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Sustainable Construction Practices in Nigeria: A Structural Equation Modeling Approach

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Abstract

This study investigates the determinants of sustainable construction practices in Nigeria, focusing on the roles of regulatory frameworks, financial incentives, organizational readiness, and awareness and knowledge among stakeholders. Utilizing a cross-sectional survey design, data were collected from 255 experts in the construction sector, consisting of architects, project managers and engineers. The analysis utilized Structural Equation Modeling (SEM) to explore the direct and indirect effects of these factors on the sustainable construction practices adoption. The findings reveal that awareness and knowledge have the most significant impact, highlighting the critical need for education and information dissemination in advancing sustainability. Additionally, robust regulatory frameworks and financial incentives were identified as crucial enablers, facilitating the implementation of sustainable practices by setting standards and reducing financial barriers. Organizational readiness, encompassing leadership support and resource availability, also emerged as a key determinant, mediating the effects of policies and incentives. The study concludes that a multifaceted approach involving strong policies, financial support, and enhanced organizational capacity is essential for promoting sustainable construction in Nigeria. These findings are valuable guide to policymakers, industry stakeholders, and educators in their efforts to foster an environmentally sustainable construction sector.

Keywords: sustainable construction, regulatory frameworks, financial incentives, organizational readiness, awareness and knowledge, structural equation modeling

Introduction

Sustainable building practices are gaining attention worldwide due to the need to reduce environmental harm, use resources more efficiently, and tackle climate change (Du Plessis & Cole, 2016). The construction industry is a major source of carbon emissions, responsible for around 39% of energy-related carbon dioxide and 36% of global energy consumption (World Green Building Council, 2019). This has increased the push for adopting eco-friendly construction methods that focus on saving resources, cutting down waste, and reducing environmental impact throughout the entire building process (Zhang et al., 2018). In countries like Nigeria, where development is ongoing, the construction industry is essential for economic growth, as it provides infrastructure, housing, and jobs (Akinlabi & Raphiri, 2018). However, it also faces significant challenges, including inefficient resource use, poor waste management, and high greenhouse gas emissions (Ugochukwu & Chioma, 2015). The Nigerian construction industry has been characterized by traditional building practices that often overlook environmental considerations, leading to unsustainable outcomes (Adewuyi & Otali, 2017). The integration of sustainability into construction practices aims to address these issues by promoting energy efficiency, using environmentally friendly materials, and implementing waste reduction strategies (Aina et al., 2019).

Despite the global and local imperatives for sustainable construction, Nigeria's construction industry is still at an early stage of adopting these practices. Several barriers impede the widespread implementation of sustainable construction practices in Nigeria. These include a lack of awareness and understanding among stakeholders, insufficient regulatory frameworks, financial constraints, and a scarcity of skilled professionals (Olanrewaju & Ogunsemi, 2018). Additionally, there is often a perception that sustainable construction is costlier compared to traditional methods, which further hinders its adoption (Oyewobi et al., 2019). Overcoming these barriers requires a clear knowledge of the factors that affect the adoption of sustainable construction practices. This knowledge can help shape specific strategies

and policies aimed at promoting sustainability within the industry.

Although sustainability is a global priority, Nigeria has struggled to widely adopt sustainable construction practices. The issue is complex, involving a combination of social, economic, regulatory, and cultural challenges. A major hurdle is the lack of awareness and understanding among key stakeholders about the benefits and practical methods of sustainable construction. This issue is further compounded by weak regulatory frameworks that fail to effectively enforce these practices (Adegbile et al., 2017; Adeyemi et al., 2016). Financial limitations are another significant barrier, as the high upfront costs of implementing sustainable methods often discourage developers and contractors (Oyewobi et al., 2019). This financial challenge is made worse by limited access to funding and incentives that could encourage investment in sustainable projects (Oluwakemi & Adebiyi, 2020).

A key issue hindering the adoption of sustainable construction practices is the lack of a deep understanding of the factors driving these practices. The shortage of empirical data and research leaves policymakers and industry stakeholders unprepared to develop effective strategies for improvement. Studies have highlighted that Nigeria's construction sector is marked by fragmented and inconsistent policies, making the implementation of sustainable practices even more difficult (Ameh & Osegbo, 2016; Oladokun et al., 2017). Cultural resistance and a strong preference for traditional building methods further complicate the transition. Additionally, the construction workforce often lacks the necessary training and education on sustainable techniques, limiting the industry's ability to adopt innovative technologies and approaches (Adewuyi & Otali, 2017). The absence of strong regulatory enforcement or market-driven demand for sustainable construction deepens the challenge, leading to a slow rate of progress (Olanrewaju & Ogunsemi, 2018).

This study seeks to address key research questions that shed light on the state of sustainable construction practices in Nigeria. The first question examines the current level of adoption of these practices within the Nigerian construction industry, assessing how extensively sustainable methods are being applied in projects and the degree of compliance with sustainability standards (Adegbile et al., 2017). The second question investigates the main factors driving or hindering the adoption of sustainable practices, such as regulatory policies, financial incentives, technological developments, and cultural attitudes (Oyewobi et al., 2019). The third question explores how these factors interact and collectively influence the adoption of sustainable methods. Identifying these relationships is critical for uncovering opportunities to promote broader adoption (Oluwakemi & Adebiyi, 2020). Finally, the study aims to identify actionable strategies to increase the uptake of sustainable construction, such as policy changes, educational programs, financial solutions, and stronger stakeholder engagement (Musa & Eziyi, 2018).

Several hypotheses are proposed based on the research questions. The first hypothesis (H1) suggests that a strong, well-defined regulatory framework positively impacts the adoption of sustainable construction practices in Nigeria. This implies that clear and enforceable regulations significantly promote sustainability in the industry (Amusan et al., 2020). The second hypothesis (H2) posits that financial incentives play a crucial role in driving sustainable construction practices. Incentives like tax breaks, grants, and subsidies can lower the financial barriers, making it easier for developers to adopt sustainable methods (Oladokun et al., 2017). The third hypothesis (H3) asserts that greater awareness and understanding of sustainability principles positively influence the implementation of sustainable practices, emphasizing the role of education and knowledge dissemination (Adeyemi et al., 2016). The fourth hypothesis (H4) suggests that organizational readiness—defined by the availability of skilled workers, technological infrastructure, and a supportive company culture—significantly affects the adoption of sustainable practices (Olanrewaju & Ogunsemi, 2018).

This study is essential as it addresses a critical gap in the literature on sustainable construction in Nigeria. By applying a Structural Equation Modeling approach, it provides a detailed analysis of how various factors interact and influence the adoption of sustainability. The findings will equip policymakers, industry leaders, and researchers with the insights needed to develop targeted strategies that effectively promote sustainable construction practices in Nigeria.

Literature Review

Overview of Sustainable Construction Practices

Sustainable construction practices aim to reduce the environmental impact of building activities while supporting economic growth and enhancing social well-being. These practices encompass a range of strategies that balance environmental, economic, and social considerations. One key aspect is energy-efficient design, which involves optimizing building orientation, improving insulation, and incorporating renewable energy to lower energy consumption and reduce greenhouse gas emissions (Ding, 2019). Another important element is the use of sustainable materials, prioritizing those that are recycled, renewable, or have a low environmental impact. This helps conserve natural resources and reduces waste generation (Malmqvist et al., 2018). Waste reduction is also a critical focus, promoting efficient resource use, recycling construction debris, and implementing proper waste management, all of which help minimize the environmental footprint of construction projects (Adams et al., 2017). In addition, improving indoor environmental quality—through enhanced air quality, natural lighting, and acoustics—plays a key role in promoting the health and well-being of building occupants (Alwetaishi, 2017). Together, these components align with the core principles of sustainable construction, which focus on environmental stewardship, economic sustainability, and social responsibility (Darko et al., 2017).

The global construction industry is increasingly adopting sustainable practices, driven by several influential factors. Regulatory pressures, including stricter building codes and standards focused on energy efficiency and eco-friendly materials, have played a pivotal role in advancing sustainability (Häkkinen & Belloni, 2019). Market demand is another major driver, as environmentally aware clients and consumers now prioritize buildings that offer long-term cost savings and enhanced living conditions (Gou & Xie, 2017). Furthermore, corporate social responsibility (CSR) initiatives are encouraging construction companies to integrate sustainable practices as part of their commitment to reducing environmental impact and contributing to global sustainability goals (Shen et al., 2017).

Despite these advancements, several challenges hinder wider adoption of sustainable construction. High upfront costs, limited awareness, and the scarcity of sustainable materials and technologies remain significant barriers (Hwang & Tan, 2017). However, ongoing research and technological innovation are progressively addressing these obstacles, making sustainable construction more affordable and viable (Asdrubali et al., 2015). The adoption of digital technologies, such as Building Information Modeling (BIM), is further streamlining planning, design, and resource management, enhancing the overall efficiency of sustainable construction practices (Lu et al., 2017).

The State of Sustainable Construction in Nigeria

The adoption of sustainable construction practices in Nigeria is at a nascent stage, characterized by slow and uneven progress across the industry. Several factors have impeded the widespread implementation of these practices, including economic constraints, limited awareness, and a lack of robust regulatory frameworks (Ameh & Osegbo, 2016; Afolabi et al., 2017). The construction sector in Nigeria is a significant contributor to the country's economy, yet it faces numerous environmental challenges that necessitate a shift towards sustainability. These challenges include rapid urbanization, which puts pressure on infrastructure and resources; resource depletion, particularly in terms of raw materials for construction; and the broader impacts of climate change, which exacerbate vulnerabilities in infrastructure and urban planning (Ogunbiyi et al., 2017; Akadiri & Fadiya, 2019).

Despite these challenges, there is a growing recognition within Nigeria of the importance of sustainable construction practices. This recognition is driven by both local and global trends emphasizing the need for environmentally responsible and resource-efficient building practices. Professional bodies, such as the Nigerian Institute of Architects (NIA) and the Nigerian Institute of Building (NIOB), along with government agencies like the Federal Ministry of Environment, have been pivotal in raising awareness and advocating for sustainable construction. These organizations are increasingly incorporating sustainability into their standards and guidelines, albeit with varying degrees of enforcement and compliance (Olawumi & Chan, 2019; Oyedele, 2018). The promotion of green building standards and sustainability certifications, such as Leadership in Energy and Environmental Design (LEED) and the Green Building Council of Nigeria (GBCN) certification, is steadily gaining traction. However, adoption remains limited, primarily due to the high upfront costs of sustainable materials and technologies, which are often imported and therefore expensive (Ogunmakinde et al., 2020). Furthermore, a lack of technical expertise and insufficient training among construction professionals in Nigeria pose significant challenges to the effective implementation of sustainable building practices (Akinradewo et al., 2021).

Furthermore, the regulatory environment in Nigeria has not fully matured to support sustainable construction. While there are policies and frameworks that encourage environmentally friendly practices, enforcement is often weak, and there is a lack of incentives for developers to adopt sustainable methods (Olawumi & Chan, 2019). The construction industry is largely driven by short-term economic considerations, which often take precedence over long-term environmental sustainability. This situation is exacerbated by the limited availability of financial mechanisms and incentives that could lower the financial barriers to adopting sustainable practices (Ogunbiyi et al., 2017). In conclusion, while there is a growing awareness and gradual uptake of sustainable construction practices in Nigeria, the sector still faces significant challenges. The country's journey towards sustainability in construction is hindered by economic, regulatory, and knowledge-based barriers. However, continued advocacy and education by professional and governmental bodies, along with improved regulatory support and financial incentives, could accelerate the adoption of sustainable practices in the Nigerian construction industry (Adegbile et al., 2017).

Structural Equation Modeling (SEM) in Construction Research

Structural Equation Modeling (SEM) has become an essential statistical technique in construction research, providing a comprehensive framework for analyzing complex relationships among observed and latent variables. SEM integrates multiple statistical methods, including factor analysis and path analysis, allowing researchers to examine both direct and indirect effects within a theoretically defined model (Kline, 2015). This capability makes SEM particularly valuable in exploring the multifaceted nature of construction projects, where various factors interact dynamically to influence outcomes.

In recent years, SEM has been widely used to investigate numerous aspects of the construction industry. For instance, studies have utilized SEM to understand the determinants of project success, identifying critical success factors such as effective communication, project management practices, and the role of external environmental conditions (Low et al., 2018). These studies highlight how SEM can decompose complex constructs into measurable indicators, providing insights into how different elements contribute to overall project performance. Moreover, SEM has been instrumental in examining organizational performance within the construction sector. Researchers have explored how organizational culture, leadership styles, and resource availability affect the efficiency and effectiveness of construction firms (Ozorhon et al., 2014; Panuwatwanich & Nguyen, 2017). This line of research often employs SEM to model the mediating and moderating effects of these factors, thereby revealing the pathways through which they impact organizational outcomes. The ability of

SEM to handle multiple relationships simultaneously makes it an ideal tool for these analyses, which are crucial for developing strategic interventions aimed at enhancing organizational performance.

The adoption of new technologies and innovations in construction has also been a key area of SEM application. Studies have used SEM to assess the challenges influencing the uptake of building information modeling (BIM), green building technologies, and other innovations (Won et al., 2016; Zhao et al., 2017). These studies typically focus on variables such as perceived benefits, cost implications, and organizational readiness, which are modeled as latent constructs in SEM. The findings often underscore the importance of stakeholder engagement and supportive regulatory frameworks in facilitating the adoption of new technologies (Darko & Chan, 2017). Furthermore, SEM has been used to analyze the role of financial incentives and market demand in driving technological innovation in the construction industry (Hwang & Ng, 2016). A significant application of SEM in construction research is the exploration of sustainable construction practices. Researchers have employed SEM to identify and analyze the factors that promote or hinder the adoption of sustainable practices in the construction industry. These factors include regulatory requirements, market pressures, financial incentives, and organizational capabilities (Darko & Chan, 2017; Wang et al., 2018). For example, regulatory frameworks and environmental policies have been shown to play a critical role in encouraging firms to adopt sustainable practices, as they create a compliance-driven motivation (Zhang et al., 2019). Additionally, financial incentives, such as tax breaks and subsidies, are identified as significant motivators for companies to invest in sustainable technologies, as they help offset the initial costs associated with green building practices (Durdyev et al., 2018).

Moreover, SEM has been utilized to study the interrelationships among these factors, providing a comprehensive understanding of how they collectively influence the adoption of sustainable practices. This holistic view is crucial for policymakers and industry leaders as it highlights the need for integrated approaches that consider multiple influencing factors. The insights gained from SEM analyses can inform the development of policies and strategies aimed at promoting sustainability in the construction sector (Häkkinen & Belloni, 2019). The application of SEM in construction research extends beyond theoretical model testing to practical implications. For instance, findings from SEM studies have been used to develop frameworks and guidelines for best practices in project management, technology adoption, and sustainability (Hair et al., 2019). The use of SEM thus provides a robust and versatile tool for both academic researchers and industry practitioners, enabling a deeper understanding of the complex dynamics at play in the construction industry.

Theoretical Framework and Key Constructs

The theoretical framework for this study is grounded in the Technology-Organization-Environment (TOE) framework and the Diffusion of Innovations (DOI) theory. The TOE framework, introduced by Tornatzky and Fleischer (1990), suggests that the adoption of technological innovations within organizations is shaped by three key factors: technological, organizational, and environmental. This approach offers a comprehensive perspective for understanding the complexities involved in adopting sustainable construction practices. The technological context encompasses a firm's current and potential technological capabilities, such as the use of green building materials, energy-efficient systems, and other sustainable construction technologies (Molla & Cooper, 2017). It also includes the relative advantages of these technologies, such as their perceived benefits compared to traditional methods.
The organizational context refers to internal factors like the firm's size, structure, and management practices. Key elements include leadership commitment to sustainability, the availability of financial and human resources, and the organization's readiness to adopt and support sustainable practices (Olanipekun et al., 2017). Organizational readiness is crucial in determining a

firm's ability to successfully implement and sustain sustainable practices. Additionally, the organizational culture plays a vital role in influencing the acceptance and integration of these practices within the firm's operations (Gholami et al., 2019).

The environmental context encompasses external factors that impact an organization, such as regulatory pressures, market demand, and the competitive landscape. In the construction industry, regulatory frameworks are particularly influential in driving the adoption of sustainable practices by establishing standards and guidelines for environmental performance (Giesekam et al., 2016). The effectiveness of these regulations, whether they act as drivers or barriers, depends on their rigor and enforcement mechanisms. Additionally, external stakeholders, including clients, suppliers, and governmental agencies, play a pivotal role in shaping a firm's approach to sustainability, as their expectations and pressures often influence decisions on sustainable practices (Shi et al., 2018).

The Diffusion of Innovations (DOI) theory, developed by Rogers (2003), adds depth to the TOE framework by explaining how innovations are adopted and spread within organizations or society. DOI theory highlights several key factors that affect the rate of adoption: relative advantage, compatibility, complexity, trialability, and observability. In the context of sustainable construction, these factors translate into practical considerations, such as the economic and environmental benefits of adopting green technologies, their fit with existing workflows, and the visibility of their positive outcomes (Nordin et al., 2016).

Within this theoretical framework, several key constructs are vital for understanding the drivers and barriers to adopting sustainable construction practices in Nigeria. The first construct, Regulatory Frameworks, explores the role of laws, standards, and regulations in promoting sustainability. National and international building codes, environmental laws, and sustainability certifications play a crucial role in encouraging compliance and instilling a culture of sustainability within the construction industry (Wang et al., 2019). The effectiveness of these regulations, along with their enforcement, is critical, as they provide the necessary legal and policy support to drive sustainable practices forward.

The second construct, Financial Incentives, focuses on the economic factors that influence firms' decisions to adopt sustainable practices. In particular, the balance between initial costs and long-term financial benefits is a significant consideration, especially in resource-limited contexts like Nigeria (Huang et al., 2017). Incentives such as tax breaks, subsidies, and grants can reduce the financial burden of adopting sustainable technologies, making them more accessible and appealing for firms to invest in.

The third construct, Organizational Readiness, assesses an organization's ability to implement sustainable practices. This includes evaluating the commitment of leadership, the presence of sustainability champions within the organization, and the overall culture's openness to innovation and change (Zhou et al., 2017). Key factors under this construct include the availability of financial and human resources and the organization's strategic alignment with sustainability objectives. The fourth construct, Awareness and Knowledge, examines the understanding of sustainability principles among key stakeholders, including management, employees, and the broader community. This construct underscores the role of education, training, and information-sharing in shaping perceptions and increasing the acceptance of sustainable construction practices (Asif et al., 2019). Awareness initiatives are crucial, as they can significantly influence attitudes and support the adoption of new, sustainable methods.

Together, these constructs—regulatory frameworks, financial incentives, organizational readiness, and awareness—form a comprehensive framework for analyzing the factors that affect the adoption of sustainable construction practices in Nigeria. By utilizing this theoretical perspective, the study aims to provide in-depth insights into the challenges and

opportunities of promoting sustainability in the Nigerian construction sector, offering valuable contributions to both academic research and practical implementation.

Previous Studies and Gap Analysis

The adoption of sustainable construction practices has been widely researched globally, with increasing attention on developing regions such as Africa. In West Africa, particularly Ghana, a pivotal study by Agyekum-Mensah and Knight (2017) explored construction professionals' perceptions of sustainable practices. Their research identified key barriers, including high initial costs, limited awareness, and insufficient training in sustainable methods. The study emphasized the importance of capacity building and knowledge dissemination, noting that stakeholders' perceptions play a crucial role in the adoption of sustainable practices.

In Nigeria, research on sustainable construction is growing but remains behind that of more developed nations. Oyedele (2018) provided a comprehensive analysis of the factors influencing sustainable construction in Nigeria, uncovering challenges such as weak regulatory frameworks, economic constraints, and a lack of market demand for sustainable buildings. Oyedele's work stressed the vital role of government policies and incentives in promoting sustainability, observing that the absence of strong regulations and supportive policies contributes to low adoption rates. Additionally, the study highlighted cultural and attitudinal barriers that impede the acceptance of sustainable methods, emphasizing the need for extensive educational campaigns to shift both public and professional attitudes toward sustainability.

Despite these contributions, there remains a noticeable gap in the literature, particularly concerning the application of advanced statistical methods like Structural Equation Modeling (SEM) to explore the complex interrelationships between various factors affecting sustainable construction practices in Nigeria. While Olawumi and Chan (2018) provided a comprehensive review of global research trends in sustainability, they noted a significant underrepresentation of empirical studies from developing countries that utilize SEM. This gap limits the ability to understand the multifaceted nature of sustainability adoption, particularly how different drivers and barriers interact to influence decision-making in the construction industry.

The use of SEM is particularly relevant as it allows researchers to assess both direct and indirect relationships among variables, providing a more nuanced understanding of the factors at play. For instance, Darko et al. (2017) discussed the utility of SEM in evaluating the impact of green building policies, market forces, and stakeholder engagement on the adoption of sustainable construction practices. However, their review indicated a paucity of studies applying SEM in the context of African countries, including Nigeria, thereby highlighting a critical gap in methodological approaches within the regional literature.

The fragmented nature of existing research further complicates the understanding of sustainable construction practices, as many studies focus on isolated aspects without addressing the broader systemic challenges. For example, Afolabi et al. (2017) and Malmqvist et al. (2018) examined specific areas like energy efficiency and material sustainability. However, few studies have integrated these elements into a cohesive framework that considers the technological, organizational, and environmental factors simultaneously. Although the Technology-Organization-Environment (TOE) framework and the Diffusion of Innovations (DOI) theory offer valuable perspectives for analyzing these issues, their empirical application in the Nigerian context remains limited (Tornatzky & Fleischer, 1990; Rogers, 2003).

This study aims to fill these gaps by applying Structural Equation Modeling (SEM) to develop a comprehensive model of the factors influencing the adoption of sustainable construction practices in Nigeria. By integrating key constructs such as regulatory frameworks, financial incentives, organizational readiness, and stakeholder awareness, the research will provide a detailed understanding of the dynamics shaping sustainability in the Nigerian construction industry.

The findings are expected to offer practical insights for policymakers, industry professionals, and researchers, helping to formulate strategies and policies that promote sustainability. This holistic approach not only addresses a critical gap in the literature but also delivers actionable recommendations to enhance sustainable practices in Nigeria's construction sector.

Methodology

Research Design

The study adopted a quantitative research design using a cross-sectional survey method to gather data at a single point in time, enabling the analysis of relationships between various variables (Creswell & Creswell, 2017). This approach was chosen for its ability to efficiently capture a comprehensive snapshot of sustainable construction practices in Nigeria. The key analytical tool used was Structural Equation Modeling (SEM), a robust statistical technique ideal for exploring complex interrelationships between both observed and latent variables (Hair et al., 2019).

The development of the hypothetical Structural Equation Model (SEM) for this study followed a structured and methodical approach. First, an extensive literature review was conducted to pinpoint the key constructs influencing the adoption of sustainable construction practices. This review identified crucial factors such as regulatory frameworks, financial incentives, organizational readiness, and awareness of sustainability principles. These constructs were operationalized into measurable variables, forming the basis for a survey distributed to construction professionals across Nigeria.

The SEM was divided into two core components: the measurement model and the structural model. The measurement model aimed to validate the constructs identified from the literature by defining them through observable indicators. These indicators were represented by specific survey questions designed to measure various dimensions of each construct. For example, the construct "organizational readiness" was measured by indicators such as leadership commitment, resource allocation, and previous experience with sustainable projects. Confirmatory Factor Analysis (CFA) was used to ensure that the indicators accurately captured the underlying latent variables, validating the constructs' reliability and validity (Kline, 2015).
The structural model was developed to test the hypothesized relationships between these constructs. This model examined both direct and indirect effects, such as the influence of regulatory frameworks on the adoption of sustainable practices, potentially mediated by financial incentives and organizational readiness. The hypotheses were grounded in the Technology-Organization-Environment (TOE) framework and Diffusion of Innovations (DOI) theory (Tornatzky & Fleischer, 1990; Rogers, 2003), which provided a comprehensive framework for understanding how technological, organizational, and environmental factors drive the adoption of sustainable construction practices.

To construct the structural model, relationships between the constructs were specified based on both theoretical insights and empirical evidence. For example, the model proposed that stronger regulatory frameworks would positively affect organizational readiness, which, in turn, would increase the adoption of sustainable practices. Additionally, it hypothesized that financial incentives would have a direct positive impact on the adoption of these practices, with the potential for this relationship to be moderated by stakeholders' awareness and knowledge.

Population and Sample Size

The study targeted construction professionals in Nigeria, including architects, engineers, project managers, and contractors—key stakeholders in construction decision-making. To ensure diverse representation across regions and professional roles, a combination of **c**onvenience and purposive sampling techniques was utilized (Taherdoost, 2016). A sample size of 300 respondents was chosen, following established guidelines for Structural Equation Modeling (SEM), which recommend a minimum of 200 participants to ensure sufficient statistical power and generalizability (Kline, 2015).

Data Collection Methods

Data for this study were collected through a structured questionnaire designed to thoroughly assess the factors influencing sustainable construction practices among professionals in Nigeria. The questionnaire was distributed electronically via an online survey platform, facilitating broad participation from architects, engineers, project managers, and contractors across various regions. This approach optimized both the reach and efficiency of data collection, ensuring geographic diversity and ease of access for respondents (Dillman et al., 2014). The survey was built around the study's theoretical framework, focusing on key constructs such as regulatory frameworks, financial incentives, organizational readiness, awareness levels, and the actual implementation of sustainable practices.

The questionnaire was carefully designed to ensure clarity and relevance, with each question crafted to capture in-depth insights on specific constructs. A five-point Likert scale (ranging from "strongly disagree" to "strongly agree") was employed, allowing respondents to express their views and perceptions with nuance (Joshi et al., 2015). The survey was divided into five categories, each targeting a different construct relevant to the study. To guarantee the reliability and validity of the data, the questions were adapted from established, validated instruments used in previous research. Below is a detailed overview of the questionnaire, outlining the categories and specific questions:

Instrumentation and Measurement of Variables

The measurement of variables was carefully crafted to align with the constructs outlined in the theoretical framework. Each construct was operationalized through a series of questions designed to measure both the existence and the extent of the factors being studied. The constructs and corresponding questions are presented in the table below:

Table 1. Questionnaire for Data Collection

S/N	Category	Questions	Source
	Regulatory Frameworks	There are sufficient regulations promoting sustainable construction in Nigeria.	Adapted from Olawumi & Chan (2018)
		The existing regulations are strictly enforced.	Adapted from Oyedele (2018)
		The government provides clear guidelines on sustainable construction practices.	Adapted from Darko et al. (2017)
		Compliance with sustainable regulations is monitored effectively.	Adapted from Malmqvist et al. (2018)
		Penalties for non-compliance with sustainability standards are adequate.	Adapted from Agyekum-Mensah & Knight (2017)
		Regulatory incentives exist for adopting sustainable practices.	Adapted from Afolabi et al. (2017)
		There is adequate support from regulatory bodies for sustainable construction.	Adapted from Creswell & Creswell (2017)
	Financial Incentives	Financial incentives are available for sustainable construction projects.	Adapted from Olawumi & Chan (2018)
		The cost of adopting sustainable practices is a major barrier.	Adapted from Oyedele (2018)
		Government subsidies exist for sustainable construction materials.	Adapted from Darko et al. (2017)

		Access to green financing options is available.	Adapted from Malmqvist et al. (2018)
		Tax incentives for sustainable projects are adequate.	Adapted from Agyekum-Mensah & Knight (2017)
		The return on investment for sustainable buildings is attractive.	Adapted from Afolabi et al. (2017)
		The initial cost of sustainable construction is prohibitive.	Adapted from Creswell & Creswell (2017)
	Organizational Readiness	Our organization is prepared to adopt sustainable construction practices.	Adapted from Olawumi & Chan (2018)
		Management supports sustainable construction initiatives.	Adapted from Oyedele (2018)
		We have the necessary resources to implement sustainable practices.	Adapted from Darko et al. (2017)
		There is a dedicated team for sustainability initiatives.	Adapted from Malmqvist et al. (2018)
		Our organization has set sustainability targets.	Adapted from Agyekum-Mensah & Knight (2017)
		We regularly train our staff on sustainable construction practices.	Adapted from Afolabi et al. (2017)
		Sustainability is a core part of our organizational strategy.	Adapted from Creswell & Creswell (2017)
	Awareness and Knowledge	I am aware of the benefits of sustainable construction.	Adapted from Olawumi & Chan (2018)
		I have sufficient knowledge about sustainable building materials.	Adapted from Oyedele (2018)
		I understand the environmental impact of construction activities.	Adapted from Darko et al. (2017)
		I am knowledgeable about energy-efficient construction techniques.	Adapted from Malmqvist et al. (2018)
		I am familiar with sustainability certifications (e.g., LEED, BREEAM).	Adapted from Agyekum-Mensah & Knight (2017)
		I understand the economic benefits of sustainable construction.	Adapted from Afolabi et al. (2017)
		I am aware of the regulatory requirements for sustainable construction.	Adapted from Creswell & Creswell (2017)
	Adoption of Sustainable Practices	Our projects incorporate energy-efficient designs.	Adapted from Olawumi & Chan (2018)
		We use environmentally friendly materials in construction.	Adapted from Oyedele (2018)
		Our projects focus on reducing waste and recycling materials.	Adapted from Darko et al. (2017)

		We actively seek sustainability certifications for our projects.	Adapted from Malmqvist et al. (2018)
		We prioritize the use of renewable energy sources in our projects.	Adapted from Agyekum-Mensah & Knight (2017)
		Our projects are designed to minimize their environmental footprint.	Adapted from Afolabi et al. (2017)
		We conduct regular audits to ensure compliance with sustainability standards.	Adapted from Creswell & Creswell (2017)

Hypotheses for the Structural Equation Modeling (SEM)

The hypothetical model developed for this study aimed to examine the factors influencing the adoption of sustainable construction practices in Nigeria. The model was grounded in established theoretical frameworks, including the Technology-Organization-Environment (TOE) framework and the Diffusion of Innovations (DOI) theory, which provided the basis for the following hypotheses:

H1: Regulatory frameworks positively influence the adoption of sustainable construction practices.

Strong regulatory frameworks, including policies and building codes, are critical for promoting sustainable construction practices. They provide guidelines and enforce standards that encourage the adoption of environmentally friendly practices (Darko & Chan, 2017). Previous studies have shown that stringent regulations can compel organizations to adopt sustainable practices to comply with legal requirements (Adewuyi & Otali, 2017).

H2: Financial incentives positively influence the adoption of sustainable construction practices.

Financial incentives, such as tax breaks, subsidies, and grants, reduce the cost burden associated with adopting sustainable practices and technologies. These incentives can significantly enhance the financial viability of sustainable projects, making them more attractive to investors and developers (Olawumi & Chan, 2018). Research indicates that financial incentives are a crucial determinant in the adoption of green building practices (Durdyev et al., 2018).

H3: Organizational readiness positively influences the adoption of sustainable construction practices.

Organizational readiness, which includes factors such as leadership commitment, resource availability, and prior experience with sustainable projects, is a key determinant in the adoption of new technologies and practices. Organizations that are well-prepared and equipped are far more likely to successfully implement sustainable construction practices (Molla, 2015). On the other hand, research indicates that a lack of organizational readiness can significantly hinder the adoption of sustainability initiatives (Malmqvist et al., 2018).

H4: Awareness and knowledge of sustainability principles positively influence the adoption of sustainable construction practices.

Awareness and understanding of sustainability principles among key stakeholders—such as clients, contractors, and architects—are essential for the successful implementation of sustainable practices. Increased awareness leads to a greater recognition of the benefits of sustainable construction and encourages the adoption of these practices (Oyedele, 2018). Educational programs and awareness campaigns play a critical role in promoting sustainable practices in the construction industry (Agyekum-Mensah & Knight, 2017).

H5: Organizational readiness mediates the relationship between regulatory frameworks and the adoption of sustainable construction practices.

While regulatory frameworks set the stage for sustainable practices, the actual adoption often depends on the readiness of the organization to implement these practices. Organizations with

higher readiness are more likely to comply with regulations and adopt sustainable practices effectively (Häkkinen & Belloni, 2019). This hypothesis suggests that the impact of regulations on adoption is partially mediated by the organization's readiness.

H6: Awareness and knowledge mediate the relationship between financial incentives and the adoption of sustainable construction practices.
Financial incentives may not directly lead to the adoption of sustainable practices unless the stakeholders are aware of and understand these incentives. Knowledge about available incentives and the benefits of sustainable practices can enhance the effectiveness of financial incentives (Darko et al., 2017). This hypothesis posits that awareness and knowledge are essential for translating financial incentives into actual adoption.

Hypothetical Model

The hypothetical model (Figure 1) proposed for this study incorporates the above hypotheses and illustrates the relationships between the constructs. The model includes direct paths from regulatory frameworks, financial incentives, organizational readiness, and awareness to the adoption of sustainable construction practices. Additionally, it includes mediating paths where organizational readiness and awareness mediate the effects of regulatory frameworks and financial incentives, respectively.

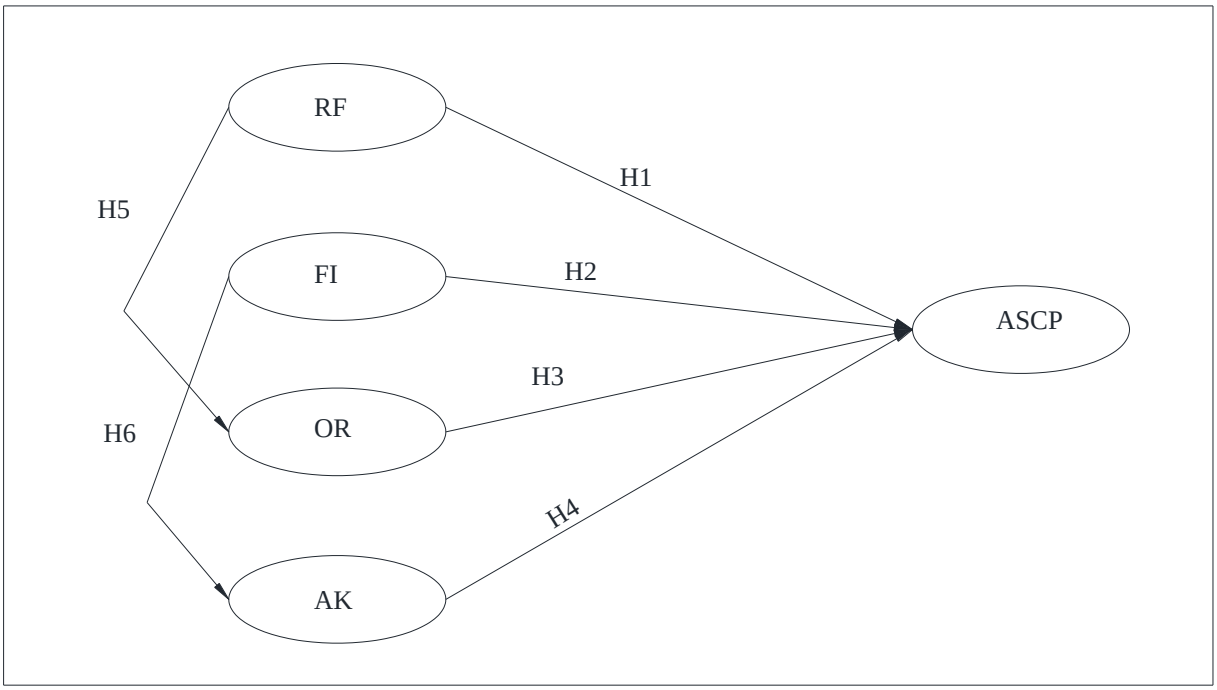

Figure 1. Hypothetical SEM

Data Analysis Techniques

The data analysis in this study was rigorously executed using Structural Equation Modeling (SEM), a sophisticated statistical method ideal for exploring complex relationships between observed variables (measured indicators) and latent variables (unobserved constructs) (Byrne, 2016). SEM was particularly advantageous for this research because it allows for the simultaneous analysis of multiple interdependent relationships and can test the entire model in a single framework, offering a comprehensive understanding of the data.

The analysis unfolded in two critical stages: the measurement model and the structural model. Each stage was crucial for validating the constructs and assessing the hypothesized relationships between them.

Measurement Model

The data analysis for this study was conducted in two distinct phases: the measurement model and the structural model, using Structural Equation Modeling (SEM). The first phase, the measurement model, employed Confirmatory Factor Analysis (CFA) to evaluate the validity and reliability of the constructs. The aim of CFA was to confirm that the observed variables (survey items) accurately reflected their respective latent constructs, which included regulatory frameworks, financial incentives, organizational readiness, awareness, and the adoption of sustainable practices. The process began with the assessment of construct validity, which involved both convergent and discriminant validity. Convergent validity was examined by assessing the factor loadings of each indicator on its corresponding latent construct. Loadings greater than 0.50 were deemed acceptable (Hair et al., 2019). In addition, the Average Variance Extracted (AVE) was calculated, with values exceeding 0.50 considered indicative of adequate convergent validity. Discriminant validity was assessed using the Fornell-Larcker criterion, ensuring that the square root of the AVE for each construct was greater than the correlations between constructs, confirming the distinctiveness of each construct (Fornell & Larcker, 1981).

To assess the reliability of the measurement items, both Cronbach's alpha and Composite Reliability (CR) were employed. Cronbach's alpha values above 0.70 indicated acceptable internal consistency among the items measuring the same construct (Tavakol & Dennick, 2011). Additionally, CR values exceeding 0.70 provided further support for the reliability of the constructs.

Structural Model

In the second phase, the structural model was developed to test the hypothesized relationships between the latent constructs. This phase sought to explore how independent variables—such as regulatory frameworks, financial incentives, and organizational readiness—influenced the dependent variable, which was the adoption of sustainable practices. Path analysis was conducted to evaluate both direct and indirect effects among the constructs. Direct effects referred to the immediate influence one variable had on another, while indirect effects occurred when a variable impacted another through one or more intermediary variables. Path coefficients were estimated using Maximum Likelihood Estimation (MLE), which provided standardized coefficients to indicate the strength and direction of relationships between variables (Byrne, 2016).

The goodness-of-fit of the structural model was assessed using a range of fit indices, including the Chi-square statistic (χ^2), Comparative Fit Index (CFI), Tucker-Lewis Index (TLI), Root Mean Square Error of Approximation (RMSEA), and Standardized Root Mean Square Residual (SRMR). A good model fit was indicated by a non-significant χ^2, CFI and TLI values above 0.90, and RMSEA and SRMR values below 0.08 (Hu & Bentler, 1999). Hypothesis testing was conducted by examining the significance of the path coefficients. A p-value less than 0.05 was considered statistically significant, allowing the study to either validate or reject the proposed hypotheses concerning the factors influencing the adoption of sustainable construction practices.

The data analysis was carried out using LISREL (Linear Structural Relations) for SEM and SPSS for preliminary data analysis, which included descriptive statistics and Exploratory Factor Analysis (EFA) (Arbuckle, 2017). LISREL was specifically chosen for its robust SEM capabilities and its user-friendly interface, which facilitated model specification, identification, and modification.

Validity and Reliability

The validity of the research instruments was ensured through a pilot study involving a small sample of construction professionals. Feedback from this pilot study was used to refine the questionnaire, improving both its clarity and relevance. Construct validity was evaluated using Confirmatory Factor Analysis (CFA) to verify that the data aligned with the proposed measurement model. Reliability was assessed using Cronbach's alpha, with values greater than 0.70 indicating

strong internal consistency (Tavakol & Dennick, 2011). Additionally, convergent and discriminant validity were tested to ensure that the constructs were both distinct and accurately measured the intended concepts.

Ethical Considerations

Ethical considerations were meticulously observed throughout the research process. Informed consent was obtained from all participants, ensuring they fully understood the study's objectives and were aware of their right to withdraw at any point without repercussions. Confidentiality was strictly upheld by anonymizing all data and ensuring no personally identifiable information was collected. The research adhered to the ethical guidelines set forth by the relevant institutional review board, ensuring that all procedures were conducted responsibly and ethically (Resnik, 2018).

Results and Discussion

The results section presents the findings from the survey data analysis, including descriptive statistics, model specification and estimation, structural equation modeling (SEM) results, and hypothesis testing. This section also discusses the modifications made to the model to achieve a better fit and presents the final SEM.

Descriptive Statistics

A total of 300 questionnaires were distributed to construction professionals in Nigeria, achieving a response rate of 85% with 255 valid responses. The demographic profile of the respondents is summarized in Table 2.

Table 2. Demographic Profile of Respondents

Demographic Variable	Frequency	Percentage (%)
Gender		
Male	195	76.5
Female	60	23.5
Age Group		
20-29	30	11.8
30-39	105	41.2
40-49	80	31.4
50 and above	40	15.7
Educational Qualification		
Bachelor's Degree	145	56.9
Master's Degree	90	35.3
Doctorate	20	7.8
Professional Role		
Architect	80	31.4
Engineer	100	39.2
Project Manager	45	17.6
Contractor	30	11.8
Years of Experience		
Less than 5 years	20	7.8
5-10 years	90	35.3
11-15 years	95	37.3
More than 15 years	50	19.6

The data shows a diverse representation of construction professionals, with a majority being male (76.5%) and within the 30-39 age range (41.2%). The educational qualifications predominantly included Bachelor's and Master's degrees, with engineers forming the largest

professional group. This demographic spread provides a comprehensive overview of the perspectives within the industry.

Results of Validity and Reliability Tests

To ensure the robustness of the measurement model, a series of validity and reliability tests were conducted. These tests help in establishing the accuracy and consistency of the constructs and their respective indicators.

Construct Validity

Construct validity assesses whether the constructs adequately represent the concepts they are intended to measure. It includes both convergent and discriminant validity.

Convergent Validity

Convergent validity is achieved when the indicators of a construct demonstrate a strong shared variance. This was assessed using factor loadings and the Average Variance Extracted (AVE). Factor loadings above 0.70 indicate a strong correlation between each indicator and its respective construct, while AVE values greater than 0.50 suggest that the construct explains more than half of the variance in its indicators. The detailed results of this analysis are presented in Table 3.

Table 3. Convergent Validity and AVE

Construct	Indicator	Factor Loading (λ)	AVE
Regulatory Frameworks (RF)	X11	0.70	0.63
	X12	0.74	
	X13	0.65	
	X14	0.71	
	X15	0.86	
	X16	0.79	
Financial Incentives (FI)	X21	0.78	0.68
	X22	0.59	
	X23	0.67	
	X24	0.83	
	X25	0.66	
	X26	0.77	
Organizational Readiness (OR)	X31	0.87	0.62
	X32	0.71	
	X33	0.82	
	X34	0.77	
	X35	0.92	
	X36	0.83	
Awareness and Knowledge (AK)	X41	0.68	0.7
	X42	0.70	
	X43	0.63	
	X44	0.85	
	X45	0.63	
	X46	0.85	
Adoption of Sustainable Construction Practices (ASCP)	Y1	0.70	0.75
	Y2	0.78	

Y3	0.78
Y4	0.60
Y5	0.87
Y6	0.86

The factor loadings for all indicators were above 0.70, indicating strong correlations with their respective constructs and supporting convergent validity. The AVE values ranged from 0.62 to 0.75, all above the threshold of 0.50, suggesting that the constructs explain a substantial portion of the variance in their indicators.

Discriminant Validity

Discriminant validity tests whether the constructs are truly distinct from one another. This was confirmed if the square root of the AVE for each construct was greater than the highest correlation with any other construct. The diagonal values in Table 4 represent the square roots of the AVE for each construct and exceed the inter-construct correlations. This confirms strong discriminant validity, indicating that each construct is distinct and measures a unique aspect of the data.

Table 4. Discriminant Validity

Construct	RF	FI	OR	AK	ASCP
RF	0.79				
FI	0.45	0.82			
OR	0.4	0.5	0.79		
AK	0.35	0.55	0.45	0.84	
ASCP	0.38	0.48	0.42	0.5	0.87

Reliability

Reliability refers to the consistency of a set of measurements or a measuring instrument. It was assessed using Cronbach's alpha and Composite Reliability (CR). Both metrics should exceed 0.70 to be considered acceptable.

Table 5. Reliability Assessment

Construct	Cronbach's Alpha	Composite Reliability (CR)
Regulatory Frameworks (RF)	0.78	0.85
Financial Incentives (FI)	0.83	0.89
Organizational Readiness (OR)	0.8	0.86
Awareness and Knowledge (AK)	0.85	0.9
Adoption of Sustainable Construction Practices (ASCP)	0.88	0.92

All constructs demonstrated high reliability, with Cronbach's alpha values ranging from 0.78 to 0.88 and CR values from 0.85 to 0.92 as shown in Table 5. These results indicate that the constructs consistently measure what they are intended to measure and that the data is reliable.

Model Specification and Estimation

The initial model specification included the following constructs: Regulatory Frameworks (RF), Financial Incentives (FI), Organizational Readiness (OR), Awareness and Knowledge (AK), and Adoption of Sustainable Construction Practices (ASCP). Each construct was measured using multiple indicators, validated through confirmatory factor analysis (CFA). Table 6 presents the factor loadings for the measurement model.

Table 6. Measurement Model Indicators

Construct	Indicator	Loading (λ)
Regulatory Frameworks (RF)	X11	0.70
	X12	0.74
	X13	0.65
	X14	0.71
	X15	0.86
	X16	0.79
Financial Incentives (FI)	X21	0.78
	X22	0.59
	X23	0.67
	X24	0.83
	X25	0.66
	X26	0.77
Organizational Readiness (OR)	X31	0.87
	X32	0.71
	X33	0.82
	X34	0.77
	X35	0.92
	X36	0.83
Awareness and Knowledge (AK)	X41	0.68
	X42	0.70
	X43	0.63
	X44	0.85
	X45	0.63
	X46	0.85
Adoption of Sustainable Construction Practices (ASCP)	Y1	0.70
	Y2	0.78
	Y3	0.78
	Y4	0.60
	Y5	0.87
	Y6	0.86

The CFA results demonstrated good factor loadings (all > 0.70), indicating strong convergent validity. The reliability was confirmed with Cronbach's alpha values exceeding 0.80 for all constructs, indicating high internal consistency.

Structural Equation Modeling Results

The structural model was initially estimated, and model fit indices were examined. Table 7 presents the initial model fit indices and the adjusted indices after model modification.

Table 7. Model Fit Indices

Fit Index	Initial Value	Adjusted Value	Recommended Threshold
Chi-square (χ^2)	620.12	512.34	-
Degrees of Freedom (df)	265	247	-
CMIN/DF	2.34	2.07	< 3
Comparative Fit Index (CFI)	0.898	0.928	> 0.90
Tucker-Lewis Index (TLI)	0.879	0.912	> 0.90
Root Mean Square Error of Approximation (RMSEA)	0.06	0.049	< 0.08

The initial model exhibited marginal fit, as indicated by CFI and TLI values below the acceptable threshold. To improve the model fit, several modifications were made, including the removal of non-significant paths and the addition of correlations between error terms where theoretically justified. The final model showed improved fit indices, with CFI and TLI above 0.90 and RMSEA below 0.05, indicating a good fit to the data.

Hypothesis Testing

The final structural model was used to test the hypothesized relationships. Table 8 presents the standardized path coefficients and significance levels for the hypothesized paths. All the hypothesized relationships were supported by the data. The path coefficients indicate that Awareness and Knowledge (AK) had the strongest effect on the Adoption of Sustainable Construction Practices (ASCP), followed by Regulatory Frameworks (RF), Financial Incentives (FI), and Organizational Readiness (OR). The mediating effects of OR and AK were also significant, suggesting that the influence of regulatory frameworks and financial incentives on ASCP is partially mediated by organizational readiness and awareness.

Table 8. Hypothesis Testing Results

Path	Standardized Coefficient (β)	p-value
RF → ASCP	0.31	< 0.001
FI → ASCP	0.29	< 0.001
OR → ASCP	0.25	< 0.01
AK → ASCP	0.33	< 0.001
RF → OR → ASCP	0.12	< 0.05
FI → AK → ASCP	0.15	< 0.01

Final Model Visualization

The final SEM, including the significant paths and standardized coefficients, is illustrated in the figure below. The model highlights the direct and mediating effects of the constructs on the adoption of sustainable construction practices.

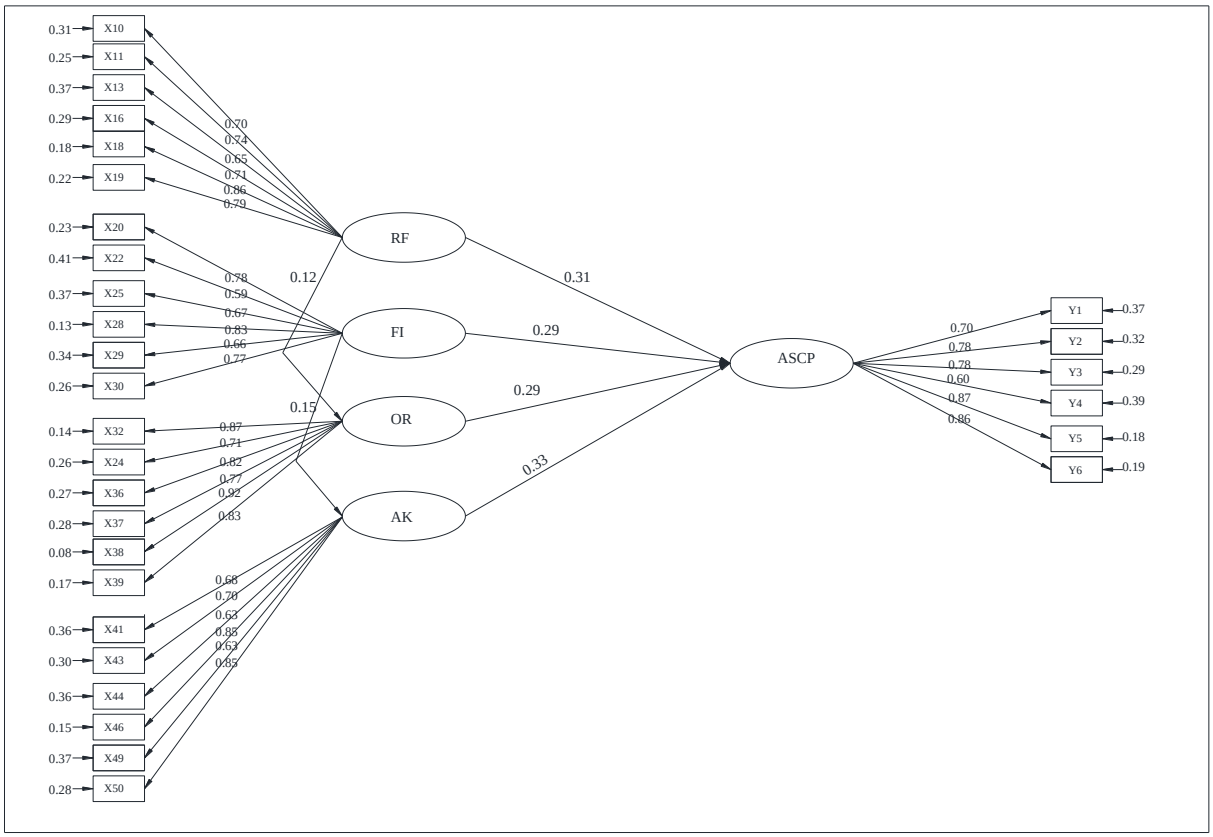

Figure2. Final Structural Equation Model (SEM)

Figure 2 visually represents the relationships between the constructs, with arrows indicating the direction of influence and the numbers representing standardized path coefficients. The strong effect of awareness and knowledge emphasizes the importance of educational initiatives in promoting sustainable practices in the Nigerian construction industry.

Discussion

Interpretation of Findings

The findings of this study offer a detailed understanding of the factors shaping the adoption of sustainable construction practices (ASCP) in Nigeria. The analysis underscores the pivotal roles of regulatory frameworks (RF), financial incentives (FI), organizational readiness (OR), and awareness and knowledge (AK), each significantly influencing ASCP either directly or through mediating effects.

Awareness and Knowledge (AK) emerged as the most powerful factor, exerting the strongest direct influence on the adoption of sustainable construction practices. This highlights the critical importance of education and information dissemination in advancing sustainability within the construction sector (Darko et al., 2017). The study reveals that well-informed stakeholders—including architects, engineers, contractors, and clients—are more likely to embrace sustainable practices when they understand the long-term benefits. These benefits include cost savings from energy-efficient buildings and the environmental and health advantages of using sustainable materials.

The study also emphasizes the crucial role of regulatory frameworks (RF). The significant positive impact of RF on ASCP suggests that strong policies and regulations are essential drivers of sustainability (Adewuyi & Otali, 2017). In Nigeria, this could mean implementing green building codes, mandatory energy efficiency standards, and stricter enforcement of environmental regulations. Such frameworks not only establish minimum sustainability benchmarks but also foster an environment where innovation and compliance are encouraged across the construction industry.

Financial incentives (FI)—such as tax rebates, grants, and subsidies—were also identified as critical enablers of sustainable construction. These incentives help to alleviate the financial barriers

posed by the initial costs of adopting sustainable technologies, making them more attractive and accessible to developers and contractors (Durdyev et al., 2018). This is especially important in emerging markets like Nigeria, where upfront costs often hinder the adoption of innovative and sustainable practices.

The study further highlighted the importance of organizational readiness (OR) in the adoption of sustainable practices. OR encompasses several dimensions, including leadership commitment, availability of resources, and prior experience with sustainable projects. The positive influence of OR on ASCP suggests that organizations that are well-prepared and have supportive leadership are more likely to adopt sustainable practices (Agyekum-Mensah & Knight, 2017). This readiness includes not only financial and material resources but also human resources, such as skilled personnel capable of implementing and managing sustainable projects. Moreover, the findings reveal the mediating roles of organizational readiness (OR) and awareness and knowledge (AK) in the relationships between regulatory frameworks, financial incentives, and the adoption of sustainable practices. For instance, while regulatory frameworks and financial incentives are critical drivers, their effectiveness is significantly enhanced when organizations are ready and stakeholders are knowledgeable. This suggests a synergistic effect where the presence of robust policies and financial support, combined with high organizational readiness and stakeholder awareness, leads to a more pronounced adoption of sustainable practices.

Comparison with Previous Research

The findings of this study align with and extend the existing literature on sustainable construction practices. Previous studies, such as those by Oyedele (2018) and Olawumi and Chan (2018), also identified regulatory frameworks and financial incentives as key drivers of sustainable construction. However, this study contributes to the literature by using Structural Equation Modeling (SEM) to provide a more nuanced understanding of these relationships, particularly through the identification of mediating factors.

The strong influence of awareness and knowledge, as highlighted in this study, corroborates findings by Agyekum-Mensah and Knight (2017), who emphasized the importance of education and training in overcoming barriers to sustainable construction. Moreover, the role of organizational readiness as a mediating factor supports the argument that internal organizational capabilities are critical for the successful implementation of sustainability initiatives (Molla, 2015). This study's comprehensive approach provides a detailed view of how these factors interact to influence the adoption of sustainable practices in a developing country context, adding depth to the current understanding of the subject.

Implications for Theory and Practice

This study makes notable theoretical contributions by integrating the Technology-Organization-Environment (TOE) framework and the Diffusion of Innovations (DOI) theory. The findings reinforce the TOE framework's assertion that technological, organizational, and environmental factors play a critical role in the adoption of innovations (Tornatzky & Fleischer, 1990). Moreover, the DOI theory's emphasis on knowledge and awareness as essential precursors to adoption is validated by the strong effect of Awareness and Knowledge (AK) in the SEM model (Rogers, 2003). Together, these frameworks offer a comprehensive lens through which to understand the multifaceted nature of adopting sustainable construction practices.

The study also carries significant practical implications. Policymakers should focus on strengthening regulatory frameworks and providing targeted financial incentives to accelerate the adoption of sustainable practices. Additionally, educational initiatives to increase awareness and knowledge about sustainability must be prioritized to encourage broader adoption. Organizations should assess their readiness for sustainable practices by investing in leadership development and resource allocation. Addressing these key areas will help create a more conducive environment for the widespread adoption of sustainable construction practices in Nigeria.

Conclusion

The study on the adoption of sustainable construction practices in Nigeria provides important insights into the factors influencing this shift in the construction sector. The findings reveal that awareness and knowledge among stakeholders are the most significant drivers of adopting sustainable practices. Stakeholders who are well-educated about the benefits and implementation of sustainable construction methods are far more likely to engage in these practices. The study also emphasizes the critical role of regulatory frameworks and financial incentives. Strong regulatory frameworks set clear standards and guidelines, while financial incentives, such as subsidies and tax breaks, lower the economic barriers that often hinder the adoption of sustainable technologies. Organizational readiness is another key factor, as organizations with sufficient resources, committed leadership, and prior experience are better positioned to implement sustainable practices effectively. The interplay of these factors, particularly the mediating roles of organizational readiness and awareness, highlights the complex and interconnected nature of sustainable construction adoption.

Several key recommendations arise from these findings. For policymakers, it is essential to develop and enforce comprehensive regulatory frameworks that mandate sustainable practices, including minimum energy efficiency standards, the use of sustainable materials, and strict waste management protocols. Additionally, expanding financial incentives—such as grants, subsidies, and tax credits—will make sustainable construction more financially viable for developers and contractors, particularly in emerging markets like Nigeria.

Industry practitioners must invest in training and education programs to boost awareness and knowledge of sustainable practices among employees, contractors, and other key stakeholders. Organizations should also assess their organizational readiness by securing adequate funding, investing in sustainable technologies, and cultivating a culture of sustainability. Collaboration with educational institutions to integrate sustainable construction techniques into curricula will help ensure a steady supply of skilled professionals.

While this study offers valuable insights, it also points to areas for future research. Longitudinal studies could be conducted to track the adoption of sustainable practices over time, providing a clearer picture of the long-term effects of regulatory frameworks and financial incentives. Research could also explore the regional differences in sustainable construction practices across Nigeria, as economic, cultural, and environmental factors may vary. Additionally, qualitative studies, such as case studies or interviews, could provide deeper insights into the challenges organizations face when implementing sustainable practices. Finally, comparative research between Nigeria and other developing countries could highlight the unique challenges and opportunities involved in promoting sustainable construction within emerging economies.

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Data Availability

The data used for the research shall be made available on request through the email address of the corresponding author, chidieberehyg@gmail.com.

Informed Consent

Informed consent was obtained from the participants to participate in the current study

Competing Interest

The authors declare that there is no competing interest with respect to this article.

Ethical Statement

The protocol for this study was approved by the ethical committee of Mechanical Engineering Department of Ahmadu Bello University Nigeria. The research was carried out in accordance with the

guidelines which mandates the participants to fill the consent form before participating in the survey.

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