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Barriers to BIM Adoption for Building Maintenance in Nigerian Public Buildings: Implications for Institutional Facilities

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Abstract

Despite the increasing global relevance of Building Information Modelling (BIM) in facility management (FM), its integration into the maintenance practices of Nigerian universities remains limited. This study systematically reviewed 30 scholarly and institutional publications from 2018 to 2025 to explore the barriers to Building Information Modelling (BIM) adoption for facility maintenance in Nigerian universities. Thematic analysis revealed five major barriers: technological, organizational/cultural, economic/financial, policy/regulatory, and human capital and training gaps. Key challenges included software interoperability limitations (cited in 7 studies), inadequate ICT infrastructure, financial constraints (noted in 6 publications), resistance to organizational change, and the absence of national BIM standards or FM mandates. Stakeholder perspectives from across the literature underscored a consistent awareness of BIM's value but highlighted the lack of hands-on training and institutional preparedness as critical impediments. Despite repeated recommendations for capacity building and policy reform, few studies provided longitudinal evidence or context-specific implementation models. The findings point to an urgent need for targeted training, infrastructure investment, and national policy guidelines to facilitate effective BIM integration in tertiary facility management systems.

Keywords: Building Information Modelling, Facility Management, Nigerian Universities, Maintenance, Interoperability, Policy, ICT Infrastructure.

Introduction

The maintenance of public buildings in Nigeria, including educational institutions, government offices, and health facilities, faces ongoing challenges. Deteriorating infrastructure, outdated documentation, reactive maintenance strategies, and constrained budgets all undermine effective facility management (Adepoju et al., 2023; Hamma-Adama et al., 2020). This situation is especially acute within universities, where the quality of the built environment directly influences teaching, learning, and research outcomes (Ikediashi et al., 2022).

Empirical evidence suggests that maintenance inadequacies are widespread across Nigerian universities. For example, at the University of Nigeria, Nsukka, approximately 80% of campus buildings require immediate maintenance, with roof repairs needed in 74.6%, wall repairs in 60%, and plumbing works in over 72% of student hostels (Ugwu et al., 2018). A study at Nnamdi Azikiwe University, Awka, identified key barriers including substandard construction materials, delayed funding releases, absence of regular building surveys, reactive maintenance approaches, and under-staffed maintenance departments (I et al., 2021). Similarly, University of Ilorin research highlights that a lack of formal maintenance policies, inconsistent funding, and governance changes disrupt consistent maintenance scheduling (Ugwu et al., 2018). These findings underscore critical maintenance inefficiencies that compromise infrastructure integrity and user comfort across higher education institutions.

Meanwhile, Building Information Modelling (BIM) presents a powerful digital solution to enhance maintenance planning, asset management, and overall building performance (Ediae & Enoma, 2018; Boufares et al., 2022). While BIM is widely adopted in post-construction and facility management workflows globally, especially in developed countries, its uptake in Nigeria remains limited, particularly for public sector maintenance applications (Okwe et al., 2022; Abdulkabir & Ayegba, 2024). This paper examines the barriers to BIM adoption for maintenance in Nigerian public buildings, with a focus on universities to illustrate the practical implications of BIM-enhanced maintenance strategies.

Problem Statement

Public buildings in Nigeria frequently suffer from suboptimal maintenance practices, resulting in rapid physical deterioration and escalating operational costs (Aghimien et al., 2018). Despite the potential of digital technology like BIM to support lifecycle-based, proactive facility management, adoption in Nigeria's public sector remains rare (Onososen & Musonda, 2022). This issue is particularly urgent in university settings, where complex infrastructure requires sophisticated maintenance strategies (Jibrin et al., 2024).

Current systems are mostly manual and reactive. Although BIM may be used during construction, its application to ongoing maintenance is hampered by technical, financial, structural, and policy-related constraints (Bamgbose et al., 2024; Alam et al., 2023). Understanding these institutional and contextual barriers is vital, especially within the higher education sector, to inform policy, strategy, and future BIM integration in public building maintenance.

Aim

This study aims to investigate the key barriers hindering the adoption of Building Information Modelling (BIM) for facility maintenance in Nigerian public buildings, to inform policy and practice in the management of public institutional buildings.

Objectives

To achieve this aim, the study is guided by the following objectives:

i. To synthesize existing literature on the benefits and applications of BIM in facility management and maintenance.
ii. To assess current maintenance practices and technological readiness in Nigerian public universities.
iii. To identify and critically analyze the technological, financial, institutional, and policy-related barriers to BIM adoption in the Nigerian higher education sector.

LITERATURE REVIEW

Overview of BIM and Its Application in Facility Maintenance

Building Information Modelling (BIM) has emerged as a transformative tool in the architecture, engineering, and construction (AEC) industry, enabling data-driven decision-making across a building's lifecycle. Defined as a digital representation of a facility's physical and functional properties (Edirisinghe et al., 2017), BIM extends beyond design and construction into post-occupancy stages like operations and maintenance.

The concept of 6D BIM integrates asset data such as equipment specifications, warranties, and maintenance schedules into intelligent digital models (Edirisinghe et al., 2017; Jibrin et al., 2024). Embedding operational data within BIM allows facility managers to perform predictive maintenance, reduce energy consumption, and extend asset life (Jibrin et al., 2024). Internationally, BIM has become central to facilities management in universities and other public institutions (Alam et al., 2023).

Table 1: Comparative Overview of BIM Dimensions

S/N	BIM Dimension	Focus Area	Application in Facility Maintenance
1	3D	Geometry	Spatial coordination
2	4D	Scheduling	Maintenance planning timelines
3	5D	Cost	Lifecycle cost estimation
4	6D	Sustainability & Operations	Asset lifecycle data, predictive maintenance
5	7D	Facility Management Integration	Comprehensive FM platform integration

Source: (Monarch Innovation. (2023), (Kansara, 2023) & (Al-Raqeb & Ghaffar, 2025)

Building Maintenance Challenges in Nigerian Public Institutions

In Nigeria, maintenance performance in public institutions, including universities, remains poor. Studies highlight the prevalence of reactive maintenance cultures, outdated records, limited funding, and insufficient staff capacity (Aghimien et al., 2018; Olanrewaju et al., 2020; Babatunde et al., 2020). Such challenges accelerate facility deterioration, primarily due to a lack of data guiding proactive maintenance (Ikediashi et al., 2022; Adepoju et al., 2023). Public sector maintenance also suffers from the absence of Computerized Maintenance Management Systems (CMMS), fragmented documentation, and bureaucratic procurement processes (Ebekozien et al., 2021; Bamgbose et al., 2024). These systemic inefficiencies render maintenance costly and unsustainable. Scholars argue that integrating BIM can digitize current manual systems, centralize data, and transition processes from corrective to preventive maintenance (Okwe et al., 2022; Bello & Ayegba, 2024).

Benefits of BIM for Maintenance and Operations

Adopting BIM during the post-construction stage delivers numerous benefits tailored to public buildings.



Figure 1: Benefits of BIM for Facility Management
Source: (Kavya, 2023)

i. Centralized Information Access: BIM consolidates as-built drawings, maintenance histories, manuals, and asset data into a unified digital platform (Boufares et al., 2022; Ediae & Enoma, 2018).
ii. Predictive Maintenance: The integration of BIM with IoT and sensor technologies enables real-time monitoring and anticipatory servicing, leading to reduced downtime (Alam et al., 2023; Durdyev et al., 2021).

iii. Cost Efficiency: BIM supports lifecycle-cost analyses, enabling improved budgeting and lower emergency repair expenses (Jibrin et al., 2024; Babatunde et al., 2020).
iv. Standards and Frameworks: Adoption of international standards like COBie and ISO 19650 fosters consistency and transparency in asset information management (Bamgbose et al., 2024; Mansur & Kouider, 2019).

These benefits are particularly relevant for resource-constrained Nigerian public buildings, where inefficiencies in maintenance practices are prevalent (Aghimien et al., 2018; Babatunde et al., 2020)

Table 2: Comparative Benefits of BIM for Facility Maintenance

S/N	Maintenance Task	Traditional Approach	BIM-Enabled Approach
1	Asset tracking	Manual logs	Real-time digital access via BIM
2	Scheduling maintenance	Paper-based	Predictive with IoT/BIM integration
3	Data consistency	Fragmented systems	Centralized model with standards (e.g., COBie)
4	Lifecycle costing	Difficult to estimate	Accurate through BIM cost simulations

Source: (Walker, 2025) & (The AEC Associates, 2024)

Barriers to BIM Adoption in Maintenance Contexts

Despite its recognized benefits, the integration of Building Information Modelling (BIM) into building maintenance operations remains limited, particularly in developing countries like Nigeria. Numerous interrelated barriers hinder adoption at the institutional level, especially within publicly funded facilities:

i. Technological Limitations: Many institutions in Nigeria lack the foundational infrastructure necessary for BIM implementation. These include limited access to compatible hardware, insufficient internet connectivity, outdated maintenance systems, and poor interoperability between BIM and legacy software (Olanrewaju & Anigbogu, 2023; Bamgbose et al., 2024). The digital divide remains a major obstacle to full lifecycle information integration.
ii. Skill Deficiency: A recurring theme in the literature is the shortage of skilled personnel in BIM and facilities management integration. Most facility managers, maintenance staff, and even professional consultants lack formal training or exposure to BIM tools, hindering its uptake and operationalization (Adebowale et al., 2021; Ikediashi et al., 2022). The learning curve associated with BIM-based FM software further limits its utility in institutions that rely on manual or paper-based record systems.
iii. Cost and Budget Constraints: High initial costs for BIM implementation—including software licenses, staff training, hardware procurement, and data migration—remain

a significant barrier in budget-constrained environments (Saka & Chan, 2020; Ediae & Enoma, 2018). Public universities often struggle to justify these investments amid pressing operational and academic funding needs.

iv. Policy and Regulatory Gaps: The absence of a national BIM implementation strategy or legal mandate for its adoption in public-sector projects has slowed institutional uptake (Akerele et al., 2024). Without standardized frameworks or compliance mechanisms, BIM remains optional rather than integral to facility management practices. Furthermore, limited awareness among decision-makers about BIM's long-term benefits for asset performance undermines prioritization in capital budgeting (Okwe et al., 2022).

Implications for Nigerian Public Buildings

While empirical research on BIM-enabled maintenance within Nigerian universities remains scarce, broader studies on public buildings provide applicable insights. Many of the identified barriers, technological, institutional, economic, and policy-related, are systemic and reflective of the public sector's operational context. These barriers highlight the need for comprehensive capacity building, policy reforms, and contextualized implementation strategies.

This study addresses a significant knowledge gap by focusing on BIM adoption for maintenance in Nigerian universities, offering insights that can inform the development of practical guidelines and institutional frameworks. By advancing the discourse on lifecycle-oriented asset management, the research emphasizes the strategic role of BIM in improving the durability, functionality, and sustainability of Nigeria's public infrastructure.

METHODOLOGY

This study employs a Systematic Literature Review (SLR) to explore the barriers to the adoption of Building Information Modelling (BIM) for facility maintenance in Nigerian universities. The review adheres to structured protocols for identifying, screening, selecting, and analyzing relevant literature published between 2018 and 2025. A critical review strategy was adopted to synthesize insights from diverse sources, uncover research gaps, and generate new knowledge, particularly relevant in an emerging, interdisciplinary area like BIM in Facility Management (FM). Given the complexity of BIM adoption in Nigeria's higher education sector, this method provides a comprehensive lens to examine the technological, organizational, and policy dimensions involved.

Literature Search Strategy

A systematic search was conducted across reputable academic databases including Google Scholar, Scopus, ScienceDirect, SpringerLink, and institutional repositories. Search queries were developed using Boolean operators (AND, OR), and included combinations such as:

i. "BIM in facility management"
ii. "BIM adoption barriers"
iii. "BIM in Nigeria"

iv. “BIM for maintenance”
v. “BIM in higher education infrastructure”

Filters were applied to limit results to peer-reviewed publications and relevant reports within the specified time frame (2018–2025). In addition to academic studies, relevant policy documents, institutional guidelines, and conference proceedings were included to incorporate practical perspectives.

Inclusion and Exclusion Criteria

To ensure methodological rigor and relevance, the following inclusion criteria were applied:

i. Studies focused on BIM applications in facility management or post-construction maintenance.
ii. Publications that addressed barriers, challenges, or strategies for BIM adoption.
iii. Priority was given to studies from Nigeria or comparable developing contexts, especially within higher education and public infrastructure.
iv. Only peer-reviewed journal articles, credible institutional reports, or professionally validated documents were considered.

Exclusion criteria eliminated studies that:

i. Focused solely on the design or construction stages of BIM.
ii. Lacked empirical depth or contextual relevance.
iii. Were not published in English.

PRISMA Flow Diagram

To ensure transparency and reproducibility in the review process, the selection of studies followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. The PRISMA 2020 flow diagram (Figure 1) summarizes the number of records identified, screened, included, and excluded, along with reasons for exclusion at each stage.

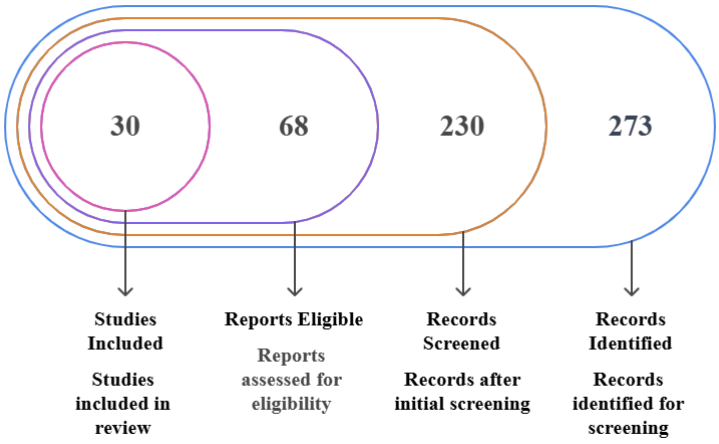


Figure 2: Study Selection Process

Source: Adapted from Page et al. (2021), PRISMA 2020 statement.

Data Analysis

Selected literature was subjected to thematic analysis, which enabled the identification of recurring patterns and categorization of barriers. Themes were grouped into four major categories: Technological, Organizational, Economic/Financial, and Policy and Regulatory Additional themes, including enabling factors and recommendations for improving adoption, were also extracted to support a more holistic understanding. This thematic approach offers a structured and interpretive framework for synthesizing insights across studies. It also enables the alignment of observed challenges with potential solutions, thereby informing both academic research and policy development related to BIM implementation in the Nigerian FM context.

RESULTS AND DISCUSSION

A total of 30 publications from 2018 to 2025 were systematically reviewed, encompassing peer-reviewed journal articles, institutional reports, and case studies. The selection criteria focused on studies related to BIM in facility management (FM) or maintenance within the Nigerian context or comparable environments. The literature was analyzed thematically to identify recurring barriers and recommendations for BIM adoption in Nigerian universities.

Table 3: Analytical Matrix: BIM Adoption for Maintenance – Key Themes

Area of Investigation	Papers	Findings and Gaps in the Papers	Limitations
Technological Infrastructure & Interoperability	(Babatunde et al., 2020), (Okwe et al., 2022), (Durdyev et al., 2021), (Abdulkabir Opeyemi Bello & Calistus Ayegba, 2024), (Boufares et al., 2022), (Majrouhi Sardroud et al., 2018), (Olanrewaju et al., 2020).	Common challenges include software licensing issues, deficient interoperability standards (e.g., COBie/IFC gaps), and inadequate IT infrastructure. **Gaps**: Few studies focus on FM-related interoperability and integration of BIM with existing CMMS systems in Nigerian contexts.	Over-reliance on self-reported survey data; limited in-depth technical assessment; often neglects real-world pilot implementations in universities or public buildings.
Organizational Capacity & Cultural Readiness	(Andersson & Eidenskog, 2023), (Adepoju et al., 2023), (Okwe et al., 2022), (Abdulkabir Opeyemi Bello & Calistus Ayegba, 2024), (Aghimien et al., 2018), (Toyin & Mewomo, 2022),	Resistance to change, low awareness of BIM's FM advantages, and lack of stakeholder engagement are recurrent obstacles. Bello & Ayegba link these awareness gaps to the need for grassroots training. **Gaps**: Little understanding of workflow-level or behavioral barriers when FM teams are not involved in BIM planning stages.	Most findings are SAT-based and focus on Lagos/Abuja, limiting generalizability; qualitative dimensions receive insufficient depth.

Area of Investigation	Papers	Findings and Gaps in the Papers	Limitations
Economic & Financial Constraints	(Abdulkabir Opeyemi Bello & Calistus Ayegba, 2024), (Adepoju et al., 2023), (Bamgbose et al., 2024), (Durdyev et al., 2021), (Abdulkabir Opeyemi Bello & Calistus Ayegba, 2024), (Hamma-adama et al., 2020),	Financial barriers include expensive software/hardware, unproven ROI, and high training costs, particularly affecting SMEs. **Gaps**: Little cost–benefit modelling exists for BIM in FM; long-term ROI remains weakly evidenced.	Absence of lifecycle cost analysis; strategies suggested but not tested for affordability in public institutions or universities.
Policy, Regulatory & Institutional Support	(Andersson & Eidenskog, 2023), (Okwe et al., 2022), (Bamgbose et al., 2024), (Adepoju et al., 2023), (Mansur Hamma-adama & Tahar Kouider, 2019), (Ebekozien et al., 2021), (Alam et al., 2023),	Stakeholders identified weak legal frameworks, lack of enforcement, and poor procurement systems as key impediments to BIM integration **Gaps**: No national BIM mandate or FM standards (e.g., COBie) integrated into government policy.	Wide generalizations across Nigeria, with limited exploration of regional variations or institutional precedent especially in higher education.
Human Capital, Awareness & Training	(Abdulkabir Opeyemi Bello & Calistus Ayegba, 2024), (Ediae & Enoma, 2018), (I.M. Jibrin et al., 2024), (Ikediashi et al., 2022), (Onososen & Musonda, 2022),	Awareness of BIM's potential is moderate, yet FM-specific knowledge is low. Workshops and curricula recommendations emerge as key strategies. **Gaps**: Training programs often target designers/contractors, not FM professionals; FM-specific workflows are overlooked.	Lacks longitudinal studies on training impact; absence of evaluation of university FM curriculum; limited hands-on insights.

Source: Authors' compilation from the reviewed literature

Identified Barriers to BIM Adoption

The thematic analysis revealed four primary categories of barriers hindering BIM adoption in Nigerian universities:

Technological Barriers

i. Software Interoperability Issues: Incompatibility between different BIM software platforms hampers seamless information exchange among stakeholders.
ii. Inadequate ICT Infrastructure: Many universities lack the necessary technological infrastructure, including reliable internet connectivity and up-to-date hardware, essential for effective BIM implementation.
iii. Limited Technical Expertise: There is a scarcity of personnel proficient in BIM tools and processes, leading to underutilization of available technologies.

Organizational and Cultural Barriers

i. Resistance to Change: Institutional inertia and a preference for traditional methods over innovative practices impede the adoption of BIM.

ii. Lack of Awareness and Training: A significant number of university staff and management are unaware of BIM's benefits, and there is a dearth of training programs to build necessary competencies.
iii. Bureaucratic Challenges: Complex administrative procedures and hierarchical decision-making processes slow down the integration of new technologies like BIM.

Policy and Regulatory Barriers

i. Absence of Standardized Guidelines: The lack of national or institutional policies mandating or guiding BIM implementation results in inconsistent practices.
ii. Unclear Legal Frameworks: Ambiguities in legal responsibilities and data ownership within BIM processes deter institutions from full-scale adoption.

Stakeholder Perspectives

Interviews and surveys from the reviewed literature indicate that stakeholders, including facility managers, architects, and university administrators, acknowledge the potential benefits of BIM. However, they also highlight the pressing challenges, particularly the lack of training and financial constraints, as significant impediments to adoption.

CONCLUSION

This study systematically reviewed 30 publications from 2018 to 2025 to investigate the barriers to Building Information Modelling (BIM) adoption for facility maintenance in Nigerian universities. The findings reveal a multifaceted challenge involving technological, organizational, economic, and regulatory dimensions. Technologically, inadequate ICT infrastructure and software interoperability issues significantly impede integration. Organizationally, resistance to change, poor awareness of BIM's facility management (FM) applications, and the absence of FM personnel in early decision-making processes create internal bottlenecks. Financial constraints—especially high software/hardware costs and the lack of clear return on investment (ROI) evidence remain a major obstacle, particularly for public institutions. Moreover, a lack of national BIM mandates, standardized FM protocols, and legal clarity further compounds the challenge. Despite growing interest and acknowledgment of BIM's potential among stakeholders, adoption within universities remains limited due to these persistent structural and contextual barriers. Most reviewed studies called attention to the same recurring issues but offered limited longitudinal data or context-specific policy frameworks. This underscores a significant research and implementation gap.

Recommendations

To improve the adoption of BIM for building maintenance in Nigerian universities, the following strategies are recommended:

1. Strengthen Technological Infrastructure

i. Universities must prioritize investment in ICT infrastructure, including broadband internet, BIM-compatible servers, and cloud-based data management systems.

ii. Promote the use of open standards (e.g., COBie, IFC) to address interoperability issues between software platforms used by different stakeholders.

2. Promote Institutional Capacity and Cultural Change
   i. Integrate FM professionals early in the BIM process to improve operational continuity post-construction.
   ii. Facilitate organizational change management programs to address resistance and institutional inertia.
3. Develop Targeted Training and Awareness Programs
   i. Establish BIM-for-FM curricula and continuous professional development (CPD) modules tailored to facility managers in tertiary institutions.
   ii. Encourage collaboration between academia and industry to provide hands-on training, internships, and pilot implementation projects.
4. Address Financial Constraints Through Strategic Planning
   i. Conduct cost–benefit and lifecycle analyses specific to public sector FM to build a compelling business case for BIM investment.
   ii. Explore open-source BIM tools and public–private partnerships (PPPs) as cost-saving alternatives for early-stage implementation.
5. Policy and Regulatory Reform
   i. Develop national BIM guidelines specifically targeting FM and public sector buildings, ensuring integration into Nigeria's National Building Code and tertiary education infrastructure policies.
   ii. Establish institutional mandates that outline BIM standards for maintenance, data management, and asset handover.
6. Encourage Empirical and Longitudinal Research
   i. Support empirical research into BIM implementation case studies in Nigerian universities, including longitudinal evaluations of training outcomes and pilot programs.
   ii. Promote regionally differentiated research to account for contextual variations in policy readiness, infrastructure, and stakeholder dynamics.

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