Relevance of Building Information Modelling (BIM) to Sustainable National Development in Nigeria

Wodike, Obinna O.
Dept. of Architectural Technology, Obicks3d@gmail.com
Captain Elechi Amadi Polytechnic, Rumuola Port Harcourt, Nigeria.

Ejuh, Godstime O.
Dept. of Building Technology, ejuhgodstimeogechi@gmail.com
Captain Elechi Amadi Polytechnic, Rumuola Port Harcourt, Nigeria.
DOI: 10.56201/ijemt.vol.11.no1. 2025.pg206.219

Abstract
BIM is a revolutionary technology that has transformed the construction industry worldwide. It allows architects, engineers, and contractors to collaborate seamlessly on a project from start to finish. By creating a digital model of a building, BIM enables stakeholders to visualize and analyze every aspect of the design, including structural elements, mechanical systems, and even lighting. This level of detail helps identify potential issues early in the process, reducing errors and saving time and money. Thus, this study investigated the relevance of BIM to sustainable national development in Nigeria. Specifically, the study discussed the potential benefits of BIM in improving the efficiency and effectiveness of construction projects, reducing waste and environmental impact, and promoting economic growth. The study also discussed sustainable national development and how BIM can contribute to achieving it by enhancing collaboration, communication, and coordination among stakeholders in the construction industry. The content analysis method was used to analyze existing literature on BIM and sustainable national development in Nigeria. The findings of the study revealed that BIM has the potential to revolutionize the construction industry in Nigeria by improving project delivery, reducing costs, and enhancing quality. Additionally, BIM can contribute to sustainable national development by promoting environmental sustainability, social equity, and economic growth. In conclusion, the adoption of BIM in Nigeria is crucial for sustainable national development as it provides a platform for efficient and effective construction practices that are environmentally friendly and economically viable. The study recommended that stakeholders in the construction industry should embrace BIM technology and incorporate it into their project delivery processes to achieve sustainable national development goals. Furthermore, the government should provide incentives and support for the adoption of BIM technology in the construction industry to promote economic growth and sustainable development in Nigeria.

Keywords: Building Information Modelling, Sustainable, National Development

INTRODUCTION

In recent years, there has been an increasing global emphasis on sustainable development, with many countries recognizing the need to balance economic growth with environmental conservation. Nigeria, as a developing nation, is also striving to achieve sustainable national development. However, the construction industry in Nigeria faces numerous challenges, such as inefficiency, waste generation, and limited collaboration among stakeholders. Corroborating this assertion, Onyejeakor et al. (2020), highlighted in their study that despite the fact that the construction industry is Nigeria's mainstay and prime mover of economies of nations, it is characterized by schedule overruns, budget overruns, poor quality, safety issues, claims and disputes, and dissatisfaction of contract parties. Therefore, this study aims to explore the potential benefits of BIM in addressing these challenges and driving sustainable national development in Nigeria.

Over time, the blame for these challenges has been placed on various factors, such as inadequate project planning, a lack of skilled labour, and corruption within the industry. According to Samimpay and Saghatforoush (2020), the difficulties encountered in the construction industry are typically attributed to the complexity of the construction project, operational inefficiency, level of uncertainty, poor productivity, lack of information reuse and management, and poor collaborative working. The basis for coming to such a conclusion is large because most players in the sector carry out their operations using traditional methods and have not fully embraced technological advancements. This reliance on outdated practices hinders the industry's ability to adapt to changing demands and efficiently manage projects. However, BIM offers a promising solution by providing a collaborative platform that enables efficient communication, accurate project visualization, and improved coordination among stakeholders. By implementing BIM, the construction industry in Nigeria can enhance productivity, reduce costs, minimize errors, and ultimately deliver projects on time and within budget.

BIM is a technology-driven approach that allows for the creation and management of digital representations of the physical and functional characteristics of a project. According to Rogers et al. (2015), BIM is the breakthrough in technology that has revolutionized the construction industry by streamlining communication and collaboration among project teams. This definition is consistent with that of Azhar et al. (2012). "BIM is a shared knowledge resource for information about a facility, forming a reliable basis for decisions throughout its life cycle, from earliest conception to demolition," the authors write. Similarly, Succar (2009) cited in Usman et al. (2021) sees BIM as a technology capable of handling all data in its entirety, taking into account the various stages of a building's life cycle, which can be held in a single mutual technological setting. This concept has served as the foundation for BIM technology since its inception. With BIM, stakeholders can easily access and share real-time project data, leading to better decision-making and more efficient workflows. Additionally, BIM enables the identification of potential clashes or conflicts early on in the design phase, allowing for timely resolution and avoiding costly rework during construction.

The concept of sustainable national development has gained significant attention in recent years. It focuses on the integration of economic growth, social progress, and environmental protection. This is because sustainability in the construction industry plays a crucial role in

reducing carbon emissions, conserving natural resources, and promoting green building practices. According to Usman et al. (2021), sustainable national development is defined as "the pursuit of long-term economic prosperity, social well-being, and environmental preservation through the implementation of sustainable practices across all sectors, including construction. It requires a holistic approach that considers the entire life cycle of infrastructure projects, from design and materials sourcing to construction and operation. By adopting sustainable construction methods such as energy-efficient designs, use of renewable materials, and waste reduction strategies, countries can minimize the negative impact on the environment while creating jobs and improving the quality of life for their citizens."

The question of how BIM can contribute to sustainable national development is also an important consideration. BIM can support sustainable design by providing accurate data on energy consumption, material usage, and environmental impact. This information not only helps architects and engineers make informed decisions to reduce energy consumption and minimize waste but also enables them to incorporate renewable energy sources and environmentally friendly materials into their designs. By optimizing building performance through BIM, sustainable practices can be integrated from the early stages of a project, resulting in long-term environmental benefits for the community and the nation as a whole. Corroborating the foregoing, According to Yongliang et al. (2020), research done by Stanford University's Center for Integrated Facilities Engineering shows that using BIM correctly on building projects is expected to cut down on 40% of unplanned changes, shorten the expected length of the project by 7%, save 80% of the time used to calculate the cost of the project, save nearly 10% more in contract value savings, and give the project a 3% profit margin.

With all the benefits that BIM technology offers, there remain obstacles to its deployment to construction projects. These hindrances, which are discussed in detail in a subsequent section of this report, point out that certain elements that are required for the successful application of BIM are not in place. As such, without these elements, the full potential of BIM technology cannot be realized in the construction industry. However, Succar and Kassem (2015) highlight that despite these obstacles, there is a growing recognition of the value of BIM in the construction industry. This has led to increased efforts to overcome these challenges and create an environment that supports the successful implementation of BIM. Therefore, this study aims to explore the relevance of BIM to sustainable national development in Nigeria.

I. BIM in the Construction Phases

Building information modeling is a process that involves the creation and management of digital representations of the physical and functional characteristics of a building. According to Abdullah and Ibrahim (2016), BIM was developed as a framework to address the limitations of conventional Computer Aided Drafting (CAD) systems by providing a functional digital interface that integrates essential building details into an electronic filing system that is utilized by all project stakeholders. It allows for the integration of various aspects of a construction project, such as design, planning, construction, and operation, into a single cohesive model.

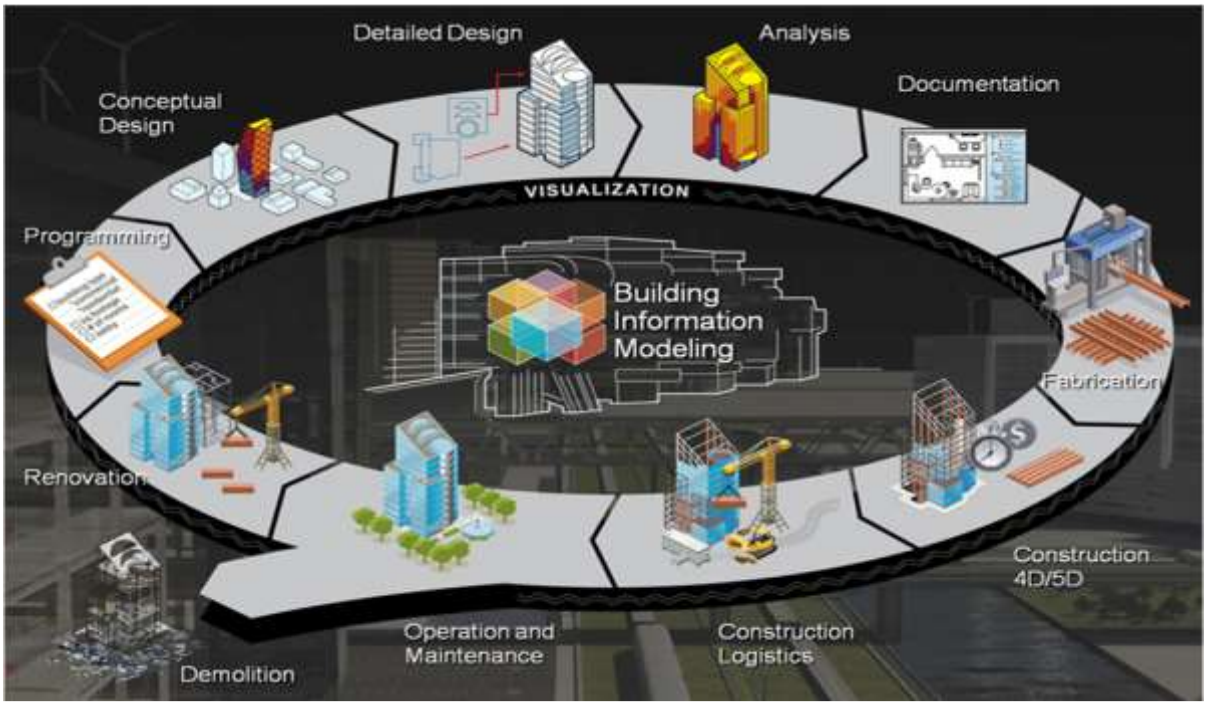

Figure 1: Schematic Representation of BIM interaction
Source: Hamma-Adama and Kouider (2018)

Designing Phase

During the design phase, BIM enables architects and engineers to collaborate more effectively by providing a virtual environment where they can visualize and analyze the building's performance before it is constructed. The research of Ibrahim et al. (2019) indicates that the most significant benefits of BIM during the design phase are the following: concepts become clearer and project conceptualization is simplified; earlier and more accurate visualizations of a design are provided to the owner; design decisions are supported; design quality is enhanced; design and installation services coordination is enhanced; design efficiency is increased; design time and costs are reduced; the planning process is enhanced; and the accuracy rate is increased. This helps identify potential issues and make informed decisions early on, leading to cost savings and improved project outcomes.

Figure 2: BIM for Infrastructure
Source: Hamma-Adama and Kouider (2018)

At this phase, BIM also allows for the integration of different disciplines and trades, such as structural, mechanical, and electrical systems, ensuring that all components work together seamlessly. If any issues or conflicts arise during the virtual modeling process, they can be addressed and resolved before construction begins, saving time and resources. Just like simulation software, BIM enables stakeholders to visualize the project in a realistic and interactive manner. This allows for better communication and collaboration among team members, resulting in fewer misunderstandings and errors during construction. For instance, BIM can provide a 3D model that is simple to share and access by all stakeholders, enabling them to virtually walk through the project and identify any potential design flaws or clashes. This early detection of issues helps to minimize costly rework and delays during the construction phase.

Planning Phase

During the planning phase, BIM can also assist in creating accurate cost estimates and schedules by integrating data from various sources. These data include information on materials, labor costs, equipment rentals, and subcontractor bids. By analyzing this data, BIM can generate detailed cost breakdowns and project timelines, allowing project managers to make informed decisions and allocate resources efficiently. Even though the project manager or team may encounter unexpected challenges or changes during construction, having accurate cost estimates and schedules from the planning phase can help them adapt and mitigate potential delays. Also, during the planning phase, using BIM can help identify potential clashes

or conflicts between different building systems or components, allowing for early detection and resolution. This can save time and money by avoiding costly rework or delays during construction.

Construction Phase

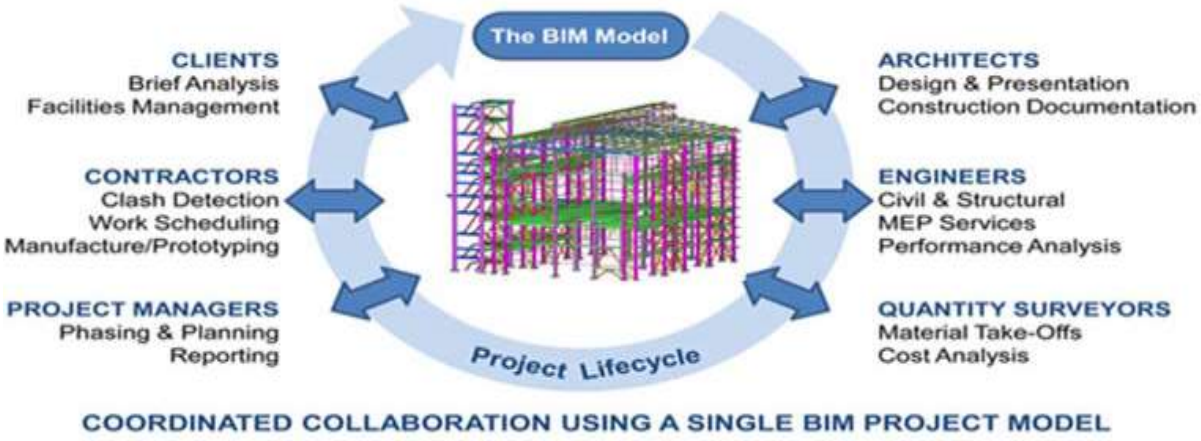

Figure 3: Data exchange and collaboration using BIM
Source: Hamma-Adama and Kouider (2018)

During the construction phase, it is important for project managers to closely monitor progress and ensure that the work is being executed according to the plans and specifications. Regular site visits and communication with contractors and subcontractors can help identify any issues or deviations from the original plan, allowing for timely adjustments and corrective actions. According to Masood et al. (2014), Building Information Modeling (BIM) means "the development and implementation of a computer-generated model to integrate the planning, design, construction and operation of a facility. At this phase, BIM can be particularly useful as it allows for real-time collaboration and coordination among all stakeholders, ranging from the design team to the construction team. This would help streamline communication and minimize errors or conflicts during the construction process.

Operational Phase

During the operation phase, BIM can continue to be beneficial as it allows for the integration of facility management systems and data, enabling efficient maintenance and operation of the building. Information on the design, planning, construction, facility management, and operation phases of a project are included in the BIM documentation process (Kumar & Mukherjee, 2009 cited in Hamma-Adama & Kouider, 2018). It is expected at this phase that BIM can provide valuable insights and data analytics to optimize energy usage, reduce costs, and improve overall building performance. Sustainability at this phase would mean implementing strategies and technologies that promote energy efficiency, waste reduction, and environmental responsibility. This could include utilizing renewable energy sources, implementing smart building automation systems, and incorporating sustainable materials and

practices. By prioritizing sustainability during the operation phase, the building can not only reduce its environmental impact but also potentially save on long-term operational costs.

II. Potential Benefits and Relevance of Building Information Modeling

The benefits or relevance of Building Information Modeling (BIM) are numerous. One of the main advantages is improved collaboration among project stakeholders. BIM allows architects, engineers, contractors, and other professionals to work together in a virtual environment, sharing and accessing real-time information. This streamlines the decision-making process and reduces errors or conflicts during construction. According to Matarneh and Hamed (2017), the benefits of BIM are as follows: reducing rework during construction, maximizing productivity, minimizing conflicts and changes, detecting clashes, enhancing communication and collaboration, enhancing visualization, enhancing project documentation, using faster and more effective methods, enhancing quality, and enhancing design review.

In the context of this study, the benefits and relevance of BIM are discussed under the themes of Improving the efficiency and effectiveness of construction projects, reducing waste and environmental impact, and promoting economic growth.

Efficiency and Effectiveness of Construction Projects: The efficiency and effectiveness of construction projects can be significantly improved through the use of BIM. By utilizing BIM, project teams can collaborate more effectively, streamline communication, and identify potential issues or conflicts early on. This leads to better coordination and planning, ultimately resulting in reduced construction time and costs. In Malaysia, Al-Ashmori et al. (2020) identified the most significant benefits of BIM adoption as follows: increase productivity and efficiency, assess time and cost associated with design changes, eliminate of clashes in design, improve multi-party communication and maintaining synchronized communication, integration of construction scheduling & planning, identify time-based clashes, and track and monitor construction progress.

Reducing Waste and Environmental Impact: Reducing waste and environmental impact is another significant benefit of incorporating BIM in construction projects. By utilizing BIM, stakeholders can effectively plan and optimize material usage, leading to a reduction in waste generation. According to Li et al. (2014), BIM can also help identify opportunities for sustainable design and construction practices, such as using renewable materials or implementing energy-efficient systems. This not only reduces the environmental impact of the project but also contributes to long-term cost savings through reduced energy consumption. In other words, implementing BIM in construction projects not only benefits the environment but also improves the overall financial performance of the project.

Promoting Economic Growth: Economic growth is a key goal for many countries and industries. By implementing BIM in construction projects, there is an opportunity to stimulate economic growth through job creation and increased productivity. The use of BIM can streamline project timelines, reduce errors, and improve collaboration among stakeholders, ultimately leading to more efficient and successful construction projects. According to Ibrahim et al. (2019), BIM has been shown to improve construction productivity by up to 30% and

reduce project costs by up to 7%. These improvements can have a significant impact on the overall performance of the project, attracting more investors and boosting economic growth in the long run. Additionally, the adoption of BIM can also lead to the development of new industries and services that support its implementation, creating further job opportunities and contributing to economic diversification.

III. Sustainable National Development

The concept of sustainable national development refers to the long-term growth and progress of a country while taking into consideration environmental, social, and economic factors. It encompasses the idea of balancing economic development with the preservation and protection of natural resources, as well as promoting social equity and inclusivity. Sustainable national development aims to meet the needs of the present generation without compromising the ability of future generations to meet their own needs. It involves implementing policies and practices that promote sustainable use of resources, reduce carbon emissions, and foster social well-being through education, healthcare, and poverty alleviation initiatives. In the construction industry, Ezennia and Hoskara (2019) highlight the importance of sustainable development by emphasizing the need for eco-friendly building materials and energy-efficient designs. They argue that incorporating green technologies and practices not only reduces environmental impact but also leads to long-term cost savings for both individuals and society. Additionally, they stress the significance of involving local communities in decision-making processes to ensure that their needs and concerns are addressed, thus promoting social equity and inclusivity in construction projects.

According to Oladigbolu et al. (2019), sustainability cannot be achieved in the built environment without considering the social and economic aspects. They emphasize the importance of adopting sustainable building materials and techniques that minimize resource consumption and waste generation. With sustainable building materials and techniques, construction projects can reduce their environmental impact and contribute to the overall well-being of communities. These materials and techniques also have the potential to create job opportunities and support local economies, further enhancing social equity and inclusivity in construction projects. For instance, most buildings in developing countries like Nigeria are constructed using traditional materials such as concrete and steel, which have a significant carbon footprint. However, by incorporating sustainable alternatives like bamboo or recycled materials, construction projects can greatly reduce their greenhouse gas emissions and promote a more sustainable future. Additionally, implementing energy-efficient techniques such as passive design and solar panels can further enhance the environmental performance of buildings while also reducing long-term operational costs.

IV. Why the Emphasis on Sustainable National Development

There is an increasing emphasis on sustainable national development due to the recognition of the finite nature of resources and the need to protect the environment. Additionally, sustainable development ensures long-term economic growth and social progress by balancing the needs of the present generation without compromising the ability of future generations to meet their own needs. Over the years, the UN has played a crucial role in promoting sustainable national

development through various initiatives and frameworks such as the Sustainable Development Goals (SDGs). These goals provide a comprehensive roadmap for countries to address pressing global challenges, including poverty, inequality, and climate change, while also fostering economic prosperity and environmental sustainability. According to Dalibi and Bello (2017), the UN formulated the 17 outlined SDGs plan of action (169 targets) for people, the planet, and prosperity for effective implementation within the BE and the natural habitat. However, achieving these SDGs hinges on each country's implementation and policy frameworks to achieve the goals. In the built environment, technological advancements and innovations like BIM have the potential to greatly contribute to the achievement of these SDGs. BIM allows for more efficient and sustainable construction processes, reducing waste and energy consumption. For example, the use of renewable energy sources and energy-efficient building designs can help reduce carbon emissions and combat climate change. These technological solutions, combined with supportive policies and regulations, can pave the way for a more inclusive and sustainable built environment that contributes to the achievement of the SDGs.

Nigeria, which is still an emerging nation, is also experiencing these alterations in BIM adoption. Consequently, Nigeria, whose infrastructural deficit is significant, needs to prioritize the adoption of BIM in order to effectively address its infrastructural challenges. By embracing BIM technology, Nigeria can enhance collaboration, improve project efficiency, and reduce costs in the construction industry. Adequate infrastructure bridges the socio-economic gaps and deficits that will, in turn, ensure excellent livability for all people in societies, sustainable consumption, jobs, and equality while alleviating hunger.

V. How BIM Contribute to Sustainable National Development in Nigeria

BIM can enable efficient planning and design of infrastructure projects, leading to reduced material waste and energy consumption. By accurately simulating and analyzing various aspects of a building's lifecycle, BIM helps optimize resource utilization and minimize environmental impact. According to Eastman et al. (2011) cited in Ibrahim and Mohd (2022), BIM has the potential to increase the efficiency, quality, and productivity of construction projects by decreasing the number of errors and incompatibilities, providing more accurate and up-to-date information, and providing a more illustrative and approachable presentation of a building. For example, BIM can detect clashes and conflicts in the design phase, allowing for early resolution and avoiding costly rework during construction. It can assess the energy performance of a building, allowing for the identification of energy-saving measures and the implementation of renewable energy systems.

BIM can facilitate collaboration among stakeholders, such as architects, engineers, contractors, and policymakers, fostering better decision-making processes that prioritize sustainable practices. This integrated approach ensures that sustainable design principles are incorporated from the early stages of a project, allowing for the identification and implementation of environmentally friendly strategies. Onungwa and Uduma-Olugu (2017) revealed that, as a collaborative tool, BIM leverages the value of good, reliable information, enabling better coordination, synchronization, and sequencing of projects by allowing all project participants to access and interrogate project information. For example, BIM allows architects, engineers, and contractors to collaborate and make informed decisions during the design phase, resulting

in more efficient construction processes and reduced errors. Additionally, BIM can also be used for facility management purposes, as it provides accurate and up-to-date information about the building's components and systems, allowing for better maintenance planning and cost optimization. This process also helps identify opportunities for passive design strategies, such as maximizing natural lighting and ventilation, which can significantly reduce energy consumption.

BIM enables the analysis and simulation of various design scenarios, allowing for the evaluation of their energy efficiency and environmental performance. According to Egbu and Sidawi (2012), BIM has the ability to reuse information stored in databases. This helps in identifying potential areas for improvement and making informed decisions to achieve sustainable outcomes. Moreover, BIM's ability to track and monitor the lifecycle of a building ensures that sustainability goals are maintained throughout its operation, contributing to long-term environmental benefits. For instance, BIM has been used to optimize the design of buildings by analyzing different energy-efficient strategies and materials. This has resulted in reduced energy consumption and lower carbon emissions, aligning with the country's commitment to sustainable development.

BIM enables the adoption of sustainable design strategies and technologies. By integrating BIM into the design process, architects and engineers can easily analyze and evaluate the environmental impact of different design options. This allows for the implementation of energy-efficient systems, renewable materials, and other sustainable practices that contribute to a greener built environment. For example, BIM can help identify opportunities for passive design strategies such as natural ventilation and day lighting, reducing the need for artificial lighting and Heating, Ventilation, and Air Conditioning (HVAC) systems. BIM enables the simulation of building performance, helping to optimize energy consumption and reduce carbon emissions throughout the lifecycle of a project.

Improved project planning and design. BIM allows for more accurate and detailed project planning and design, reducing the risk of errors and rework. According to Gordon and Holness (2008), BIM can provide building design development, including bills of material and the automatic generation of shop drawings, for everything from structural steel to sheet metal duct fabrication, fire protection and piping fabrication, electrical cabling, and bus duct layouts. This can lead to increased efficiency and cost savings during the construction phase. For example, BIM can provide real-time data on material quantities and costs, allowing project teams to make informed decisions and avoid over-ordering or under-utilizing resources. .

VI. Challenges of Adopting BIM in Nigeria

Lack of awareness and understanding of BIM among stakeholders: In the Nigerian construction industry, there is a significant lack of awareness and understanding of Building Information Modeling (BIM) among stakeholders. Many professionals and decision-makers are unfamiliar with the concept and its potential benefits. This lack of knowledge hinders the widespread adoption of BIM in Nigeria, as stakeholders may be hesitant to invest in a technology they do not fully understand. This assertion is corroborated by Babatunde et al.

(2020), who found that a lack of BIM technical know-how and awareness among stakeholders in Nigeria is a major barrier to the implementation of BIM in the construction industry.

Limited access and high initial costs of implementing BIM: Another factor that contributes to the limited adoption of BIM in Nigeria is the limited access to BIM software and technology. Due to the high cost associated with acquiring and implementing BIM tools, many construction companies and professionals in Nigeria may not have the financial resources to invest in these technologies. According to Gardezi et al. (2014), Fatima et al. (2015), and Babatunde et al. (2020), the high initial costs of implementing BIM can be a significant barrier for construction companies in Nigeria. This financial constraint not only hinders the adoption of BIM but also limits the potential benefits that can be derived from its use.

Inadequate training and education on BIM: In Nigeria, there is a lack of comprehensive training and education programs focused on BIM. This hinders the widespread adoption of BIM, as professionals may not have the necessary skills and knowledge to effectively implement it in their projects. This assertion is corroborated by the studies of Gardezi et al. (2014) and Babatunde et al. (2020), who found that many professionals in the Nigerian construction industry have a limited understanding of BIM and its potential benefits. Without proper training and education, it becomes challenging for individuals and organizations to fully embrace BIM and integrate it into their workflows.

Resistance to change from traditional construction practices: Many construction professionals in Nigeria are accustomed to traditional methods and may be hesitant to embrace the new technology and processes associated with Building Information Modeling (BIM). This resistance to change can hinder the widespread adoption of BIM in the country. Researchers like Gardezi et al. (2014), Jadhav and Ghadge (2016), and Babatunde et al. (2020) also share similar thoughts, highlighting that attitude and mindset play a crucial role in the acceptance and implementation of new technologies.

Unreliable internet connectivity in some areas: This can hinder the smooth transfer and sharing of BIM data as well as real-time collaboration among project stakeholders. Because Nigeria is still developing its internet infrastructure, there may be frequent disruptions in connectivity, making it difficult to fully leverage the benefits of BIM technology. Expressing a similar view, Babatunde et al. (2020) highlighted limited access to reliable internet can result in delays and communication gaps, leading to inefficiencies in project delivery.

Lack of standardized BIM protocols and guidelines: This makes it difficult for professionals to consistently implement BIM across projects, leading to inconsistencies and inefficiencies in the adoption process. The absence of standardized BIM protocols makes it challenging for professionals to accurately exchange and share BIM data, which can result in errors and delays during the construction process. Gardezi et al. (2014), Jadhav and Ghadge (2016), and Babatunde et al. (2020) also highlight the negative impact of the lack of standardized BIM protocols on collaboration and coordination among project stakeholders. Without clear guidelines, it becomes harder for different teams to effectively communicate and integrate their work, leading to potential clashes and rework.

CONCLUSION

The implementation of BIM in Nigeria can significantly contribute to sustainable national development. By enhancing collaboration, reducing errors and rework, and improving project efficiency, BIM can help accelerate infrastructure development, promote economic growth, and ensure environmental sustainability. It is imperative for the Nigerian government and construction industry stakeholders to embrace BIM as a strategic tool for achieving sustainable development goals and positioning Nigeria as a leader in the global construction industry.

SUGGESTIONS

In view of the findings of the study, the following recommendations are made:

1. Stakeholders in the construction industry are encouraged to adopt and implement BIM as a standard practice. This will enable efficient collaboration and coordination among all parties involved in the construction process, leading to improved project outcomes.
2. The government should provide incentives and support for the implementation of BIM, such as training programs and funding for research and development, to ensure its widespread adoption and integration into sustainable national development strategies.
3. The government should also establish regulations and guidelines that mandate the use of BIM in construction projects. This will create a level playing field and ensure that all stakeholders are utilizing the technology to its full potential.

REFERENCES

Abdullahi, M., & Ibrahim, Y.M. (2016). Building information modeling. A paper presented at 3-Day Workshop/Annual General Meeting of the Nigerian Institute of Quantity Surveyors, available at: http://niqs.org.ng/wpcontent/ uploads/2016/

Al-Ashmori,Y.Y., ,Othman, I., Rahmawati, Y., Amran, Y.H.M., Sabah, S.H .A., Rafindadi, A.D., & Mikic´, M. (2020). BIM benefits and its influence on the BIM implementation in Malaysia. *Ain Shams Engineering Journal*, 11(2), 1013–1019

Azhar, S., Khalfa,M. and Maqsood, T. (2012). Building information modeling (BIM): now and beyond. *Construction Economics and Building*, 12(4), 15-28.

Babatunde, S. O., Udeaja, C., & Adekunle, A. O. (2020). Barriers to BIM implementation and ways forward to improve its adoption in the Nigerian AEC firms. *International Journal of Building Pathology and Adaptation*, 39(1), 48-71.

Babatunde, S., Ekundayo, D. O., Adekunle, A. & Bello, W. (2020). Comparative analysis of drivers to BIM adoption among AEC firms in developing countries: A case of Nigeria. *Journal of Engineering, Design and Technology*, 18(6), 1425-1447.

Dalibi, S. G., Feng, J. C. Shuangqin, L. Sadiq, A. Bello, B. S. & Danja, I. I. (2017). Hindrances to green building developments in Nigeria's Built Environment: 'the Project Professionals' Perspectives.

Egbu, C. & Sidawi, B. 2012. Building information modelling (BIM) implementation and remote construction projects; issues, challenges, and critiques. *Journal of Information Technology in Construction*, 47(2), 75- 85.

Ezennia, I. S. & Hoskara, S. O. (2019). Exploring the severity of factors influencing sustainable affordable housing choice: Evidence from Abuja, Nigeria. *Sustain.*, 11(20), 34-48.

Fatima, A., Saleem, M., & Alamgir, S. (2015, December). Adoption and scope of building information modeling (BIM) in the construction industry of Pakistan. *In Proceedings of 6th International Conference on Structural Engineering and Construction Management*, Kandy, Sri Lanka, 90-99.

Gardezi, S. S. S., Shafiq, N., Nuruddin, M. F., Farhan, S. A., & Umar, U. A. (2014). Challenges for implementation of building information modeling (BIM) in Malaysian construction industry. *Applied Mechanics and Materials*, 567(3), 559-564, Trans Tech Publications Ltd.

Hamma-Adama, M., & Kouider, T. (2018). A review on building information modelling in nigeria and its potentials. *International Scholarly and Scientific Research & Innovation* 12(11), 1113-1119.

Ibrahim, A., & Mohd, T. (2022). The benefits and challenges of building information modelling (BIM) in Green Building. *International Journal of Academic Research in Business and Social Sciences*, 12(11), 1249 – 1260.

Ibrahim, H.S., Hashim, N., & Jamal, K.A.A. (2019). The potential benefits of building information modelling (bim) in construction industry. *IOP Conf. Series: Earth and Environmental Science*, 385, (9) 1-11.

Jadhav, S., & Ghadge, A. N. (2016). Application of building information modeling in construction projects–A critical review. *International Journal of Engineering Research*, 5(2), 26-31

Li, J., Wang,Y., Wang, X.,, Luo, H., Kang, S.C., Wang, J.,, Guo, J., & Jiao, Y., (2014). Benefits of building information modelling in the project lifecycle: construction projects in Asia. *International Journal of Advanced Robotic Systems*, 11(124), 1-11.

Masood, R., Kharal, M.K.N., & Nasir, A.R. (2014). Is BIM adoption advantageous for construction industry of pakistan? *Procedia Engineering*, 77, 229 – 238

Matarneh, R.T., & Hamed, S.A. (2017). Exploring the adoption of building information modeling (BIM) in the Jordanian construction industry. *Journal of Architectural Engineering Technology*, 6(10), 1-7.

Oladigbolu, J. O., Ramli, M. A. M. & Al-Turki, Y. A. (2019). Techno-economic and sensitivity analyses for an optimal hybrid power system which is adaptable and effective for rural electrification: A case study of Nigeria, *Sustain.*, 11(18), 28-39.

Onungwa, I.O., Uduma-Olugu, N., & Igwe, J.M. (2017). Building information modelling as a construction management tool in Nigeria. *WIT Transactions on the Built Environment*, 169(1), 25-22.

Onyejeakor, H.I., Eze, E.C., Onyeagam, O.P., & Adegboyega, A.A. (2020). Factors influencing the deployment of innovative (ICT) facilities by construction organisations in port Harcourt, Nigeria. *Independent Journal of Management & Production*, 11(4), 1357-1380.

Rogers, J., Chong, H.Y., & Preece, C. (2015). Adoption of building information modelling technology (BIM); Perspectives from Malaysian engineering consulting services firms. *Engineering, Construction and Architectural Management*, 22(4), 424-445

Samimpay, R., & Saghatforoush, E. (2020). Benefits of implementing building information modeling (BIM) in infrastructure projects. *Journal of Engineering, Project, and Production Management*, 10(2), 123-140

Succar, B. & Kassem, M. (2015). Macro-BIM adoption: conceptual structures. *Automation in Construction*, 57(1), 64-79.

Usman, I. L., Dalibi, S. G., Danja, I.I., Akali, M. A., Kumo, H. A., Adamu, K., & Umar, A. M. (2021). Sustaining the sustable development in Nigeria's build environment: Determinant factors. *IOP Conf. Series: Earth and Environmental Science* 793(1), 1-7.

Yongliang, D., Jinyun, L., Qiuting, W., Shuangshuang, P., Na, X. & Guodong, N. (2020). Using network theory to explore BIM application barriers for BIM sustainable development in China. Sustainability.