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Assessment of construction professionals' awareness of the smart building concepts in the Nigerian construction industry

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Abstract

Purpose – The current movement toward digitisation has promoted the adoption of smart building technology globally. Despite its advantages, its usage in developing countries such as Nigeria is still very low. Therefore, the purpose of this paper is to investigate construction professionals' awareness of smart building concepts (SBCs) in the Nigerian construction industry and identify the parameters by which SBCs can be measured.

Design/methodology/approach – A quantitative survey was carried out using a questionnaire to gather relevant data in the study area. This paper was conducted on 363 registered construction professionals in the Nigerian construction industry. The collected data were analysed using descriptive statistics and Kruskal–Wallis *H* test analysis.

Findings – This paper indicated that the majority of Nigerian construction professionals are aware of SBCs. Furthermore, the Kruskal–Wallis *H* test shows no significant difference between the awareness level of the various construction professionals. This paper further revealed energy management systems, IT network connectivity, safety and security management systems and building automation systems as the most significant parameters in which SBCs can be measured.

Practical implications – This paper identified significant parameters influencing SBCs awareness in the Nigerian construction industry. These parameters can be integrated into the building during the design stage and can be incorporated into the policymaking process of construction firms to promote the awareness of SBCs and encourage practices related to construction sustainability.

Originality/value – This paper provides empirical evidence on the awareness of SBCs among construction professionals and significant parameters influencing awareness in the Nigerian construction industry.

Keywords Smart building, Green economy, Sensors, Environmental sustainability

Paper type Research paper

1. Introduction

The impact of technologies in construction processes cannot be over-emphasised. It influences the building component and the construction method used. In construction,

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technology is a system for reaching future advancement at various stages of development (Makarfi, 2015). Several countries have keyed into this development with increased interest in its usage. The Nigerian construction industry's interest in smart buildings has risen dramatically because of technological improvement and the need for increased productivity, efficient energy management and good indoor air quality (Oyewole *et al.*, 2019). Integrating smart building technologies into a construction process in the Nigerian construction industry is critical, especially in developing economies facing security issues in the country (Oyewole *et al.*, 2019). Smart building technology adoption is critical to addressing the significant problem associated with the low rate of productivity, delay in construction time, limited knowledge about the advancement of technology and environmental challenges that hamper development in developing countries (Adeosun and Oke, 2022; Indrawati and Amani, 2017; Oyewole *et al.*, 2019). Smart buildings provide considerable solutions to the challenges faced by construction firms which are not limited to: inefficiency of energy, poor indoor air quality and cost of operations by using data from sensors installed into the building to enhance building management (Mewomo and Ejidike, 2021; Ghansah *et al.*, 2021). Smart buildings use emerging technologies such as the Internet of Things (IoT), augmented reality and artificial intelligence, among others, to provide solutions to long-standing challenges of inefficiency in building design and performance and lack of productivity and security in buildings (Adeosun and Oke, 2022; Ghansah *et al.*, 2021).

To mitigate the enormous environmental challenges and economic concerns that have hampered advanced development within Nigerian construction, it is evident that adopting smart building technologies becomes vital for development to drive innovativeness and competitiveness. Several advantages have been associated with the integration of smart technologies in building sectors. For instance, Bandara *et al.* (2019) and Oyewole *et al.* (2019) indicated that energy conservation, increased system functionality, life and property security and occupant health and productivity are considered as most significant advantages of using smart building technologies. However, there are significant impediments to smart building development and investment, particularly in Nigeria and other developing countries. Perhaps, the most significant impediment is the lack of awareness and knowledge about smart building concepts (SBCs) in Nigeria and other developing countries. Information on professional awareness for a smart building is beneficial in overcoming many limitations to smart building practices in Nigeria and other developing countries. In Nigeria and other developing countries, few researchers have worked on SBCs, while others have worked on the awareness of intelligent building, building automation and smart building features in the Nigerian construction industry. Makarfi (2015), in his study, worked on an assessment of the level of awareness of intelligent buildings among the Nigerian architects in the Kaduna metropolitan area and discovered that the awareness of intelligent buildings is deficient among these professionals in the study area. Ogunde *et al.* (2018) investigated the integration of building automation systems in Nigerian homes and observed a low awareness among construction professionals, a critical component of SBCs. Oyewole *et al.* (2019) examined smart building awareness and the resident's desire for the feature of smart buildings. They found fair awareness of smart buildings, and the most desired feature identified is security and safety features (CCTV, intrusion detection system and fire detection alarm system), while those related to building maintenance (moisture and humidity sensor and building performance analytic device).

However, the author did not consider the importance to examine the parameters for measuring the SBC. Thus, this was considered a knowledge and evidence gap in a Nigerian context. Therefore, this study aims to fill this gap by investigating the awareness of SBCs among construction professionals and identifying the significant parameters to measure the depth of SBC adoption by the professionals with particular reference to Lagos, Nigeria.

To further achieve this study's aim, two hypotheses were postulated:

- *H1*. There is no significant difference in the profession's awareness of smart building concepts to promote smart building practices in the Nigerian construction industry.
- *H1a*. There is a considerable difference in the profession's awareness of smart building concepts to promote smart building practice in the Nigerian construction industry.
- *H2*. There is no significant difference in professionals' experience on the awareness of smart building concepts to promote smart building practices in the Nigerian construction industry.
- *H2a*. There is a significant difference in professionals' experience on the awareness of smart building concepts to promote smart building practices in the Nigerian construction industry.

Hence, the empirical evidence on the subject matter is expected to assist the policymakers, investment developers, clients and construction professionals in management and smart building technology execution planning.

2. Literature review

2.1 Awareness of smart building concepts among construction professionals

SBC has gained traction among construction professionals and academics working to preserve the environment and advance the construction industry's building sector (Ogunde *et al.*, 2018). According to Kashada *et al.* (2016), adopting SBC can be categorised into five stages which include the awareness stage, conviction stage, decision-making stage, implementation stage and confirmation stage. The awareness stage involves the end-users and professionals acquiring information and knowledge about the technology. In contrast, the conviction stage involves the end-users and professionals choosing to adopt the new technologies, while the decision-making phase involves the end-users and professionals deciding to adopt the new technology. Both parties finally implement the new technology in the implementation stage. In the confirmation stage, the end-users and professionals assess the result of technologies and expect better outcomes (Kashada *et al.*, 2016).

Ahiabor (2019) posited that many organisations and professionals are not fully aware of the SBC, therefore lacking the full knowledge of the concept, which has hindered the adoption and implementation of smart buildings in the construction industry. The SBC potential has not been fully exploited because of the lack of awareness by the organisation and construction professionals. In the same vein, Renaud and Biljon (2008) revealed that SBC adoption is a process that begins with the professional's and owner's awareness of the smart building practices and its implementation in our present construction industry. Ogunde *et al.* (2018) opined that awareness of SBC is vital for the adoption and implementation in the building sector of the construction industry. Umar and Khamidi (2012) revealed that the awareness of SBC refers to strategies and exercises that help professionals understand the concept. Research into the construction industry in developing countries indicates that the adoption of SBC is still low, and this significantly attributed to low awareness and cognisance of SBC among construction professionals (Ghansah *et al.*, 2021).

In addition, Ahiabor (2019) also revealed that SBC needs better understanding by professionals to create a clear opportunity for real estate and developer adoption. Mensah (2016) also opined that awareness of smart buildings by professionals is still low because of a lack of knowledge on how to execute the concept of smart buildings, which is a part of construction environmental sustainability. Hahn and Oluwatofumi (2021) examined adopting innovative technologies for sustainable real estate practice in Edo State, Nigeria. The study discovered that websites and geospatial technologies are the most effectively used innovative technologies among real estate firms, and these were considered the most significant factors influencing the awareness and adoption of SBCs among real estate firms. Ciroma *et al.* (2021) examined the awareness and acceptance of smart security systems among occupants of selected public buildings in (FCT-Abuja) Nigeria and revealed that occupants are pretty aware of smart security systems as security mechanisms, which is a part of the function of SBC. Thus, awareness and adoption of smart building security systems would significantly improve security concerns among building occupants in Nigeria. Thus, this measure would also minimise external forces and security threats through intelligent remote monitoring and controlling connectivity. Shehu Isa *et al.* (2016) studied smart technologies and strategies for improving energy efficiency and reducing greenhouse gas (GHG) emissions in office buildings in Nigeria. The study revealed that this could be achieved by applying the three-pronged approach, reducing energy consumption, deploying renewable energy technology and monitoring GHG emissions. This is the basis of technology application in the construction industry, advocating the potential energy reduction in consumption, GHG emissions and energy efficiency, which is required to enhance a clean and sustainable future for humanity and its future generations and promote awareness of the SBC. However, in other developing countries, few studies have been carried out on SBCs.

In Ghana, for example, Ghansah *et al.* (2020) revealed that the level of awareness of SBC in construction firms among construction professionals is moderate and also noticed that there is a need for enlightenment on adopting SBC to improve energy efficiency, occupant comfort and sustainability. Also, in Sri Lanka, Bandara *et al.* (2019) revealed that the benefits that can be derived from SBCs are long term, although most of the clients in the study area do not recognise the value of SBCs in terms of sustainability. Given this, the authors suggested improving the knowledge and awareness of professionals. Furthermore, Ghansah *et al.* (2021) suggested that education informs engaging the professionals in training, conferences and workshops seminars, as it will help to improve the awareness and its adoption among the professionals. This corroborates the study of Bandara *et al.* (2019), who mentioned that education and training could be used to enhance the awareness and total adoption of SBCs. The study of Agirbas (2020) emphasises the importance of SBCs on the simple effectiveness and attitude on education such as BIM. Furthermore, Debauche, Mahmoudi and Moussaoui (2020) revealed that practical knowledge about IoT technologies is becoming inevitable in education, hence the importance of the research.

2.2 Parameters to measure smart building

The parameters for measuring the SBC are critical for its adoption in the construction industry as a result of its positive impact on several aspects of human life and environment sustainability, including how people live in comfort, how they fulfil their wants, security, long-term flexibility and demands and how people support their lifelong comfort needs (Indrawati and Amani, 2017). Furthermore, Indrawati and Amani (2017) identified seven parameters to measure the smart building: building control system, safety, security management system, IT network connectivity, enterprise management system, green building construction, energy management system (EMS) and building automation system.

2.3 Building automation system

The building automation system is a vital parameter in measuring the smart building because of the cooperation of smart sensors in the building system. This implies technical control and fast response when detecting threats to occupants' comfort (Buckman *et al.*, 2014). Using computers and information technology (IT) to manage building appliances for better performance of an automated building is referred to as a building automation system (Ogunde *et al.*, 2018). The author explained that the control system is a sophisticated network of electronic devices that monitor and control a building's mechanical, electronic and lighting systems. While comparing the conventional building, the temperature control, energy management, fire and security systems are all separated in a traditional building.

2.4 Energy management system

An EMS improves energy efficiency and maximises energy savings over time (Batov, 2015). According to Sgrò (2018), an EMS is the system that ensures that energy consumed in the building is controlled and monitored in real time. Amaral *et al.* (2013) further explained that EMS is a system that monitors the cost of energy at home and controls how much energy is used, such as lowering the costs of operations and maintenance or even lowering the costs of fixed appliances.

2.5 Building control system

According to Wu and Noy (2010), a building control system is essential in managing occupants' comfort, monitoring the Heating ventilation and air conditioning (HVAC) and lighting system and reducing energy waste. An example of a building control system is the sensor. The occupancy sensors aid in energy conservation. The HVAC and lighting systems can stop when occupancy sensors detect no movement for a predetermined amount of time. When the HVAC and lighting systems detect occupancy once more, they restart their operation according to the user's preferences.

2.6 Safety and security management system

According to Honeywell and IHS (2015), the way a building responds to threats, manages access to the facility, secures lives and assets and makes it comfortable and productive are all examples of safety and security systems (illumination, thermal comfort, air quality, connectivity and energy availability). In addition, Ciroma *et al.* (2021) studied selected public buildings in Central Business District FCT-Abuja, Nigeria. They revealed that a smart security system is beneficial, as it will enable them to accomplish security tasks more quickly, increase their level of productivity, make it easier to do their job and enhance their effectiveness on the job.

2.7 Enterprise management system

According to Buckman *et al.* (2014), an enterprise is a new emerging integrated system within the SBC, consisting of software and hardware to overcome fragmented, non-proprietary and non-compatible legacy systems, allowing building operations to be optimised toward the building functions. Developing a method that uses the data gathered is called enterprise, for instance, reserving a hotel for a conference or meeting or planning a movie schedule in a theatre.

2.8 IT network connectivity

It has been demonstrated that the development of information and communication technologies has led to the creation of strong, clever and smart industrial systems and applications (Lokshina *et al.*, 2019); with the rise of the IoT, it is now possible to monitor and gather any data that is necessary for smart buildings (Laryea and Laryea, 2012). The smart building now includes various gadgets that track building's performance because of recent advancements in sensor technology and software (Jia *et al.*, 2019).

2.9 Green building construction

The environmental benefits of green and smart buildings are a component of green buildings and significantly impact their certification (Vattano, 2014). At every stage of the building life cycle, the idea of a smart building is being developed, emphasising the design, construction and operational phases traits of a sustainable building and a green building are frequently combined to create a smart building (Apanaviciene *et al.*, 2020). Using the most recent and efficient technological solutions for building materials and products, building services and construction processes based on ICT, the energy efficiency of the future building is simulated and analysed during the design stage while taking location and orientation, urban infrastructure and other environmental conditions into consideration (Apanaviciene *et al.*, 2020; Gourlis and Kovacic, 2017).

3. Methodology

3.1 Research method and instrument adopted for the study

The study adopted a quantitative method. It is objective and scientific and comprises the gathering of quantitative data that can be subjected to rigorous quantitative analysis using standard statistical techniques in a formal and disciplined manner (Gibson and Fedorenko, 2013). The quantitative approach incorporates the opinions of respondents to study (Gibson and Fedorenko, 2013; Nardi, 2018). The study used a random sampling technique to select professionals within the population sample. These include architects, builders, engineers (mechanical, electrical and structural) and quantity surveyors practising in Nigeria.

Lagos State was selected because of its economic hub and most industrial zone in Nigeria (Osotimehin *et al.*, 2012). Lagos state is in Nigeria's south-western region, between latitudes 6^{0}20'00" N and 6° 40'0"N and longitudes 2^{0}50'0"E and 4^{0}20'0"E; one of Nigeria's 36 states occupies an area of approximately 3,496 km^2 (Kaoje and Ishiaku, 2017). The state has approximately 14 million people, with an annual population growth of 5.7%, making it one of the fastest-growing megacities globally (Dano *et al.*, 2020). Lagos is highly developed, with a high density of construction professionals; 70% of Nigeria's construction firms are physically present in Lagos; 60% of Nigeria's building operations take place in Lagos; and it is Nigeria's most industrialised zone (Afolabi *et al.*, 2018; Ogunmakinde *et al.*, 2019). A total of 5,108 construction professionals were within the study area (Table 1).

According to Islam (2018), sample size selection is made using the Yamane formula (1967) to calculate the sample size. The Yamane formula was applied to each professional category to obtain the sample size.

$$\mathbf{n} = \frac{\boldsymbol{N}}{[1 + \boldsymbol{N}(\mathbf{e}^2)]} \tag{1}$$

where:

n = the sample size;
N = the total population;
e = the level of precision, which will be 10%; and
1 = unit (constant).

3.2 Data collection procedure

The questionnaire forms were distributed in person to the professionals and because Lagos is a metropolitan city. In all, 363 copies of the questionnaire were administered to construction professionals in the Lagos State chapter of the Nigerian construction industry, and 316 copies of the questionnaire were completed and retrieved accordingly. The overall response rate for this study was 87.05%. From the retrieved questionnaires, 276 were found relevant and suitable for analysis with an appropriate response rate of 87.3% (Owusu-Manu *et al.*, 2021).

The questionnaire was used to assess the professional's background information, vital parameters to measure the SBC and awareness of the SBC. The professionals were asked to respond to the questionnaire using a five-point Likert scale of 1 to 5 (1 = very low; 2 = low; 3 = average; 4 = high; and 5 = very high). The five-point Likert scale has become universally acceptable because it allows respondents to measure their freedom of attitude and manage their various options (Iyiola and Mewomo, 2022).

The statistical package for social sciences, version 26, analysed the data collected. The analysis was conducted to determine the significant parameters to measure SBCs using each parameter means item score (MIS). An MIS of 3.50 was used to indicate the importance of the parameters. MIS $\geq$ 3.50 was considered an important measure, while MIS $<$ 3.50 has an insignificant measure to SBCs (Opawole and Jagboro, 2016). Kruskal–Wallis rank test was used to determine the awareness of SBCs difference in the perceptions of construction professionals.

4. Finding and discussion

This section contains the analysis results and a discussion of the findings.

4.1 Reliability test

The questionnaire's reliability was first tested using Cronbach's alpha test, which yielded a score of 0.836. Cronbach alpha values between 0.7 and 1.0 are considered acceptable (Pallant, 2016), indicating that the survey instrument consistently and reliably measures the correct construct (Chan *et al.*, 2019). As a result, the questionnaire is suitable for the analysis.

4.2 Background information of professionals

4.2.1 Respondents summary of information. The questionnaires aimed to obtain pertinent information about the professionals, such as gender, educational qualifications and construction industry experience. Academic qualifications represent a person's professional development capability, critical thinking skills and ability to improve the reliability of the

S/N	Professionals group	Population	Sample size
1	Architects	958	*91*
2	Builders	610	*86*
3	Quantity surveyors	870	*90*
4	Engineers	2,670	*96*
	Total		*363*

Notes: *NIA – Nigerian Institute of Architecture; NIOB – Nigerian Institute of Building; NIQS – Nigerian Institute of Quantity Surveying; NSE – Nigerian Society of Engineers
Source: NIA (2020), NIOB (2020); NIQS (2020); and NSE (2020)

Table 1.
Sample population

findings (Ghansah *et al.*, 2020). The data was analysed, and it was discovered that 276 respondents (87%) are aware of SBC, while the remaining 40 are not. As a result, the data from the 40 respondents (13%) was not used for further study.

The remaining 276 valid survey responses revealed that most respondents (71%) identified as male, while the rest identified as female, revealing the underlying gender difference in the construction industry. In addition, as indicated in Figure 1, approximately one-third of the professionals have a PhD, and 31% have a bachelor's degree. Furthermore, one-quarter of survey respondents have more than 20 years of professional construction expertise, with only 8% having fewer than 5 years of experience (Figure 1). As a result, the data's reliability is enhanced.

4.3 Assessment of the professional's awareness of smart building concepts

This section of the questionnaire seeks to identify the professional awareness of the SBC based on the perception of their knowledge and different professions by using (YES or NO) questions to ascertain the level of their knowledge, and it further serves as a means to proceed in answering the remaining questionnaire. Thus, all "No" responses did not proceed to the next questions because the "Yes" response was a pre-requisite. From the analysis, 276 respondents selected YES (87.4%), while 40% of respondents selected NO (12,6%) (Table 2). The response rate demonstrated that Lagos's Nigerian construction industry professionals are highly aware and perhaps knowledgeable about the practice of smart building. The professional's awareness and knowledge about SBCs have significantly influenced the acceptance and execution of SBCs. Thus, attaining the necessary awareness and knowledge is crucial, as a lack of understanding prevents the successful adoption and usage of new technology. It also requires more effort from the professional body to educate the

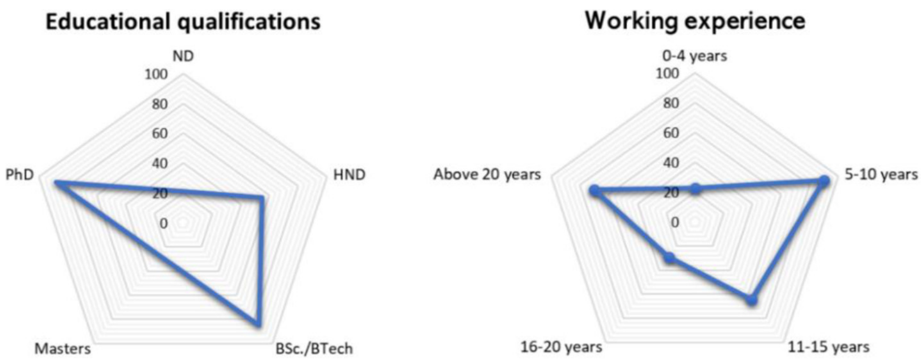

Figure 1. Respondents' demographics

Notes: *HND – higher national diploma; ND – national diploma

Table 2. Professional's awareness of smart building concepts

Construct	Response	F	%
Are you aware of the smart building concept?	YES	276	87.4
	NO	40	12.6
	TOTAL	316	100

Source: Field survey (2021)

house-owner, developer and government on the importance of adopting the practices of smart building construction in the state, because of its enormous benefits to the economy and environment. The study elaborates on Oyewole *et al.* (2019), who studied the awareness and aspiration for smart building features among residents in Lagos and discovered fair awareness among the residents. Therefore, professionals should extend the awareness of the smart building practice to the house-owner, developer and government to increase the chance of the smart building technology use over the conventional building construction practices in the state, as the professional's response rate is above average.

4.4 Test of relationship among the professions on the awareness of smart building concepts

4.4.1 Testing the hypothesis. The relationship between professions is required to offer a basis for recommendation and additional research based on the data collected to see whether SBC awareness can be generalised among professionals in the construction industry. The Kruskal–Wallis test was used to obtain this. The Kruskal–Wallis (H) test for one-way analysis of variance is a non-parametric statistical measure (Pallant, 2016; Ade-Ojo and Awodele, 2020). This test is used when the parametric statistic assumption cannot be satisfied or is violated (Pallant, 2016). The hypothesis's findings demonstrated that the chi-square (χ^2) value is 8.824, with a p-value of 0.066, implying no significant difference in the profession's perception of the awareness of SBCs. The p-value of 0.66, greater than 0.05, shows no significant difference in perceptions of SBCs knowledge among construction industry professions. The agreement in the perception of the professions implies that the professions are fully aware of the SBC practice, which can further deepen the practice and spread to other neighbouring states and the county at large. The agreement among the professionals on awareness of SBCs could be attributed to the introduction of different technologies used in the construction industry, such as automated door control and video surveillance for security. The professional's experiences revealed the chi-square χ^2 value of 8.323 with a p-value of 0.00. This indicates a significant difference in perception of the profession on the awareness of SBCs with the Professional experience. The p-value of 0.00, which is ≤ 0.005, confirms a significant difference in the perceptions of awareness of SBCs among professional experience in the construction industry. Further implies that professionals' experience does not impact their awareness of SBCs in the construction industry. The reason could be attributed to the sophisticated nature of the technology and lack of familiarity of the ageing professionals to technologies, as it is difficult to change from the conventional tradition way of construction (Table 3).

4.5 Evaluation of parameters to measure smart building concepts

This section evaluated the professionals' perception of the seven parameters to measure the MIS of SBC. The score of each parameter based on the professionals' perception was calculated to identify the most crucial parameters to measure SBC (See Table 4 for the results). All the seven parameters have MIS are above 3.4 minimum cut-off value for significance which are the EMS (M = 4.46 and SD = 0.678), IT network connectivity (M = 4.34 and SD = 0.813), safety and security management system (M = 4.18 and SD = 0.567), building automation system (M = 4.05 and SD = 0.956), building control system (M = 3.97 and SD = 1.019), green building construction (M = 3.90 and SD = 0.706) and enterprise management system (M = 3.48 and SD = 0.760).

However, the EMS is ranked first with a mean item score of 4.46. IT network connection comes in second with a mean score of 4.34. With a mean score of 4.18, the safety and security management system ranked third. The building automation system has a mean score of 4.05, means it ranked four. The building control system has the second-highest mean score

Profession	Ranks N	Mean rank	χ^2	df	Significance	Decision
Awareness Of smart building						
Builder	149	160.13	8.824	4	0.066	Accept
Quantity surveyor	39	143.92				
Engineer	38	142.41				
Architect	34	134.42				
Others	16	109.79				
	Total	276				
Professional experience						
Less than 5 years	31	45.44	8.323	4	0.000	Reject
5–10 years	104	148.90				
11–15 years	42	119.36				
16–20 years	16	159.00				
More than 20 years	83	165.96				
	Total	276				

Table 3. Results of the Kruskal–Wallis

N/S	Parameters to measure smart buildings	Mean	SD	RANK
1	Energy management system	4.46	0.678	1
2	IT network connectivity	4.34	0.813	2
3	Safety and security management system	4.18	0.567	3
4	Building automation system	4.05	0.956	4
5	Building control system	3.97	1.019	5
6	Green building construction	3.90	0.706	6
7	Enterprise management system	3.48	0.760	7

Source: Field survey (2021)

Table 4. Parameters to measure smart building concepts

of 3.97, green building construction has the third-highest mean score of 3.90 and the enterprise management system has the lowest mean score of 3.48. The finding suggested that for a building to be smart, all the parameters identified in this study should be associated with the building. The result of the study practically showed the importance of the parameters in achieving smart buildings in the Lagos state construction industry. Similarity studies conducted in the Indonesian and Ghana construction industries also emphasised the importance of the parameters (Indrawati and Amani, 2017; Owusu-Manu *et al.*, 2021).

5. Conclusion and recommendation

The study has investigated the construction professional's awareness of SBC in Lagos, Nigeria, and has identified the significant parameters to measure SBC in the construction industry. The study found that the professionals are generally aware of SBC, as observed among the construction professionals. The result of the hypothesis revealed no significant difference in the perception of the professions on the awareness of smart building practices in the construction industry for project delivery. Similarly, the professionals' experiences indicated a significant difference in the construction industry's awareness of smart building practices. Thus, it appears that professionals with experience of between five and twenty years have an understanding of smart building; this can be attributed to modern professional's adoption of new technologies. The parameters to measure smart buildings were also evaluated to determine the significant parameters that make SBC functional in the construction industry. Based on the professional's response to the parameters, it was observed that EMSs, safety and security management, IT network connectivity and building automation systems are significant. The study concluded that construction professionals still need more effort to increase the awareness of smart buildings in the construction industry to deepen the practices in a Nigerian context. The increase in the awareness and adoption of SBC would further assist in protecting lives and property by installing a smart security system that monitors the building. In addition, it will assist in energy efficiency improvement, thereby saving energy costs and protecting the environment from harmful GHG. They have also improved management by integrating building technology systems to increase operation and functionalities of the building in terms of comfort and security and assist the disabled.

Consequently, upon these findings, the study recommends that maximum strategies be formulated to systematically increase awareness of SBC among construction professionals and academics. Training and workshop programs such as conferences and seminars can form a source of education about SBC. Construction professionals should engage more in SBC, propagating the country's awareness and developing smart building construction. The study findings demonstrated how building industry professionals in developing countries feel about SBC. Understanding SBC is essential for carrying out and delivering smart building projects. Furthermore, to the authors' knowledge, this study is the first of its kind; it is believed that it will make a reasonable contribution to the literature on professional behaviour concerning the idea of smart buildings.

This study was limited to the Lagos state Nigerian construction industry. However, the study's finding is based on Lagos state data but not on other developing countries. Furthermore, the study was limited in the methodology, as quantitative data analysis was performed on the awareness and parameters to measure smart building; further studies can conduct qualitative research from the professionals and experts to determine the awareness and the parameters to measure smart building in the country and other developing countries.

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