Building Information Modelling for Sustainable Construction Project Delivery in Nigeria

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Abstract

The Fragmented nature of the Nigerian Architecture, Engineering, and Construction (AEC) Industry, and lack of coordination and communication among parties in its supply chain has led to the industry's continued failure to meet up with client's demands of delivering sustainable and quality projects on time and at required cost. Consequently, adversarial contractual relationships among professionals, and failure to embrace sustainability as an integral aspect in carrying out its processes, have made it difficult for construction teams to effectively deliver sustainable value to its customers. In addressing the issue, Building Information Modelling (BIM) was deployed as a significant tool for enhancing collaboration and thus boosting the sustainable focus of the AEC industry. This study was aimed at advancing the adoption of BIM as a tool for enhancing sustainable project delivery in Nigeria. A quantitative research approach was adopted to carry out the study. A total of 100 copies of well-structured questionnaire with 5-point Likert scale question items were administered to construction stakeholders. The data were analyzed using both descriptive and inferential statistical methods, including mean item scores, percentages, and the relative importance index. The findings of the study show that the level of implementation of BIM in the Nigerian construction industry is inadequate because of the industry's resistance to change, lack of proper understanding of BIM, and perceived excessive cost of BIM implementation. The findings also indicated that effective implementation of BIM in Nigeria's AEC industry would enhance professional collaboration and minimize the wastage of construction resources. This will consequently bring about substantial improvement in the sustainability approach in the AEC industry in Nigeria.

Keywords: Building information modelling, sustainability, sustainable construction

Introduction

On a global scale, the construction industry and its products contribute to sustainability problems arising because of resource depletion, energy consumption, pollution, and waste creation (CIOB, 2004). A review made by Koleosho and Adeyinka (2006) shows that there is a need for cross-examination of the activities of the construction industry in Nigeria and its products that cause sustainability crises in the environment, to identify their impacts for mitigation. This was corroborated by the UN-Habitat report in Nigeria (2004) which stated that "the design, construction, maintenance and use of structures have impacts on the environment; some of these adverse impacts include energy impact, ecological impact, visual impact as well as material impact". Aje (2016) further posits that the Architecture, Engineering, and Construction (AEC) industry in Nigeria faces the problem of delivering sustainable construction projects which have resulted in its inability to meet client's expectations of delivering quality projects on time and at a required cost, coupled with the fact that the construction sector is responsible for a large proportion of energy and material consumption, biodiversity loss, waste generation and pollution (CIOB, 2004).

Egan (1998) submits that the major problems inhibiting the construction industry from meeting its expectations of delivering sustainable projects stem from the industry's fragmented nature in its processes and lack of coordination and communication among parties in the supply chain. Aranda-Mena et al. (2009) submitted that fragmentation and calcified processes inhibit widespread change in the building industry, thus, the disintegration of the design and construction activities coupled with adversarial contractual relationships amongst professionals have made it difficult for construction teams to effectively deliver sustainable value to its customers. Bola-Efe, Ajayi, and Ordu (2019) argued that for Nigeria's construction industry to deliver the needed outputs while advancing sustainability, it must embrace more sustainable policies and practices.

The report by Egan (1998) identified five key drivers for a radical change. One of the drivers was that the project team needs to be integrated around the product to effectively combine their skills and knowledge resulting in sustainable value creation for the client. One of such tools that will be able to meet this requirement and which is currently gaining popularity among most developed countries is Building Information Modeling (BIM). It has been in use internationally for several years, and its use continues to grow (Ryan & Derek, 2014). As an emerging concept in sustainable construction, BIM has become widely recognized and adopted by construction professionals globally. It is also likely to become the industry standard for project design and also a fundamental tool in project procurement in the near future (Weddikkara & Jayasena, 2013). Campbell (2007) noted that the AEC industry is undergoing a significant transformation toward adopting BIM as a tool to unify its fragmented structure, reduce inefficiencies, strengthen collaboration and communication, and boost overall productivity.

However, compared with the international practice of BIM which has been on the rise in the past decades, Nigeria as a developing nation is still lagging. The AEC industry globally is adapting to increased demands for the use of BIM during the design and construction phases of projects. Building owners are progressively mandating the use of BIM on their projects, as the approach has demonstrated multiple benefits in the construction process—such as improved clash detection, enhanced collaboration and visualization, energy performance assessment, and positive effects on life cycle costs—ultimately saving time and money while ensuring more sustainable and higher-quality outcomes (Aðalsteinsson, 2014).

Over the past decade, projects have been completed and documented in developed countries which demonstrate the capability of using BIM in construction, and these BIM applied projects have been demonstrated to be more sustainable compared to non-BIM Projects (Mihindu and Arayici, 2008). To achieve a wider perspective during the decision-making process, sustainable decisions can be combined with BIM in the process to accomplish sustainable project delivery in the construction industry.

Problem Statement

The Nigerian Architecture, Engineering and Construction (AEC) Industry is faced with significant challenges in delivering sustainable projects due to its fragmented nature and lack of communication and coordination among parties in the supply chain. This challenge has hindered construction teams from providing sustainable outcomes for clients and has contributed to the industry's failure to meet expectations for timely, high-quality, and cost-effective project delivery.

Aim

The purpose of this paper is to highlight the advantages of BIM and promote its wider adoption in Nigeria’s AEC industry as a means of achieving sustainable project delivery.

Objectives

The objectives of this paper will focus on the following;

a) Evaluate the level of knowledge of BIM among construction professionals in Nigeria

b) Identify the benefits of BIM application in the construction Industry

c) Examine the factors hindering the implementation of BIM within Nigeria's construction industry.

d) Demonstrate how BIM contributes to the advancement of sustainable construction practices.

Methodology

The study employed a quantitative research approach, utilizing both primary and secondary data collection methods. A thorough examination of academic journals, textbooks, online media, and other publications provided the secondary data, while primary data came from participants who completed hand-administered questionnaires with five-point Likert scale responses. The study focused on AEC industry professionals—including architects, quantity surveyors, builders, and engineers—working in consulting firms, contracting companies, and government agencies who had substantial experience with building construction projects in southeastern Nigeria. Out of one hundred (100) questionnaires that were distributed, eighty (80) were accurately completed, returned, and considered usable, which represents an 80% response rate. Descriptive statistics, mean index scores (MIS), and Relative Importance Index (RII) were used to analyze the data, with computations supported by BolaCart, a proprietary spreadsheet program.

Concept Of Sustainable Construction Project Delivery

Sustainable development (SD), as defined by the American Institute of Architects (AIA, 2007), refers to advancement that addresses present-day needs without undermining the capability of future generations to meet theirs. Hill and Bowen (1997) describe sustainable construction as the creation and responsible management of a healthy built environment based on resource efficiency and ecological principles. It follows that sustainable construction represents the practical application of sustainable development concepts to the construction industry.

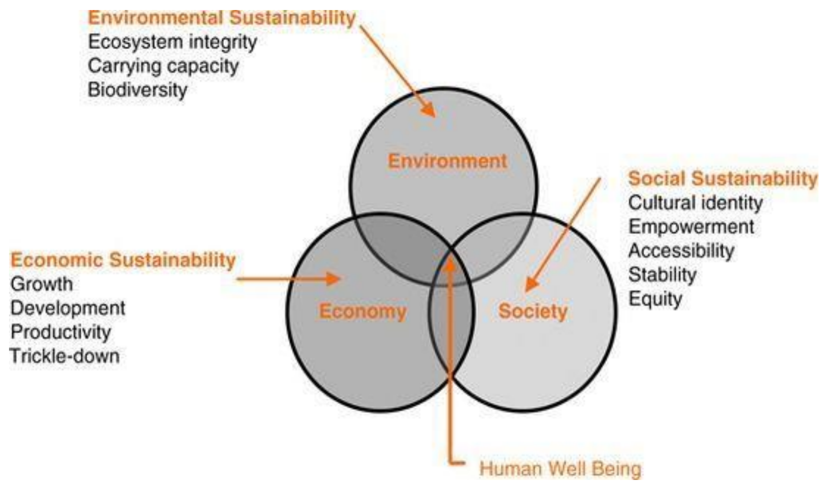

Figure 1 – Pillars of Sustainable Construction - Source – Al Elfy (2010)

Typically, sustainable construction seeks to enhance living, working, and leisure environments for individuals and communities; use minimal energy and generate minimum waste over the course of its lifecycle; integrate with the natural environment, and use renewable resources where possible.

To fully achieve sustainability in the construction industry, Kilbert (2012) identified seven principles which include reducing resource consumption (Reduce), reusing resources (Reuse), using recyclable resources (Recycle), protecting nature (Protect), eliminating toxic substances (Toxic), applying life-cycle costing (Economics), and focusing on quality (Quality). Riley and Horman (2004) assert that delivering sustainable building projects demands extensive cross-disciplinary cooperation, sophisticated design evaluation, and meticulous selection of materials and systems, especially during the early stages of project execution. Also Soltani (2016) further tenders that BIM technology can facilitate sustainable building delivery in various phases from the initiation stage to demolition by providing an integrated design workflow at each stage.

Concept Of Building Information Modeling

With the burgeoning literature on BIM, it is obvious that BIM is perceived as an ambiguous term that means different things to different professionals. According to a study conducted by Aranda-Mena *et al*, (2009), BIM can be seen as a software application on the one hand, and as a process for designing and documenting building information on the other. Bhagat & Agrawal (2015) describe BIM as a project as well as a process simulation where designs are produced using virtual supported software that gives a form of interactive representations of a model, where any changes made in the Model are automatically coordinated throughout the project which helps to eliminate any coordination mistakes and improves the overall quality of work.

BIM enables the creation of virtual construction project simulations through software applications, producing results that closely mirror real-world conditions. Virtual building implies that it is possible to practice construction, experiment, and adjust in the project before it is actualized. Virtual mistakes do not have profound consequences if they are identified and addressed early enough and can be avoided during the actual construction of the project. When a project is planned and built virtually, most of its relevant aspects can be considered and communicated before the instructions for construction are finalized.

By logical extension, BIM functions as a methodology rather than a tangible product. The resulting outputs, known as Building Information Models (BIMs), are digital documents that capture comprehensive project details and facilitate decision-making across the entire project lifecycle. It has been thought that BIM was nothing more than 3D modelling but it involves more than that. Building Information Modeling (BIM), along with its various subsystems and analogous technologies, encompasses dimensions that extend beyond the conventional three-dimensional framework (length, breadth, and height) to integrate additional dimensions, including the fourth dimension (temporal aspect), the fifth dimension (financial implications), and even the sixth dimension (operational performance post-construction) (Smith, 2014).

BIM Activities

BIM activities and processes involve the creation of intelligent data that can be used throughout the lifecycle of a building or infrastructure project. The process begins with the creation of an intelligent 3D model that enables document management, coordination and simulation during the entire project lifecycle. The four-dimensional (4D) model delineates a relationship among construction operations, temporal frameworks, and three-dimensional (3D) visualizations, culminating in a real-time graphical simulation that illustrates the advancement of construction projects. The incorporation of the temporal dimension enables a thorough evaluation of both the feasibility of construction and the planning of workflows relevant to the undertaking.

All participants involved in the project possess the capacity to proficiently and effectively visualize, analyze, and communicate concerns pertaining to the sequential, spatial, and temporal aspects of the construction progress. This ultimately results in the enhancement of scheduling, site configuration, and logistical strategies that contribute to increased productivity. The five-dimensional (5D) model integrates the dimension of "Cost" within the Building Information Modeling (BIM) paradigm, thereby facilitating the instantaneous formulation of cost estimates and financial representations of the model in relation to time. This innovation substantially augments the accuracy of financial estimations, reduces the incidence of conflicts commonly linked with Computer-Aided Design (CAD) data, and facilitates cost consultants in dedicating a greater proportion of their time towards value optimization. The six-dimensional (6D) model incorporates sustainability components within the BIM framework. It empowers professionals and designers to achieve carbon objectives for specific project elements, while simultaneously validating decisions or evaluating and contrasting alternatives. The 7D model facilitates the integration of facilities management into the BIM paradigm. The inclusion of detailed descriptions of architectural elements and engineering services, alongside comprehensive accounts of geometry, interrelations, and property functionalities, renders BIM an exemplary database for facilities management. The 8D model integrates safety considerations into both the design and construction phases (Kameedan 2010). In conclusion, BIM equips designers with the capability to accurately forecast project performance prior to construction, adapt to design modifications with increased agility, enhance designs through analytical methods, simulations, and visualizations, and produce superior quality construction documentation.

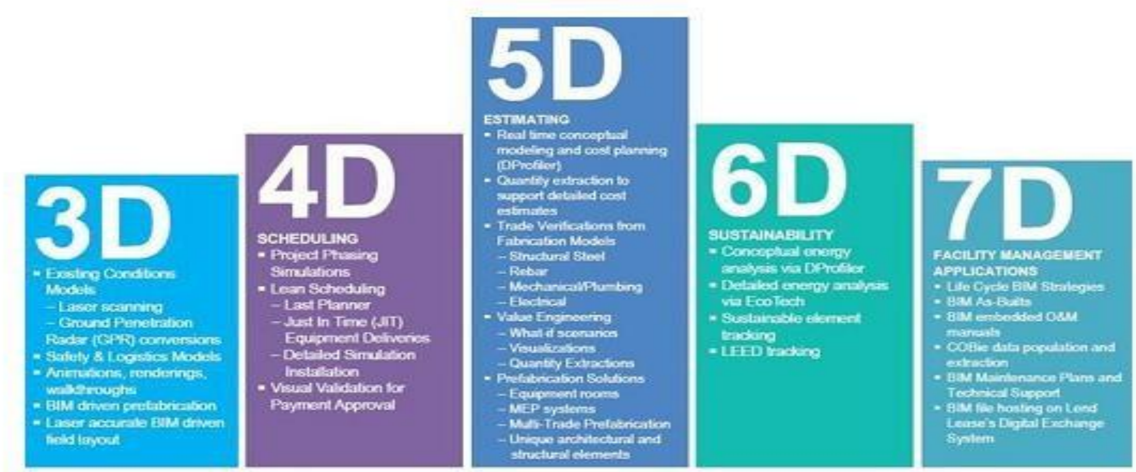

Figure 2 - Subsets of BIM, courtesy of Synchro Software

Benefits of BIM

A comprehensive analysis presented in a McKinsey report (2012) indicated that 75% of organizations that have implemented Building Information Modeling (BIM) experienced favorable returns on their investments, characterized by expedited project timelines and reductions in documentation and material expenditures. In light of these advantages, numerous governments, including those of the United Kingdom, Finland, and Singapore, have instituted regulations mandating the application of BIM for public infrastructure endeavors (Agarwal et al., 2016).

Poirier (2015) posits that Building Information Modeling (BIM) demonstrates a substantial enhancement in labor productivity. In an investigation involving a modest contracting firm, the influence of BIM on labor productivity was quantified, revealing an increase ranging from 75% to 240% in productivity within modeled and prefabricated sectors. For construction practitioners engaged in infrastructure projects, BIM facilitates the transmission of a virtual information model from the design team to the primary contractor and subcontractors, subsequently to the owner/operator, with each professional contributing specific data to the unified shared model. The entire framework is meticulously designed to mitigate information losses that commonly occur, particularly when a new team assumes responsibility for a project. Furthermore, it offers comprehensive information regarding intricate structures (Eastman, 2009).

Laiserin (2002) posits that the implementation of Building Information Modeling (BIM) solutions within the construction industry is likely to yield enhanced work quality, increased efficiency and productivity, as well as reduced expenses for construction professionals concerning the design, execution, and management of structures. Furthermore, Rowlinson et al. (2010) assert that the demand for BIM is primarily propelled by the prospective cost reductions that arise from abbreviated project timelines, a decrease in design conflicts occurring on site, which subsequently leads to diminished delays and financial overruns.

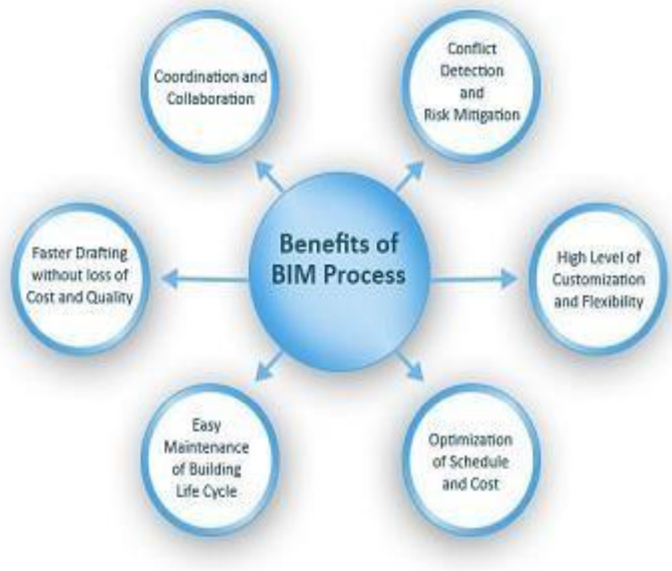

Figure 3 Image courtesy of BluEnt: Summary of Benefits of BIM

BIM for Sustainable Construction Delivery

Azhar and Brown (2009) opined that BIM technology, along with its general uses, can contribute to sustainable construction delivery in various stages of a building project from making important decisions in early phases in enhancing the building productivity and performance to its demolition. According to Wong and Fan (2013), BIM is rapidly becoming an integral part of sustainability analysis and simulation and plays an important role in decreasing industry waste and environmental harm. Therefore, the demand for BIM-based analysis in the field of sustainability is seen to be increasing dramatically. In regards to sustainable construction delivery, the contribution of BIM to the building process can be visibly streamlined with the three main pillars of sustainability, which includes; environmental, economic and social aspects.

Economic Dimension

Hartmann et al (2012) submit that one of the main contributions of BIM to sustainable construction delivery is its direct role in the economic dimension by the process of cost estimating and risk management. BIM helps to accurately estimate the costs of the project and resources required, thus, enabling the actors to take practical economic decisions. 4D models alongside 3D BIMs aid professionals in incorporating time in their analysis and estimation of project risks more efficiently and effectively (Zhang and Hu, 2011). Eastman et al (2011) and Hartman et al (2012) opine that the implementation of BIM on other aspects of the project can have an influential role in economic efficiency.

Sassi (2006) argues that even though this process can aid the project to be progressive and cost-effective, it would not be considered as a sustainable approach unless it includes the benefit of the environment and the concept of promoting the quality of life in its calculation, and put the human well-being and socially-oriented values in their priorities.

Environmental Dimension

During BIM operation, much of the data required for supporting performance analysis is captured naturally as the design of the project proceeds. By using a Building Information Model, designers can analyze how a building will perform in the very early stages of design and based on that, they can quickly assess design alternatives to make a better decision to iterate on a greener design (Azhar et al., 2011). Wong and Fang (2013) submit that Most BIM tools have various features for evaluating energy and material consumption analysis and electrical and mechanical portion of the building so that it would create explicit information on decreasing the wastage of energy and resources. BIM softwares such as Autodesk Ecotect and Revit provide some common tools that process information to analyze the environmental features of the project. This further enables architects and designers to manage energy usage and exploit resources efficiently. Such software can integrate data to achieve a more sustainable design (Azhar et al., 2011).

Social Dimension

The benefits of sustainability for social aspects are studied within the improvement on other aspects of sustainability which in turn brings about improvement in human well-being, comfort and health (Kohler, 1999). Sassi (2006), opined that improving some environmental features through sustainable design induces health and performance, which consequently have an overall effect and benefit on the whole community and society. Also sustainable design helps improve the quality of life in the society, including improving environmental quality, neighborhood restoration, and reduced health risks from pollutants associated with building energy use.

Barriers to Implementation of BIM in the Construction Industry

Despite the multifarious benefits of BIM, the process of its implementation has faced very crucial limitations in recent years. Barriers' hindering the implementation of BIM in the AEC industry are seen to be dynamic and multifaceted. As an example, one significant benefit linked to BIM implementation is interoperability, defined as the capability of software and computer systems to share information across different platforms while preserving data integrity. This allows multiple project stakeholders to collaborate as project details and information are refined, updated, and evolved (Azhar, 2011). However, the existence of various software producers which has encouraged innovation and competition leading to lower software costs, has also created with it, issues of interoperability between softwares.

Given the multitude of software companies existing in the market today, there is a greater possibility that a lot of the softwares may not be compatible with one other. Also, there are instances where data have been lost in the process of transfer (Tulenheimo, 2015). According to Reche (2020), key barriers to BIM implementation include poor leadership and limited awareness, substantial implementation expenses, organizational resistance to change, lack of clear standards, and deficient collaboration.

Weak Leadership And Awareness

Even though some professionals are aware of the general benefits of BIM, most construction owners and operators do not fully understand the real scope and implementation of its methodology and how it works. Without strong leadership that understands the true dimension of BIM and takes steps to bring all team members on board, BIM implementation will be seen to be difficult.

High Cost Of Implementation

When implementing BIM, all elements of the business operations, from compliance applications to vendor component specifications need to be streamlined and integrated into a single system. Also, the potential cost of hiring external consultants or training in-house staff to acquire sufficient knowledge in BIM is most times expensive and this tends to discourage the process of BIM implementation.

Resistance To Change

Most operators in the AEC industry are used to working with traditional tools that they know and have mastered perfectly, so they develop cold feet when introduced to new innovations for the fear of failure, leaving their comfort zones, time to learn how to use the novel software etc.

Indefinition

Proper BIM deployment represents a multifaceted process demanding simultaneous engagement from diverse professionals. Therefore, careful planning and clear definition of BIM's application scope are imperative. Organizations must implement BIM at appropriate levels aligned with their goals to avoid squandering resources. BIM teams need to establish their specific intent, such as visualization, simulation creation, clash identification, safety plan development, 4D timeline animations, or project cost analysis using fifth-dimension (5D) capabilities.

Data Presentation and Analysis

Table 1: Respondents profile

Description	Frequency	Cum. Frequency	Percentage	Cumulative %
Job Title of respondents (N=80)				
Architect	25	25	31.3%	31.3%
Quantity Surveyor	20	45	25.0%	56.3%
Builder	10	55	12.5%	68.8%
Engineer	20	75	25.0%	93.8%
Contractors	5	80	6.3%	100.0%
		80		**100.0%**
Years of working Experience (N=80)				
0 - 5 years	10	10	10.0%	10.0%
05 - 10 years	10	20	15.0%	25.0%
10 - 15 years	30	50	20.0%	45.0%
15_20 years	10	60	30.0%	75.0%
20 - more than 20 years	20	**80**	25.0%	**100.0%**

Highest Educational Qualification (N=80)

ND/Diploma	0	0	0.0%	0.0%
B.Sc/HND	25	25	30.0%	30.0%
M.Sc/B.Tech	35	60	40.0%	70.0%
PhD	20	80	25.0%	95.0%
Others	0	**80**	5.0%	**100.0%**

Table 1 - Source: Researcher's Field Survey (March 2021)

Table 1 shows the respondents' profiles. It is evident from the table that the respondents are adequate in work experience, academic and professional qualification. Therefore, based on the respondents' profiles, it is considered that the opinions of these stakeholders in the construction industry are satisfactory enough to report the findings of this study.

Table 2: Participants' BIM awareness levels and perspectives on the adequacy of existing construction industry concepts in addressing sustainability concerns

Survey Scale: 1 = Very Low 2 = Low 3 = Moderate 4 = High 5 = Very High

Questions	1	2	3	4	5	N	MIS
1. How familiar are you with Building Information Modelling (BIM) concepts and methodologies within the construction industry?	8	41	27	2	2	80	**2.36**
2. To what extent is BIM concept/methodologies applied in the construction industry in Nigeria?	18	43	16	2	1	80	**2.11**
3. To what extent are issues bothering on sustainability handled by any known concept in the construction industry in Nigeria	32	30	18	-	-	80	**1.87**

Table 2 - Source: Researcher's Field Survey (March 2021)

The results in Table 2 reveal that the level of awareness of BIM concept/ methodology is fairly low with a mean value of 2.36. This corresponds with the extent of its application in practice also, which is seen to have a mean score of 2.11, as very few respondents acknowledged its usage. The results also show that sustainability issues are still not being properly handled by any known concept in the industry, as almost all respondents' opinion about this is either low or very low, with a mean score of 1.87. This shows that the AEC industry in Nigeria still faces huge challenges of delivering sustainable construction projects to date, which aligns with Aje's (2016) position that the AEC industry in Nigeria faces the problem of delivering sustainable construction projects.

Table 3: Reasons for Non-adoption of BIM in the Construction Industry in Nigeria

Survey Scale: 1 = Very Low 2 = Low 3 = Moderate 4 = High 5 = Very High

Reasons for non-adoption of BIM	5	4	3	2	1	N	MIS	RII
Lack of Proper Understanding and Awareness of BIM concepts and their applications	28	25	5	12	10	80	**3.61**	**0.72**
Resistance to Change	32	23	12	10	3	80	**3.89**	**0.78**
High Cost of Implementation	15	10	4	25	26	80	**2.54**	**0.51**
It is In-effective	2	3	5	30	40	80	**1.71**	**0.34**
No proper definition/Indefinition	20	25	9	16	10	80	**3.36**	**0.67**
It seems too complex	15	5	10	30	20	80	**2.44**	**0.49**

Table 3 - Source: Researcher's Field Survey (March, 2021)

Table 3 presents factors hindering BIM adoption in Nigeria's construction sector, revealing that the primary obstacle is the reluctance of AEC practitioners and professionals to embrace change, reflected in a mean score of 3.89 and RII of 0.78. This agrees with the findings of Reche (2020) where he indicates that most operators in the AEC industry are used to working with traditional tools that they know and have mastered perfectly, and so develop cold feet when introduced to new innovations for fear of failure, leaving their comfort zones, and time to learn how to use the novel software etc.

Results further indicate that insufficient comprehension and knowledge of BIM principles and their practical use represents a critical barrier to BIM adoption in the AEC sector. This had a mean score of 3.61 and RII of 0.72. Indefinition was seen as the third-ranked barrier with a mean score of 3.36 and RII of 0.67, while high cost of implementation ranked as the forth barrier with a mean score of 2.54 and RII of 0.51. This correlates with the findings of Criminale and Langar (2017) where they posit that most common barriers to implementation of BIM in the AEC industry are the cost of hiring or training people to use BIM, coupled with economic conditions of AEC companies and the ability to invest in maintaining innovativeness and competitiveness. These barriers can be crucial for small and medium-sized design and construction companies.

Table 4: Relevance of BIM in Improving Sustainability in the Nigerian construction industry

Survey Scale: 1 = Strongly Disagree 2 = Disagree 3 = Undecided 4 = Agree 5 = Strongly Agree

Variables	**5**	**4**	**3**	**2**	**1**	**N**	**MIS**
Better collaboration and communication among stakeholders in the construction industry helps in reducing wastage of construction resources, better project cost estimating and thus decrease of project cost	35	20	10	10	5	80	**3.88**
Better visualization and collaboration among professionals especially before construction helps to improve construction resource selection and conservation	30	30	8	5	7	80	**3.89**

Table 4 - Source: Researcher's Field Survey (March 2021)

Better collaboration, proper communication and enhanced visualization of construction projects especially before execution are some of the most important benefits of BIM application. Therefore, in the bid to justify BIM as a tool for improving sustainability, these factors were analyzed to find out if these benefits derived from BIM application can help to improve sustainability in the Nigerian Construction Industry. The findings in Table 4 reveal that most respondents agree that improved stakeholder collaboration and communication within the construction sector minimizes resource wastage and enables more accurate project estimates, consequently reducing total project expenditure. This corroborates Eastman et al (2011) and Hartman et al's (2012) findings, where they opined that the implementation of BIM enhances collaboration and communication among stakeholders which leads to reducing wastage, saving time, promoting building management and subsequently decreasing projects costs which can have an influential role in the economic efficiency of the project. The table further shows respondents' strong agreement that enhanced visualization and collaboration among professionals, especially before project execution, helps at improving construction resources selection and conservation.

Conclusion

From the study, BIM is seen as a valuable tool that enhances collaboration and streamlines communication between professionals, owners, and operators of the AEC Industry. This translates to a higher quality of work, greater speed, productivity, and lower costs for buildings. BIM offers a new paradigm in terms of design, construction, operation, and maintenance of buildings. It is a process that requires an alternative way of thinking and a different approach to project procurement and delivery which helps to facilitate sustainable building in various design phases from the initiation stage to demolition by providing an integrated design workflow at each stage. The study further demonstrates that BIM brings about improved visualization. This gives construction professionals a better understanding of their choices for materials used in construction projects, and how these materials can affect the environment, thereby necessitating consideration of alternatives based on improved quality, recyclability, reduced toxicity, and minimal waste generation. These in turn bring about resource conservation, environmental protection, and biodiversity safety.

Study findings indicate that BIM adoption in Nigeria's construction sector remains insufficient due to industry opposition to change, inadequate comprehension of BIM principles and approaches, and the belief that implementation costs are excessively high. Additional results suggest that proper BIM application within Nigeria's AEC sector would minimize construction resource waste and enhance cost estimation accuracy, ultimately leading to reduced total project expenditure. Thus, this demonstrates that the proper implementation and application of BIM will bring about substantial improvement in the sustainability approach in the Nigerian construction industry.

According to the United Nations (UN), by 2050 the world’s population will be about 10 billion. The AEC industry globally, with particular emphasis on Nigeria, should embrace innovative, sustainable, and efficient construction and design practices, not simply to satisfy existing demands but to create environments that exhibit greater intelligence and resilience. BIM does not only allow design and construction teams to work more efficiently, but also allows them to capture the data they create during the process to fit operations and maintenance, which will consequently advance sustainable project delivery in the construction industry in Nigeria.

Recommendations

To fully leverage BIM's potential for advancing sustainable construction practices, Nigeria's Architecture, Engineering, Construction Owners, and Operators (AECOO) community should integrate BIM comprehensively throughout all project phases—from planning and execution to operation and maintenance. For the Nigerian AEC sector to genuinely embrace BIM as a core operational tool, construction-related professional organizations must prioritize extensive training programs, workshops, and seminars focused on BIM implementation.

Clients, Professionals, and construction stakeholders are encouraged to adopt BIM as an integral part of sustainability analyses in the planning and execution of construction projects, so as to improve on the sustainable focus in the Nigerian construction industry. Also, adequate professional development should be undertaken by all construction stakeholders to equip themselves with various BIM packages and how these packages can be applied in given areas of specialties' to derive maximum benefits.

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