Impact of Building Information Modelling on Construction Project Performance in Abuja Municipal Area Council, Nigeria

Tochi Nwafor & Edo Oga Ojoko

Ibrahim Usman Jibril Institute of Built Environment, Nasarawa State University, Keffi, Nigeria.

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ABSTRACT

This study examined the impact of BIM on construction project performance by assessing awareness, adoption, perceived benefits, and barriers to implementation among construction professionals. A mixed-methods research design was employed, involving a questionnaire survey of 529 construction professionals across in AMAC, Abuja, Nigeria. A total of 515 valid responses were analysed, representing a 97.4% response rate, while qualitative insights were obtained through interviews with 15 BIM experts. Quantitative data were analysed using descriptive statistics, and qualitative data were subjected to thematic analysis. The findings revealed a moderately high level of BIM awareness (overall mean = 3.39), with awareness of the BIM concept recording the highest mean score (3.54). BIM adoption was highest for design visualization and quantity take-off, while advanced applications such as 4D scheduling and facility management remained limited. Respondents agreed that BIM positively influences project performance (overall mean = 3.44), particularly in design quality (3.55) and collaboration (3.47). The principal barriers were the absence of a national BIM policy (3.88), inadequate technical skills (3.78), and high software costs (3.75). The study concludes that strengthening policy support, professional capacity, and organizational investment is essential for accelerating BIM adoption and improving construction project performance in Nigeria.

Keywords: Building Information Modelling; construction project performance; adoption; digital transformation; Technology Acceptance Model; Nigeria.

INTRODUCTION

The construction industry is a major contributor to economic growth, infrastructure development, and employment generation worldwide. Despite its strategic importance, the industry continues to experience persistent challenges, including project delays, cost overruns, material wastage, poor quality delivery, and inadequate coordination among project stakeholders. These challenges have negatively affected project performance and limited the industry's contribution to sustainable development, particularly in developing countries (Umar et al., 2023). As construction projects become increasingly complex, the demand for innovative technologies that improve efficiency, collaboration, and decision-making has continued to grow. Among these innovations, Building Information Modelling (BIM) has emerged as one of the most transformative digital technologies in the Architecture, Engineering, and Construction (AEC) industry (Olawumi & Chan, 2020).

Building Information Modelling is an integrated digital process that enables the creation, management, and exchange of project information throughout the lifecycle of a facility. Unlike conventional design approaches, BIM facilitates real-time collaboration among project stakeholders by integrating architectural, structural, engineering, scheduling, and cost information into a shared digital environment. This integrated approach improves project visualization, minimizes design conflicts, enhances communication, supports informed decision-making, and reduces construction errors and material waste (Abubakar et al., 2023). Consequently, BIM has become an important tool for improving project delivery by enhancing cost efficiency, schedule adherence, quality performance, and stakeholder collaboration.

The benefits of BIM have been widely demonstrated in developed economies where governments and industry stakeholders have integrated digital technologies into construction practices. Countries such as the United

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Kingdom and Singapore have institutionalized BIM through national standards and public procurement requirements, resulting in improved project coordination, reduced rework, enhanced cost predictability, and better construction quality (Saka et al., 2020). Similarly, several African countries, including South Africa, Kenya, and Ghana, have recorded increasing levels of BIM adoption on major infrastructure and commercial projects, demonstrating its potential to improve multidisciplinary collaboration and project efficiency (Akinlolu et al., 2021). However, BIM implementation across many developing countries remains constrained by inadequate digital infrastructure, shortage of skilled professionals, high implementation costs, and weak institutional support (Saka et al., 2020).

Nigeria's construction industry continues to face many of the challenges that BIM is designed to address. Project delays, budget overruns, poor coordination among project participants, and quality deficiencies remain common features of construction projects despite increasing investments in infrastructure development (Oyewobi et al., 2022). Although awareness of BIM has improved among construction professionals, its practical application remains limited and is often confined to three-dimensional visualization during the design stage. More advanced applications, such as project scheduling, cost management, facility management, and lifecycle information management, are rarely implemented (Abubakar et al., 2023). The slow pace of BIM adoption has been attributed to several factors, including high software acquisition and training costs, limited technical expertise, organizational resistance to change, inadequate digital infrastructure, and the absence of a comprehensive national BIM implementation framework (Saka et al., 2020).

Despite increasing scholarly attention to BIM adoption in Nigeria, important knowledge gaps remain. Existing studies have largely focused on professionals' awareness of BIM, perceived benefits, and barriers to adoption, while relatively little empirical evidence exists regarding the extent to which BIM adoption influences construction project outcomes within the Nigerian context (Abubakar et al., 2023; Oyewobi et al., 2022). Furthermore, limited attention has been given to examining how barriers to BIM adoption affect project performance, particularly in terms of cost efficiency, time performance, quality delivery, and collaboration among construction professionals. This lack of empirical evidence limits the ability of policymakers, professional bodies, and construction firms to develop effective strategies for accelerating digital transformation within the Nigerian construction industry.

This study addresses these gaps by examining the impact of Building Information Modelling on construction project outcomes in Nigeria. Specifically, the study assesses the level of BIM awareness among construction professionals, identifies the barriers affecting BIM adoption, evaluates the influence of these barriers on project performance, and proposes strategies for improving BIM implementation within the Nigerian construction industry. The findings are expected to contribute to the growing body of knowledge on digital transformation in construction while providing practical evidence to support policy formulation, professional capacity development, and the wider adoption of BIM for improved construction project performance in Nigeria.

LITERATURE REVIEW

Building Information Modelling (BIM) has transformed the global construction industry by providing an integrated digital platform for planning, designing, constructing, and managing built assets throughout their lifecycle. Unlike conventional two-dimensional design methods, BIM integrates geometric, technical, financial, and operational information into a shared digital environment that facilitates collaboration among project stakeholders. The technology enables architects, engineers, quantity surveyors, contractors, and clients to access real-time project information, thereby improving coordination, minimizing design conflicts, and supporting informed decision-making (Abou-Ibrahim & Hamzeh, 2021).

The adoption of BIM has been associated with significant improvements in construction project performance. Studies have shown that BIM enhances project visualization, improves communication among multidisciplinary teams, reduces design errors, minimizes material waste, and supports accurate cost estimation and scheduling (Olawumi & Chan, 2020). Its multidimensional capabilities, including three-dimensional visualization (3D), scheduling (4D), cost estimation (5D), and lifecycle management (6D), enable project teams to identify potential

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construction challenges before physical implementation, thereby reducing rework and improving project efficiency (Latiffi et al., 2021).

Project performance in construction is commonly evaluated using indicators such as cost efficiency, timely completion, quality of work, and stakeholder satisfaction (Adeleke et al., 2023). Research indicates that organizations implementing BIM consistently achieve better project outcomes than those relying solely on conventional project delivery methods. Improved information sharing and integrated project planning reduce uncertainties during construction, leading to better schedule adherence and enhanced quality performance (Enshassi & El-Ghandour, 2023). Consequently, BIM is increasingly recognized as a strategic tool for improving construction productivity and promoting sustainable infrastructure development.

Although BIM adoption has expanded rapidly in developed economies, implementation in many developing countries remains limited. The slow pace of adoption has been linked to inadequate digital infrastructure, shortage of skilled professionals, high implementation costs, organizational resistance to change, and weak policy support (Saka et al., 2023). These constraints are particularly evident in Nigeria, where BIM implementation remains at an early stage despite increasing awareness among construction professionals (Abubakar et al., 2023).

METHODOLOGY

This study adopted a mixed-methods research design to examine the impact of Building Information Modelling (BIM) on construction project outcomes in Nigeria's Architecture, Engineering, and Construction (AEC) industry. The mixed-methods approach integrates quantitative and qualitative techniques to provide a more comprehensive understanding of BIM implementation than either method alone (Creswell & Creswell, 2018; Saunders et al., 2019). The quantitative component assessed BIM awareness, adoption, barriers, and project performance, while the qualitative component explored professionals' experiences and perspectives regarding BIM implementation.

The target population comprised registered professionals in the Nigerian AEC industry, including architects, civil engineers, builders, quantity surveyors, project managers, and construction firm executives. These professionals were selected because of their direct involvement in project planning, design, coordination, and execution, making them well positioned to evaluate BIM implementation and its influence on project performance. The study focused on major construction hubs in Nigeria, namely Lagos, Abuja, Port Harcourt, Kano, and Enugu, where construction activities and BIM awareness are relatively more developed.

The study population consisted of approximately 25,000 registered construction professionals based on membership records obtained from the Council for the Regulation of Engineering in Nigeria (COREN), the Nigerian Institute of Architects (NIA), the Nigerian Institute of Quantity Surveyors (NIQS), and the Nigerian Institute of Building (NIOB). The sample size was determined using the Yamane (1967) formula at a 95% confidence level and a 5% margin of error, resulting in a minimum sample of 529 respondents. In addition, 15 BIM experts and experienced project managers were purposively selected for semi-structured interviews to provide detailed insights into BIM implementation, adoption challenges, and strategies for improving project performance.

A stratified random sampling technique was employed for the questionnaire survey to ensure proportional representation of the major professional groups within the AEC industry. Respondents were randomly selected from each professional stratum according to its population size, thereby improving representativeness and reducing sampling bias (Saunders et al., 2019). For the qualitative phase, purposive sampling was used to identify participants with substantial knowledge and practical experience in BIM implementation (Creswell & Creswell, 2018).

Primary data were collected through a structured questionnaire and semi-structured interviews. The questionnaire was adapted from established BIM adoption literature and organized into five sections covering respondents' demographic characteristics, BIM awareness, BIM adoption, project performance, and barriers to BIM implementation. Responses were measured on a five-point Likert scale ranging from Strongly Disagree (1)

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to Strongly Agree (5). The interviews explored organizational readiness, implementation challenges, policy support, and strategies for enhancing BIM adoption within Nigeria's construction industry.

To establish instrument quality, the questionnaire and interview guide were reviewed by experts in construction management and research methodology to ensure content validity. A pilot study involving 20 construction professionals was subsequently conducted to evaluate the clarity and relevance of the questionnaire. Reliability was assessed using Cronbach's Alpha, which produced a coefficient of 0.84, exceeding the recommended minimum threshold of 0.70 for acceptable internal consistency (Hair et al., 2019). Feedback from the pilot study was used to refine the questionnaire before the main survey.

Quantitative data were analysed using the Statistical Package for the Social Sciences (SPSS) Version 25. Descriptive statistics, including frequencies, percentages, mean scores, and standard deviations, were used to summarize respondents' characteristics and assess BIM awareness, adoption, implementation barriers, and project performance. Qualitative interview data were transcribed verbatim and analysed using thematic analysis involving coding, theme development, and interpretation of recurring patterns (Braun & Clarke, 2006). Findings from both datasets were integrated through methodological triangulation to enhance the credibility and validity of the study (Creswell & Creswell, 2018).

Ethical standards were maintained throughout the study. Participants were informed about the purpose of the research, participation was voluntary, and informed consent was obtained before data collection. Respondents were assured of anonymity and confidentiality, and all information collected was used solely for academic purposes in accordance with accepted research ethics (Saunders et al., 2019).

RESULTS AND DISCUSSION

Response Rate and Respondents' Profile

A total of 529 questionnaires were distributed to construction professionals across Karu, Garki, Wuse, Kabusa and Gwarinpa. Of these, 515 valid questionnaires were retrieved and used for analysis, representing an effective response rate of 97.4%, which exceeds the minimum response rate generally considered adequate for construction management surveys. The high response rate enhances the reliability and generalizability of the study findings.

Table 1.0: Questionnaire Distribution and Response Rate

Location	Distributed	Valid Responses	Response Rate (%)
Karu	185	172	93.0
Garki	130	123	94.6
Wuse	95	89	93.7
Kabusa	70	65	92.9
Gwarinpa	49	46	93.9
Total	**529**	**515**	**97.4**

Source: Field Survey (2025).

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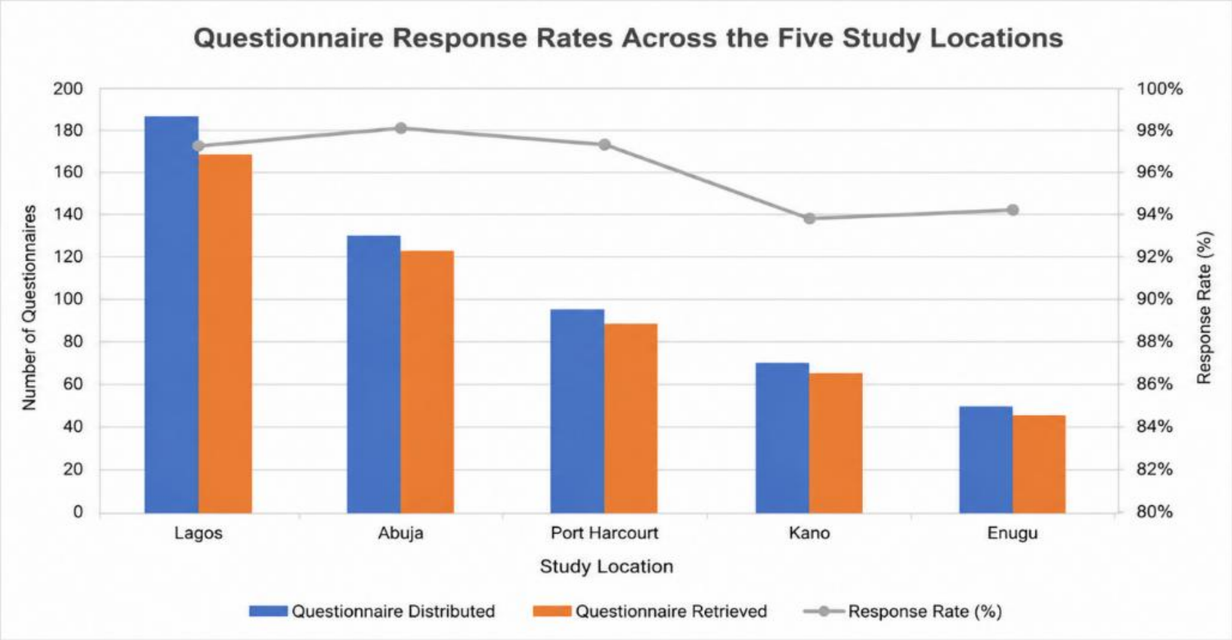

Figure 1.0: Questionnaire response rates across the five study locations.

Source: Field Survey, 2025

The wide geographical spread of respondents indicates that the findings reflect perspectives from the major construction centres in Nigeria, thereby reducing regional bias and improving the representativeness of the survey. Similar nationwide sampling approaches have been adopted in BIM studies by Oyewobi et al. (2022) and Abubakar et al. (2023).

Level of BIM Awareness among Construction Professionals

The first objective examined the level of BIM awareness among construction professionals. The findings indicate an overall awareness mean score of 3.39, suggesting a moderate to high level of awareness. Awareness of the BIM concept recorded the highest mean score (3.54), whereas awareness of government and industry BIM initiatives (2.95) and BIM standards and protocols (2.99) recorded the lowest scores.

Table 2.0: Level of BIM Awareness

Variable	Mean	Rank
Awareness of BIM concept	3.54	1
Knowledge of BIM software	3.26	2
Understanding of BIM workflow	3.21	3
BIM standards and protocols	2.99	4
Government BIM initiatives	2.95	5
Overall Mean	**3.39**	

Source: Field Survey (2025).

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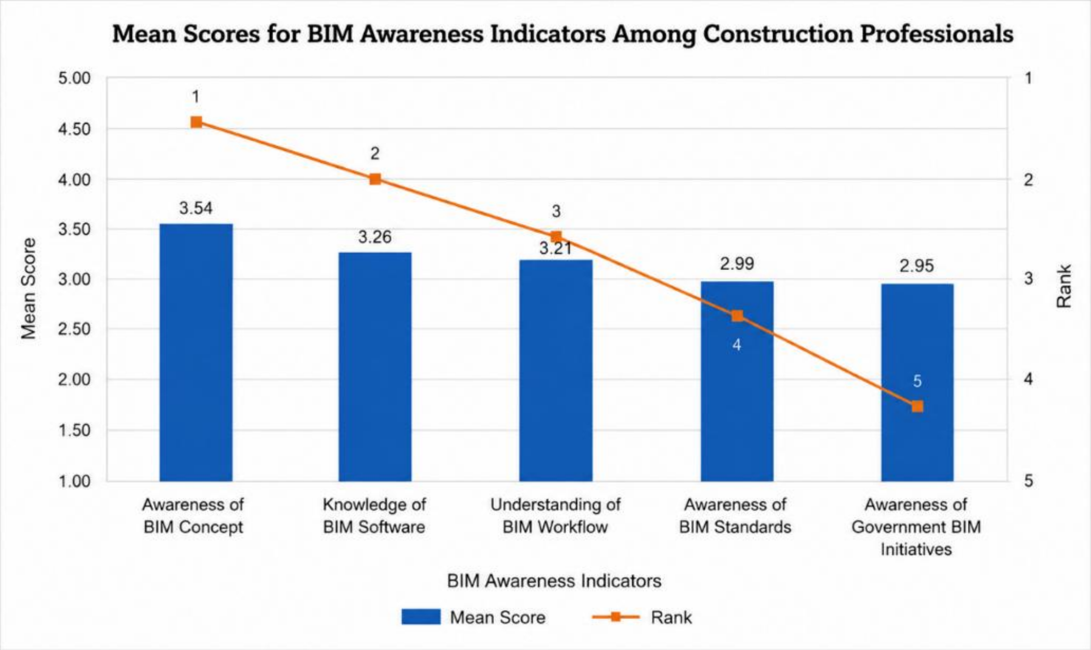

Figure 2.0: Mean scores for BIM awareness indicators among construction

Source: Field Survey, 2025

The findings suggest that although construction professionals are familiar with BIM as a concept, awareness has not translated into comprehensive understanding of implementation standards and regulatory frameworks. This indicates that awareness is largely conceptual rather than operational.

These findings corroborate Abubakar et al. (2023), who reported relatively high BIM awareness but low practical implementation among Nigerian professionals. Similarly, Saka et al. (2023) argued that awareness alone does not guarantee adoption unless supported by institutional frameworks and professional capacity building. Within the Technology Acceptance Model, awareness contributes to perceived usefulness, which influences users' intention to adopt new technologies (Davis, 1989; Venkatesh & Davis, 2000).

BIM Adoption and Utilization

The second objective evaluated the extent of BIM adoption among construction firms. The results reveal that BIM adoption remains partial and uneven, with most organizations using it primarily for design visualization. In contrast, more advanced applications such as project scheduling, lifecycle management, and facility management remain limited. Adoption is concentrated in Lagos and Abuja, where large firms and multinational contractors are more active.

Table 3.0 Major BIM Applications

BIM Application	Adoption Level
Design visualization	High
Quantity take-off	Moderate
Cost estimation	Moderate
Project scheduling (4D)	Low
Facility management	Very Low

Source: Field Survey (2025).

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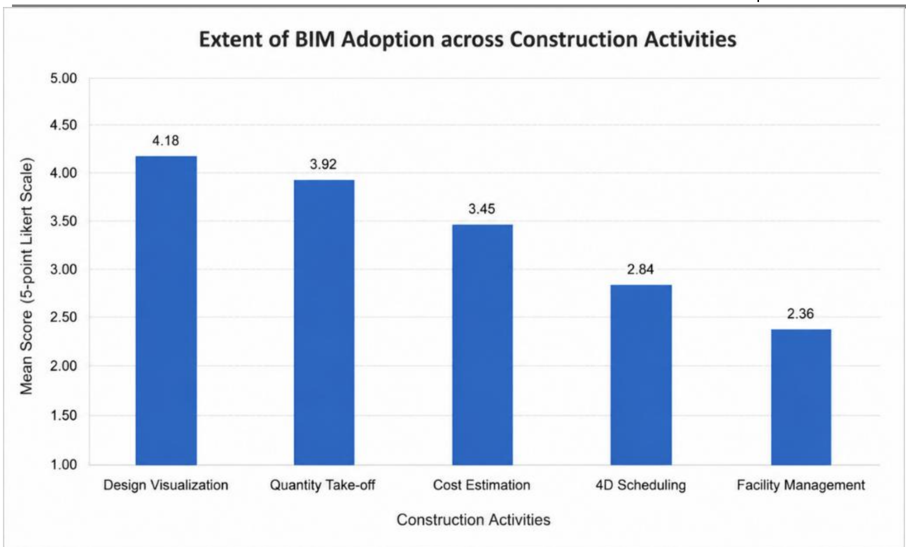

Figure 3.0: Extent of BIM adoption across major construction activities.

Source: Field Survey, 2025

The results demonstrate that Nigeria remains in the early stages of BIM maturity. Organizations have embraced BIM mainly for visualization rather than exploiting its full lifecycle capabilities.

These findings are consistent with Oyewobi et al. (2022), Abubakar et al. (2023), and Latiffi et al. (2021), who reported similar incremental adoption patterns in developing economies. According to the Technology Acceptance Model, these findings indicate that professionals recognize BIM's usefulness but perceive implementation as technically demanding, thereby reducing adoption.

Impact of BIM on Construction Project Outcomes

The third objective examined the perceived influence of BIM on project performance. Respondents generally agreed that BIM positively affects project outcomes, with an overall mean score of 3.44. The highest-rated benefits were improved design quality (3.55) and enhanced collaboration (3.47), followed by reduced rework and improved cost estimation.

Table 4.0: Perceived Impact of BIM

Performance Indicator	Mean
Design quality	3.55
Collaboration	3.47
Reduced rework	3.45
Cost estimation	3.44
Project scheduling	3.38
Documentation	3.38

Source: Field Survey (2025).

The findings demonstrate that BIM contributes most strongly to improving design quality and multidisciplinary collaboration. These benefits arise from the technology's ability to integrate project information and facilitate early detection of design conflicts.

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The results support previous studies by Abou-Ibrahim and Hamzeh (2021), Olawumi and Chan (2020), and Umar et al. (2023), which found that BIM enhances coordination, reduces errors, and improves project efficiency. From the TAM perspective, these positive perceptions strengthen perceived usefulness, thereby increasing professionals' willingness to adopt BIM.

Barriers to BIM Adoption

The fourth objective identified barriers hindering BIM implementation. Respondents perceived all investigated factors as moderate to severe barriers, with an overall mean score of 3.62. The most significant barriers were the absence of government policy (3.88), inadequate technical skills (3.78), and high software costs (3.75).

Table 5.0: Major Barriers to BIM Adoption

Barrier	Mean	Rank
Lack of government policy	3.88	1
Insufficient technical skills	3.78	2
High software costs	3.75	3
Resistance to change	3.64	4
Poor interoperability	3.47	5
Weak collaboration	3.45	6
Low client demand	3.38	7

Source: Field Survey (2025).

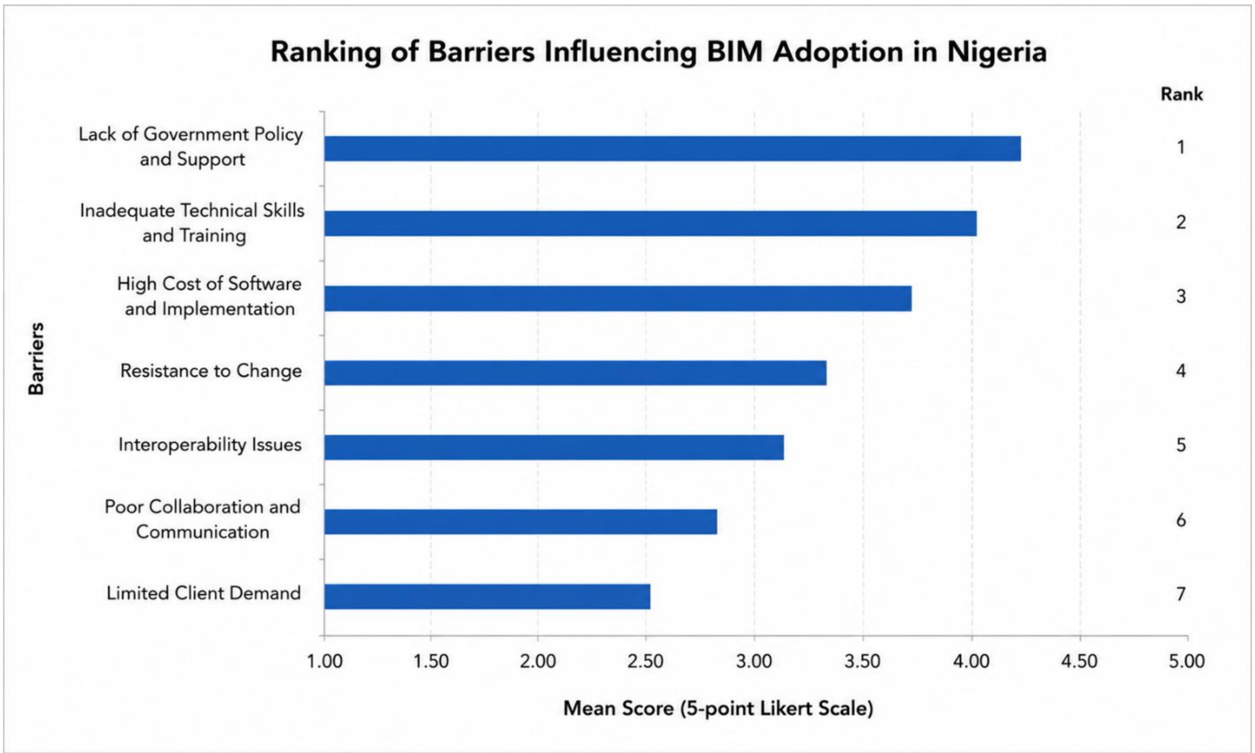

Figure 4.0: Ranking of barriers influencing BIM adoption in Nigeria.

Source: Field survey, 2025

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These findings indicate that institutional and economic constraints are more influential than professional resistance. The absence of a national BIM implementation framework appears to be the most critical impediment to widespread adoption.

The results are consistent with Abubakar et al. (2023), Olawumi and Chan (2020), and Saka et al. (2023), who identified policy support, technical capacity, and affordability as key determinants of BIM diffusion. Under TAM, these barriers primarily reduce perceived ease of use, limiting professionals' behavioural intention to adopt BIM despite recognising its benefits.

Synthesis of Findings

The combined quantitative and qualitative evidence suggests that BIM awareness among Nigerian construction professionals is increasing, and respondents generally recognise its potential to improve project quality, collaboration, cost management, and scheduling. However, adoption remains constrained by inadequate institutional support, limited technical capacity, and financial barriers. Consequently, BIM implementation is largely driven by organisational initiatives rather than a coordinated national strategy. These findings underscore the need for policy reforms, capacity building, and stronger industry collaboration to accelerate digital transformation within Nigeria's construction sector.

CONCLUSION

This study examined the impact of Building Information Modelling (BIM) on construction project outcomes in Nigeria using a mixed-methods approach guided by the Technology Acceptance Model (TAM). The findings show that although awareness of BIM among construction professionals is relatively high, its practical adoption remains moderate and is largely limited to basic applications such as design visualization, quantity take-off, and cost estimation. Nevertheless, BIM is widely perceived to improve project performance through enhanced design quality, interdisciplinary collaboration, communication, cost control, and reduced design conflicts.

The study further established that the slow pace of BIM implementation is primarily influenced by institutional, financial, and technical constraints, including the absence of a national BIM policy, inadequate professional training, high software acquisition costs, limited client demand, and insufficient organizational readiness. These challenges suggest that while professionals recognize the usefulness of BIM, its effective implementation depends on creating an enabling environment that supports digital transformation across the construction industry.

Overall, the study concludes that Building Information Modelling has significant potential to improve construction project delivery in Nigeria.

Achieving this potential will require the development of a national BIM policy and standardized implementation framework, greater investment by construction firms in digital infrastructure and workforce development, and the integration of BIM education into university curricula and professional training programmes. Equally important is stronger collaboration among government agencies, professional bodies, educational institutions, software vendors, clients, and construction firms to promote knowledge sharing, provide implementation incentives, and establish industry-wide standards that will facilitate sustainable and widespread BIM adoption.

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