Sustainable Construction Understanding among Architecture, Engineering and Construction (AEC) Professionals in Abuja

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Globally, there is a growing desire to deliver sustainable infrastructure projects. However, the implementation of sustainable construction in Nigeria is still in its early stages. It is believed that the successful adoption of sustainable construction in Nigeria depends, in part, on the understanding of sustainable construction among professionals in the architecture, engineering, and construction (AEC) industry. This study argues that the extent to which AEC professionals demonstrate a clear understanding of sustainable construction reflects their knowledge and provides a starting point for effective implementation in the future. By focusing on the current efforts of the Nigerian AEC industry to embrace sustainability, this study aims to identify key factors that exemplify the understanding of sustainable construction among professionals. A survey was conducted among 290 registered construction professionals in Abuja. The data was analysed using factor analysis and partial least squares structural equation modelling (PLS-SEM) approach. The result from the analysis shows seven factors: awareness, political factors, passive culture, knowledge, demand, financial, and attitude. These factors characterise sustainable construction practices understanding among AEC professionals in Abuja. This serves as a foundation for future implementation of sustainable construction practices in Nigeria in line with the views of many sustainable construction researchers.

Key words: Sustainable development, sustainable construction, sustainable construction practices, Nigeria, structural equation modelling

INTRODUCTION

The growing concerns over energy and water consumption, air pollution, and greenhouse gas emissions have led to increased attention towards sustainable construction (Berardi, 2013a). Olayinka (2018) opined that implementing sustainable construction practices can help reduce energy consumption and mitigate air pollution. However, the existing literature on sustainable construction is vast (Sfakianaki, 2019) and conducted in various economies, emphasizing the need for incorporating sustainable practices (Ujene & Oladokun, 2017). Sustainable construction focuses on environmental impact, resource efficiency, and the integration of economic and social factors (Vilnitis *et al*., 2019). In Nigeria, the construction industry plays a crucial role in the country's development, but sustainable construction practices adoption is low (Akinshipe *et al*., 2019). This is chiefly because there is no clear sustainable construction policy direction (Aghimien *et al*., 2018). The lack of relevant sustainable construction practices regulations and a clear understanding of sustainable construction hinder its implementation. Therefore, to drive the adoption of sustainable construction practices, it will be important to identify all factors that impede the progress of sustainable construction practices. More so, many authors (Aghimien *et al*., 2019; Davies & Davies, 2017; Isa Kalsum *et al.*, 2014) have reported inconsistencies in how experts in the AEC industry envision the future application of sustainable construction, influenced by Nigeria's unique context and expertise of professionals. Therefore, it is imperative to gauge the understanding of sustainable construction among AEC professionals in Nigeria who are the drivers for its implementation.

LITERATURE REVIEW

Agenda 21 serves as a foundational framework for determining sustainability in the construction sector (Du Plessis, 2007). Initially focused on addressing resource constraints and mitigating environmental and energy impacts in construction operations (Ciegis *et al*., 2009; Du Plessis, 2002), its scope has expanded over time to encompass technical considerations related to building components, energy-efficient designs, construction technology, and materials (Banani *et al*., 2016; Häkkinen & Belloni, 2011). In recent years, there has been a growing emphasis on cultural, economic, and social aspects within sustainable construction practices (Murtagh *et al*., 2018; Tunji-Olayeni *et al*., 2018).

A comparative study examining sustainability awareness in Nigeria and Malaysia by Abolore, (2012) and Aghimien *et al*. (2018) highlighted that Nigerian built environment specialists possess a lower level of awareness and expertise compared to their counterparts in Malaysia. In Nigeria, the adoption of

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sustainable construction methods in the AEC sector faces significant challenges due to various factors.

Knowledge

The lack of comprehensive information on sustainable construction represents a major barrier to effective sustainable development (Darko *et al.*, 2017). Studies conducted in the Nigerian construction industry (Okoh *et al*., 2017; Tunji-Olayeni *et al*., 2018) and similar countries have underscored the necessity for knowledge tailored to their specific characteristics and resources. The absence of education and accurate information, coupled with the ambiguous nature of the economic development definition, further impedes sustainable development efforts.

Awareness

Limited awareness of sustainable construction among stakeholders, such as the clients and construction professionals, hampers its successful implementation (Sfakianaki, 2019). Insufficient knowledge, concerns about heightened risks, and resistance to change contribute to the challenges encountered in Nigeria (Antwi-Agyei *et al*., 2018; Olawumi & Chan, 2020). Additionally, the lack of support from manufacturers and suppliers presents an additional obstacle to the widespread adoption of sustainable construction practices.

Political Will

Oke *et al*. (2019) reported that the role of the government in enforcing regulations, policies, and incentives is crucial for facilitating sustainable development. In Nigeria, the government's lack of commitment and accountability has hindered the implementation of sustainable practices. The formulation of clear policies and active involvement of the government are essential in driving sustainable construction within the construction industry.

Attitude

The attitudes of construction stakeholders towards sustainable construction practices are influenced by their perceptions, awareness, and education. Resistance to change and misplaced priorities can impede the adoption of sustainable practices (Darko *et al*., 2017). Therefore, the perspectives of professionals and their willingness to embrace sustainable construction play a critical role in ensuring successful implementation.

Passive Culture

The passive culture prevailing in the Nigerian construction industry contributes to the limited adoption of sustainable construction. Factors such as the absence of case studies, prevailing business culture, lack of coordination, and ambiguous information hinder professionals who rely on proven models and data (Bamgbade *et al.*, 2015). Overcoming resistance to change and transitioning to more advanced sustainability-oriented methods are crucial steps to be taken.

Financial

Financial challenges, including the perception that sustainable construction is costlier, contribute to the reluctance of developers to adopt sustainable practices (Isa Kalsum *et al*., 2014). Addressing these economic factors and integrating life-cycle costs into project evaluations can help promote the implementation of sustainable construction.

Demand

Ayarkwa *et al*. (2017) asserted that the increasing demand for development of projects sustainably is the driving force behind the proliferation of construction projects. Enhancing awareness and education among clients and other stakeholders are pivotal for fostering the growth of sustainable construction. The construction industry should assume a leadership role in guiding clients and stakeholders regarding sustainability issues and the inherent benefits associated with them.

RESEARCH METHODOLOGY

The research methodology employed a cross-sectional design (Creswell & Creswell, 2018) and utilised a survey as the data collection method. The survey comprised 35 factors which were obtained from various literatures (Chan *et al*., 2017; Dahiru *et al*., 2014; Divine *et al*., 2017; Faith *et al*., 2018; Heilman, 2016; Olanipekun, 2015) which constituted the survey instrument. The questionnaire was divided into two sections: respondent demographic information and factors underlying sustainable construction understanding. A close ended questionnaire was used with a 5-point Likert scale ranging from strongly disagree to strongly agree. The study specifically focused on registered construction professionals in the Federal Capital Territory, Abuja. This is because it is assumed that registered construction professionals are well trained and better equipped in carrying out construction activities (Daniel *et al.*, 2018). The sample was selected by retrieving the names of all registered professionals from the regulatory bodies' websites.

Pilot Study

A pilot study was conducted with a selected group of professionals to assess the reliability of the survey instrument. Fifty sets of survey questionnaires were randomly distributed among the selected group, and the reliability of all items listed in the survey was determined using Cronbach's Alpha values. For this study, the Cronbach's Alpha value was found to be 0.912 (Table 1), exceeding the recommended threshold of 0.7 (Fellows, 2015).

Table 1: Cronbach Alpha

Cronbach's Alpha	N of Items
.912	35

Data Collection and Analysis

Having established that the survey instrument has satisfactory reliability, data collection was carried out using stratified random sampling or registered construction professionals in Abuja. 394 questionnaires were distributed, out of which 104 were rejected because there were incorrectly filled

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with several missing data and multiple answers. The remaining 290 valid questionnaires were used for the analysis representing 49.57 per cent response rate. Consequently, this research considered the response rate as sufficient for this analysis because Hair *et al*. (2016) and Sekaran & Bougie (2016) suggest that a 30 per cent rate of response is sufficient for survey research.

The collected responses were coded, and data analysis was performed using SPSS version 25 and SmartPLS 3. The analysis methods employed in this study included ANOVA (to take care of biases because different construction professionals were used), factor analysis, and Confirmatory Factor Analysis (CFA) using structural equation modelling. These analyses aimed to develop an initial model representing the underlying factors that demonstrate sustainable construction understanding.

RESULTS AND DISCUSSION

The professional distribution of respondents is presented in Table 2, indicating that Architects accounted for 26.6%, Builders for 31%, Civil Engineers for 35.2%, and Quantity Surveyors for 7.2%. This distribution ensures adequate representation of different professional groups. In terms of working experience, 31.4% of participants had up to 5 years of experience, 44.5% had up to 10 years, 12.4% had up to 15 years, and around 11.7% had up to 20 years. Additionally, 73.1% of the professionals worked in the private sector, while 26.9% worked in the public sector.

Table 2: Demographic Distribution

Demographic Variables	Categories	Frequency	Per cent
Profession	Architecture	77	26.6
	Building	90	31
	Structural Engineering	102	35.2
	Quantity Surveying	21	7.2
	Total	290	100
Construction work experience	Up to 5 years	91	31.4
	6 – 10 years	129	44.5
	11 – 15 years	36	12.4
	16 – 20 years	34	11.7
	Total	290	100
Highest Qualification	Bachelors / HND	93	32.1
	Masters	146	50.3
	PhD	45	15.5
	Others	6	2.1
	Total	290	100
Practice Sector	Private Practice	212	73.1
	Public sector	78	26.9
	Total	290	100
Sustainable construction experience	Yes	124	42.8
	No	166	57.2
	Total	290	100

ANOVA

The mean scores of responses from a group of construction professionals were analysed using Oneway ANOVA (Table 3) to determine if the responses could be considered equal. Several parameters were considered: variance homogeneity (5%), significance level (5%) in mean scores for each component, and the effect size, which measures the strength of the variance and decision-making (Ahmad *et al*., 2019; Baldi & Moore, 2018). The hypothesis was formulated as thus:

i. H_0: There is a significant difference in the responses from the groups of construction professionals on the factors underlying sustainable construction understanding.

ii. H_1: There is no significant difference in the responses of between the groups of construction professionals on the factors underlying sustainable construction understanding.

From Table 3, the strength of the mean difference of responses of the groups of construction professionals was small, based on the effect size calculated using Eta squared (Baldi & Moore, 2018). Therefore, responses of the group of registered construction professionals' show a similar disposition towards factors that underlying sustainable construction understanding. Hence, the understanding of the group can be taken as a whole.

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Table 3: Analysis of Variance in the Mean Scores of a Group of Construction Professionals on Factors that Characterise Sustainable Construction Understanding

SN	Factors	Group means			
		p-value	Effect size	Decision on hypothesis	The decision on effect size
1	UF1	0.247	0.014	Reject Ho	Small
2	UF2	0.617	0.006	Reject Ho	Small
3	UF3	0.048	0.027	Reject Ho	Medium
4	UF4	0.159	0.018	Reject Ho	Small
5	UF5	0.453	0.009	Reject Ho	Small
6	UF6	0.009	0.004	Reject Ho	Small
7	UF7	0.001	0.056	Reject Ho	Medium
8	UF8	0.728	0.005	Reject Ho	Small
9	UF9	0.001	0.055	Reject Ho	Medium
10	UF10	0.540	0.008	Reject Ho	Small
11	UF11	0.374	0.011	Reject Ho	Small
12	UF12	0.000	0.066	Reject Ho	Medium
13	UF13	0.044	0.028	Reject Ho	Medium
14	UF14	0.128	0.002	Reject Ho	Small
15	UF15	0.121	0.002	Reject Ho	Small
16	UF16	0.323	0.012	Reject Ho	Small
17	UF17	0.419	0.010	Reject Ho	Small
18	UF18	0.610	0.006	Reject Ho	Small
19	UF19	0.101	0.021	Reject Ho	Medium
20	UF20	0.126	0.020	Reject Ho	Medium
21	UF21	0.006	0.042	Reject Ho	Medium
22	UF22	0.002	0.049	Reject Ho	Medium
23	UF23	0.000	0.061	Reject Ho	Medium
24	UF24	0.272	0.014	Reject Ho	Small
25	UF25	0.285	0.013	Reject Ho	Small
26	UF26	0.032	0.003	Reject Ho	Small
27	UF27	0.077	0.024	Reject Ho	Medium
28	UF28	0.044	0.028	Reject Ho	Medium
29	UF29	0.277	0.013	Reject Ho	Small
30	UF30	0.249	0.014	Reject Ho	Small
31	UF31	0.030	0.031	Reject Ho	Medium
32	UF32	0.219	0.015	Reject Ho	Small
33	UF33	0.024	0.032	Reject Ho	Medium
34	UF34	0.829	0.003	Reject Ho	Small
35	UF35	0.153	0.018	Reject Ho	Small

Factor Analysis

The guidelines recommended by Hooper (2012) were followed to determine the factorability of the 35 factors. After the first round, 30 factors remained, showing reasonable factorability as the items initially correlated with each other at a value greater than 0.3. Furthermore, Table 6 presents the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy, which yielded a value of 0.611, surpassing the recommended threshold of 0.5. Bartlett's test of sphericity was also statistically significant with a *p*-value less than 0.05, confirming the suitability of the data for factor analysis (Hair *et al.*, 2019).

All factors exhibited intercorrelations above 0.4, indicating shared common variance (Leimeister, 2010). With these conditions met, the principal component extraction method was applied. The exploratory factor analysis (EFA) results show that seven components have Eigen values greater than one, collectively explaining 74.714% of the variance in the variable structure. These seven factors (awareness, demand, political, attitude, economic, knowledge, and passive culture) provide valuable insights into underlying factors of sustainable construction understanding. The factor loadings and eigenvalues indicate the strength and significance of each variable in the factor structure (Kang *et al.*, 2015).

Confirmatory Factor Analysis (PLS-SEM)

These seven factors were used in developing the model of factors underlying sustainable construction understanding. Partial Least Squares Structural Equation Modelling (PLS-SEM) will be employed to assess the strength of each factor's influence on sustainable construction understanding. Table 4 shows factor loadings above 0.7 and satisfactory reliability indicated by composite reliability values

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exceeding 0.7. Construct validity is supported by the average variance extracted values equal to or greater than 0.5 for all factors (Hair *et al*., 2017; Hair *et al*., 2019; Hair, Hult *et al*., 2017; Hair *et al*., 2016).

Table 4: Measurement model of sustainable construction understanding

SN	Factors	Item	Factor Loadings	CR	AVE
1	Attitude	Atd 1	0.876	0.790	**0.57**
		Atd 2	0.835		
		Atd 3	0.494		
2	Awareness	Awr 1	0.711	0.843	**0.518**
		Awr 2	0.760		
		Awr 3	0.683		
		Awr 4	0.724		
		Awr 5	0.718		
3	Demand	Dmd 1	0.816	0.875	**0.638**
		Dmd 2	0.796		
		Dmd 3	0.862		
		Dmd 4	0.714		
4	Financial	Fin 1	0.544	0.751	0.536
		Fin 2	0.633		
		Fin 3	0.823		
		Fin 4	0.609		
5	Knowledge	Knw 3	0.610	0.804	**0.582**
		Knw 4	0.838		
		Knw 5	0.820		
6	Passive Culture	PaC 2	0.874	0.915	**0.781**
		PaC 3	0.912		
		PaC 4	0.865		
7	Political	Pol 1	0.587	0.907	**0.665**
		Pol 2	0.869		
		Pol 3	0.885		
		Pol 4	0.875		
		Pol 5	0.823		

Figure 1 shows the path coefficients between the exogenous latent constructs and the endogenous latent construct of sustainable construction understanding. The results show statistically significant positive relationships. The study identified several underlying factors that influence sustainable construction understanding. Awareness exhibits the highest influence, followed by political factors, passive culture, and demand. Economic and knowledge-related factors have a relatively low impact, while attitude has a minimal influence. The overall findings suggest a lack of proper understanding of sustainable construction among construction professionals in Nigeria's AEC industry, despite global efforts.

Awareness was found to have a significant positive impact on understanding sustainable development practices which is in line with the findings of Aghimien *et al*. (2019), Ayarkwa *et al*. (2017), Osuizugbo *et al*. (2020). Increased awareness among construction stakeholders can enhance the implementation of sustainable construction practices. The political factor, which encompasses government interventions and regulations, was also found to play a significant role in sustainable construction understanding. Government support through policies and enforcement is crucial for making progress in sustainable construction implementation (Adamu *et al*., 2015; Aliyu *et al.*, 2015; Ametepey *et al*., 2015).

The passive culture factor highlights the perception of sustainable development as an academic exercise rather than a practical approach. To overcome this, sustainable construction practices need to be integrated into construction planning from the early stages (Daniel *et al*., 2018; Olav *et al*., 2018; Otegbulu & Adewunmi, 2009) to mitigate the perception of higher costs and resistance to innovation. Demand for sustainable construction practices was identified as a key factor (Azeem *et al*., 2017; Benson *et al*., 2017; Chegut *et al*., 2014; Ayarkwa *et al*., 2017; Sorrell, 2015). Low demand in both government-approved and private sector projects hinders the advancement of sustainable development practices. Client demand and willingness are among the most important drivers for promoting sustainable construction practices implementation.

The economic factor was found to have a minimal impact on sustainable construction understanding (Benson *et al*., 2017; Isa Kalsum *et al*., 2014; Lélé, 2018). Providing economic incentives can encourage the adoption and implementation of sustainable practices (Adepoju & Aigbavboa, 2020; Saleh & Alalouch, 2015) and address concerns about high initial investments. Myers (2005) and Yin *et al.* (2018) asserts that the attitude of construction professionals towards sustainable construction has f an impact on understanding. The findings of this study also align

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with this position. This is because while some professionals showed an increasing interest in delivering sustainable projects (Berardi, 2013b; Chan *et al*., 2017), there is a belief that more needs to be done by the industry and regulatory bodies to promote sustainable development literacy (Okolie, 2013). To improve sustainable development comprehension, it is necessary to shift from perceiving sustainable construction as solely an academic exercise (Sfakianaki, 2019; Sorrell, 2015).

Insufficient knowledge and comprehension of sustainable construction were identified as barriers to its implementation (Aghimien *et al*., 2019; Murtagh *et al*., 2018). Adequate knowledge and understanding of sustainable construction are crucial for its successful implementation. Overall, these findings highlight the importance of awareness, political support, addressing passive culture, increasing demand, enhancing knowledge, and improving attitudes to foster sustainable construction understanding among construction professionals in Nigeria's AEC industry.

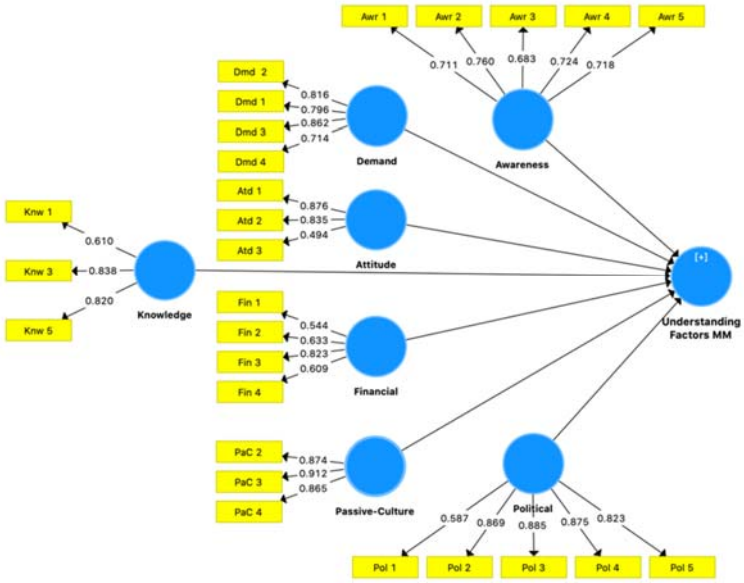

Figure 1: Factors underlying sustainable construction understanding

CONCLUSION

From the findings of this research, it can be inferred that there is a lack of understanding of sustainable construction practices among construction professionals in Nigeria's AEC industry. Furthermore, proper education of industry participants is required to grasp the inherent benefits of implementing sustainable construction practices correctly. Therefore, for the successful implementation of sustainable construction practices in Nigeria's AEC industry, more attention should be given to increasing awareness, backed by a political will. Their involvement will play a significant role in transforming the passive culture of construction professionals to meet the anticipated surge in demand. Increased financial incentives and knowledge will also have a significant impact on the attitudes of construction professionals in Nigeria's AEC industry toward sustainable development practices. The findings of this research support all the proposed hypotheses, indicating that sustainable development understanding is influenced by all seven constructs, namely awareness, political, passive culture, demand, economic, knowledge, and attitude-related factors.

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