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A Review of Adoption of Building Information Modelling (BIM) for the Nigerian Building and Construction Industry

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ABSTRACT

Building information modelling (BIM), which is a technological advancement that is crucial for modernizing construction work and enhances value for stakeholder groups, has had a big impact on the construction industry from the implementation stage to the decommissioning phase of the project cycle. It has been widely used in various stages of construction projects, including the design process, production, cooperation, cost savings, and operation. In recent years, the determinants and mechanisms of increasing the use of BIM have attracted increasing attention from the academic community, government agencies, and the media in the developed world. However, BIM technology still faces numerous obstacles, leading to its low adoption in the Nigerian construction industry, which is beset by numerous problems such as conflicts, project abandonment, cost overruns, and time overruns. This paper explores articles and conference papers dwelling on the barriers and benefits associated with adopting BIM as a digital information tool in the construction industry. Its further periscopes comprehensive and qualitative impact and the level of usage of BIM in different climes. The paper concludes that BIM utilization in Nigeria has the potential to facilitate better decision-making ability and savings in operating costs, amongst others, if the benefits are more emphasized amongst the stakeholders in the construction industry.

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Introduction

According to other experts, building information modelling (BIM) is a cutting-edge technique that promotes efficient teamwork among project teams, improves quality delivery and safety performance, and improves customer satisfaction and relationships [1,2]. Building information modelling (BIM), according to is a technological advancement that is crucial for modernizing construction work and enhancing value for stakeholder groups [3].

Building Information Modeling is an IT-enabled procedure for the digital representation of the building and interaction with it by the many stakeholders throughout the project's lifecycle [4]. The use of BIM at the project, organizational, and industry levels has been associated with several advantages. Studies that have already been conducted have proven benefits like improved design processes, cooperation, time and cost savings, and increased production. These advantages, along with several others, have motivated governments and other institutions to launch BIM campaigns in the building sector [4].

The construction industry is a complex industry with low productivity when compared to other industries, e.g., the manufacturing industry [5]. Additionally, this industry boosts employment and raises revenue for businesses. The building sector, according to serves as the foundation and driving force of national economies [6]. Despite these crucial and significant roles played by the construction sector, delays in schedule and budget, low quality, safety concerns, claims and disputes, and contract party unhappiness are some of the characteristics of construction projects.

Averred that to reduce inefficiencies in the industry, construction sectors must make use of this cutting-edge technology that is transforming project management [7]. The construction industry needs to innovate to maintain its favorable image in the sector and remain sustainable and competitive. Successful competition is necessary for building firms to exist. This can be accomplished by using modern technologies; the outcomes since the UK-enforced BIM application are astonishing [8].

However, the majority of developing nations have reportedly been hesitant to adopt and implement BIM [9]. Nigeria, a developing country, is likewise noting these developments in BIM usage. Similar to other developing countries, Nigeria experiences several challenges with its building projects, including delays, cost overruns, project delays, project abandonments, corruption, disputes, and the production of waste [10,11]. Because of this, the adoption and implementation of BIM will be of utmost importance and value in the Nigerian construction sector when carrying out building projects [4,12,13].

Despite the advantages that have been mentioned and the potential that BIM provides for the construction industry in developed and a few developing countries, not so much has been done in the Nigerian construction industry. Maintained that BIM offers a lot

of promise for the Nigerian construction industry [14,15]. It is therefore necessary to assess the potential benefits of BIM adoption in the Nigerian construction industry to improve its application, safety management, and impact on sustainable architecture in Nigeria.

The Concept of Building Information Modelling (BIM)

The building construction industry has undergone significant transformations in its manufacturing processes and operational protocols over the years [16,17]. From the time of conception until the processes of delivery and completion, the building—the principal product of the industry—is always being innovated, modified, and changed. One of these more recent breakthroughs is building information modelling or BIM. Claims that Building Information Modeling (BIM) is a new and innovative approach to building design, construction, and management that has changed the way experts in the industry consider how technology may be applied nationally and internationally [1]. According to one of the most interesting advancements in building design, management, maintenance, and operations is the recent introduction of BIM [18]. These developments have provided project teams with the potential for novel communication formats as well as multisensory collaborative tools. These days, there are sophisticated analytical and multidisciplinary decision-making instruments intended to model and replicate real or imagined structures and environments [19]. Thus, BIM has significant effects on the purchase of buildings [20].

Describes BIM as a process that begins with the creation of an intelligent 3D model and enables document management, coordination and simulation during the entire lifecycle of a project plan, including design, build, operation and maintenance [21]. BIM has been defined as a highly collaborative process that allows multiple stakeholders and construction professionals to collaborate on the planning, design, and construction of a building within 3D models. Data created, modified and added to by the several professionals involved is used in the operation and management of buildings. These data allow owners and stakeholders to make decisions based on pertinent information derived from the model, even after the building is constructed. According to BIM is the process of developing an intelligent building model which can be more easily modified, and which can accurately represent the final building product [22]. It can be used to illustrate the entire building lifecycle, from cradle to inception, design and demolition and material reuse; quantities and properties of materials, which can be easily extracted from the model; and the scope of work, including the management of project targets and facilities throughout the building's life.

Adoption of Building Information Modelling (BIM) Around the World

United States

The United States has historically been a global leader in the development and use of Building Information Modeling (BIM) in the construction industry [23]. The General Services Administration (GSA) in the US was a pioneer in the use of BIM on public projects. All government facilities in the United States are constructed and run by the General Services Administration (GSA). In 2003, they introduced a national 3D-4D-BIM program through its Public Buildings Service (PBS) office. In 2007, it mandated that all of its projects use BIM for spatial program validation [24]. A variety of international standards and recommendations, including the National BIM Standard, have also been developed by them. The GSA is undoubtedly in the lead when it comes to BIM usage initiatives [25]. This program has significantly influenced the use of BIM by the public sector, with approximately 8700 structures and over 300 million square feet of space nationwide. This demonstrates the significance of significant client and governmental leadership for the sector [26].

"A deliberate and gradual deployment of 3D, 4D, and BIM technologies is what the GSA is committed to," according to Building Smart Australasia [26]. GSA's next step in the deployment of BIM is to examine how BIM technology is used in the following domains throughout a project: building elements, energy and sustainability, laser scanning, 4D phasing, spatial program validation, building elements, and circulation and security validation. CIBER also notes that it is the intention of the US government to mandate BIM [25].

United Kingdom

There is a widespread belief that the UK government has executed the world's most advanced and comprehensive centrally-driven BIM implementation program for the UK construction sector [27]. The objective is to position the UK sector as a global leader in BIM in a reasonably short period of time [28]. The UK Government Construction Strategy was launched in 2011 and has a five-year phased implementation plan. By 2016, BIM will be mandatory for all government projects. The government's objective of reducing procurement costs by 20 percent is thought to depend on BIM [29]. This strategy has caused a big change in the UK construction industry since businesses now have to deal with the difficulty of developing the necessary technological capabilities to meet these objectives. The UK government established a BIM task group to assist clients in the public sector and the commercial sector supply chain in reengineering their work processes to accept BIM delivery [30].

Scandinavian Region

The Scandinavian region leads the world in the adoption and deployment of BIM. Norway, Denmark, and Finland were among the first countries to embrace model-based design, advocate for standards and interoperability, and play a significant role in the development of industry foundation classes (IFCs) and other interoperability projects. They were also early adopters of ArchiCAD software. Model-based BIM technology is ideal for this type of building, and prefabrication plays a big part in construction in this area, claims [24]. The development and use of BIM technology are also highly encouraged and supported by the several governments in this region. The major government agency in charge of managing the country's real estate holdings, Senate Properties, is the driving force behind the implementation of BIM in the public sector in Finland. Senate Properties has been setting the bar for BIM modelling since 2007 and insisting that it be IFC compliant [26].

The Danish government is a strong supporter of BIM and makes large R&D investments [31]. Projects for Danish government clients, such as the Palaces & Properties Agency and the Defense Construction Service, must employ BIM [32]. BIM implementation in Norway is handled by the company Stratsbygg, which is in charge of creating, maintaining, and constructing government buildings. They have been using BIM for projects since 2007 and have required BIM that meets IFC standards since 2010 [26].

Singapore

The Singapore Building and Construction Authority (BCA) has created a plan to have BIM widely utilized on public projects

by 2015 [31]. Furthermore, with a particular focus on BIM, the government established the $250 million Construction Productivity and Capability Fund (CPCF). The Construction and Real Estate Network (CORENET) program was established in 2000 as a strategic endeavour to use information technology to promote industry transformation. Another initiative to support the industry's use of BIM is the CORENET e-Plan Check system for development apps. The technology provides an online "portal" for engineers and architects to confirm that the regulations are met by the structures they have created using BIM. In Singapore, the Industry Foundation Classes (IFC) serve as the benchmark for BIM implementation [26].

South Korea

South Korea's degree of BIM implementation and involvement is comparatively low when compared to other nations in the region. This was unexpected considering that South Korea is known for being a highly "high-tech" nation and for being a global leader in the integration of ICT into education [30].

Japan

According to the McGraw Hill report, Japan has a greater level of BIM implementation. Almost every contractor who responded to their survey indicated a favorable return on investment (ROI) for their involvement and implementation of BIM, which is an intriguing discovery [30]. Additionally, supply chain management, model-driven robotics, and post-construction tasks were among the areas where BIM was used frequently.

Australia

There are presently no government mandates requiring the use of BIM on significant projects in Australia's construction industry, nor is BIM use in the sector particularly widespread. However, over the past five years, efforts to involve and educate project stakeholders about the potential for productivity improvements and obtaining competitive advantage have led to an increase in interest in the implementation of BIM [25]. The National BIM Guide by the National Specification (NATSPEC), the National Guidelines for Digital Modelling by the Corporate Research Centre for Construction Innovation (CRC-CI), the Australian and New Zealand Revit Standards (ANZRS), and the BIM-MEPAUS guidelines and models are a few examples of these initiatives. The organization "Building Smart," formerly known as the International Alliance for Interoperability, is still at the forefront of BIM development and application in Australia. This includes creating the "Open BIM Alliance of Australia," which unites several software providers to advance the idea of "Open BIM" [25].

Brazil

Brazil has a significant impact on the South American region because it is the largest nation and has the greatest economy in Latin America. The staging of important events like the Olympic Games in 2026 and the FIFA World Cup in 2014 has contributed to the growth of the Brazilian construction business. Numerous multinational corporations are operating in Brazil, impacting the BIM landscape and elevating the degree of BIM implementation in the regional market. While the Brazilian industry is still relatively new to embracing BIM, there is growing momentum in the nation, according to the McGraw Hill international study of contractors. Nonetheless, there is a dearth of government coordination and corporate leadership [30].

China

In Chinese companies, BIM usage is still relatively new. In a 2012 survey by the China Construction Industry Association, less than 15% of the 388 Chinese construction companies evaluated said they used BIM [30]. To find out more about the use of BIM in China, McGraw Hill also spoke with leading industry figures through interviews. Since they believed that BIM was "additional work" that had a fixed cost, designers had little incentive to use it. They also found that the Chinese industry had structural barriers, like the difficulty of changing conventional norms, and that Chinese law required the design and construction phases to be separated on many projects. Nevertheless, the Ministry of Science and Technology established the China BIM Union in 2013 as a component of the China Industry Technology Innovation Strategic Alliance. BIM standards are being developed, and a draft of the Chinese National Standard, "Unified Standard for BIM Application," has been finished and made available for review [33].

India

India is just starting to use BIM, according to [30]. Nevertheless, they note that a large number of international companies are moving their operations to India and that the country's construction industry, currently valued at US$140 billion, is projected to grow significantly to $620 billion by 2020. This is going to help get BIM into the market. They found that while big construction companies are starting to use BIM more frequently in large project sectors like hotels and airports, it is still not being used extensively. The industry requires more thorough training and development because of the restricted, ad hoc use of BIM, which results in high implementation costs.

Middle East

The Middle East has a relatively low adoption rate of BIM, at about 30% [34].

Malaysia

Found that just 13% of 268 participants from both public and commercial enterprises in Malaysia had used BIM, indicating a poor adoption rate [35]. Low knowledge, a prolonged adoption process, and unclear policy guidelines were blamed for this situation. In Malaysia, there is a low level of BIM awareness, according to [36].

Indonesian

Despite Indonesia's expanding construction industry, BIM has not been widely used in the country's construction sector, especially among local contractors [37,38].

Africa

The adoption of BIM is still very low in Africa, according to the article by [39]. Inadequate coordination and information management among project stakeholders have led to the Kenyan construction industry's current BIM adoption lagging behind, according to assessment [40]. There has been little research done in Nigeria and other African countries on the adoption and use of BIM [35, 9].

Nigeria

Like most developing nations, Nigeria's construction sector is considered a "BIM infant industry" [41]. This is true even though Nigeria has the biggest construction industry in all of West Africa discovered that while BIM awareness is reasonable, adoption of the technology is poor in Nigeria because of the high degree of change management needed, the need to overcome human resistance, and the comfort level with the current traditional ways, adopting BIM has proven to be a difficult process [5,42,43]. Noted that mainstream construction organizations and projects have

not yet fully benefited from BIM due to its inherent difficulties in implementation [44]. Despite the benefits of BIM, Nigeria, a developing country, is still unable to make the same claim because the majority of BIM research has come from developed countries [45]. Are a few examples of BIM research in Nigeria that has focused on the reasons for and challenges of BIM [43,46-48]. However, the benefits of IBM have not been accentuated and bolstered, thereby making the adoption of BIM taking longer than anticipated [45]. Making stakeholders aware of BIM's benefits could encourage and hasten the industry's adoption of the technology [49].

Listed the potential barriers to BIM adoption in the Nigerian construction Industry to be social and habitual resistance to change, legal and contractual constraints and high cost of integrated software for all professionals, lack of enabling environment in form of policies and legislations of government towards the adoption and then lack of trained professionals to handle the tools [50]. The findings are consistent with on BIM awareness in the Nigerian construction industry [51,19].

Benefits of Building Information Modelling (BIM) Adoption in the Construction Industry

The adoption of BIM has numerous advantages, ranging from project design and planning to construction, operation, and maintenance. Divided the benefits of BIM into five categories: budget, schedule, design, communication, and documentation-related [52]. The main underlying issues with the benefits of BIM adoption are related to project pace, clients, the innovation system, competition, efficiency, and cost versus time [53]. According to a study by The creation of time-based simulations of construction operations, enhanced building performance and quality, concept, feasibility and design, and expanded design are the main advantages of BIM in the pre-construction stage [49].

State that the primary advantages of BIM throughout the operation and maintenance phases are: the facilitation of the sharing of building life cycle information; the enhancement of teamwork, improving whole-life cost control, lowering the chance of project information loss, and improving environmental sustainability [49]. According to BIM enhances design, better clash detection, coordination, synchronization, and project sequencing are just a few of the advantages outlined [54,55]. BIM also makes it possible for the project team to access and analyse project information.

The advantages of BIM were categorized by into three stages: pre-construction, construction, and post-construction [56]. During the pre-construction stage, Building Information Modeling (BIM) facilitates quicker and more precise cost estimation, promotes sustainable design, enhances energy efficiency, improves concept and feasibility, and resolves design conflicts by visualizing a model [57-59].

BIM facilitates the fabrication of building components offsite, allows for effective and efficient site utilization, improves resource planning and sequencing during the construction phase, and allows for effective management of project resource procurement and storage [57,58,60-62].

According to the most significant post-construction benefits of BIM are: enhanced facility management and operation following completion; a streamlined approach where data is shared in a collaborative manner; improved design quality, sustainability, and client communication; savings in design coordination, drawing production, information management & exchange; reduces information loss when project is transferred from design team to construction team to owner; controlled whole-life cost and environmental data; easier maintenance work scheduling; better access to information during maintenance; enhanced asset management with faster and more accurate information; and enhanced decision-making at the operation and maintenance stages [60,62,63].

Assert that BIM has a more pronounced beneficial influence on productivity, which may be helpful in motivating SMEs to switch from the conventional construction method to a more practical one that makes use of BIM [23]. BIM enhances and supports the services provided by experts in the built environment [64].

The most often mentioned advantage of BIM in the literature is cost control and reduction throughout the project's life cycle [65]. Claim that one of the newest developments in a building that has accelerated problem-solving is BIM [66]. It was also mentioned that when used by professionals in the construction industry, it can reduce design errors and mistakes, enhance project performance in terms of cost and schedule, improve design quality, boost stakeholder cooperation and coordination, and enhance construction integration. BIM may reduce costs, reduce design conflicts, facilitate informed and high-quality decision-making, enhance project performance, and foster better teamwork [67]. Using BIM-based technologies allows an engineer or architect to apply innovative methods that reduce risk.

Conclusion

This review has covered in detail the benefits, adoption rate, and usage of BIM throughout all continents. The lack of BIM technology awareness among professionals and clients, the absence of knowledgeable and experienced partners, the absence of trained professionals and frequent power outages, societal and habitual resistance to change, legal and contractual restrictions, the high cost of integrated software for all professionals, the absence of supportive policies and legislation from the government, the lack of professionals with the necessary training to handle the tools, and the absence of standards to direct the implementation of BIM were all noted as obstacles to the adoption of BIM in Nigeria.

Cooperation from all parties involved in the supply chain for building design and construction, as well as the education and training of building design experts, The industry will be ready for BIM adoption if the government provides guidance and support, requires the use of BIM in projects, and collaborates with Nigerian construction stakeholders and government regulatory organisations to provide standards and regulations. The Nigerian construction industries would be prepared to take advantage of the possibilities of Building knowledge Modelling technology in their services if all adoption barriers are eliminated or greatly reduced and stakeholders are given enough knowledge about the benefits.

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