while fostering healthy indoor environments for occupants, reduces adverse environmental effects and may even produce beneficial ones. The major principles of green building includes the resource efficiency, environmental responsibility, healthy indoor environments, life cycle approach and sustainable materials. Green building practices, encompassing resource efficiency, renewable energy, eco-friendly materials,

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indoor air quality, environmental impact, occupant well-being, reduced environmental impact, cost savings, improved occupant health and well-being, increased productivity, enhanced property value and sustainable design, are recognized worldwide as a means to address these challenges. It involves making efficient use of resources like energy and water, using renewable energy, and employing eco-friendly materials. The goal is to reduce waste, pollution, and environmental degradation while creating healthier and more productive indoor environments. The goal is to reduce waste, pollution, and environmental degradation while creating healthier and more productive indoor environments.

The use of green building techniques is growing in significance within Nigeria's construction sector because of its capacity to tackle social, economic, and environmental issues. In the construction industry, green building technology is a ground-breaking strategy that aims to create sustainable and environmentally friendly structures.

According to Razkenari (2022), green building system is an integrated approach to developing, maintaining, and operating structures with the least possible negative impact on the environment. Green building technology uses cutting-edge materials and technologies to lower energy use for heating, lighting, and cooling; insulation, natural lighting, and solar panels are common ways to achieve a 15–30% decrease (Shajal, 2023). Green building technology enhances indoor air quality, acoustics, and natural light access to prioritize human comfort and health. According to Uddin and Elumalai, (2021), a key component of green building technology is the use of recyclable, locally sourced, and environmentally friendly materials, which lowers the embodied carbon of the building process. Nonetheless, the construction industry, which has historically depended on traditional techniques that frequently overlook sustainability, will undergo a substantial transformation with the adoption of green building technology practices. This will also improve the structures' economic, social, and environmental performance. Therefore, the use of smart building technology, sustainable materials, waste reduction, and water efficiency through the use of rainwater harvesting, grey water recycling systems, and water-saving fixtures are all highlighted by green building technology. Globally, green construction techniques which include resource conservation, energy efficiency, and sustainable design are acknowledged as a way to deal with these issues. Nigeria's adoption of green building practices might be characterized as still in its infancy, with little knowledge of and use of sustainable construction techniques (Adewolu, 2023). In order to preserve sustainability and lessen the ecological impact of the building sector, the region as a whole must immediately adopt greener construction practices, as recommended for all of Nigeria by Oladoja and Ogunmakinde (2021).

II.Literature Review

In a variety of domains, including green building, health, and economic growth itself, the Sustainable Development Goals (SDGs) have become a framework for international policy, encouraging economic growth, social inclusion, and environmental protection, sustainable development has become the development goal of all countries worldwide (He W, Zhang Y, Kong D, et al., 2024). UN-Habitat. (2021) accurately reflects the broad adoption of the United Nations' sustainable development strategy. In order to achieve a prosperous and just future for everyone and the earth, the strategy tackles important problems like hunger, poverty, education, and climate change. Reducing

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environmental effect and encouraging eco-friendly building methods in the construction industry need the use of sustainable materials. Soni and Chelliapan (2022) state that using locally obtained materials, such as bamboo, reclaimed wood, and recycled glass, metal, and plastic, can lower transportation-related emissions while also boosting local economies. The requirement for virgin materials is decreased by using sustainable materials, which are derived from recycled or renewable resources. Recycled materials are sustainable. Reusing materials for building, such as recycled steel, glass, and plastics, can drastically cut down on the waste and energy needed to produce new materials (Sormunen, 2019). On the other hand, hemp fibres are used to make sustainable materials. Because they are lightweight, insulating, and carbon-negative, they are a sustainable choice for wall construction. Bamboo is robust, flexible, and biodegradable, making it a great substitute for conventional timber, according to Marut et al. (2020), who claim that sustainable materials are quickly renewable resources. As a result, sustainable materials in the construction sector are still growing, and it is anticipated that new materials and technologies will significantly expand in the future, further reducing environmental impact while satisfying the functional requirements of contemporary buildings.

Waste reduction encompasses a variety of methods, including reducing material usage, reusing items, recycling, and designing products with sustainability in mind. Yazdani and Lakzian (2023) define waste reduction as the methods and techniques used to lessen the quantity and effects of waste produced by human activity. In theory, waste reduction promotes material recycling and reuse, which preserves natural resources and lessens the demand for extracting new materials. In order to lessen the impact on the environment and promote sustainability, waste reduction in the construction industry entails reducing the quantity of waste produced during construction projects, such as excess concrete and cement, surplus steel and metal, and unused roofing materials (Bajjou and Chafi, 2024). However, minimizing environmental effects, preserving energy, and conserving resources all depend on waste minimization. Kabirifar et al. (2020) state that waste reduction entails putting policies and procedures in place to lessen the amount of trash produced during the phases of planning, design, construction, and demolition, including brick wood, demolition debris, and rehabilitation waste. Therefore, waste reduction in the construction industry entails creating products and procedures to minimize material use and waste formation. Projects including residential, commercial, and infrastructure development are all included in the crucial construction sectors, which include planning, designing, and building, maintaining, and operating physical buildings. By fostering job possibilities, attracting investment, and boosting GDP, the construction sector is essential to an individual's or an organization's economic development, claim Tekola and Gidey (2019). However, considerable cost reductions and better project delivery can result from the application of lean construction concepts along with efficient project planning and administration. According to Ashworth and Perera (2018), the construction industry supports government initiatives, creates jobs, attracts investment, and involves a wide range of stakeholders, including clients, professional advisers, contractors, suppliers, manufacturers, financial institutions, and public authorities. The provision of the physical infrastructure required for social and economic growth depends on the

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construction sector (Iacovidou and Purnell 2016).
Efficiency, which includes the efficient use of resources to accomplish desired results within financial and schedule restrictions, is a crucial component that affects project performance in the construction industry. Harris and Baldwin (2021) state that efficiency in construction entails streamlining procedures to preserve high standards of quality while cutting expenses. Efficiency is the capacity to maximize output while minimizing input in the construction industry. According to Suresh and Sivakumar (2021), efficiency involves properly managing time, labour, materials, and equipment to guarantee that projects are finished on time and within budget. An efficient construction industry can regularly produce high-quality work, which improves its standing and ability to compete in the market. Zhang Azhar and Khalfan (2018) define efficiency as the process of streamlining processes and resources to cut costs, minimize waste, and complete projects on schedule without sacrificing quality. Effective green building solutions provide a host of advantages, such as increased energy efficiency, better occupant health, and a smaller environmental impact, according to Murtala et al. (2024).

III.Methodology

This study made use of eighty (80) questionnaires which was distributed among construction industry professionals for the purpose of achieving the objectives of the effectiveness of the green building as a ways of sustainability in the construction industry. Data were obtained from both the primary and secondary sources which include interview, questionnaire, textbooks journal publications and internet facilities. The data was analyzed (i.e. the mean and standard deviation), using statistical package for social society (SPSS). The statistical tools used for this study include percentage, mean, and relative significance index RSI (also known as Index of Relative Importance, IRI or Relative Importance Index, RII) to determine their authenticity of the factors studied. The Likert scale involving rating on interval scale of 5 and 1 developed for application in social sciences and management researches for quantification of qualitative variable were used. It elicited information from the effectiveness of the green building as a ways of sustainability in the construction industry in Nigeria. The responses of the items on the questionnaire were obtained on a 5-point scale ranging from 1 to 5. ‘‘Very High” were scored 5, ‘‘High’’ were scored 4, ‘‘Average’’ were scored 3, ‘‘Low’’ were scored 2 and ‘‘Very Low’’ were scored 1. The relative significance index ranking (RSI) was used for ranking of the factors studied. Bakhary (2005), Elhag and Boussabaine (1999), Faniran (1999), Idrus, A. B. and Newman, (2002), Kangwa and Olubodun (2003) among others gave an equation that could be useful for determining Relative Significance Index (RSI) in prevalence data as:

$$\text{RSI} = \frac{\sum \mu}{\text{AN}} = \frac{5a_5+4a_4+3a_3+2a_2+1a_1}{5\text{N}}$$

Where μ is the weighting given to each factor by respondents;
A is the highest weight (i.e. 5 in this case);
N is the total number of respondents

IV.Data Analysis and Results

The data were presented using tables for clarification and better interpretation. The analysis tools included both descriptive and inferentialstatistics.

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A.Respondents Profile

Table 1: Sex

Sex	Frequency	Percentage (%)
Male	66	82.50
Female	14	17.50
Total	80	100.00

Table 1 showed the gender of the respondents. It showed that sixty six (82.50%) are male and fourteen (17.50%) are female. The result shows the representation of genders in the construction industry in the study area.

Table 2: Length of service

Years	Midpoint (x)	Frequency (f)	Fx	Percentage (%)
1-5	6	22	132	14.21
6-10	8	19	152	16.36
11-15	13	18	234	25.19
16-20	18	10	180	19.38
above 21	21	11	231	24.87
Total		**80**	**929**	**100.00**

Mean = $\sum fx/\sum f$= 929/100 = 9.29

Table 2 shows the respondents mean year of experience estimated at approximately ten years (10yrs). With this average working experience of thirteen years, respondents are deemed experienced enough to supply reliable data for the research.

Table 3: Professional qualification

Educational Qualification	Frequency	Percentage (%)
NIOB	36	45.00
NIQS	14	17.50
NIA	12	15.00
NSE	10	12.50
Others	8	10.00
Total	**80**	**100.00**

Table 3 represents the educational qualification obtained by the respondents. 45% is registered with NIOB, while 17.50% is registered with NIQS, 15% is registered with NIA, 12.50% with NSE and 10% with other professional bodies. The result shows that all respondents possess registration of their various professional bodies in Nigeria and adequate professional training to supply reliable data for the study.

4.1 Assessing the Effectiveness of The Green Building as a Ways of

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Sustainability in the Nigeria Construction Industry

Table 4 identified the effectiveness of the green building as a ways of sustainability in the construction industry in Nigeria and the ranking of the factors through the use Relative Significance Index (RSI).

Table 4: Factors influencing the effectiveness of green building adoptions in Nigeria

S/N	Factors	5	4	3	2	1	Total	TWV	RSI	Rank
1.	Environmental concerns	40	30	4	4	2	80	342	0.855	1
2.	Economic benefits	36	32	6	4	2	80	336	0.84	2
3.	Regulatory and policy framework	30	36	8	4	2	80	328	082	4
4.	Social and market demand	24	38	10	6	2	80	318	0.795	6
5.	Technological advancements	28	32	12	6	2	80	320	0.80	5
6.	Need for sustainable development	34	30	10	4	2	80	332	0.83	3
7.	The challenges of global climate change	26	34	8	10	2	80	312	0.78	8
8.	Client's preferences	18	36	14	8	4	80	296	0.74	9
9.	Safety concerns	22	34	12	10	2	80	316	0.79	7
10.	**Preferences of other stakeholders**	**20**	**30**	**16**	**10**	**4**	**80**	**292**	**0.73**	**10**

TWV = Total Weight Value, RSI = Relative Significance Index

It show that *environmental concerns* ranked first with RSI value of 0.855 (85.50%), *economic benefits* ranked second with RSI value of 0.84 (84%) and the need for sustainable development ranked third with RSI value of 0.83 (83%). While *preferences of other stakeholders* ranked least with RSI value of 0.73 (73%), client's reference (74%), and the challenges of global climate change (78%) in its relevance to their effectiveness.

Table 5: Challenges in implementing the green building adoptions in Nigeria

S/N	**Factors**	**5**	**4**	**3**	**2**	**1**	**Total**	**TWV**	**RSI**	**Rank**
1.	**High maintenance costs**	**42**	**24**	**6**	**6**	**2**	**80**	**338**	**0.845**	**1**
2.	**Limited access to finance**	**38**	**28**	**8**	**4**	**2**	**80**	**336**	**0.84**	**2**
3.	**Lack and shortage of expertise and training**	**34**	**30**	**10**	**4**	**2**	**80**	**330**	**0.825**	**3**
4.	**Technological limitations**	**32**	**32**	**8**	**6**	**2**	**80**	**326**	**0.815**	**4**
5.	**Complexity of implementation**	**28**	**36**	**8**	**6**	**2**	**80**	**314**	**0.785**	**7**
6.	**Inadequate policies and incentives**	**26**	**34**	**12**	**6**	**2**	**80**	**316**	**0.79**	**6**
7.	**Bureaucratic delays**	**30**	**28**	**14**	**6**	**2**	**80**	**318**	**0.795**	**5**
8.	**Inconsistent standards**	**24**	**30**	**16**	**6**	**4**	**80**	**304**	**0.76**	**9**
9.	**Limited awareness among the public**	**28**	**26**	**18**	**6**	**2**	**80**	**312**	**0.78**	**8**
10.	**Fear of encroachment by other organisms**	**22**	**28**	**20**	**6**	**4**	**80**	**298**	**0.745**	**10**

TWV = Total Weight Value, RSI = Relative Significance Index

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Table 5 showed that high maintenance costs ranked first with RSI value of 0.845 (84.50%), limited access to finance ranked second with RSI value of 0.84 (84%) and lack and shortage of expertise and training rank third with RSI value of 0.825 (82.50%). Fear of encroachment by living organisms ranked least with RSI value of 0.745 (74.50%).

Table 6: Environmental sustainability impact of green building practices in Nigeria

S/N	Factors	5	4	3	2	1	Total	TWV	RSI	Rank
1.	Reduced energy consumption	38	24	10	6	2	80	330	0.825	1
2.	Rainwater harvesting and greywater recycling	34	28	8	6	4	80	322	0.805	2
3.	Material efficiency	30	32	10	4	4	80	320	0.80	3
4.	Waste reduction	28	30	12	8	2	80	314	0.785	5
5.	Indoor environmental quality	32	24	16	6	2	80	318	0.795	4
6.	Thermal comfort	26	28	18	6	2	80	310	0.775	6
7.	Reduced site disturbance	24	30	16	6	4	80	304	0.76	7
8.	Ecosystem protection	20	34	14	8	4	80	298	0.745	8
9.	Reduction of greenhouse gas emissions	22	32	12	10	4	80	298	0.745	8
10.	Enhanced sustainability	24	28	14	8	6	80	296	0.74	9
11.	Reduced cost of execution	18	30	16	10	6	80	284	0.71	10

TWV = Total Weight Value, RSI = Relative Significance Index

It showed that reduced energy consumption ranked first with RSI value of 0.825 (82.50%), rainwater harvesting and greywater recycling ranked second with RSI value of 0.805 (80.50%), and material efficiency ranked third with RSI value of 0.80 (80%). While reduced cost of execution and enhanced sustainability ranked least with RSI value of 0.71 (71%) and 0.74 (74%) in ascending order from the rear but still indicate moderate to high levels of impact.

4.0 Discussion of findings

According to the study, the factors influencing the effectiveness of green building adoptions in Nigeria showed that *environmental concerns* ranked first with RSI value of 0.855 (85.50%), *economic benefits* ranked second with RSI value of 0.84 (84%) and the need for sustainable development ranked third with RSI value of 0.83 (83%) followed by regulatory and policy framework with RSI value of 0.82 (82%), Technological advancements with RSI value of 0.80 (80%), Social and market demand with RSI value of 0.795 (79.50%), Safety concerns with RSI value of 0.79 (79%). While *preferences of other stakeholders* ranked least with RSI value of 0.73 (73%), client's reference (74%), and the challenges of global climate change (78%) in its relevance to their effectiveness.

Challenges in implementing the green building adoptions in Nigeria as shown**,** that *high maintenance costs* ranked first with RSI value of 0.845 (84.50%), limited access to finance ranked second with RSI value of 0.84 (84%) and lack and shortage of expertise and training rank third with RSI value of 0.825 (82.50%) followed by

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technological limitations with RSI value of 0.815 (81.50%), bureaucratic delays with RSI value of 0.795 (79.50%), inadequate policies and incentives with RSI value of 0.79 (79%) and Complexity of implementation with RSI value of 0.785 (78.50%), limited awareness among the public with RSI value of 0.78 (78%) and inconsistent standards with RSI value of 0.76 (76%), while *Fear of encroachment by living organisms* ranked least with RSI value of 0.745 (74.50%).

Environmental sustainability impact of green building practices in Nigeria showed that *reduced energy consumption* ranked first with RSI value of 0.825 (82.50%), rainwater harvesting and greywater recycling ranked second with RSI value of 0.805 (80.50%), and material efficiency ranked third with RSI value of 0.80 (80%), indoor environmental quality with RSI value of 0.795 (79.50%), waste reduction with RSI value of 0.795 (79.50%), thermal comfort with RSI value of 0.775 (79.50%), reduced site disturbance with RSI value of 0.76 (0.76%), ecosystem protection with RSI value of 0.745 (74.50%), and reduction of greenhouse gas emissions with RSI value of 0.745 (74.50%). While reduced cost of execution and enhanced sustainability ranked least with RSI value of 0.71 (71%) and 0.74 (74%) in ascending order from the rear but still indicate moderate to high levels of impact.

5.0.Conclusion

The extensive use of green buildings in Nigeria has been investigated in detail, and some significant findings have been made. In order to promote the use of green buildings, strategies include raising awareness and educating others, enacting laws and regulations that support the practice, developing professional capacity, offering financial assistance, and embracing innovation and technology. Although it holds a prominent place in the national economy, its economic performance has been and remains extremely bad (Wang and Pettit, 2012).

6.0.Recommendations

From the conclusions of this project the following recommendations are made:

i. Enacting laws and regulations that support the practice, developing professional capacity that can encourage wider adoption among developers and contractors.

ii. Offering financial assistance, and embracing innovation and technology for construction professionals on the benefits and implementation of green technologies is essential.

iii. Increasing public awareness educating the community and others to values sustainability of green building in construction practices.

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