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Barriers Impeding the Implementation of Intelligent Buildings in Lagos State, Nigeria

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ABSTRACT

The concept of intelligent buildings has gained traction in recent years and many developed countries have already embraced intelligent buildings. However, the implementation of intelligent buildings in Nigeria has been limited due to various barriers. This paper examines the barriers hindering the execution of intelligent buildings and propose strategies for successful implementation. Primary data were obtained with the use of structured questionnaires that were administered to construction professionals in Lagos State. A non-probability sampling procedure was adopted in this study. The sample representative for questionnaire dissemination was chosen using the purposeful sampling method. One hundred and fifty (150) copies of questionnaires were distributed to the respondents and a total of 124 copies of questionnaire administered were completed, retrieved and used for analysis. Data collected were analyzed using descriptive and inferential statistics. The findings revealed that the main barrier inhibiting the development of intelligent buildings is the high upfront costs of implementing intelligent building technologies. The installation and integration of intelligent systems involve significant capital investments, making it unaffordable for many developers and building owners. It showed that government and financial institutions can work together to provide accessible and affordable financing options for intelligent building projects. The study recommends the need for government, in collaboration with industry stakeholders to work towards improving the country's infrastructure, particularly in the areas of telecommunications and energy, to create a conducive environment for the development of intelligent buildings.

1. INTRODUCTION

Nigeria, like many other developing countries, is experiencing rapid urbanization and economic growth, resulting in a high demand for buildings (Adojo and Eugene, 2020). This rapid growth has put pressure on the country's already strained infrastructure, including its buildings, which has resulted in a need for sustainable and efficient solutions. The increasing demand for sustainable designs led to the development of intelligent buildings (Omar, 2018). Sustainable development goals necessitate promoting efficient

technologies and the adoption of intelligent buildings (Darko and Chan 2018). With the increasing global focus on sustainable and efficient building practices, the concept of intelligent buildings has gained traction in recent years.

Intelligent buildings, also known as smart buildings, are defined as those that use advanced technologies to manage and monitor building systems, such as lighting, heating, ventilation, air conditioning, and security, in an integrated and automated manner (Hamida et al., 2022). These buildings are designed to optimize energy consumption, reduce operational costs, and enhance occupant comfort and productivity. Intelligent buildings could provide these solutions (Olawumi and Chan, 2020). More so, the emergence of intelligent buildings, is to enhance the efficiency, safety, and comfort of users' lives (Hamida et al., 2022). Intelligent buildings help to promote sustainable construction practices, and advancements in technology. The use of intelligent buildings is rapidly increasing globally, and they are not new in the building sector of the construction industry. The benefits of Intelligent buildings are cost savings, energy saving and greenhouse gas emission reduction (Owajionyi, 2007; Iwuagwu and Iwuagwu, 2014). Intelligent buildings could reduce building costs and energy consumption when compared to conventional buildings. (Harris, 2012) and they are geared towards user comfort, safety, security, environmental techniques and energy consumption (Omar, 2018). The findings of Oke et al., (2020) revealed that the highest benefit of adopting intelligent buildings are; better environment and intelligent city, sustainability, reduced energy cost and greenhouse gas emissions and optimised cleaning among others. They further argued that Intelligent Building Systems aids Sustainability of both buildings and cities.

The adoption of intelligent buildings is gaining momentum in many developed countries, while their implementation has been slow in developing countries (Chan et al., 2017) and Nigeria is not an exception as they are still a rarity in the country despite their numerous benefits (Iwuagwu and Iwuagwu, 2014). Most developing countries still adopt the traditional/conventional buildings which delays the progress and development of the construction industry and does not promote the achievement of sustainable development goals (Gbadamosi et al. 2019). Although intelligent buildings have been gaining popularity globally, their adoption in Nigeria has been relatively slow (Opawole et al., 2022). This is due to various barriers which includes high initial cost of construction associated with implementing smart technologies. (Ahn, et al., 2013; Azeem et al., 2017; Shen et al., 2017). Building owners and developers often perceive intelligent building solutions as expensive investments that may not yield immediate returns. Additionally, the lack of access to affordable financing options further exacerbates this financial barrier. Another barrier is lack of education and awareness as individuals, organizations, and government agencies are not fully informed about the benefits of intelligent buildings and how they can transform the built environment. (Zhang and Wang 2013; Iwuagwu and Iwuagwu, 2014; Chan et al., 2017; Opawole et. el, 2022). Other barriers to the implementation of intelligent buildings are: low level of technical expertise (Omopariola et al., 2019), lack of power supply (Iwuagwu and Iwuagwu, 2014; Luthra et al., 2015; Chan et al., 2017; Omopariola et al., 2019), lack of regulation and standards (Chan et.al.2017), lack of research, risks and uncertainties involved in adopting new technologies (Chan et al., 2017; Omopariola et al., 2019), reduced support from government policies and institutional structures for the development of intelligent technologies (Ghansah, 2021), Challenges in obtaining sustainable and intelligent materials and equipment (Ghansah et al., 2021), lack of unanimity on the concept of intelligent buildings (Omar, 2018) and professionals' resistance to change (Azeem et al. 2017; Nguyen et al., 2012). Furthermore, Interoperability issues when different systems fail to work together seamlessly, hampering the overall performance of the building and Scalability issues when building owners may struggle to scale up their smart building solutions to accommodate future growth and changing needs, leading to inefficiencies and underutilization of the technology are also barriers inhibiting the implementation of intelligent buildings in Nigeria. Therefore, this study aims to explore the barriers hindering the execution of intelligent buildings in Nigeria and propose strategies for successful implementation which will pave the way for a more sustainable and intelligent built environment in Nigeria.

2. METHODOLOGY

The study explored the barriers impeding the implementation of intelligent buildings in Nigeria. This study adopted a survey research design and both primary and secondary sources of data were used in this study.

The primary data involved the use of a questionnaire administered to major professionals in the construction industry, which comprises of the Architects, Builders, Quantity Surveyors, and Engineers who are knowledgeable on the subject matter, practicing and actively engaged with construction projects in Lagos state. The research was conducted in Lagos State and it was chosen because it is the economic and commercial hub of Nigeria. A non-probability sampling procedure was adopted in this study. The sample representative for questionnaire dissemination was chosen using the purposeful sampling method. A snowball sampling technique was used to administer 150 copies of questionnaires to the respondents. A total of 124 copies of questionnaire administered were completed, retrieved and used for analysis. The analysis was aided by the use of statistic package for social science (SPSS) application. The questionnaire designed for the study consisted of close-ended questions comprising of two sections: the first section contained demographic questions where respondents had to choose and answer from the alternatives provided while the second section was designed to assess the barriers impeding the execution of intelligent buildings in Nigeria and mitigating measures. The background information of respondents was analysed by means of frequency distribution and percentage. Mean item score was used to rank the barriers impending the adoption of intelligent buildings in Nigeria and mitigating measures. In order to achieve the objectives of the study, 5-point Likert scale was used to inquire information from respondents where 1= strongly disagree, 2= Disagree, 3= Neutral, 4= Agree, 5= strongly agree. The Likert scale was transformed to Mean Item Score (MIS) for each of the identified variables.

3. RESULTS AND DISCUSSION

3.1. Background Information of Respondents

Table 1 presents a summary of background information of respondents. Analysis in Table 1 revealed the academic qualification of the respondents where 39.52% of the respondents had obtained MSc/M.Tech, 27.42% of the respondents had B.Sc/B.Tech, 15.32% were HND holders, 10.48% had PGD and 7.26% had PhD. Table 1 also revealed that, the participants' professional backgrounds include architects (32.26%), builders (25.81), Engineers (22.58%) and quantity surveyors (19.35%). The vast majority of respondents (67.75%) had more than ten years of experience which is adduced sufficient and they are knowledgeable on the subject matter.

Table 1: Summary of background information of respondents

Category	Classification	Frequency	Percent (%)
Profession of respondents	Architecture	40	32.26
	Building	32	25.81
	Engineering	24	22.58
	Quantity Surveying	28	19.35
	Total	124	100.00
Years of experience	21 and above	23	18.55
	16-20	27	21.77
	11-15	34	27.42
	6-10	24	19.36
	1-5	16	12.90
	Total	124	100.00
Academic qualification	Ph.D.	9	7.26
	M.Sc./M.Tech	49	39.52
	P.G.D.	13	10.48
	B.Sc. /B.Tech	34	27.42
	HND	19	15.32
	Total	124	100.00

Table 2: Barriers inhibiting the implementation of intelligent buildings

Identified barriers	Mean	Rank
High initial cost of intelligent buildings	4.75	1
Unstable power supply	4.53	2
Limited technical expertise	4.41	3
Lack of awareness	4.38	4
Resistance to change	4.36	5
Risk and uncertainties involved in implementing new technology	4.36	6
Reliability Concerns about the performance of intelligent buildings	4.33	7
Regulatory challenges	4.31	8
Inadequate finance schemes	4.29	9
Inconsistent government policy	4.27	10
Lack of local institutional facilities for research	4.19	11
Low enforcement of building laws	4.12	12
Lack of intelligent building database/Information	4.01	13
Lack of government support	3.97	14
Poor maintenance culture	3.85	15
Lack of standardized products and services	3.74	16
Lack of scalable & customizable options for intelligent buildings	3.56	17
Interoperability concerns	3.47	18
Security concerns/ fear of data breaches	3.38	19

3.2. Barriers Inhibiting the Implementation of Intelligent Buildings

Table 2 shows the identified barriers impeding the adoption of intelligent buildings. From the analysis, the five major challenges are: High initial cost of intelligent buildings, unstable power supply, and limited technical expertise, Lack of awareness, Resistance to change while Scalability concerns, Interoperability concerns and security concerns / fear of data breaches were ranked the least barriers. The findings from this study reveals that high Initial cost of Intelligent building technologies often comes with a high upfront cost, making it challenging for many developers and building owners in Nigeria to justify the investment. This in line with the studies of (Ahn et al., 2013; Shen et al., 2017; Chan et al., 2017; Azeem et al., 2017). Frequent power outages in Nigeria can disrupt the functionality of intelligent building systems, affecting their reliability and performance. The unstable power supply in the country poses a significant barrier to the widespread adoption of smart building technologies. This agree with the findings of (Iwuagwu and Iwuagwu, 2014; Luthra et al., 2015; Chan et al., 2017; Omopariola et al., 2019). Nigeria faces an energy crisis, with a high demand for electricity and an unreliable power supply and ensuring sufficient and consistent power supply is crucial.

3.3. Mitigating Strategies

The result presented in Table 3, shows that the mitigating strategy that ranked first with a mean score of 4.51 is providing financial support/incentives such as tax breaks, loans, grants, and subsidies which can make investments in intelligent technologies more feasible. Providing training programs to professionals in the construction industry which can enhance their skills and knowledge in implementing intelligent building technologies which is in line with Ghansah et al., (2020) ranked 2nd with a mean score of 4.46. Thus, Investing in technical capacity building and training programs can enhance the skills of professionals involved in the design, construction, and operation of intelligent buildings.

Table 3: Mitigating strategies to the barriers hindering the adoption of intelligent bu4ildings

Identified mitigating measures	Mean	Rank
Provide financial incentives/support to developers and building owners	4.51	1
Training and capacity building	4.46	2
Ensuring sufficient and consistent power supply	4.43	3
Encourage more research and development in intelligent buildings	4.38	4
Promoting the development of local content and technology solutions	4.36	5
Promote Public awareness and education	4.32	6
Provide regulatory framework and standards	4.24	7
Foster Partnership and collaboration between stakeholders	4.23	8
Publicize successful case studies in intelligent building projects	4.18	9
Performance Benchmarking and Monitoring Implementing	4.16	10
Conducting life cycle cost analysis on the benefits of intelligent buildings	4.01	11
Ensuring data privacy and security	3.98	12

4. CONCLUSION

The development of intelligent buildings in Nigeria has the potential to revolutionize the construction and real estate industry and contribute to the country's sustainable development goals. However, there are several barriers that need to be addressed to ensure the successful implementation of this technology. The high upfront costs of implementing intelligent building technologies are a significant barrier to their adoption in Nigeria. The installation and integration of intelligent systems involve significant capital investments, making it unaffordable for many developers and building owners, especially in a country where the cost of construction is already high. Additionally, the lack of local manufacturers of intelligent building systems and reliance on imported equipment further increases the costs. The government and financial institutions can work together to provide accessible and affordable financing options for intelligent building projects. This can include low-interest loans and other financial instruments geared towards promoting the adoption of these technologies. Nigeria faces an energy crisis, with a high demand for electricity and an unreliable power supply. This has led to an increase in electricity costs and a rise in greenhouse gas emissions. As a result, there is a growing demand for energy-efficient buildings that can help reduce energy consumption and costs. Intelligent buildings, with their automation and optimization capabilities, are well positioned to meet this demand and promote sustainability in the country. The government, in collaboration with industry stakeholders, must work towards improving the country's infrastructure, particularly in the areas of telecommunications and energy, to create a conducive environment for the development of intelligent buildings. Additionally, there is a need for more resources and training to raise awareness and promote the understanding of intelligent building technologies among stakeholders in the construction industry. With the right policies and initiatives in place, intelligent buildings have the potential to significantly improve the quality of life for Nigerians and contribute to the country's economic growth, play a significant role in the country's sustainable development and provide a more comfortable and efficient living and working environment for its citizens. This paper has highlighted some of the key barriers hindering the widespread implementation of intelligent buildings in Nigeria and provided strategies for overcoming these barriers. It is recommended that further research be conducted to expand on these strategies and gather more data on the current state of intelligent buildings in the country. With proper support from the government and stakeholders, intelligent buildings can become the norm in Nigeria, leading to more efficient and sustainable built environment.

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6. CONFLICT OF INTEREST

There is no conflict of interest associated with this work.

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