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SOCIO-ECONOMIC AND ENVIRONMENTAL IMPACTS OF ADOPTING GREEN BUILDING TECHNIQUES IN FEDERAL CAPITAL CITY, ABUJA NIGERIA

OLUWASEGUN V. A.; S. Y. KPALO; & EKPO A. S.
Department of Geography, Faculty of Environmental Science, Nasarawa State University, Keffi.
Corresponding Author: segunbolaji01@gmail.com
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Abstract
This study employed a Descriptive-Survey Research Design with a mixed-method approach, combining both quantitative and qualitative data collection techniques to assess the socio-economic and environmental impacts of adopting green building techniques in Abuja, Nigeria. Data were collected from primary sources through structured surveys, semi-structured interviews, field observations, and secondary sources, including literature reviews. A multi-stage sampling method was used to select key stakeholders, such as developers, architects, government officials, and property owners. The Krejcie and Morgan sample size determination table was applied to ensure statistical validity. The quantitative data focused on financial metrics, cost analysis, and perceptions of stakeholders regarding green buildings. The qualitative data provided insights into construction practices through interviews and observations. Statistical techniques, including AMOS (Structural Equation Modeling), were applied to analyze key sustainability indicators, economic viability, and policy frameworks. Results indicated that the adoption of green building techniques offers substantial socio-economic benefits. The economic viability of green buildings was highlighted by reduced operational costs, energy savings, and water conservation

strategies. The environmental benefits included significant reductions in carbon emissions, improved air quality, and waste reduction. However, challenges such as high initial costs, limited technical expertise, weak policy enforcement, and a lack of awareness among stakeholders were identified as barriers to widespread adoption. The findings suggest that green building practices can contribute to Abuja's urban sustainability goals, but further improvements in policy, training, and public awareness are necessary to maximize these benefits. Statistical results, such as a Chi-squared/degree of freedom ratio (ChiSq/df) of 2.331, a Goodness of Fit Index (GFI) of 0.916, and Root Mean Square Error of Approximation (RMSEA) of 0.066, supported the model's adequacy. Furthermore, the overall Cronbach's alpha coefficient for the reliability test was 0.956, indicating high internal consistency.

Keywords: Environment, Benefit, Green, Building, Conservation

INTRODUCTION

The Federal Capital City (FCC) of Abuja, Nigeria, is undergoing rapid urbanization, leading to increased demand for housing, commercial buildings, and infrastructure. However, conventional construction practices contribute significantly to environmental degradation, resource depletion, and socio-economic challenges such as high energy costs and poor indoor air quality. As a response to these challenges, green building techniques have emerged as a viable approach to achieving sustainable urban development. Green buildings integrate environmentally responsible practices throughout a building's lifecycle, reducing energy consumption, minimizing waste, and enhancing occupant well-being (Adebayo & Yusuf, 2023). Given Abuja's unique climatic conditions and socio-economic dynamics, adopting green building techniques presents both opportunities and challenges that require a comprehensive assessment of their impacts on the city's development.

One of the key socio-economic benefits of adopting green building techniques in Abuja is cost savings in energy and water consumption.

Energy-efficient buildings significantly reduce electricity demand through passive cooling strategies, solar energy integration, and efficient lighting systems, leading to lower utility bills for households and businesses (Olaniyan & Ogbu, 2022). Additionally, green construction techniques create job opportunities in emerging sectors such as renewable energy installation, sustainable architecture, and environmental engineering. This shift toward a greener economy can contribute to poverty reduction and workforce development, aligning with Nigeria's broader economic diversification goals (Akinyemi et al., 2023).

From an environmental perspective, green buildings help mitigate climate change by reducing carbon emissions associated with conventional construction methods. Sustainable site planning, waste reduction strategies, and the use of eco-friendly materials contribute to lower greenhouse gas emissions and improved air quality in urban areas (Eneh, 2023). Moreover, water conservation techniques such as rainwater harvesting and greywater recycling help address Abuja's growing water scarcity challenges. By reducing the reliance on municipal water supply and promoting responsible water usage, green buildings contribute to long-term environmental resilience and resource conservation (Ajayi & Okonkwo, 2023).

Beyond economic and environmental considerations, green buildings also enhance human health and social well-being. Improved indoor air quality, access to natural lighting, and thermal comfort create healthier living and working environments, reducing cases of respiratory diseases and improving overall productivity (Green Building Council Nigeria, 2023). In Abuja, where rapid urban expansion has led to concerns about pollution and poor housing conditions, adopting green building techniques can significantly improve the quality of life for residents. Additionally, sustainable urban planning fosters community engagement, promoting inclusivity and equitable access to green spaces and essential services.

Despite these benefits, the adoption of green building techniques in Abuja faces several challenges, including high initial costs, limited awareness, and inadequate policy enforcement. While long-term cost savings are evident, the upfront investment required for sustainable construction materials and technologies remains a barrier for developers and homeowners (Federal Ministry of Housing & Urban Development, 2024).

MATERIALS AND METHODS

Abuja is the planned capital city of Nigeria which was created in February 1976. Its creation was as a result of the intolerable living and working conditions, environment pollution, overcrowding, growing squalor, in adequate infrastructure and limitation of space in Lagos. Mabogunje, (1994). Abuja which has a population of over 1 million is located in the center of the country, Abuja FCT is the capital city of Nigeria and located in between latitude 8° 50′ 0″ N, and longitude 8^0 7° 10′ 0″ E. It covers a total of 7,315 square kilometers, and lies in the middle part of the country, The Abuja FCT area features an interesting terrain, which combines rounded hills and clusters of rock outcrops dissected by river valleys, as well as gentle rolling plains, it falls within the Abuja hills and dissected zones, The territory is located just north of the confluence of the Niger River and Benue River. It is bordered by the states of Niger to the West and North, Kaduna to the northeast, Nasarawa to the east and south and Kogi to the southwest.. Generally viewing the study area, the hilly areas are found towards the eastern part, posing constraint to physical development while the plains occupy the central and western areas.

The study area which is the Federal Capital City (FCC) is located in the Gwagwa Plains, in the north-eastern "panhandle" of the Federal Capital Territory (FCT). The FCC lies within latitude 9 0 15'N and 8 0 56'N of the equator and longitude 7 0 09'E and 7 0 34'E. It occupies about 535sq km that constitute about seven percent (7%) of the total 8,000 km2 land area of the FCT.

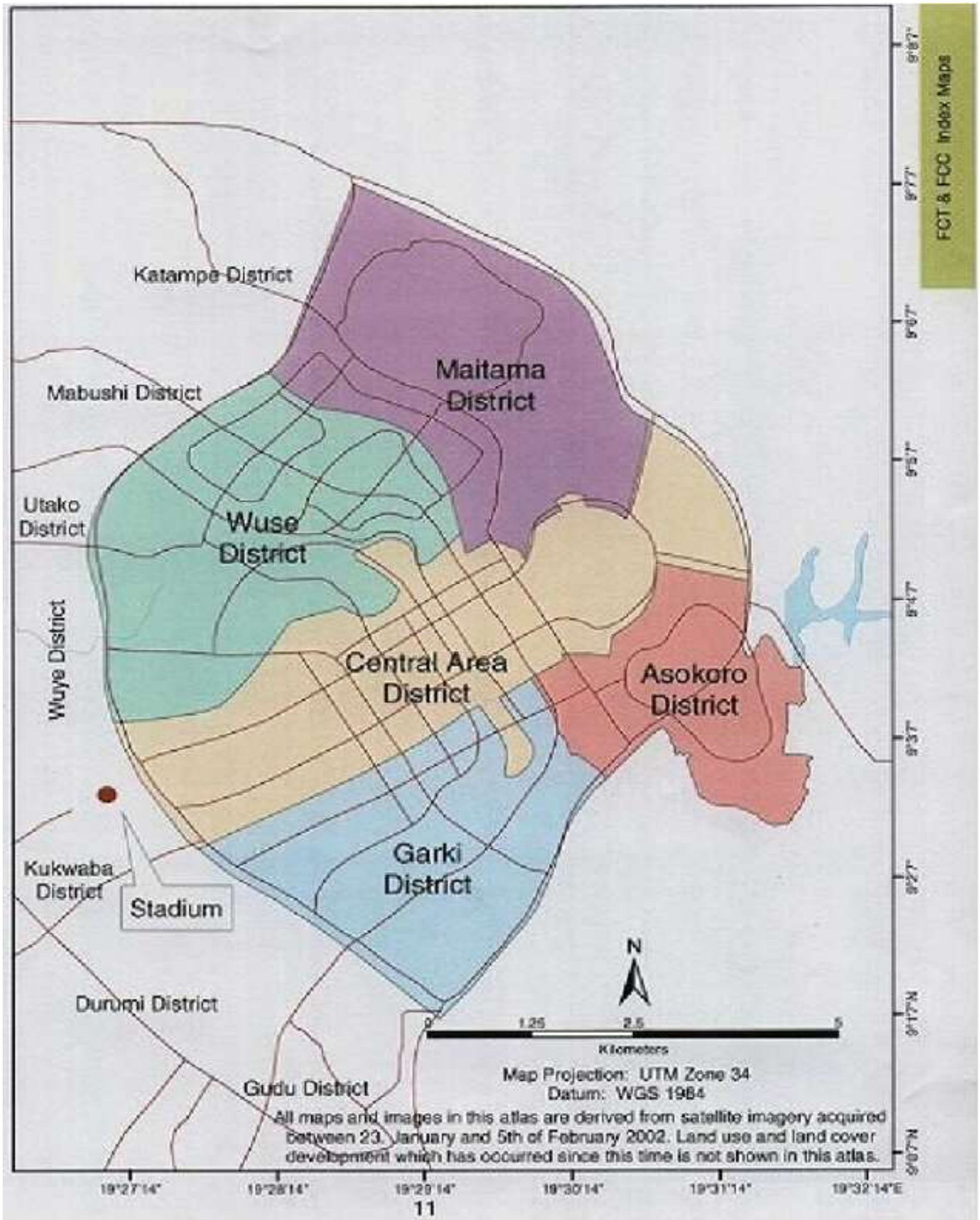

Figure 1: Map of the Federal Capital City
Source: Fanan, 2010.

The study employed a **Descriptive-Survey Research Design** with a mixed-method approach, incorporating both **quantitative and qualitative** data collection techniques to gain a comprehensive understanding of the socio-economic and environmental impacts of green building techniques in **Abuja, Nigeria**. Data was gathered from both **primary and secondary sources,** including structured surveys, semi-structured interviews, field observations, and literature reviews. The **sampling technique** followed a multi-stage approach, selecting **key stakeholders** such as developers, architects, government officials, and property owners, with the **Krejcie and Morgan sample size determination table** used to ensure statistical validity. **Quantitative data** focused on financial metrics, cost analyses, and stakeholders' perceptions of green buildings, while **qualitative data** provided insights through interviews and direct observations of construction practices. The **data analysis** incorporated **statistical techniques, AMOS (Structural Equation Modeling), comparative analysis, and content analysis** to evaluate key sustainability indicators, economic viability, and policy frameworks. This mixed-method approach allowed for a **holistic assessment** of green building adoption in Abuja, addressing both the **opportunities and challenges** associated with sustainable construction practices.

RESULTS

Socio-economic and environmental impacts of adopting green building techniques in the study area

Socio-economic impacts of adopting green building techniques in the study area

The structural equation model (SEM) used in carrying a confirmatory factor analysis (CFA) of the constructs. The construct, which was on socio-economic benefit (economic viability) of green materials, contains 15 indicators that evaluated in confirmatory factor analysis. The 15 observed variables derived from two sub-scales in part of the survey (Figure 1), was the first measurement model for the concept of economic viability of green materials, and (Table 1) the displays for the first measurement model for economic viability of GMs construct.

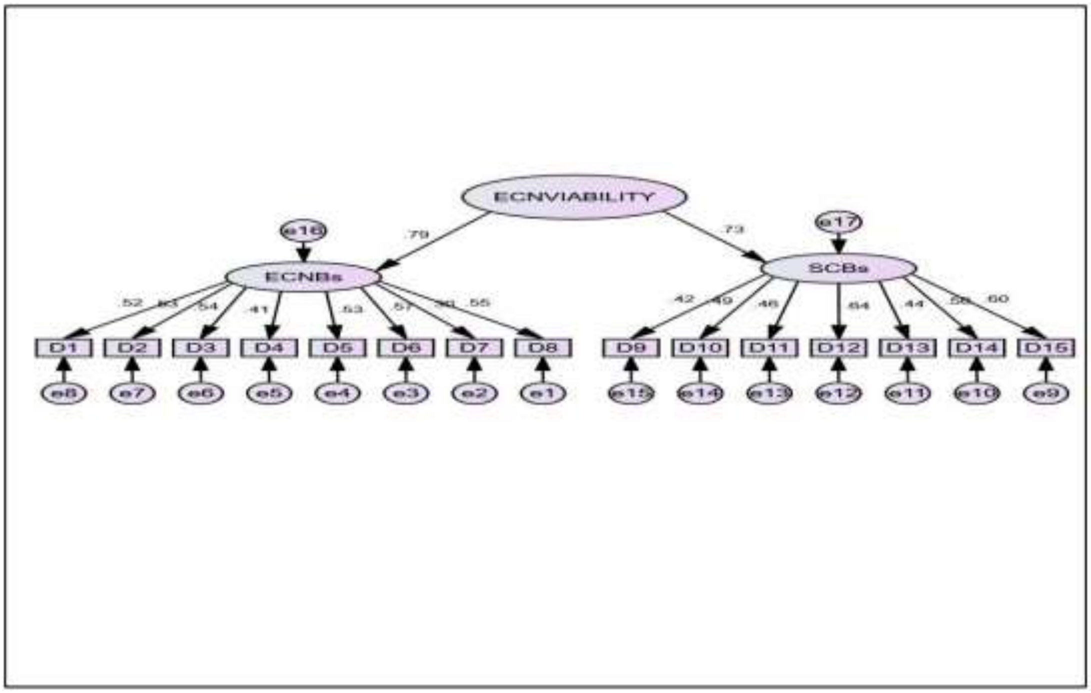

Figure 1: First measurement model (CFA) for construct on socio-economic benefit

Source: Field Analysis, 2024

Table 1: Details of the first measurement model for concept on socio-economic benefit of GMs

Construct	Sub-construct	Code	Indicators
Economic Viability of GMs	Economic Benefits	D1	Cost-effectiveness
		D2	Readily available
		D3	Energy efficiency
		D4	Create a job for people
		D5	Reduced cost of construction
		D6	Reduced waste
		D7	Aesthetics /beautification
		D8	Improved the economy of the community
	Socio-benefits	D9	Promote cultural heritage
		D10	Improved occupant productivities
		D11	Adaptability to the environment
		D12	Eco-friendly
		D13	Improved social capital
		D14	Enhance social well being
		D15	Reduced CO2 emission

Source: Field Analysis, 2024

The suitability index parameter, as illustrated in Figure 4.8, highlights the inadequacy of the initial measurement model. The results showed a Chi-squared/degree of freedom ratio (ChiSq/df) of 2.331, which is below the threshold of 3.00, indicating a reasonable fit. However, several indices, including the Adjusted Goodness of Fit Index (AGFI), Comparative Fit Index (CFI), Tucker-Lewis Index (TLI), and Normed Fit Index (NFI), were all below the acceptable level of 0.90. The only exception was the Goodness of Fit Index (GFI), which was measured at 0.916, exceeding the minimum requirement of 0.900. Additionally, the Root Mean Square Error of Approximation (RMSEA) was recorded at 0.066, which is below the acceptable threshold of 0.08. This analysis suggested that adjustments were necessary to improve the model's fit by trimming variables with factor loadings of less than 0.50.

After excluding these low-loading items, the revised model focused on the socio-economic benefits of green materials (GMs) in affordable housing. The final model, as depicted in Figure 4.8, met all parameters required for acceptance: the p-value was 0.041, RMSEA was reduced to 0.046, GFI increased to 0.977, AGFI was 0.957, CFI was 0.954, TLI was recorded at 0.93, NFI reached 0.900, and ChiSq/df improved to 1.63. These results indicate a significant enhancement in the model's fit after the adjustments were made.

Table 2 provides a detailed overview of the indicators for the modified measurement model related to the socio-economic benefits of green materials in affordable housing within the context of the FCC (Federal Communications Commission). This comprehensive assessment underscores the importance of refining measurement models to ensure their reliability and validity in evaluating the benefits of sustainable practices in housing development.

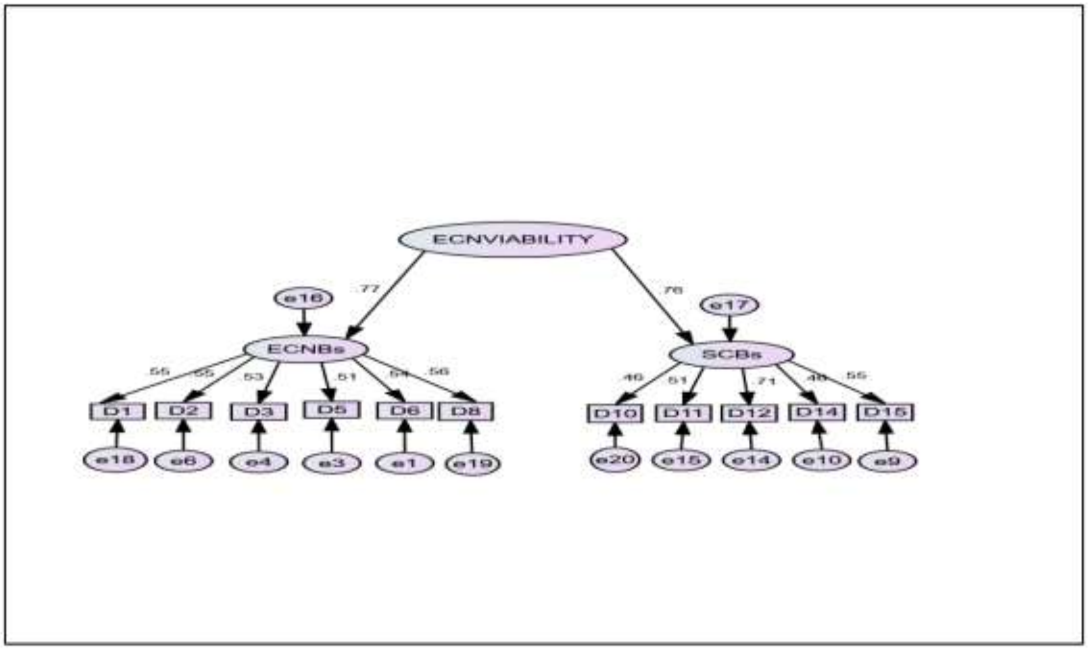

Figure 2: Modified measurement model for construct on socio-economic benefits
Source: Field Analysis, 2024

Table 2 Details for the modified model for construct on socio-economic benefits of GMs

Construct	Sub-construct	Code	Indicators
Economic Viability of GMs	Economic Benefits	D1	Cost-effectiveness
		D2	Readily available
		D3	Energy efficiency
		D5	Reduced cost of construction
		D6	Reduced waste
		D8	Improved the economy of the community
	Socio-Benefits	D10	Improved occupant productivities
		D11	Adaptability to the environment
		D12	Eco-friendly
		D14	Enhance social well being
		D15	Reduced CO2 emission

Source: Field Analysis, 2024

The composite reliability and convergent validity for the model also realised with the CR value of 10.8, and 7.20 (≥0.6) and an AVE value of 1.80, and 1.44 (≥0.6). The overall fitness parameter accomplished. Table 3 displays information on the reliability and validity evaluation for the model.

Table 3 : Validity and reliability assessment for economic viability of GMs measurement model

Constructs	Sub-construct	Items	Factor Loading (≥ 0.5)	AVE (≥ 0.6)	CR (≥ 0.6)
Economic Viability of GMs	Economic Benefits	D1	0.55	1.80	10.80
		D2	0.55		
		D3	0.58		
		D4	deleted		
		D5	0.51		
		D6	0.54		
		D7	deleted		
		D8	0.56		
		D9	deleted		
	Socio-benefits	D10	0.46	1.44	7.20
		D11	0.51		
		D12	0.71		
		D13	Deleted		
		D14	0.46		
		D15	0.55		

Source: Field Analysis, 2024

Environmental Impacts of adopting Green Building Techniques in the study area

To portray a vivid picture of the environmental importance of green building techniques, the study collected and analyzed data on the Impacts of construction waste to the environment

Table 4: Descriptive statistics and normality test of the collected data on Impacts of construction waste

S.No	Impacts of construction waste	Mean	Std. Deviation	Rank	Cronbach's alpha if item deleted a	Kolmogorov-smirnov test		
						Statistic	Df	Sig.
EN1	Pollution of the environment by discharging chemicals and other materials	4,14	.967	2	.953	.284	70	.000
EN3	Pollution of soil by chemicals and other materials	3.93	1.121	6	.952	.270	70	.000
EN4	Sustainability reduction of construction sector	3.87	1.006	9	.956	.237	70	.000
EN5	Generate waste that causes water pollution	3.83	1.239	10	.952	.269	70	.000
EN6	Land occupancy or land consumption for dumping waste	3.81	.997	11	.956	.188	70	.000
EN7	Effect on biodiversity and destruction of the living environment	3.76	1.233	14	.952	.207	70	.000
EN8	Severe effects on the welfare of the waste disposed communities	3.67	1.487	17	.954	.210	70	.000
EN9	Emission of greenhouse gases into the atmosphere causes climate change	3.61	1.487	19	.954	.288	70	.000
EN10	Increase in illegal dumping b	3.60	1.411		.958	.231	70	.000
EN11	Dust generation to the surrounding	3.47	1.411	20	.954	.217	70	.000

a; Overall Cronbach's alpha coefficient is 0.956.
b; Item was removed because it does not contribute to the overall reliability

EN are environmental impacts of construction waste

As presented in Table 4, the results from the comprehensive analysis indicate that the primary environmental impact of construction waste is environmental pollution, with a mean score of 4.14. Waste generated on construction sites significantly contributes to environmental pollution by releasing harmful chemicals and materials into the surroundings. Numerous studies have identified environmental pollution as one of the most significant impacts of construction waste (Nayanthara and S.B.K.H, 2008; Coelho and Brito, 2012; Hossain and Ng, 2019). The construction industry is responsible for generating substantial amounts of waste, which further exacerbates environmental pollution, contributing to over 33% of global CO2 emissions (Li et al., 2013; Ajayi et al., 2015; Anderson and Thornback, 2012; Baek et al., 2013).

Following environmental pollution, the excessive consumption of raw materials and the depletion of natural resources ranked second in terms of its adverse environmental effects, with a mean score of 3.89. The primary sources of construction materials are non-renewable resources, which are increasingly being degraded and depleted. Consequently, construction projects become a significant environmental burden by consuming vast amounts of non-renewable resources and generating large quantities of waste (Faleschini et al., 2016; Husnain et al., 2017). It is estimated that construction projects consume approximately 40% of the world's natural resources and energy (Wu, 2003). Furthermore, improper waste management contributes to the depletion of these natural resources (Castellano et al., 2016).

The pollution of soil due to chemicals and other materials from construction waste ranked as the third environmental impact, with a mean score of 3.93, according to the respondents' perceptions. Construction waste is often dumped on or around construction sites, leading to direct contact with the soil. In the Federal Capital City, there is a lack of effective policies, characterization, and methods for separating and disposing of harmful waste. This finding aligns with the argument made by Olusanjo et al. (2014), which states that waste consumes land and significantly contaminates the soil, adversely affecting agricultural productivity and forestation. Additionally, Mbala et al. (2019) identified land pollution from construction waste as the most detrimental impact. Importantly, reducing construction waste can lower the volume of hazardous waste, consequently mitigating its negative impact on the environment (Liu et al., 2020).

Green building has emerged as a viable solution to address various environmental, economic, and social challenges. This concept is progressively developing and gaining traction worldwide. However, the promotion and implementation of green building practices are influenced by multiple factors, which are continuously studied. The results of such studies may vary across different regions and timeframes due to the unique characteristics of each area. Therefore, the development of green buildings necessitates ongoing trade-offs and adaptations to effectively balance these influencing factors.

CONCLUSION

The adoption of green building techniques in the Federal Capital City (FCC), Abuja, Nigeria, presents significant socio-economic and environmental benefits, including energy efficiency, cost savings, improved public health, job creation, and reduced environmental degradation. The study highlights that integrating sustainable construction practices can mitigate the negative impacts of conventional building methods, such as excessive energy consumption, waste generation, and carbon emissions. The economic viability of green buildings is evident in their long-term cost-effectiveness, as they reduce operational expenses through energy-efficient designs and water conservation strategies. Additionally, the environmental advantages of green buildings—such as improved air quality, waste reduction, and sustainable resource utilization—support Abuja's broader urban sustainability goals. However, despite these benefits, widespread adoption remains limited due to challenges such as high initial costs, limited technical expertise, weak policy implementation, and lack of awareness among stakeholders.

RECOMMENDATIONS

To accelerate the adoption of green building techniques in Abuja, the government should strengthen policy frameworks by enforcing existing building regulations and introducing mandatory green building codes. Financial incentives such as tax breaks, subsidies, and low-interest loans should be provided to encourage developers to invest in sustainable projects. Additionally, capacity-building programs should be implemented to train architects, engineers, and construction workers on sustainable building practices. Public awareness campaigns can also play a crucial role in educating property owners, investors, and the general public about the long-term economic and environmental benefits of green buildings.

Furthermore, public-private partnerships (PPPs) should be encouraged to facilitate the financing and implementation of large-scale green building projects. Collaboration between the Federal Capital Development Authority (FCDA), private developers, financial institutions, and environmental organizations can create an enabling environment for sustainable urban development. Additionally, research and development (R&D) should be promoted to explore locally sourced, cost-effective eco-friendly materials that can reduce construction costs while maintaining sustainability standards.

Incorporating smart technologies and renewable energy solutions—such as solar panels, energy-efficient appliances, and intelligent building management systems—can further enhance the efficiency and performance of green buildings in Abuja. Moreover, community engagement should be prioritized by involving residents in decision-making processes related to urban planning and sustainable development initiatives. This will foster a sense of ownership and commitment to maintaining green infrastructure.

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