

BUILDING INFORMATION MODEL IN NIGERIA CONSTRUCTION INDUSTRY: BENEFITS AND BARRIERS

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Introduction

Over time, stakeholders have often misunderstood the discussions surrounding the built environment and the construction industry, particularly regarding the need for greater project certainty, cost efficiency, and timely execution. Concurrently, the compelling trend of digitalization continues to grow, with numerous projects illustrating that digital workflows are becoming increasingly integrated, offering a real chance to revolutionize the delivery of major programs. Digital disruption can no longer be viewed as limited to Building Information Modeling (BIM) specialists or confined to model-based approaches; it is now a permanent aspect of the construction sector. Data and technology are enabling a new form of collaboration among project teams (Jon, 2022).

The construction industry has become more intricate and harder to manage due to low investment rates, escalating costs, heightened risks, waste, and a significant increase in labor productivity (Ibrahim & Ahmad, 2020). As a result, BIM emerges as a valuable solution focused on managing information and addressing building challenges. Digital technologies are being employed to enhance sustainability and productivity in the construction sector, streamlining procurement activities and project execution. Consequently, architects and construction professionals can now visualize and convert building designs and data into detailed information through innovative processes enabled by BIM.

Research increasingly supports the idea that digital technologies, like BIM, have significant potential to enhance the quality of services offered by design, engineering, construction, and real estate professionals (Charlesraj & Dinesh, 2020; Olawumi & Chan, 2019; Yin *et al.*, 2019). The introduction of computers and related technologies has notably impacted construction professionals (Othman *et al.*, 2022). Samimpay and Saghatforoush (2020) highlight that construction professionals, such as architects and civil engineers, primarily use BIM to visualize their designs before actual construction begins, thereby minimizing errors and saving costs for clients, as any changes made to the digital model or database are automatically updated throughout the entire model. Furthermore, Albert, Akanni and Onumisi (2024) argued that BIM has enhanced collaboration among architects, clients, engineers, building services, manufacturers, contractors, and other consultants involved in infrastructure projects, which was previously challenging.

The construction industry in Nigeria is rapidly expanding due to urbanization, infrastructure growth, and a rising population (Albert *et al.*, 2025). This growth has led to increased demand for sustainable construction practices that comply with global standards and the United Nations Sustainable Development Goals (Ahankoob, Manley & Abbasnejad, 2022). However, despite the potential advantages of BIM in meeting these objectives, its adoption in Nigeria remains low. Research by Oke *et al.* (2019) indicates that this is primarily due to challenges such as lack of awareness, insufficient training, high implementation costs, and resistance to change among stakeholders. Consequently, many construction projects in Nigeria continue to rely on traditional methods, leading to delays, cost overruns, and

environmental harm. While previous studies have identified barriers to BIM in Nigeria, none have quantified its effect on reducing material waste in sustainable projects. The urgency to adopt innovative technologies like BIM is growing, especially as the Nigerian government and various stakeholders advocate for greener construction practices to address climate change. BIM provides a valuable opportunity to integrate sustainability into the planning, design, and construction phases of building projects.

Concept of Building Information Model

The building construction industry has experienced significant changes in its manufacturing methods and operational procedures over the years (Popoola *et al.*, 2024). From conception through to delivery and completion, the core product of the industry buildings continually undergoes innovation, modification, and transformation. A notable recent advancement in this field is Building Information Modeling (BIM), which represents a fundamental shift in the architecture, engineering, and construction (AEC) sectors, fundamentally changing how projects are designed, constructed, and managed.

BIM is an innovative approach to building design, construction, and management that has reshaped how industry experts view the application of technology both nationally and internationally (Azhar, 2011). Its introduction has been one of the most significant advancements in building design, management, maintenance, and operations (Ayarici *et al.*, 2009). These innovations have equipped project teams with new communication formats and collaborative tools that engage multiple senses. BIM provides sophisticated analytical tools and decision-making instruments that model and replicate both real and conceptual structures and environments, thus significantly impacting building procurement.

BIM Dimensions

Parametric 3D Modelling (3D BIM): 3D BIM enables work in three dimensions, applying construction logic within a virtual environment. This means that any changes made in one part of the model are automatically reflected in other areas, eliminating the need for manual updates. Starting with a three-dimensional perspective allows all professionals and project stakeholders to make better decisions and minimizes changes during project execution (Staub-French & Khanzode, 2007). Foster (2008) explains that building components are analyzed using clash detection tools to identify and resolve conflicts before installation in the field. The ability of construction managers and specialized contractors to perform 3D coordination prior to construction significantly reduces design errors and enhances understanding of the work required (Young *et al.*, 2009).

BIM-Based Scheduling (4D BIM): In the past decade, research on scheduling has evolved from 3D CAD model-supported construction to 3D BIM with enhanced information-based scheduling (time) (Harrison & Thumell, 2015; Liu *et al.*, 2014). 4D BIM technology links 3D BIM models to associated activities, following the principles of the Critical Path Method (CPM). This integration enables users to run simulations of the project to identify and resolve spatial and temporal conflicts, thereby improving project performance (Elghaish *et al.*, 2018; Zigurat, 2018). Keegan (2010) notes that incorporating scheduling into the virtual construction process introduces time as the fourth dimension (4D BIM). In CPM, activities are listed, linked by their dependencies, and assigned durations, with each activity serving as either a predecessor or successor based on the planned execution order.

Cost Estimation (5D BIM): 5D BIM technology automates measurements and project cost estimation, often by directly linking modeling software to cost control software. Since the budget is derived from the project design, cost values are based on actual measurements rather than estimates (Zigurat, 2018). Elghaish *et al.* (2018) explain that 5D BIM facilitates cost planning and prepares bills of quantities (BoQ). Noor, Scott, and Robert (2016) highlight that BIM improves the reliability of cost estimates, provides early schedule information, quickly predicts the cost impact of design changes, enhances understanding

through better visualization, and increases access to documentation. Makenya and Ally (2018) argue that BIM allows estimators to identify relationships between quantities, costs, and locations, and to understand how various components of a construction project contribute to the overall cost.

Green Design (6D BIM): Improving energy efficiency and utilizing renewable energy sources have become global priorities, prompting many governments to support and promote BIM adoption. Rising energy costs for electricity, gas, and water have motivated building owners to integrate features that reduce energy consumption. Unlike CAD programs, BIM tools enable energy analysis by incorporating the technical properties of materials used in the project (Harrison & Thurnell, 2015; Zigurat, 2018).

Facility Management(7D BIM): The operational phase of a building is often the most costly part of its lifecycle. BIM provides better control over the information and documentation generated by a building's properties, which is a key reason public administrations are eager to transition from outdated systems to fully functional BIM systems (Zigurat, 2018).

Benefits of BIM

Building Information Modeling (BIM) provides substantial advantages in construction projects by improving efficiency, minimizing waste, and fostering collaboration among stakeholders (Gourlis&Kovacic, 2017). A key benefit of BIM is its ability to create accurate, detailed 3D models that enhance planning and visualization (Djuedja *et al.*, 2018; Chong *et al.*, 2017). This feature helps project teams identify potential design problems early, reducing the need for costly rework and ensuring efficient resource use. BIM also enables precise material quantification and scheduling, lowering the chances of over-ordering and waste, which supports sustainable resource management (Nechyporchuk&Bašková, 2020).

Additionally, Oladiran, Simeon & Anyira (2022) noted that BIM enhances energy efficiency by integrating with energy modeling tools that simulate a building's performance under different conditions. This allows architects and engineers to assess design alternatives and make informed decisions to improve energy performance, such as optimizing insulation, choosing energy-efficient systems, and incorporating renewable energy sources. Consequently, projects utilizing BIM can achieve lower operational costs and reduced carbon footprints, aligning with global sustainability goals and enhancing the building's longevity (Chen *et al.*, 2017).

Collaboration is another vital benefit of BIM in sustainable construction. The platform improves communication among architects, engineers, contractors, and owners by providing a centralized model accessible to all stakeholders (Albert, Shakantu& Ibrahim, 2020; Rowlinson, 2017). This collaborative environment ensures alignment on project goals and sustainability objectives, facilitating better decision-making throughout the project lifecycle. As a result, BIM not only streamlines workflows but also enhances the overall quality and sustainability of construction projects, making it an essential tool for environmentally responsible building practices.

Barriers to Implementing BIM

The adoption of Building Information Modeling (BIM) in sustainable construction projects is hindered by several barriers (Succar, 2009). Technologically, the high costs associated with BIM software and the limited interoperability between different platforms pose significant challenges (Teichholz, 2014). Many organizations lack the necessary hardware and infrastructure to support BIM, and integrating it with existing systems can be complex and resource-intensive. Additionally, the scarcity of BIM-compatible tools complicates implementation, especially for smaller firms that may not have the financial and technical resources required.

Organizationally, a shortage of trained personnel and resistance to change are major obstacles. Many companies face budget constraints that result in inadequate organizational structures to support BIM initiatives (Silva *et al.*, 2016). Insufficient support from top management further complicates these challenges, hindering a unified approach to BIM integration (Siew, 2015).

Culturally, a lack of collaboration and communication among project stakeholders can impede effective data sharing and information flow (Nasila&Cloete, 2018; Albert, Shakantu& Ibrahim, 2018). Resistance to data sharing often arises from differing work cultures and languages, leading to misunderstandings about BIM's benefits and potential conflicts between traditional practices and modern approaches (Sinclair, 2012). Lastly, regulatory barriers, such as the absence of clear regulations and standards, can create confusion regarding BIM adoption, while limited enforcement and inconsistent building codes can stifle innovation. Without adequate government support to encourage BIM adoption, the construction industry may continue to face significant challenges in leveraging BIM for sustainable practices.

Conclusion

In conclusion, Building Information Modeling (BIM) presents a transformative opportunity for the construction industry, significantly enhancing efficiency, sustainability, and collaboration among stakeholders. By providing detailed 3D models, BIM enables early identification of design issues, reducing costly rework and waste while promoting effective resource management. Additionally, its integration with energy modeling tools supports informed decision-making that optimizes energy performance, aligning construction projects with global sustainability goals. The collaborative nature of BIM fosters improved communication among architects, engineers, contractors, and owners, ensuring that all parties are aligned on project objectives and sustainability initiatives. However, the successful implementation of BIM is not without its challenges. Technological barriers, such as high software costs and limited interoperability, hinder adoption, particularly for smaller firms lacking the necessary resources. Organizational issues, including insufficient training and resistance to change, further complicate integration efforts. Cultural barriers, characterized by a lack of collaboration and communication, along with regulatory uncertainties, create additional obstacles for the construction industry. Addressing these challenges through enhanced support, training, and regulatory frameworks remain essential for fully realizing the potential of BIM in promoting sustainable construction practices.

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