

Appraisal of Building Information Modelling Implementation on Construction Project Performance in Nigeria

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Abstract

The Nigerian construction industry continues to face challenges related to project inefficiencies, cost overruns, time delays, and low productivity. Despite the global advancement of Building Information Modelling (BIM) as a tool for improving construction project performance, its adoption and implementation in Nigeria remain limited. This study investigates BIM impact on construction project performance in Nigeria, addressing a significant gap in empirical research within the local context. To achieve the objective, a quantitative survey method was adopted following a pilot study to refine the research instrument. The study population comprised 85 key professionals, including principal partners, project quantity surveyors, architects, engineers, and project supervisors drawn from both private and public construction and consultancy firms. A census sampling technique was employed, and 63 valid responses were retrieved, yielding a response rate of 74.12%. Data were analyzed using Mean Item Score (MIS) and Relative Importance Index (RII) to rank the impact of BIM on various performance indicators. The results reveal that BIM significantly enhances project performance, with safety, labour productivity, customer satisfaction, and time management ranking highest in impact (RII = 0.86, 0.81, 0.76, and 0.75 respectively). Cost efficiency, supply chain management, sustainability, risk management, and quality control followed, with RII values ranging from 0.74 to 0.68. The study concludes that stakeholders generally perceive BIM positively, acknowledging its transformative potential for the Nigerian construction industry to what the study reveals, which is same as finding. It recommends that construction firms actively embrace BIM technologies and practices, as doing so would significantly enhance project outcomes, reduce inefficiencies, and promote sustainable development.

Keywords: Building, BIM, Construction Professionals, Project Performance, Stakeholders.

1. Introduction

Building Information Modeling (BIM) has been conceptualized and interpreted in various ways by different scholars. Karen (2014) characterizes BIM as an integrated and structured digital database utilized within the architecture, engineering, construction, and operations (AECO) industry. This database comprises 3D parametric objects and facilitates interoperability. Azhar *et al.* (2012) describe BIM as an advanced process and tool that incorporates virtual components, concepts, and systems of a facility within a unified digital environment. According to Sacks (2020), BIM involves using a database infrastructure to represent built facilities from the perspectives of different stakeholders, enabling them to query, simulate, estimate activities, and oversee the building lifecycle. Arayici and Aouad (2010) define BIM as the application of ICT technologies to streamline building lifecycle processes, ensuring a safer and more efficient environment for occupants while minimizing environmental impact and enhancing operational efficiency for owners. Similarly, Arayici and Coates (2012) simplify BIM as the use of a database infrastructure to encapsulate built environments with stakeholder-specific viewpoints, integrating digital representations of building objects and their relationships in a structured manner to facilitate

informed decision-making throughout the building lifecycle.

Assessing BIM adoption in Nigeria presents a valuable opportunity to enhance the efficiency and competitiveness of the country's construction industry by leveraging ICT advancements and addressing existing challenges. Through strategic implementation, Nigeria can emerge as a leader in BIM adoption within Africa, fostering sustainable development and economic growth.

Given this context, there is a need to evaluate the influence of BIM implementation on construction project performance in Nigeria. This study aims to assess the current level of BIM adoption and its impact on construction project outcomes within the Nigerian construction industry, providing essential insights for industry stakeholders.

2. Literature Review

Performance is a crucial aspect of construction projects, as it often determines their overall success. The concept of performance has been defined in various ways, reflecting the diverse nature of construction activities. Ingle and Mahesh (2022) describe performance as the extent to which a project effectively meets its objectives in terms of time, cost, and quality,

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emphasizing efficiency in resource utilization. Similarly, Van Tam *et al.* (2023) define performance as the degree to which project goals are achieved, incorporating not only time, cost, and quality but also safety and client satisfaction. These definitions highlight performance as a multidimensional concept that integrates key parameters essential for evaluating construction project outcomes.

Performance in construction projects is fundamental to financial success. High performance ensures profitability, as projects completed on time and within budget are more likely to yield financial returns. Kerzner (2022) identifies effective resource management as a primary factor in maximizing profits and minimizing losses. Moreover, client satisfaction is closely linked to high performance, as meeting or exceeding expectations regarding time, cost, and quality fosters repeat business and positive referrals (Kerzner, 2022). Repeat clients and recommendations play a crucial role in the long-term sustainability of construction firms (Fewings & Henjewelw, 2019). Additionally, consistently high performance enhances a firm's reputation, attracting more clients and prestigious projects, thereby strengthening its market position. Many definitions of high performance also emphasize sustainability, which is increasingly demanded by clients and regulatory bodies. Sustainable construction practices not only benefit the environment but also reduce long-term operational costs and enhance project value (Maraveas, 2020).

Various metrics are used to assess performance in construction projects, each holding significant importance. The most common metrics are time, cost, and quality (Tunji-Olayeni *et al.*, 2016). Time performance refers to a project's ability to meet its scheduled completion date, as delays often lead to cost overruns and client dissatisfaction (Hussain *et al.*, 2019). Cost performance measures a project's ability to remain within its budget, which is crucial for financial stability and profitability (Jahan *et al.*, 2022). Quality performance evaluates whether the final project meets client requirements and expectations, ensuring client satisfaction and minimizing future maintenance costs (Hussain *et al.*, 2019).

Safety is another vital metric in project performance evaluation. It assesses adherence to safety regulations and the frequency of accidents or injuries on-site (Abas *et al.*, 2020). A strong safety record is essential for protecting workers, reducing legal liabilities, and maintaining a positive company image (Mohammadi *et al.*, 2018). Sustainability performance examines the environmental impact of a project and its alignment with sustainable practices. (Rajabi *et al.*, 2022) highlight that sustainable construction is crucial for regulatory compliance and cost reduction, ultimately enhancing project value. Client satisfaction is also a key performance indicator (Tunji-Olayeni *et al.*, 2016),

measuring the overall experience and satisfaction level of clients regarding the final project outcome. High client satisfaction leads to repeat business and positive referrals, which are essential for a construction firm's long-term survival and growth in the industry.

2.1. *BIM and the Construction Industry in Nigeria*

The adoption of Building Information Modeling (BIM) within the Nigerian construction industry has been relatively slow. According to Monejo and Makinde (2020), BIM adoption in Nigeria is still in its early stages, though awareness of its benefits among industry stakeholders is gradually increasing. The Nigerian construction industry is highly fragmented, with many small and medium-sized enterprises (SMEs) operating independently. This fragmentation poses a major barrier to BIM adoption, as the methodology requires extensive collaboration and information sharing among project stakeholders (Olanrewaju *et al.*, 2020).

One of the key drivers of BIM adoption in Nigeria is its potential to enhance project performance. BIM improves project visualization, facilitates better coordination, and enhances cost estimation and scheduling accuracy. Many of the persistent challenges in the Nigerian construction industry, such as cost overruns, delays, and poor work quality, can be directly addressed through BIM. For instance, Bamgbose *et al.*, (2024) note that BIM adoption significantly reduces rework and errors in construction projects, leading to cost savings and timely project delivery.

However, several challenges hinder BIM adoption in Nigeria. A significant barrier is the shortage of skilled professionals proficient in BIM tools and technologies (Bamgbose *et al.*, 2024). The existing education and training infrastructure in Nigeria is insufficient to produce the required number of skilled personnel to drive BIM adoption meaningfully (Toyin & Mewomo, 2023). Additionally, the high cost of BIM software and associated training programs presents a significant financial burden for many construction firms, particularly SMEs (Olanrewaju *et al.*, 2020).

Infrastructure-related challenges also impact BIM adoption in Nigeria. The effective use of BIM relies on stable internet connectivity and robust technological infrastructure, yet many parts of Nigeria still suffer from poor internet access and inadequate digital infrastructure (Eze *et al.*, 2024). This limitation hinders the full utilization of BIM's collaborative and real-time capabilities.

Despite these challenges, several strategies can be implemented to promote BIM adoption and integration in Nigeria. One critical approach is strengthening BIM-related skills and capacities by incorporating BIM training into tertiary education curricula for construction-related courses. Construction firms can

also invest in continuous professional development programs to enhance their workforce's BIM proficiency (Olanrewaju *et al.*, 2020).

Increasing awareness about BIM's benefits and dispelling misconceptions that prevent firms from adopting it is also essential. Government intervention can play a significant role in promoting BIM adoption by developing policies and regulations that mandate its use, particularly for public construction projects (Saka *et al.*, 2022). Additionally, improving technological infrastructure, including internet connectivity, would further support BIM implementation (Eze *et al.*, 2024). Empirical studies indicate that BIM adoption has had a positive impact on project performance in Nigeria. For example, research conducted by Onungwa and Uduma-Olugu (2017) found that BIM significantly improves key project performance indicators such as completion time, client satisfaction, and quality. Similarly, Monejo and Makinde (2020) reported that BIM implementation enhances project control, improves collaboration, facilitates conflict resolution, and reduces labor inefficiencies.

Furthermore, BIM has the potential to enhance the sustainability of construction projects in Nigeria. According to Bamgbose (2024), BIM enables more accurate and detailed planning, optimizing resource utilization, minimizing waste, and reducing the

consultancy firms in Abuja. The sample size is determined based on size of the study population and some other parameters such as desired confidence level and margin of error (Taherdoost, 2016). Due to the impracticality of reaching and collecting data from all professionals in the construction industry in Abuja, a sample that is representative of the population is taken in order to ensure that the findings of the study can be generalized to a larger industrial context. Taro Yamane's formula was used to determine the appropriate sample size for the study. This formula used for calculating the sample size is one of the most widely used among researchers since it is effective in determining sample sizes for studies. The Taro Yamane formula for calculating the sample size is given as:

$$n = \frac{N}{1 + N * e^2}$$

Where;

n represents the sample size.

N presents the population size (estimated total number)

e represents the margin of error (0.05).

A total number of 80 individuals were given the questionnaire. However, out of the 80 questionnaires, 63 (78.75%) were filled and submitted, indicating a high response rate. All the submitted questionnaires were used in the study analysis (Figure 1).

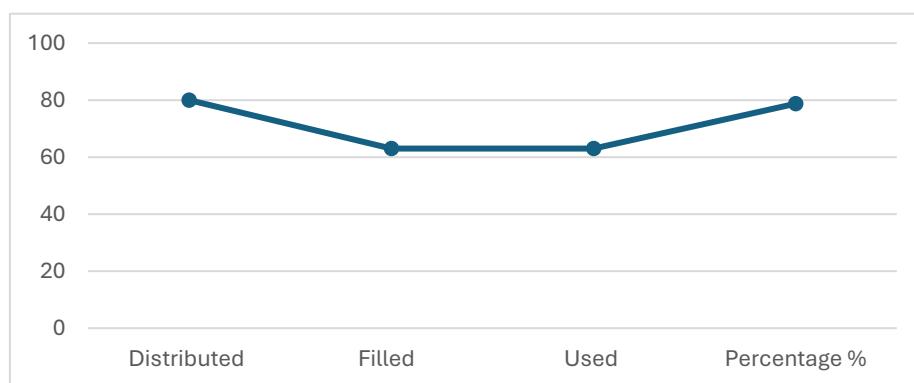


Figure 1: Number of Questionnaires

environmental impact of construction activities. This is particularly relevant in Nigeria, where the growing rate of urbanization and environmental concerns necessitate the adoption of sustainable construction practices.

3. Research Methodology

The study area is Abuja, situated in North central Nigeria and the capital city of Nigeria. Survey design was adopted for the study, which involved collection of data through questionnaires administration. The population of the study was professionals, individuals in both private and public construction companies and

4. Findings and Discussions

Figures 2- 5 (see Appendix 1) presents the distribution of respondents' background information. Out of the 63 respondents, 71.4% were male and 28.6% were female, indicating that male was more than female in the study. Majority of the respondents were Master's degree holder (36.5%), followed by BSC/B-tech holder (34.9%), HND holder (17.5%) and PhD holder (11.1). Those with Masters and Doctorate degrees accounted for a reasonable number of total respondents, indicating that, most of the respondents have a higher level of educational qualification. On the profession of the

respondents, majority of the respondents were architects represented by 33.3%, this is followed by engineers (23.8%), Quantity Surveyors have representation of (20.6%), builders represented by 12.7% and project manager accounted for 9.5%. Furthermore, most of the respondents have 11-15 years professional experience, this is followed by 22.2% of the respondents with 6-10 years, another 12.7% have 16-20 years professional experience, 19.0% have 1-5 years of experience and 7.9% have over 20 years professional experience. The cumulative percentage of respondents with 11 years and above professional experience is 58.8% indicating that, the study is dominated by those with high level of professional experience in the Nigerian construction industry.

However, project performance using BIM does not perform better in terms of communication (8th) with their RII being 0.48. This result shows that the overall performance of project using BIM is higher compared to without using BIM i.e. BIM adoption has a higher positive impact on project performance.

4.2. Stakeholder Perception and Attitude towards BIM and its Benefits

Figure 7 presents the distribution of respondents' response on whether they believe BIM has potential benefits for the Nigerian construction industry. 9.52% claimed they do not believe BIM has potential benefits for the Nigerian construction industry while 90.48% claimed that BIM has potential benefits for the Nigerian

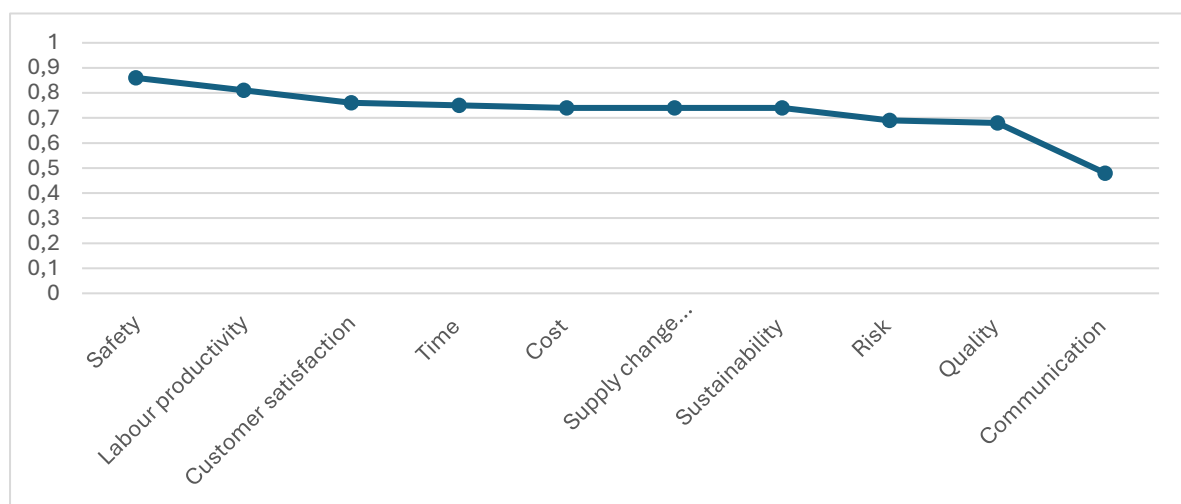


Figure 6: RII of Stakeholders Perception

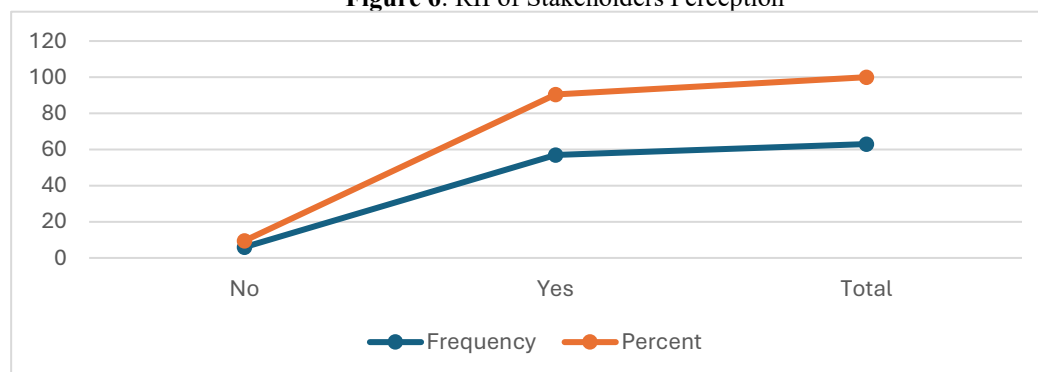


Figure 7: BIM Potential Benefits for the Nigerian Construction Industry

4.1. Impact of BIM on Project Performance

Figure 6 shows the rating of project performance using BIM compared to without using BIM. As shown, the project performed better using BIM in terms of safety (1st), labour productivity (2nd), customer satisfaction (3rd), time (4th), cost., supply change management, sustainability(5th), risk (6th), quality(7th) with RII of 0.86, 0.81, 0.76, 0.75, 0.74, 0.69 and 0.68 respectively.

construction industry. This shows that majority have a positive perception toward BIM potential benefits.

The study investigated BIM adoption and implementation on construction project performance in Abuja, Nigeria. The objectives of the study were; To assess the current level of BIM adoption in the study areas construction industry; to identify the level of BIM implementation in FCT construction industry; to

evaluate the barriers hindering the successful implementation of BIM in construction projects in Abuja, Nigeria; to assess the impact of BIM adoption level on project performance metrics, and to investigate the perceptions and attitudes of stakeholders towards BIM and its potential benefits on construction projects.

5. Conclusion

The paper concluded that Stakeholders' perception of BIM is generally positive, with majority recognizing its potential benefits for the Nigerian construction industry. But, the variation in the stakeholders' willingness to recommend BIM indicates that more advocacy and evidence of its effectiveness are needed to build a wider base of support.

6. Recommendation

Based on the findings, the paper recommended appraisal the adoption and implementation of BIM in the Nigeria construction industry so that Investment should be made in training and development – comprehensive training programmes with certification for BIM proficiency should be organized for existing professionals. Increase research for BIM technology in institutions of higher learning, Government should provide support by offering financial incentives to companies that are investing in BIM and encourage its

use in public sector projects Stakeholders should be educated on the capabilities and benefits of BIM through campaigns aimed at raising awareness, while universities and technical colleges should be mandated to incorporate BIM training into their programs, There should be platforms for professionals to share knowledge on BIM with each other and promote integrated project delivery methods, this will enhance collaboration among different stakeholders, To tackle financial barriers, Small and Medium Scale Enterprises (SMEs) should be encouraged to develop and adopt cost-effective BIM tools. Also, there should be establishment of funding mechanisms specifically for supporting adoption of BIM tools by SMEs.

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Appendix 1

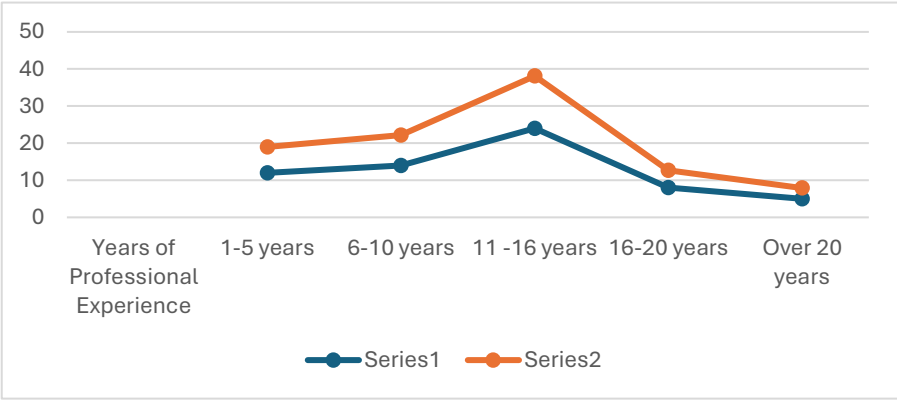


Figure 5: Year of Professional Experience

Figure 2: Gender

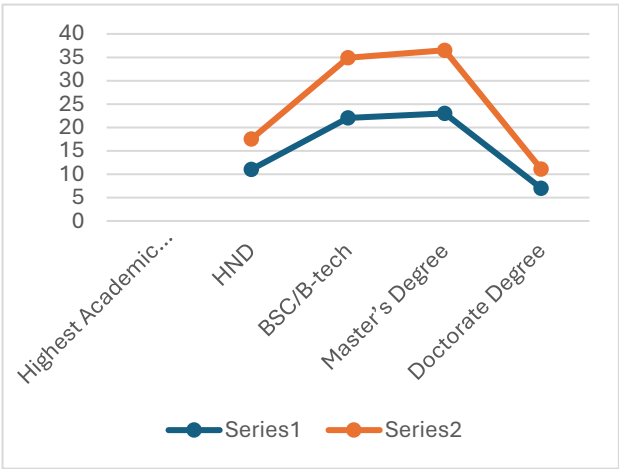


Figure 3: Highest Academic Qualification

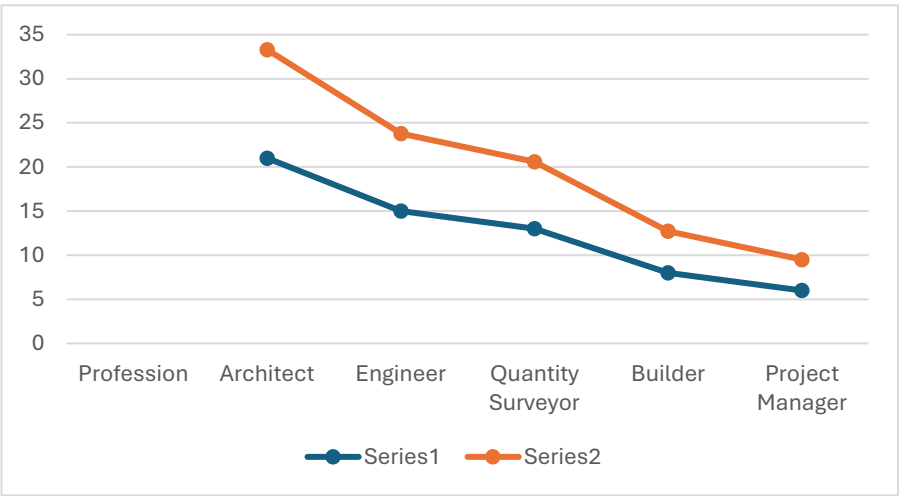


Figure 4: Profession