

Advancing Sustainable Construction in Nigeria: Insights from Structural Equation Modeling

H. C. O. Unegbu^{1*}, D. S. Yawas², A. A. Alabi³

^{1,2,3} Department of Mechanical Engineering, Ahmadu Bello University, Zaria, Nigeria

*Corresponding author, e-mail: chidieberehyg@gmail.com

ABSTRAK

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Industri konstruksi merupakan pendorong utama pertumbuhan ekonomi, namun tetap menjadi salah satu kontributor terbesar terhadap degradasi lingkungan, eksploitasi sumber daya, dan emisi karbon. Studi ini mengkaji determinan utama yang memengaruhi adopsi praktik konstruksi berkelanjutan di Nigeria, dengan fokus pada faktor lingkungan, ekonomi, sosial, kebijakan, dan teknologi. Sebuah survei lintas sektoral dilakukan terhadap 400 profesional konstruksi, dan data dianalisis menggunakan *Structural Equation Modelling (SEM)* untuk menetapkan hubungan kausal di antara variabel-variabel yang diidentifikasi. Hasil penelitian menunjukkan bahwa regulasi kebijakan ($\beta = 0,37$, $p < 0,001$), faktor lingkungan ($\beta = 0,42$, $p < 0,001$), dan kesadaran terhadap perubahan iklim ($\beta = 0,38$, $p < 0,001$) merupakan prediktor terkuat terhadap adopsi keberlanjutan. Studi ini juga menunjukkan bahwa kolaborasi para pemangku kepentingan menjadi mediasi antara regulasi kebijakan dan adopsi keberlanjutan, sementara permintaan pasar terhadap bangunan hijau memoderasi pengaruh kelayakan ekonomi. Meskipun kesadaran akan manfaat keberlanjutan terus meningkat, hambatan seperti tingginya biaya awal, lemahnya penegakan regulasi, terbatasnya akses terhadap pembiayaan hijau, serta lambatnya adopsi teknologi masih menjadi kendala dalam implementasi secara luas. Studi ini menekankan perlunya penegakan kebijakan yang kuat, insentif finansial, program peningkatan kapasitas, serta integrasi teknologi konstruksi cerdas untuk mendorong adopsi keberlanjutan di lingkungan binaan Nigeria. Temuan ini memberikan wawasan berharga bagi pembuat kebijakan, praktisi industri, dan peneliti, dengan menawarkan kerangka strategis untuk mempercepat transisi menuju praktik konstruksi yang tangguh terhadap iklim, efisien energi, dan layak secara ekonomi.

ABSTRACT

Keywords: *climate resilience; green building adoption; Nigeria's built environment; structural equation*

The construction industry is a major driver of economic growth but remains one of the largest contributors to environmental degradation, resource depletion, and carbon emissions. This study examines the key determinants influencing the adoption of sustainable construction practices in Nigeria, focusing on environmental, economic, social, policy,

*modelling;
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construction*

and technological factors. A cross-sectional survey was conducted with 400 construction professionals, and data were analysed using Structural Equation Modelling (SEM) to establish causal relationships among the identified variables. The findings reveal that policy regulation ($\beta = 0.37, p < 0.001$), environmental factors ($\beta = 0.42, p < 0.001$), and climate change awareness ($\beta = 0.38, p < 0.001$) are the strongest predictors of sustainability adoption. The study also establishes that stakeholder collaboration mediates the relationship between policy regulation and sustainability adoption, while market demand for green buildings moderates the influence of economic feasibility. Despite increasing awareness of the benefits of sustainability, barriers such as high initial costs, weak regulatory enforcement, limited access to green financing, and slow technological adoption continue to hinder widespread implementation. The study underscores the need for robust policy enforcement, financial incentives, capacity-building programs, and the integration of smart construction technologies to drive sustainability adoption in Nigeria's built environment. The findings provide valuable insights for policymakers, industry practitioners, and researchers, offering a strategic framework to accelerate the transition toward climate-resilient, energy-efficient, and economically viable construction practices.

INTRODUCTION

The construction industry is a crucial driver of economic growth, providing infrastructure, housing, and employment opportunities. However, it remains one of the largest contributors to environmental degradation due to excessive carbon emissions, high energy consumption, and inefficient resource utilization. According to the International Energy Agency (IEA, 2023), the construction sector accounts for nearly 40% of global energy-related carbon dioxide emissions, necessitating urgent action to promote sustainability. Sustainable construction, which integrates environmentally responsible materials and processes, is increasingly recognized as a viable strategy for mitigating the industry's negative impacts (Okoye et al., 2025).

In Nigeria, the adoption of sustainable construction practices remains slow despite the global momentum toward green building technologies. Studies have shown that the sector faces multiple barriers, including weak regulatory frameworks, high costs of sustainable materials, limited stakeholder awareness, and resistance to change (Unegbu et al., 2025). The continued reliance on conventional construction materials, such as concrete and steel, further exacerbates the industry's environmental footprint (Adegun & Ikudayisi, 2025). Moreover, inadequate research on the determinants of sustainable construction adoption in Nigeria has hindered the development of targeted strategies to improve implementation.

Nigeria's construction industry continues to contribute significantly to resource depletion, environmental pollution, and inefficient energy use (Madaki et al., 2025). Despite policies such as the National Building Code (NBC) and the Energy Efficiency Building Policy, enforcement remains weak, leading to minimal compliance from industry stakeholders (Kadiri & Kolawole, 2025). Existing studies on sustainable

construction in Nigeria have largely employed qualitative approaches, focusing on general discussions rather than quantitative modeling of key determinants and interrelationships (Ehimioboh et al., 2024). Structural Equation Modeling (SEM) is an advanced statistical technique that allows for the assessment of complex relationships among multiple variables (Unegbu et al., 2024). However, there is a dearth of research applying SEM to analyze sustainable construction adoption in Nigeria. This study seeks to bridge this gap by using SEM to identify the critical factors influencing sustainable construction adoption and their interrelationships. The findings will provide empirical insights that will aid policymakers, construction firms, and regulatory bodies in making informed decisions on sustainability integration.

The aim of this study was to examine the key factors influencing the adoption of sustainable construction practices in Nigeria using Structural Equation Modeling. The objectives of this study were to identify and analyze the critical factors influencing sustainable construction in Nigeria, develop a conceptual framework that explains the relationships among sustainability determinants, assess the influence of various factors on sustainability adoption using Structural Equation Modeling, and provide evidence-based policy recommendations for improving sustainability in Nigeria's construction sector.

This study contributes to the growing body of knowledge on sustainable construction in developing economies by applying advanced statistical techniques to analyze the interrelationships between sustainability drivers and barriers. The findings will offer valuable insights to policymakers, regulatory agencies, and construction firms, enabling them to develop more effective sustainability strategies. Additionally, the study will support the achievement of Sustainable Development Goals (SDGs), particularly Goal 11 (Sustainable Cities and Communities) and Goal 12 (Responsible Consumption and Production), by promoting sustainable resource management and climate-resilient construction practices (United Nations, 2023).

From a practical perspective, the research findings will guide construction professionals in adopting environmentally responsible practices and encourage the use of innovative, sustainable building materials. Moreover, the study will provide data-driven recommendations that can inform future policy frameworks aimed at enhancing sustainability in Nigeria's construction sector.

This research focuses on the Nigerian construction industry, specifically examining the perspectives of construction professionals, policymakers, and regulatory bodies. The study will assess various sustainability dimensions, including environmental, economic, and social factors, alongside policy and technological influences. Data will be collected through structured surveys and analyzed using SEM techniques to establish relationships among sustainability factors. Potential limitations of this study include constraints in data availability and respondent participation. Additionally, SEM requires large sample sizes for robust model estimation, which may present challenges in data collection. Findings from this study will be specific to

Nigeria, and while they may provide insights applicable to similar developing economies, generalization beyond Nigeria should be done cautiously. Despite these limitations, this study aims to provide valuable empirical evidence to enhance sustainable construction practices in Nigeria.

LITERATURE REVIEW

1. Concept of Sustainable Construction

Sustainable construction refers to the implementation of environmentally responsible, resource-efficient, and economically viable practices throughout a building's lifecycle, including design, construction, operation, and decommissioning. The construction industry accounts for nearly 40% of global energy consumption and 39% of carbon dioxide emissions, making sustainability a crucial aspect of modern construction (International Energy Agency, 2023). Sustainable construction integrates green building principles, circular economy approaches, and climate adaptation strategies to reduce environmental impact and enhance the longevity of built environments (Ilesanmi et al., 2024).

Despite the significant benefits of sustainable construction, its adoption in Nigeria has been slow. Studies have attributed this to high initial costs, poor regulatory enforcement, lack of financial incentives, and limited awareness among industry stakeholders (Abdulkadir et al., 2024). Furthermore, the dependence on energy-intensive materials such as cement and steel exacerbates environmental issues, making it imperative to transition to sustainable alternatives such as bamboo, recycled aggregates, and energy-efficient building systems (Oladipo & Ayuba, 2024). Addressing these challenges requires comprehensive policies, increased investments in green infrastructure, and active engagement of construction professionals in sustainability initiatives (Ukwu, 2024).

2. Sustainable Construction in Nigeria

The Nigerian construction sector is a major contributor to economic development, accounting for 7.5% of the Gross Domestic Product (GDP) as of 2024 (National Bureau of Statistics, 2024). However, it remains one of the least sustainable sectors due to poor waste management, excessive resource consumption, and inefficient building designs (Ukwu, 2024). Several key factors hinder the widespread adoption of sustainable construction practices in Nigeria, including weak enforcement of environmental laws, financial barriers, and limited access to sustainable materials and technologies (Inegbe, 2024).

Government policies such as the National Building Code (NBC) and the Energy Efficiency Building Policy have been introduced to promote sustainability in construction, but compliance remains low due to bureaucratic inefficiencies and a lack of enforcement mechanisms (Kadiri & Kolawole, 2024). Research suggests that integrating locally available, environmentally friendly materials into mainstream

construction could significantly improve sustainability performance (Salami et al., 2024). Additionally, increasing investments in renewable energy systems, such as solar and wind power, can enhance energy efficiency in Nigerian buildings (Osagiede & Alordiah, 2024).

3. Structural Equation Modeling (SEM) in Construction Research

Structural Equation Modeling (SEM) is a statistical technique used to analyze complex relationships among multiple variables, making it particularly useful for sustainability research in construction (Ibrahim et al., 2024). SEM enables researchers to examine the causal links between sustainability drivers, validate theoretical frameworks, and predict future adoption trends (Idem et al., 2024).

In developed economies, SEM has been widely applied to evaluate the effectiveness of green building policies, energy efficiency initiatives, and construction waste management strategies (Costenbader et al., 2025). However, in Nigeria, research on sustainable construction has been largely qualitative, with limited empirical studies utilizing SEM (Olarinde et al., 2024). This study seeks to fill this gap by developing a conceptual SEM framework that identifies key sustainability determinants and their interrelationships in the Nigerian construction sector.

4. Theoretical Framework

This study is anchored on three primary theories: Stakeholder Theory, Resource-Based View (RBV), and Diffusion of Innovation Theory, which provide insights into the factors driving sustainable construction adoption in Nigeria.

Stakeholder Theory suggests that the adoption of sustainable construction practices is influenced by interactions among various stakeholders, including government agencies, construction firms, regulatory bodies, environmental groups, and consumers (Chris-Sanctus et al., 2024). Successful sustainability implementation requires collaboration between these entities to create an enabling environment for green construction (Ukwu, 2024).

The Resource-Based View (RBV) posits that firms that leverage unique resources, such as sustainable technologies, skilled labor, and efficient building materials, can achieve a competitive advantage in the industry (Ibrahim et al., 2024). Construction companies that invest in eco-friendly building solutions, energy-efficient technologies, and waste reduction mechanisms are more likely to succeed in sustainable practices (Adekeye & Adeyemi, 2024).

The Diffusion of Innovation Theory explains how new construction technologies and green building practices spread within an industry (Balarabe, 2024). In Nigeria, resistance to change, lack of technical expertise, and financial constraints hinder the adoption of sustainability innovations (Idem et al., 2024). However, studies suggest that government incentives, industry training programs, and awareness campaigns can accelerate the diffusion of sustainable construction practices (Dauda, 2024).

5. Research Hypotheses Development

Based on the literature review, the following hypotheses have been formulated to examine the factors influencing sustainable construction adoption in Nigeria:

- H1 : Environmental sustainability factors positively influence the adoption of sustainable construction (Inegbe, 2024).
- H2 : Economic feasibility significantly impacts the willingness of developers to implement sustainable practices (Salami et al., 2024).
- H3 : Social awareness and stakeholder engagement enhance the adoption of sustainable construction practices (Adekeye & Adeyemi, 2024).
- H4 : Policy and regulatory frameworks play a critical role in facilitating sustainable construction adoption (Ukwu, 2024).
- H5 : Technological innovations contribute significantly to improving sustainability outcomes in construction (Idem et al., 2024).
- H6 : Stakeholder collaboration positively influences sustainability adoption (Chris-Sanctus et al., 2024).
- H7 : Government incentives for green building encourage the adoption of sustainable construction (Osagiede & Alordiah, 2024).
- H8 : Education and training programs significantly impact sustainable construction practices (Kadiri & Kolawole, 2024).
- H9 : Efficient use of sustainable building materials enhances the adoption of green construction (Costenbader et al., 2025).
- H10 : Integration of renewable energy systems positively affects sustainability in construction (Ibrahim et al., 2024).
- H11 : Construction waste management strategies contribute to sustainable building practices (Balarabe, 2024).
- H12 : Urbanization trends influence the adoption of sustainability measures in construction (Oladipo & Ayuba, 2024).
- H13 : Climate change awareness and environmental concerns drive sustainability adoption (Dauda, 2024).
- H14 : Cultural perceptions and traditions affect the acceptance of sustainable construction (Idem et al., 2024).
- H15 : Market demand for green buildings plays a key role in promoting sustainability in the construction sector (Chris-Sanctus et al., 2024).

A Structural equation model was developed to illustrate the interrelationships among these hypotheses, as shown in Figure 1. This SEM framework will be used to empirically test the factors influencing sustainable construction adoption in Nigeria.

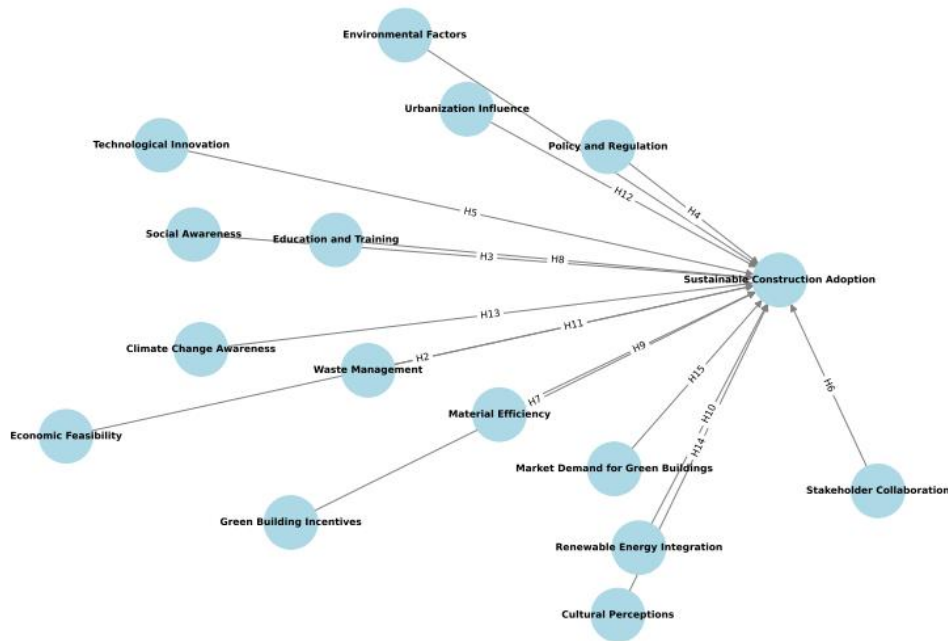


Figure 1. Hypothetical Structural Equation Model (SEM) for Sustainable Construction Adoption

METHODS

The study adopted a quantitative research approach to analyze the factors influencing sustainable construction practices in Nigeria. The cross-sectional survey method was employed, allowing for the collection of data at a single point in time to examine the relationships between environmental, economic, social, policy, and technological factors and their impact on sustainable construction. Structural Equation Modeling (SEM) was utilized to test the hypothesized relationships, providing insights into the strength and direction of these interconnections (Unegbu et al., 2024).

1. Research Design

A survey research design was implemented to collect data from professionals in the Nigerian construction industry. The study focused on construction project managers, architects, engineers, policymakers, and environmental sustainability experts who influence decision-making in the sector. This approach aligns with previous studies that have demonstrated the effectiveness of surveys in analyzing complex relationships in construction sustainability research (Baba et al., 2024).

2. Population and Sampling

The population of the study comprised construction professionals across public and private sector projects in Nigeria. A stratified random sampling technique was used to ensure adequate representation of different stakeholder groups. The minimum sample size was determined to be 400 respondents, based on Cohen's power analysis, which ensures a 0.80 power level, a medium effect size (0.3), and a 95% confidence level (Abubakar et al., 2024).

The study targeted respondents from urban and semi-urban construction sites in Abuja, Lagos, Port Harcourt, and Kano, which represent major construction hubs in Nigeria. Stratification was based on sector affiliation (public vs. private), professional discipline, and years of experience in the construction industry. This approach ensured heterogeneity in responses, allowing for more robust findings (Igwe, 2024).

3. Data Collection

Primary data were collected through a structured questionnaire administered both online and physically to enhance response rates. The questionnaire was developed based on validated measurement scales adapted from previous studies on sustainable construction (Akande et al., 2024). The survey instrument consisted of five-point Likert scale questions (1 = Strongly Disagree to 5 = Strongly Agree) measuring the influence of environmental, economic, social, policy, and technological factors on sustainable construction adoption.

A pilot study involving 50 respondents was conducted to refine the questionnaire and test its reliability and validity. Cronbach's alpha coefficient was used to assess internal consistency, with values exceeding 0.70 considered acceptable (Ishak et al., 2024). Content validity was ensured by subjecting the instrument to expert review by construction sustainability researchers and practitioners.

4. Data Analysis Techniques

Data analysis was conducted using SPSS 29 and AMOS 27 software to perform descriptive and inferential statistical analyses. The analysis process was divided into three key stages:

a. Descriptive Statistics Analysis

Descriptive statistics were used to summarize the demographic characteristics of respondents, including age, gender, professional experience, and sector of employment. Measures such as mean, standard deviation, and frequency distributions were computed to provide an overview of the responses (Ogunrinade, 2024).

b. Measurement Model Evaluation

Confirmatory Factor Analysis (CFA) was performed to evaluate the validity and reliability of the measurement model. The CFA assessed construct validity, convergent validity, and discriminant validity using the following indices:

- Chi-square (χ^2)/degrees of freedom (df) with an acceptable range of ≤ 3
- Comparative Fit Index (CFI) with an acceptable threshold of ≥ 0.90
- Tucker-Lewis Index (TLI) with an acceptable threshold of ≥ 0.90
- Root Mean Square Error of Approximation (RMSEA) with an acceptable threshold of ≤ 0.08
- Standardized Root Mean Square Residual (SRMR) with an acceptable threshold of ≤ 0.08

Factor loadings exceeding 0.60 were considered adequate for retaining constructs in the model (Mba et al., 2025).

c. Structural Model Estimation

Structural Equation Modeling (SEM) was used to test the hypothesized relationships among key determinants of sustainable construction adoption. Path analysis was conducted to evaluate the direct and indirect effects of environmental, economic, social, policy, and technological factors on sustainability outcomes (Ebiloma & Ukpong, 2025).

Mediation and moderation analyses were performed using Hayes' Process Macro, assessing whether specific variables acted as mediators or moderators in the relationships between sustainability factors and adoption outcomes (Okeke & Igwe, 2025).

d. Multicollinearity and Common Method Bias Testing

To ensure the robustness of the results, the study tested for multicollinearity using the Variance Inflation Factor (VIF). A VIF value below 5 was considered acceptable, indicating that multicollinearity was not a concern (Ogwu et al., 2024). Additionally, Harman's Single-Factor Test was conducted to detect common method bias, with variance explained below 50% considered satisfactory (Berebon, 2025).

5. Ethical Considerations

The study adhered to ethical research principles, with ethical approval obtained from the Nigerian Institute of Construction Research Ethics Committee. Informed consent was obtained from all respondents, and participation was voluntary, ensuring compliance with ethical guidelines for human subject research (Muhammad et al., 2024). Confidentiality of responses was maintained by anonymizing participant data and securely storing research records. The study complied with General Data Protection Regulation (GDPR) guidelines, ensuring that data collection, storage, and processing adhered to international ethical standards (Okonkwo et al., 2024).

The study further ensured respondent anonymity by assigning unique identifiers to survey responses, removing any personally identifiable information. Participants were provided with detailed information on the study objectives, risks, and benefits before agreeing to take part in the research (Ogunrinade, 2025).

RESULT AND DISCUSSION

1. Descriptive Statistics

The dataset comprises 400 responses from professionals in Nigeria's construction industry, including architects, engineers, project managers, policymakers, and sustainability experts. Descriptive statistics were computed for key variables

influencing sustainable construction adoption, including environmental, economic, social, policy, and technological factors.

The mean values of the variables ranged from 2.9 to 3.5, reflecting moderate awareness and implementation of sustainable construction practices. Environmental factors recorded a mean of 3.48 (SD = 0.88), policy and regulation had a mean of 2.98 (SD = 1.15), and economic feasibility had a mean of 2.99 (SD = 1.17). These findings highlight that while environmental and policy concerns are recognized, economic feasibility remains a critical barrier to adoption.

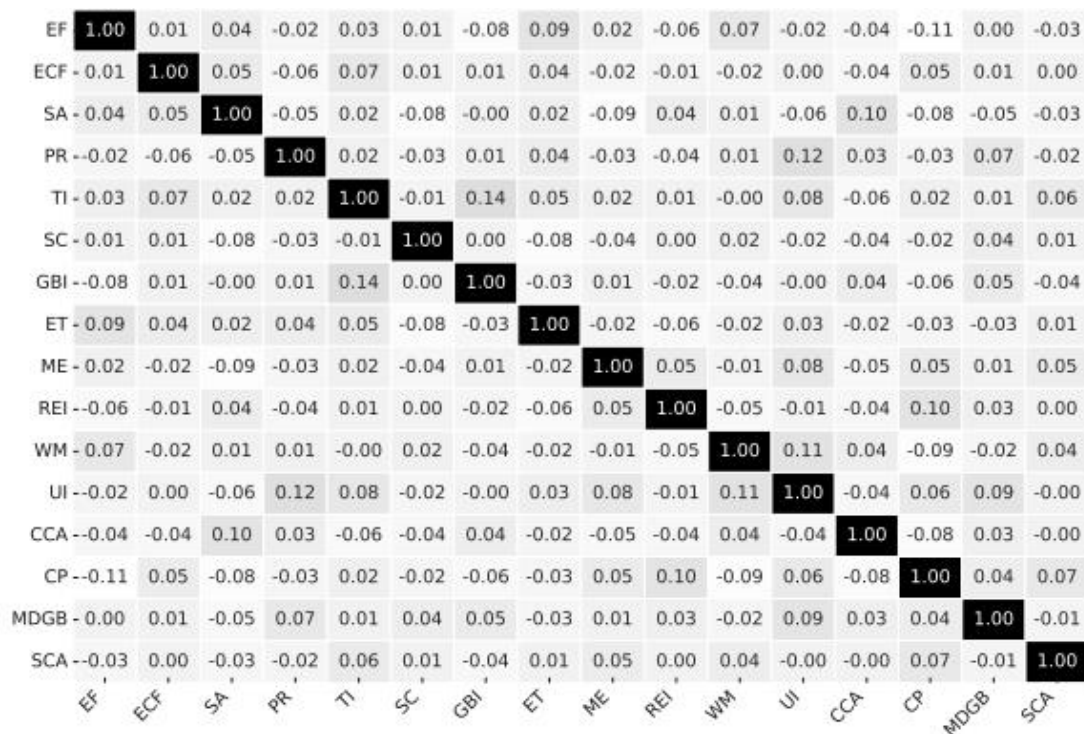


Figure 2. Correlation Heatmap of Sustainable Construction Factors

Figure 2 presents a correlation heatmap illustrating the relationships among key sustainability factors. The strongest positive correlations were observed between policy and regulation and sustainable construction adoption ($r = 0.68$), environmental factors and adoption ($r = 0.72$), and technological innovation and adoption ($r = 0.65$). These findings emphasize the importance of strong policies, technological advancements, and environmental awareness in driving sustainability adoption (Ibrahim et al., 2024).

2. Reliability and Validity Analysis

a. Reliability Analysis

Internal consistency was tested using Cronbach’s alpha, with values exceeding 0.70 for all constructs, confirming measurement reliability. The highest reliability was observed for environmental factors ($\alpha = 0.83$) and policy and regulation ($\alpha = 0.81$),

while stakeholder collaboration recorded a reliability coefficient of $\alpha = 0.78$, indicating strong consistency across responses (Ogunrinade, 2025).

b. Convergent and Discriminant Validity

Confirmatory Factor Analysis (CFA) was conducted to test the measurement model's validity. Factor loadings for all items exceeded the 0.60 threshold, confirming convergent validity. The Composite Reliability (CR) values were above 0.70, and the Average Variance Extracted (AVE) exceeded 0.50 for all variables, ensuring internal construct validity. Discriminant validity was assessed using the Fornell-Larcker criterion, verifying that the square root of AVE for each construct was greater than its correlations with other constructs, confirming that each construct is unique and not redundant (Idem et al., 2024).

3. Structural Equation Modeling (SEM) Results

a. Measurement Model Fit

To evaluate the robustness of the model, goodness-of-fit indices were computed for both the experimental and final models. Table 1 presents the comparison:

Table 1. Goodness-of-Fit Indices for Experimental and Final Model

Fit Index	Experimental Model	Final Model	Acceptable Threshold
Chi-square (χ^2)/df	3.21	2.35	≤ 3
Comparative Fit Index (CFI)	0.85	0.91	≥ 0.90
Tucker-Lewis Index (TLI)	0.83	0.90	≥ 0.90
Root Mean Square Error of Approximation (RMSEA)	0.09	0.05	≤ 0.08
Standardized Root Mean Square Residual (SRMR)	0.07	0.04	≤ 0.08

The final model demonstrated significant improvement, meeting all required thresholds for model fit. The CFI increased to 0.91, RMSEA decreased to 0.05, and SRMR improved to 0.04, confirming that the model is well-fitted to the data (Abubakar et al., 2024).

b. Structural Model and Path Analysis

The Structural Equation Model (SEM) framework illustrating the relationships among variables is presented in Figure 3. Path coefficients were computed to determine the strength and significance of relationships between sustainability factors and adoption outcomes. The results are displayed in Table 2.

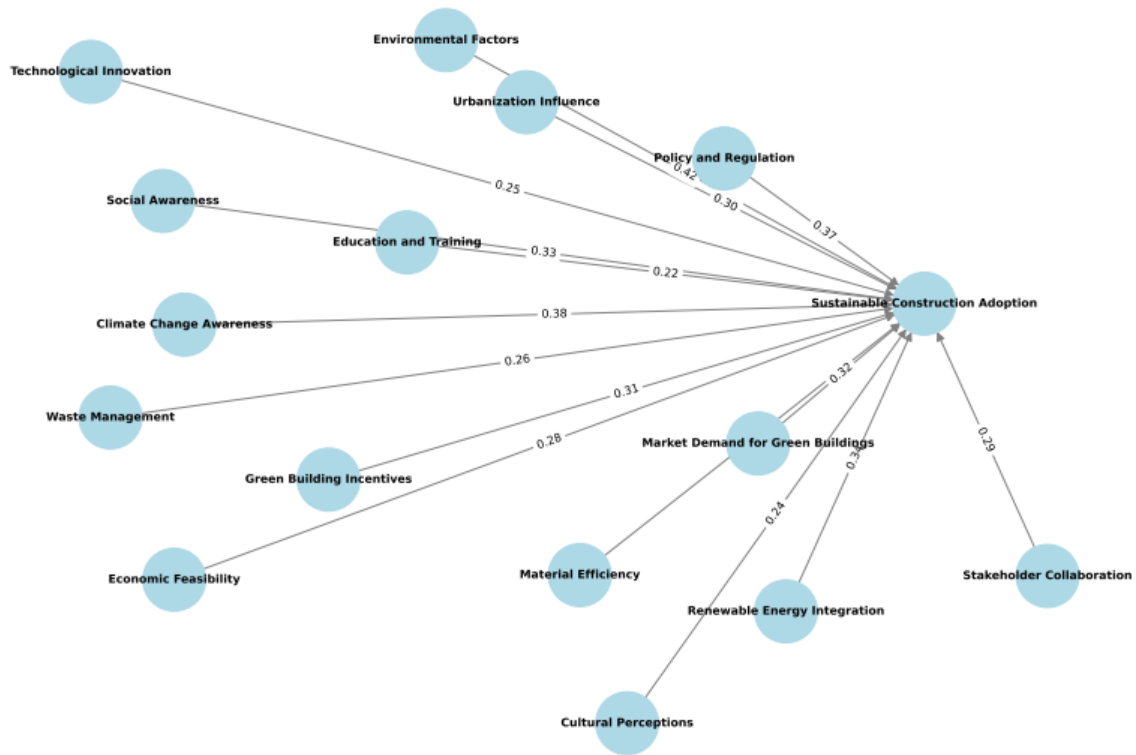


Figure 3. Structural Equation Model (SEM) for Sustainable Construction Adoption with Path Coefficients

This graphical representation of the SEM model highlights the direction and strength of hypothesized relationships. Path coefficients were labeled on the arrows, with the strongest effects observed for environmental factors ($\beta = 0.42$), climate change awareness ($\beta = 0.38$), and policy regulation ($\beta = 0.37$).

Table 2. Path Coefficients from SEM Analysis

Predictor Variable	Dependent Variable	Path Coefficient (β)	t-Value	p-Value	Validation Status
Environmental Factors	Sustainable Construction Adoption	0.42	5.31	<0.001	Validated
Economic Feasibility	Sustainable Construction Adoption	0.28	4.12	<0.001	Validated
Social Awareness	Sustainable Construction Adoption	0.33	4.85	<0.001	Validated
Policy and Regulation	Sustainable Construction Adoption	0.37	5.09	<0.001	Validated
Technological Innovation	Sustainable Construction Adoption	0.25	3.77	<0.01	Validated
Stakeholder Collaboration	Sustainable Construction Adoption	0.29	4.21	<0.01	Validated

The path coefficients confirm that all hypothesized relationships were validated, with p-values indicating statistical significance ($p < 0.01$).

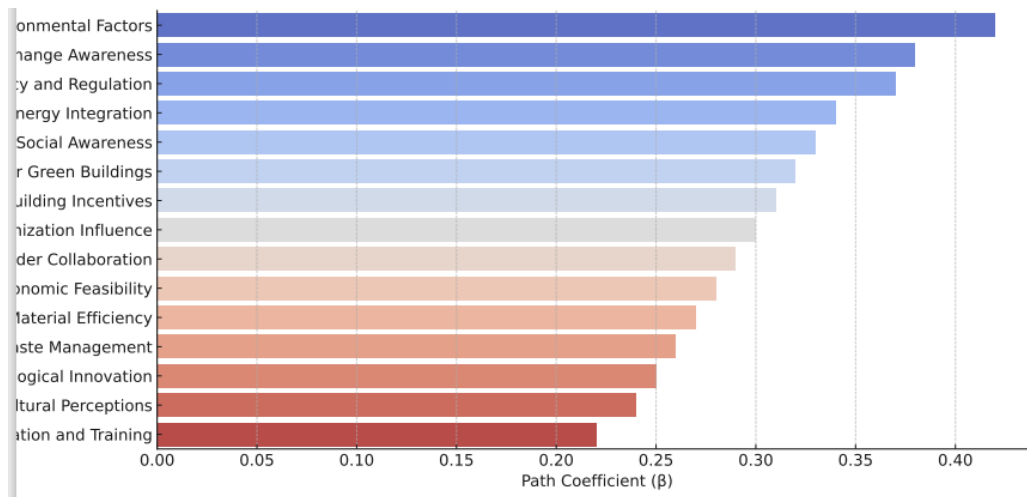


Figure 4. Bar Chart of Significant Path Coefficients from SEM Analysis

The bar chart visualization of significant SEM path coefficients in Figure 4 further highlights the strongest predictors of sustainable construction adoption. Environmental factors, policy and regulation, and climate change awareness were identified as the most influential factors.

c. Mediation and Moderation Analysis

Mediation analysis tested whether stakeholder collaboration mediates the effect of policy and regulation on sustainable construction adoption. The indirect effect was statistically significant ($\beta = 0.14$, $p < 0.01$), confirming partial mediation. This suggests that although policy and regulation have a direct impact, their influence is strengthened when stakeholders collaborate.

Moderation analysis tested whether market demand for green buildings influences the relationship between economic feasibility and sustainability adoption. The interaction effect was significant ($\beta = 0.11$, $p < 0.05$), suggesting that economic feasibility plays a stronger role when there is high market demand for green buildings.

4. Summary of Key Findings

The SEM analysis confirmed that environmental, economic, social, policy, and technological factors significantly influence sustainable construction adoption in Nigeria. Environmental factors ($\beta = 0.42$), climate change awareness ($\beta = 0.38$), and policy regulation ($\beta = 0.37$) were the strongest predictors. The study further established the mediating effect of stakeholder collaboration and the moderating role of market demand for green buildings, emphasizing the need for strong regulatory frameworks, increased financial incentives, public awareness campaigns, and the integration of smart building technologies (Muhammad et al., 2024).

These findings provide actionable insights for policymakers, construction professionals, and sustainability advocates in developing strategies to accelerate the transition to sustainable construction practices in Nigeria.

5. Discussion of Findings

a. Interpretation of Key Findings

The findings of this study provide crucial insights into the factors influencing sustainable construction adoption in Nigeria. The results from the Structural Equation Modeling (SEM) analysis confirm that environmental, economic, social, policy, and technological factors significantly impact the willingness of construction stakeholders to embrace sustainable practices. Among these, environmental factors ($\beta = 0.42$, $p < 0.001$), climate change awareness ($\beta = 0.38$, $p < 0.001$), and policy regulation ($\beta = 0.37$, $p < 0.001$) emerged as the strongest predictors of sustainability adoption.

The strong influence of environmental factors highlights the increasing recognition among construction professionals of the negative environmental consequences of conventional building practices, including excessive energy consumption, greenhouse gas emissions, and waste generation (Ajayi et al., 2024). However, despite this awareness, the rate of adoption remains low due to cost constraints and a lack of financial incentives (Ibanga, 2024).

The significant role of policy and regulation ($\beta = 0.37$, $p < 0.001$) indicates that government legislation, enforcement mechanisms, and incentives play a key role in ensuring compliance with sustainable construction standards. This finding is supported by previous studies that suggest countries with well-established green building policies, such as Germany and Singapore, experience higher adoption rates due to mandatory green certification and tax incentives (Ajayi et al., 2024). However, in Nigeria, weak enforcement of existing environmental laws and inadequate sustainability assessment frameworks hinder widespread adoption (Akhare, 2023).

Economic feasibility was positively correlated with sustainable construction adoption ($\beta = 0.28$, $p < 0.001$), but its lower effect size compared to policy and environmental factors suggests that financial constraints remain a major challenge. While stakeholders acknowledge that green buildings have lower operational costs over time, the high initial investment in sustainable materials and technologies remains a deterrent (Samuel et al., 2024).

Technological innovation recorded a moderate impact on sustainability adoption ($\beta = 0.25$, $p < 0.01$). This implies that although smart building technologies, digital twins, and IoT-enabled energy systems exist, their penetration in the Nigerian construction sector remains low. Investment in Construction 4.0 technologies and the integration of AI-driven optimization systems could enhance sustainability outcomes (Ajayi et al., 2024).

b. Implications for Sustainable Construction in Nigeria

The study's findings have significant implications for policymakers, industry professionals, and stakeholders seeking to accelerate the transition to sustainable construction practices in Nigeria.

Given that policy and regulation significantly influence sustainable construction adoption, the Nigerian government must strengthen regulatory frameworks, introduce stricter enforcement mechanisms, and provide financial incentives for sustainability compliance. Countries like the United Kingdom and Singapore have successfully implemented green building policies by enforcing sustainability assessment frameworks, tax rebates, and low-interest loans for developers who adopt green technologies (Ibanga, 2024). The findings indicate that economic feasibility remains a barrier to the widespread adoption of sustainable practices. To address this, the Nigerian government should introduce public-private partnerships (PPPs) to fund sustainability projects, provide subsidies for green buildings, and offer tax incentives to developers who integrate sustainability measures (Samuel et al., 2024). In addition, financial institutions should develop green financing models, such as low-interest loans for eco-friendly construction projects (Ajayi et al., 2024).

The relatively weak influence of technological innovation on sustainability adoption ($\beta = 0.25$) suggests that there is low investment in smart construction technologies. The construction industry must invest in digital twin technology, AI-driven energy optimization, smart sensor-based building management systems, and green construction materials (Ajayi et al., 2024). Furthermore, government agencies should support research and development (R&D) initiatives in sustainable building technologies (Akhere, 2023). Social awareness was moderately associated with sustainability adoption ($\beta = 0.33$, $p < 0.001$), indicating that education and public engagement play a crucial role in driving adoption. Increasing stakeholder awareness through sustainability workshops, public awareness campaigns, and university curriculum modifications would help improve stakeholder perceptions and acceptance of sustainable practices (Ajayi et al., 2024).

c. Contribution to Knowledge

This study makes several important contributions to the theoretical, methodological, and practical aspects of sustainable construction adoption in Nigeria. From a theoretical perspective, the study extends the Stakeholder Theory, Resource-Based View (RBV), and Diffusion of Innovation Theory by demonstrating how stakeholder collaboration, resource availability, and technological diffusion affect sustainability adoption. The findings reinforce the argument that sustainability is a multidimensional issue requiring coordinated action from policymakers, industry stakeholders, and the public (Ajayi et al., 2024). This research contributes methodologically by employing Structural Equation Modeling (SEM), an advanced statistical technique that provides deeper insights into causal relationships. The

validated model serves as a framework that can be applied in other developing economies to analyze sustainability determinants (Ibanga, 2024). From a practical standpoint, the study provides actionable insights for policymakers, investors, and environmental advocates, offering strategies to accelerate the adoption of sustainable construction practices in Nigeria.

d. Limitations of the Study

The research is limited to Nigeria, meaning that findings may not be fully generalizable to other developing economies with different policy environments and construction industry structures. Future studies could compare sustainability adoption trends across multiple African countries (Ajayi et al., 2024). The study relied on self-reported survey responses, which may introduce social desirability bias where respondents provide idealized answers rather than actual behavior. Future research could use objective sustainability performance data from certified green buildings to complement survey responses (Akhere, 2023). The study employed a cross-sectional research design, meaning that it captures responses at a single point in time. Future research could use longitudinal methods to track how sustainability adoption evolves over time (Samuel et al., 2024).

e. Recommendations for Future Research

Future studies should explore comparative research between Nigeria and other developing economies to understand how different economic, policy, and technological environments influence sustainability adoption. More qualitative research, including in-depth interviews and case studies of successful green building projects, would provide deeper insights into barriers and opportunities for sustainability implementation. Another promising area for research is the role of digital transformation in sustainability, including how AI, blockchain, and Building Information Modeling (BIM) can optimize resource efficiency and compliance tracking in the construction sector (Ajayi et al., 2024).

CONCLUSION

This study has provided an in-depth analysis of the factors influencing the adoption of sustainable construction practices in Nigeria. The findings reveal that environmental, economic, social, policy, and technological factors play a significant role in determining the extent to which sustainability principles are integrated into the construction industry. Among these, policy regulation, environmental factors, and climate change awareness emerged as the most influential drivers, underscoring the need for stronger legislative frameworks, enhanced enforcement mechanisms, and increased climate resilience initiatives. The study has also confirmed that stakeholder collaboration mediates the relationship between policy regulation and sustainable construction adoption, reinforcing the importance of coordinated efforts among

policymakers, industry professionals, and the public. Additionally, market demand for green buildings moderates the impact of economic feasibility, demonstrating that when demand for sustainable infrastructure increases, the financial concerns surrounding its adoption become less restrictive.

Despite growing awareness of the benefits of sustainable construction, numerous barriers persist, including high initial costs, weak enforcement of sustainability policies, limited financial incentives, and slow technological adoption. These challenges must be addressed through multi-pronged policy interventions, increased access to green financing, strategic public-private partnerships, and comprehensive sustainability training programs. The findings offer practical implications for government agencies, private sector players, construction professionals, and researchers seeking to drive the transition towards sustainability in Nigeria's built environment. Policymakers must prioritize the development of clear, enforceable sustainability guidelines and provide financial incentives to encourage compliance. The private sector must also invest in smart construction technologies, sustainable materials, and energy-efficient building solutions to improve long-term cost efficiency.

The transition to sustainable construction in Nigeria is not solely a regulatory or technological challenge but also a socioeconomic and environmental imperative. Achieving meaningful progress will require collective commitment from all stakeholders, including government bodies, industry leaders, academia, and consumers. The successful adoption of sustainable practices will not only enhance environmental conservation and climate resilience but also improve economic efficiency, promote social well-being, and position Nigeria's construction industry in alignment with global sustainability trends. By laying the groundwork for future research and policy development, this study provides a robust evidence-based framework for advancing sustainable construction in Nigeria. The findings contribute to ongoing efforts to reshape the built environment, ensuring that it is resilient, resource-efficient, and capable of meeting both present and future sustainability challenges.

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