ASSESMENT OF BUILDING INFORMATION MODELLING APPLICATION IN THE CONSTRUCTION INDUSTRY IN ABUJA, NIGERIA

BY

KOLO, Hosea Shaba
2018 /3 /74382TI

DEPARTMENT OF INDUSTRIAL AND TECHNOLOGY EDUCATION,

FEDERAL UNIVERSITY OF TECHNOLOGY,

MINNA, NIGER STATE.

MARCH, 2023

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A RESEARCH PROJECT SUBMITTED TO THE

DEPARTMENT OF INDUSTRIAL AND TECHNOLOGY EDUCATION

FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA

IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF BACHELOR OF TECHNOLOGY (B. TECH) DEGREE IN INDUSTRIAL AND TECHNOLOGY EDUCATION

MARCH, 2023

DECLARATION

I, **HOSEA, Shaba Kolo** with matriculation number **2018 /3/74382TI**, an undergraduate student of the department of Industrial and Technology Education, certify that the work embodied in this project is original and has not been submitted in part or full for any other diploma or degree of this or any other University.

KOLO, Hosea Shaba _____
2018 /3 /74382TI Sign and Date

CERTIFICATION

This project has been read and approved as meeting the requirement for the award of B. Tech degree in Industrial and Technology Education, School of Technology Education, Federal University of Technology, Minna.

Dr. C.O Igwe _____

Project Supervisor Signature and Date

Dr T.M. Saba

_____

Head of Department Signature and Date

_____

_____

External Examiner Signature and Date

DEDICATION

With profound joy and gratitude in my heart, I dedicate this project to God Almighty for His Unshakable and Unbreakable Faithfulness. His Divine and constant guidance in my life has made this project a reality today. Thank God.

ACKNOWLEDGEMENTS

My sincere gratitude goes to God almighty for his help and guidance that finally I was able to complete this project as one of my requirement to complete my study. I would like to extend my deepest gratitude to my grand creator, and all the individuals who in one way or the other contributed to the success of this research. My sincere appreciation also goes to my project supervisor Dr. C.O Igwe. I would also like to extend my words of appreciation to project coordinator Dr. A.M. Hassan, my HOD Dr. T.M. Saba and all staff of ITE department. My joy and happiness will be incomplete without specially thanking my parents in respect of WO2 Joseph Tsado and Mrs Florence Kolo Tsado and my siblings for their support and prayers all these years. I also wants to extend my appreciation to my helpful boss Dr pius Ibrahim onoja and also Philip Abu who have assisted me financially throughout my stay in school and to all those who by virtue of their encouragement, advice and prayers seen to the success of this work.

ABSTRACT

The research was design to investigate the application of building information modeling (BIM)in the Nigeria construction industry in Abuja. Four research question were answered and four hypotheses tested at 0.05 level of significance were formulated for the study. A survey research design was adopted for the study. The major purpose of this study is to look at the impact of building information modeling (BIM) application on building projects in the construction industry in Abuja, the constrains to the application of building information modeling (BIM) in the construction industry in Abuja and the barriers to the application of building information modeling (BIM) in the construction industry in Abuja. the literature was reviewed in line with the four research questions, and the null hypotheses were formulated to guide the study, in which several sub-headings were discussed as regard to the purpose of the study. The research design used for this study is survey research design in which questionnaire was formulated to solicit information from respondents. The targeted population comprised of automobile technology teachers and automobile workshop supervisors. The total population for the study is 120 which consisted of 85 registered builders and 35 non-professional builders (labourers, carpenters, storekeeper, masons, iron benders) practicing with the construction company in 5 construction companies in Abuja. Data obtained was analyzed using mean, standard deviation, and t-test statistics. the study concluded and recommended the following: full integration of BIM into the curricula of Academic Institutions has been highlighted as a necessary step towards increased knowledge of BIM. This will ensure that Graduates have the background knowledge of the concept and implementation of BIM in the Nigerian Construction Industry, there for, well trained professionals in the utilization of BIM in order to ensure increased knowledge of BIM in the Nigerian Construction Industry and increased productivity and efficiency should be encouraged in the Nigerian Construction Industry. This will be achieved through the participation of relevant professional bodies as the need for increased awareness of the benefits of BIM is highly important.

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CHAPTER ONE

1.0 INTRODUCTION

1.1 Background to the Study

The construction industry is dynamic due to the increasing uncertainties in technology, and development processes (Anumba, 2019). It is also described as very complex, extremely competitive, and highly fragmented with an adversarial business environment that relies on traditional ways of "doing things" and has resistive nature to change (Umar, 2019). It is a cliché within construction organizations that the construction quality is poor, budgets are unreliable and the price is too high, and failures and errors are arising due to multifarious causes and occur in all steps of the construction process (Enegbuma, 2018). The construction sector faced so many criticisms across the globe for its inefficiency and lack of productivity. Nowadays, building projects are becoming much more complex and difficult; the project team is facing unprecedented changes (Yusuf, 2020). The Nigerian construction sector is not also free from the aforementioned problems and even more. It has severally been characterized as inefficient with low productivity (Usman, 2021).

It is important to fully understand Project Consultancy services, the construction consultants have a wide variety of roles to play during the construction process, Construction consultants are hired by the owner and engaged in the construction project to oversee and control the construction process from inception to completion (Anumba, 2019). Construction consultants have varied qualifications. Some have an architectural, engineering, building, and quantity surveying background, and the owner can utilize the consultant's services in reviewing plans, budgets, and the various stages of construction on construction sites. These services need to

be improved significantly, using modern tools to meet the construction project goals and objectives and also the client's satisfaction.

Building Information Modelling BIM is a process of production of the current digital model of a building or infrastructure that enables building professionals to create and share the right information at the right time to efficiently plan, design, construct and manage buildings and infrastructure during and after the design, and construction to improve efficiency and decision making (Autodesk, 2020; Build Up, 2018 & Chartered Institute of Building, 2017). It is a combination of computer software applications, systems, materials used, economy, and processes about work practices used by building professionals and clients.

(Yongliang et al., 2020). BIM represents a fundamental change to the traditional ways construction professionals function and communicate. It allows for collaboration and ease of data sharing among construction professionals. (Dhar and Khirfan, 2017). The effects of climate change and natural disasters have always affected the landscape. Still, it is only recently that spatial strategies have been strongly seen as the way toward a resilient future. Landscape, urban design, and planning are now taking a more prominent role, especially as cities and urban conurbations have started shifting their visions and taking more strategic approaches to deal with climate change.(Toyin and Mewomo, 2021). Consequently, thisthe paper examines the BIM barriers peculiar to regions yet to fully adopt BIM with specificreference to the Nigerian construction industry as a case study.(McAdam, 2017 &Simbai, (2018) progressing globally. A growing number of architects, engineers, and contractors are using building information modeling (BIM). UK is the world leader in BIM implementation, followed by the USA where 72% of construction firms are using BIM, and 500,000 houses were designed with BIM in 2017 in France. Spain introduced a BIM mandate

on public sector projects in 2018 and mandatory use in infrastructure projects by July 2019 (Cupastone, 2020; IndiaCADworks, 2020 &Zigurat, 2018).

The need for increased productivity and higher Return on Investments (ROIs) in the construction industry has become a great concern for industry stakeholders. Such decline in productivity is bred by several factors resulting in increased wastages, rework, time overruns, cost overruns, and adversarial relationships between project stakeholders. More disputes and more adversarial positions are staked out because of actual or perceived changes in a construction project than for any other reason. Aggressive contractors will threaten slow-downs and work stoppages if they don't get paid. Overbearing owners will insist that unknown conditions, extra features, and an expanded project are covered by the original "non-fluctuating" bid price (Berger, 2018; cited in Info com, 2019). Fragmentation in the construction industry, being responsible for poor communication between project stakeholders, leads to inefficiency and low productivity in construction project delivery (Latham, 2019).

Several initiatives have been taken by nations for BIM adoption and implementation. For instance, as of April 2017, all UK government construction suppliers tendering for centrally-procured government projects must be working at BIM Level 2 which involves developing building information in a collaborative 3D environment with data attached, but created in separate discipline models. Basically, if from the government. (Theiler and Smarsly, 2018). Building Information Modelling (BIM) can be recognized as one of the most solidified digital technologies that revolutionized many processes in the built environment. In its broader context, BIM can be defined as a collaborative approach indecline by the use of technology to support centralized exchanging, sharing, and updating of data in a project. Yongliang et al. (2020), indicate that proper BIM use in buildingprojects are set to minimize

40% of the unbudgeted changes. Additionally, it produces abouta 7% reduction in the projects expected duration, leads to an 80% timesaving used withinproject costing valuation creates almost a 10% increase in contract value savings andproduces a 3% profit margin for the whole project.

(Zigurat, 2018). In New Zealand, a nationwide alliance of industry and government known as the BIM Acceleration Committee, BAC in New Zealand was established in February 2014 to coordinate efforts to increase the use of BIM in the country (BAC, 2019).

Building smart Canada, BSC 2019) to lead the transformation in achieving lifecycle BIM modeling in Canada. CanBIM, Canada BIM Council, began offering certification in - provides four levels of Certification for individuals as well as Educational Course and Program Certification (Canada BIM Council, 2018).

Despite the pace set by developed countries, in developing countries like Nigeria, the inefficient and error-prone practices based on the 2D drawings traditional approach is still the most common approach (Ganiyu*et al.*, 2018). Previous research on BIM in Nigeria shows that there is a paucity of research on BIM status and a lack of trained and skilled persons on BIM tools (Onungwa*et al*, 2021&Abubakar*et al.*, 2020*)*. Most of the research focused on awareness among professionals and organizations, BIM adoption, and barriers affecting its adoption in the Nigerian construction industry (Ganiyu*et al.*, 2018; Yusuf *et al.*, 2020; Abubakar*et al.*, 2020).

About two-thirds of construction problems are caused by inadequate communication and exchange of information as a result of the fragmentation of the construction industry (Mendez, 2019). An increase in maintenance costs can be attributed to faults in the operations of systems and components as a result of a deficiency in design (Mohammed A. H, 2018). In the past, facility managers have been included in the building planning process in a very

limited way whereby implemented maintenance strategies are based on the as-built conditions at the time the owner takes possession of the facility. And also, there are additional and valuable information required for the operation and maintenance of the building which goes unrecorded during construction (Mendez, 2019). It is important to note that buildings are becoming more complex and are taking longer to build, which makes increased productivity and coordination in the construction industry imperative (Info comm, 2019).

An innovative approach to building design, construction, and management is gradually being implemented by major countries across the globe. This paradigm shift is referred to as "Building Information Modeling" or simply put "BIM".

This research work intends to assess the application of building information modeling construction industry.

1.2 Statement of the Problem

The Nigeria potential of BIM for improving the quality of professional services in the construction industry is generally acknowledged. While report abounds on increase in the use of BIM in the construction industry in developed countries, very little exist in developing country like Nigeria (Obodoh, 2019). A survey of the current state of BIM application in architectural, engineering, and quantity surveying practices in Nigeria construction industries in Northcentral Nigeria indicates that while core architectural, engineering, and quantity surveying functions like (drawing, engineering design, and preparation of bill of quantity respectively) has been largely computerized, the professional builders are yet to key into this the new development totally

The move to adopt Building Information Modelling in Nigeria's private and public sectors and amongst different building professionals (Architects, Quantity Surveyors, Engineers,) has

been very slow (Yusuf, 2020). Few Architects have adopted but mainly for enhancing the visual quality of their presentation. This is unfortunate because of its enormous potential to enhance efficiency, reduce disputes, save costs, and curb corruption (Alufohai, 2018). A major setback to the full implementation of BIM in the Nigerian Construction industry, as with every novel technological innovation across the globe, could be related to the lack of application of BIM technology - along with the benefits of improving productivity and efficiency in the Nigerian Construction sector amongst stakeholders. It is thus imperative, as a first step, to determine the level of application of BIM in the Nigerian Construction Industry Oladepo (2017). This, in turn, will serve as a basis for developing strategies for increased awareness to encourage a holistic implementation of BIM by all industry participants, and thus, achieve the needed productivity and efficiency in the Nigerian Construction Industry.

According to (Oladepo, 2017), a major construction process demands heavy exchanges of data and information between the project participants daily. (Umar, 2019) also, identify two vital roles of the construction project which are the specification of the resulting product (design information) and the initiation and control of the activities required for constructing the facility (management information).

The potential for improving the quality of professional service in the construction industry is the effective use of BIM. According to Mafini, (2017), the effectiveness of BIM in meeting the needs of the client in the built environment is influenced by their recognition and application of context-relevant competencies.

1.3 Aim and Objective of the Study

The aim of the study is to assess the application of Building information modeling in the construction industry in Abuja.

1. To identify the impact of building information modeling (BIM) application on building projects in the construction industry in Abuja
2. To identify the constraints to the application of building information modeling (BIM) in the construction industry in Abuja
3. To determine the level of awareness in the application of building information modeling (BIM) in the construction industry in Abuja
4. To identify the barriers to the application of building information modeling (BIM) in the construction industry in Abuja.

1.4 Significance of the Study

The findings of this research will benefit the builders, engineers, architects, project managers, and clients in the construction industry, if the findings of this research are fully implemented it will enhance the exchange of information between professionals and their clients through the application BIM which will, in turn, save time and energy.

The findings of the study will also be beneficial to the construction industries, as the findings will enable the construction industries to employ the fastest method of data processing, increase productivity, effective decision-making, and better service to their clients.

The findings of the study will also be of benefit to the students as the findings will enable them to use them as a basis for further research; it will serve as a board from which further research might take off. The data already gathered and documented in this project will serve as a source of information to students as well serve as reference material in their classroom work.

The client will also benefit from the findings of this study as the finding shows that communication of information or data can be done between the clients and the construction industry.

The Government, professional bodies, and civil society groups will also benefit from the findings of this study as the findings will help the Government to improve cost management practices in Nigeria and the current efforts to promote transparency and value for money in public construction projects

The contractors will also benefit from the findings of this study as the finding will help them establish the actual and potential roles of BIM in achieving better budgeting and cost management in achieving value for money in construction projects

1.5 Scope of the Study

This study is delimited to the application of building information modeling in the construction industry in Abuja. The study also covers the impacts of building information modeling (BIM) application on a building project in the construction industry, the constraints to the application of building information modeling (BIM) in the construction industry, the level of awareness in the application of building information modeling (BIM) in the construction industry and the barriers to the application of building information modeling (BIM) in the construction industry in Abuja.

1.6 Research Questions

The following research questions will guild the study:-

1. What are the impacts of building information modeling (BIM) applications on building projects in the construction industry in Abuja?
2. What are the constraints to the application of building information modeling (BIM) in the construction industry in Abuja?
3. What is the level of awareness in the application of building information modeling (BIM) in the construction industry in Abuja?

4. What are the barriers to the application of building information modeling (BIM) in the construction industry?

1.7 Hypothesis

The following null hypothesis was formulated and will be tested at a 0.05 level of significance

HO_1: There will be no significant difference in the mean response on the impact of building information modeling (BIM) application on a building project in the construction industry in Abuja.

HO_2: There will be no significant difference in the mean response on the constraints to the application of building information modeling (BIM) in the construction industry in Abuja.

HO_3 There will be no significant difference in the mean response on the barriers to the application of building information modeling (BIM) in the construction industry in Abuja.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

2.1 Nigerian Construction Industry

As of the fourth quarter of 2015, estimates indicated that the construction industry in Nigeria contributes 1.99% of the country's GDP. The following graph demonstrates that, despite the industry's significant growth in terms of the Compound Annual Growth Rate (CAGR), the sector's contribution to the national GDP has remained static. The development business report, 2019 uncovered that in 2017, the development area represented 5.8% of the public Gross domestic product and over the most recent 3 years, Nigeria's complete Gross domestic product has raised to roughly multiple times its size. In contrast, GDP in the construction industry has only increased to 125 times its size in 2019. Over the past three years, the construction industry, crude oil production, and trade have continued to be the main drivers of the nation's GDP. Despite producing nearly 70% of the nation's fixed capital formation (Idrus and Sodangi, 2017), the construction industry in Nigeria has yet to realize its potential in comparison to other sectors. This is despite the country's significant infrastructure deficit.

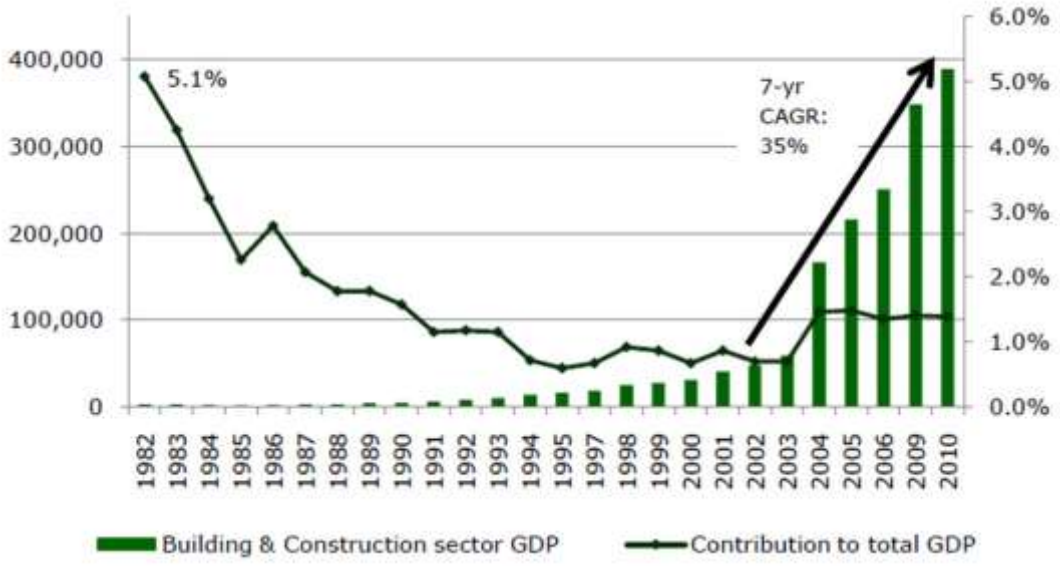


Fig 1: Nigeria Construction GDP. Source: National accounts, Vetiva Research(2019)

According to the construction industry report (2019), crude oil production, wholesale and retail trade, and GDP growth in the construction sector all increased at CAGRs of 21% and 29%, respectively, over the past three years, respectively.

Taking full advantage of the presence of crude oil in the regions, similar less diversified oil producers like Saudi Arabia and the United Arab Emirates (UAE) and more diversified oil producers like Russia experienced a significant boom in construction in the last three years. In the United Arab Emirates, for instance, the construction sector skyrocketed during the oil boom at the beginning of 2015, allowing the country to maintain its infrastructure development despite the falling oil price in 2018. These nations have experienced a significant construction boom as a result of oil-fueled economic expansion, favorable demographic fundamentals, expanding commercial activities, and tourism (Construction Industry Report, 2019).

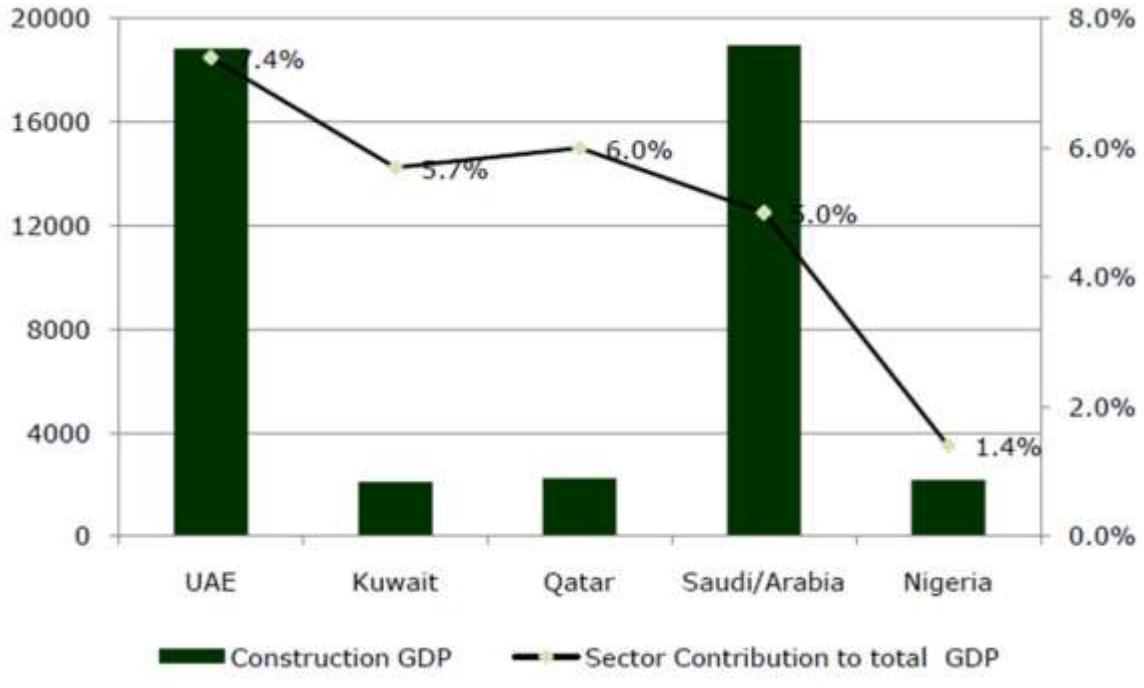


Fig25: Construction GDPs compared. Source: National accounts, Vetiva Research(2018)

By 2018, the UAE's construction industry had grown very quickly, accounting for nearly 11% of its GDP. They realized that in order to maintain their infrastructure, which has greatly benefited the construction industry, they needed to take advantage of the rising prices of oil on the global market. The GDP of some oil-producing nations and their construction industries are depicted in the table below.

As a net importer of crude oil, China's construction industry is not attributed to oil wealth like those of oil-producing economies; rather, its rapid industrialization and export-driven economy are to blame. China's construction GDP increased from 3.8% to 6.6% in the first three years of the reform, and in the last three years, construction output accounted for 13% of GDP in 2018.

Time and cost overruns, inadequate planning and budgetary provisions, contract sum inflation, inefficient service delivery, and other issues plague the Nigerian construction industry (Kuroshi, 2018). Therefore, Aibinu, Oyewobi, and Others, (2019) emphasized that the industry must improve performance and efficiency if it is to effectively meet its customers' needs and provide value for money.

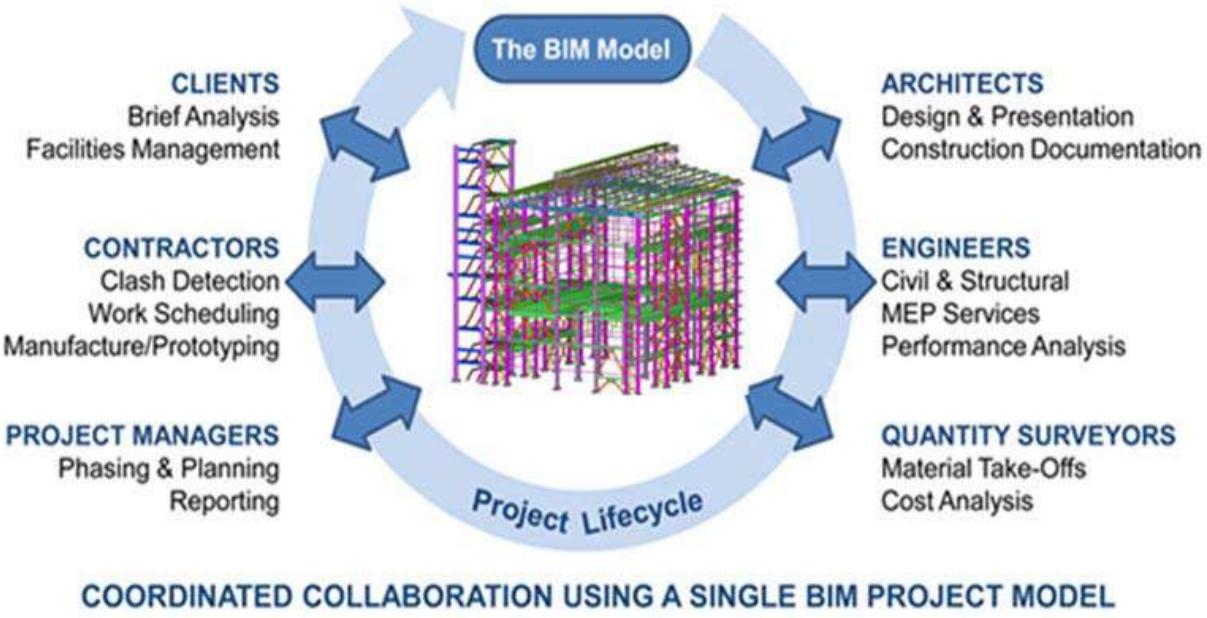
Because it serves as a platform for effective collaboration and communication between all parties to a building project and has the capacity to bring sanity to the design and construction processes, which in turn improves the overall performance of the construction industry, BIM is seen as a solution to some or even most of these issues.

2.2 The Concept of Building Information Modelling (BIM)

Building Information Modelling (BIM) is a construction method that encourages the continuous and immediate availability of high-quality, integrated information about project design scope, schedule, and cost. Sacks et al. (2016) state, "BIM is a generic term used to describe advanced 3D Computer Aided Design (CAD) technology for modeling and managing buildings and information related to them. It is distinguished from traditional CAD

systems by the fact that the software objects in a BIM model are intelligible to computer programs as representations of real-world building components, in contrast to the graphic objects in a two-dimensional CAD file."

BIM is described as "a model-based technology linked with a database of project information" by the American Institute of Architects (AIA). Geometry, spatial relationships, geographic data, and the quantities and properties of building components are all covered by BIM. As per Matta et al, (2018) "innovation propels affected the progress of plan medium from 2D paper-based drawings to 3D advanced models on the PC screen - prompted the presentation of Building Data Demonstrating (BIM)".BIM is considered to be the most recent version of object-oriented computer-aided design (OOCAD) systems. In BIM, all of the intelligent building objects that make up a building design can live together in a single project database—also known as a virtual building—that stores all of the building's information. Theoretically, a building information model provides a single, logical, and consistent source for all building-related data (Howell, 2017).



Schematic representation of data exchange and collaboration (BAC, 2019).

Amount looking over involves the exact understanding of plans and mathematical portrayal of part amounts which was for quite a while a cycle brought out through manual means.

As a result, it is difficult to use and prone to errors. According to BAC (2019), CAD software that could use graphical elements like lines, arcs, and symbols to represent 2D geometry was used. By grouping related elements, like lines that represent walls on a specific "wall layer," later on, layering made it possible to project significant meaning through the graphic elements. Subsequently, discrete 2D drawing records could be produced and plotted from computer-aided design. However, more complex information, such as the relationship between elements, could not be represented. Later, 3D computer-aided design (CAD) developed, initially focusing primarily on the creation of geometry to support visualization, but later expanding to include the ability to produce realistic lighting effects and rendering.

Building elements capable of representing the behavior of common building elements displayed in multiple views and having non-graphic attributes assigned to them have replaced 2D symbols in object-oriented CAD systems (OOCAD). By incorporating parametric 3D geometry with assigned rules and variable dimensions, complex geometric and functional relationships between building elements could be represented, giving the objects more "intelligence."Alufohai (2018) says that this made it possible to stretch and join things like walls, show their height and a specific type of cross-section, and give them properties like a fire rating or insulation value.

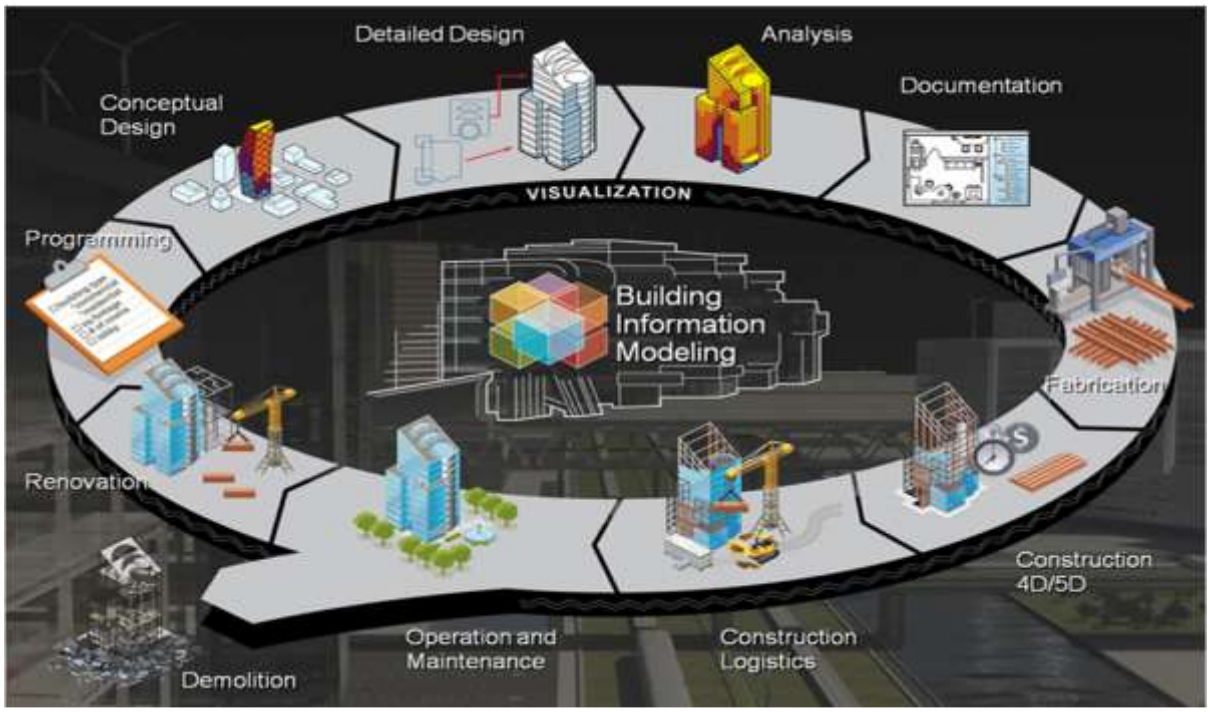
As objects, doors, and windows began to be able to show how they were connected to the wall that contained them. Taking into account the shift toward BIM, abstract objects like space could be defined by the relationship between physical building elements. They could also be identified, such as by giving a room a name or number, and described, such as by area, occupancy, volume, and so on and cited, such as included in a room schedule. It is important to note that the BIM only consists of 3D geometry. The following summarizes the

relationship: BIM encompasses the quantities and properties of building components, spatial relationships, geographic information, geometry, information shared to generate feedback, and decision-making.

According to the NBIMS Project Committee (2016), a fundamental tenet of BIM is stakeholder collaboration at various stages of the project life cycle. This makes it possible to insert, extract, update, or modify information in the BIM process to support and reflect the roles of each stakeholder. By creating a system to the house or manage all of the information required in a particular project in a single repository that could be accessed by all project participants and easily incorporated into all project documents, BIM was designed to address the issues of fragmentation and error (Khemlani, 2021).

2.3 Definition of Building Information Modelling (BIM)

Building Information Modelling (BIM) is the process of creating the current digital model of a building or infrastructure. It enables AEC professionals to create and share the right information at the right time to plan, design, build, and manage buildings and infrastructures efficiently during and after construction to increase efficiency and decision-making (Autodesk, 2020; Chartered Institute of Building, 2017). According to McAdam (2017), it is a combination of software applications, systems, utilized materials, economics, and procedures regarding work practices utilized by professionals and clients in the AEC sector.



Schematic representation of BIM interaction (Autodesk, 2020).

BIM for infrastructure (Autodesk, 2020).

Building information must be developed in a collaborative 3D environment with data attached and created in separate discipline models at BIM Level 2, which is required for government projects. primarily, if it comes from the government (Zigurat, 2018).In order to

coordinate efforts to increase the use of BIM throughout the nation, the BIM Acceleration Committee, BAC in New Zealand, a nationwide alliance of industry and government, was established in February 2014 (BAC, 2019).In 2019's Building Smart Canada, BSC laid the groundwork for Canada's transformation toward lifecycle BIM modeling. According to Canada BIM Council (2018), the BIM Council offers four levels of individual certification in addition to certification for educational courses and programs.

Even though developed nations are moving at a faster rate, developing nations like Nigeria continue to use inefficient and error-prone practices based on 2D drawings (Ganiyuet al.,2018). According to Onungwaet al. 2021, previous research on BIM in Nigeria demonstrates that there is insufficient research on BIM status and a lack of trained and skilled individuals in BIM tools. The greater part of the examination zeroed in on mindfulness among experts and associations, BIM reception, and boundaries influencing its reception in the Nigerian development industry (Abubakaret al.,2020).BIM reception and execution are advancing around the world. Building information modeling, or BIM, is being utilized by a growing number of contractors, architects, engineers, and engineers. The United Kingdom is the world leader in BIM implementation, followed by the United States, where 72% of construction firms use BIM. In 2017, 500,000 houses in France were designed using BIM. By July 2019 (Aibinu and 0yewobi, 2019), Spain will require the use of BIM in infrastructure projects as well as public sector projects.

2.4 Building Information Modelling (BIM) in Nigeria's Construction Industry

The primary role that BIM will play in the Nigerian Construction Industry will be to improve client-building professional relationships, as disagreements over work scope, modifications, overruns, and associated costs are common. Such debates are more normal between building experts and backers of land projects. Poor budgeting and corruption pose the greatest obstacles to productivity and efficiency in the public sector. Additionally, construction

projects in Nigeria frequently result in exorbitant price increases. According to Alufohai (2018), this will result in a significant increase in transparency as a result of the implementation of BIM, which will make it possible for various stakeholders (such as bidders, contractors, the parliament, and organizations representing civil society, among others) to have a better understanding of the actual scope of projects.

The Nigerian Public Arranging Commission is dealing with a Public Coordinated Framework Groundbreaking strategy (NIIMP) that plans to foster foundations all through the country somewhere in the range of 2017 and 2043, which will require $871 billion in the center foundation through 2030 to help a potential gain Gross domestic product development situation (Kaduma, 2018). The current rebasing of the Nigerian economy reveals that construction has increased to 10.2% of GDP growth between 2015 and 2020. With a contribution of 14.3% to GDP growth, this cannot be compared to manufacturing (Anuimba, 2019).

The inefficiency of construction project production processes is to blame for the low productivity of the Nigerian construction industry. In contrast, the Manufacturing Sector can boast a higher level of productivity as a result of improved efficiency achieved through the use of more efficient and cutting-edge production techniques in an environment that is well-integrated. As a result, BIM is a practical and innovative method for planning, designing, building, and managing infrastructure in a coordinated and integrated manner. This increases productivity and reduces waste, which in turn supports Nigeria's GDP growth.2017 Oladepo). Nigeria's GDP is 2 percent contributed by the construction industry. The informal sector is made up of people who hire builders to build houses, the commercial sector is made up of office buildings in a few cities like Lagos and Abuja, and the public sector is made up of residential estates built by developers. Building Information Modelling is more important to the public and commercial sectors. Because the issues surrounding cost management are very

different, it also has different repercussions for each industry. Across all industries, CAD remains the most common method for modeling projects.

The major players in the commercial sector are banks and multinational corporations, including oil companies. With better cost-management practices than the public sector, this is considered Nigeria's more productive subsector of the construction industry. Since disputes frequently arise over the scope of work, modifications, overruns, and associated costs, the primary contribution of BIM in this instance is to improve relationships between clients and building professionals. According to Mohammed (2018), disputes of this kind are more prevalent between real estate project sponsors and building professionals. This is because the industry has a more "entrepreneurial" culture; Real estate companies, in contrast to large banks and multinational corporations, do not have robust procurement departments with professionals who are skilled at documenting contracts. The likelihood of cost disagreements is greatly increased when developers refuse to pay for quantity surveyors, expecting civil engineers to estimate projects based on "experience."Building professionals' abilities to acquire BIM tools and skills vary greatly. In the commercial subsector of Nigeria's construction industry, practices like contract splitting and saving money are common. As a result, skilled but underfunded building contractors (sometimes just businessmen with no professional building training) do get contracts to work on large projects (Ganiyu, 2018).

The public sector is much more structured. Major contracts typically go to seasoned construction professionals. Corruption and poor budgeting pose the greatest obstacles to cost management in this area. Contracts are awarded for designs whose costs have not been properly estimated (Onungwa, 2021). As a result, a lot of money and resources have been invested in projects that have been put on hold. A good illustration of this is the Federal Secretariat Complex in Abuja, Nigeria's capital, which was abandoned after it was discovered that creating a substantial underground parking garage would be too costly. In Nigeria,

building projects frequently contribute to corruption. Costs frequently skyrocket as a result of this (Mendez, 2019). The use of BIM will significantly increase transparency, allowing various stakeholders (bidding contractors, parliament, civil society organizations, etc.) to have a better understanding of the actual costs of the project and the financial consequences of variations. Building Information Modelling has not been widely adopted in Nigeria's private and public sectors (client side) or among various building professionals (Architects, Quantity Surveyors, Civil Engineers, etc.).Architects have adopted, primarily to improve the presentation's visual quality. This is unfortunate because it has enormous potential to improve efficiency, reduce conflict, save money, and stop corruption. Increased awareness of the method, the tools used, and the advantages of those tools will be the first step in promoting adoption (Aunimba, 2019).

In order to raise awareness, software providers and educational establishments have a role and a commercial opportunity. Professional organizations like the Nigerian Society of Engineers and the Nigerian Institute of Quantity Surveyors must also conduct training for their members and customers, including public sector establishments. The construction press and other well-informed individuals, such as analysts, will join in the promotion of the crucial cost management tool that the BIM represents as this awareness grows.

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

One significant competitive advantage of BIM is its capacity to increase collaboration and transparency among contractors and suppliers, thereby reducing waste at all levels of the supply chain (procurement, process, and material). The fact that the benefits of BIM are shared by the client and the entire supply chain – with benefits to customers who use built assets and society as a whole as a result – is a key factor in the rapid adoption of BIM by clients and industry (Build up, 2018).

BENEFITS OF BUILDING INFORMATION MODELLING (BIM)		
PRE-CONSTRUCTION STAGE - Concept, feasibility, and design. - Increased building performance and quality. - Creating a time-based simulation of construction activities. **DESIGN STAGE** - An earlier collaboration of multiple design disciplines. - More accurate visualization of design changes. - Reduction in errors in generating construction drawings. - Early insight to design errors & omissions. - Early extraction of more accurate cost estimation & bill of quantities - Improved energy efficiency & sustainability. - Blending geospatial and building information for planning. - Information available earlier within the project. - Improved information delivery; can be reused,	**CONSTRUCTION STAGE** - Synchronization of design & construction revealing potential problems & possible improvements. - Clash detection. - Reduction in errors in generating construction drawings. - Improved coordinated approach between participating designers and contractors. - Using design model as a basis for fabricated components. - Better implementation and lean construction techniques. - Substantial cost savings, time-saving, and waste on-site. - Enhanced coordination. - Enhanced productivity. - Enhanced business operations. - Flexibility of output documentation. - Quick simulations. - Use of digital product data in manufacturing and assembly of structural	**POST-CONSTRUCTION STAGE** - Better managed and operated facilities after completion. - Streamlined approach where data is shared in a collaborative approach. - Savings in design coordination, drawing production, information management & exchange. - Improved design quality, sustainability, and client communication. - Reduces information loss when handing over the project from the design team to the construction team to the owner. - Controlled whole-life cost and environmental data.

repurposed, reviewed, revised, corrected, controlled, checked, and validated.	systems.	

Benefits of BIM during design, construction, operation, and maintenance of a building projects

The foremost contrast between BIM and 2D computer-aided design is that the last option depicts a structure through free 2D perspectives like plans, segments, and heights. According to Azhar et al. (2018), editing one of these views necessitates checking and updating all other views, a laborious and error-prone procedure. The software that enables 3D modeling and information management is at the technical heart of BIM (Autodesk, 2020). The ability to insert, extract, update, or modify information in the BIM process to support and reflect the roles of that stakeholder is made possible by the collaboration of various stakeholders throughout various phases of the project life cycle, which is a fundamental tenet of BIM. By creating a system to the house or manage all of the information required in a particular project in a single repository that could be accessed by all project participants and easily incorporated into all project documents, BIM was designed to address the issue of fragmentation and error (Berger, 2018). According to Autodesk, 2020, architects, engineers, builders, and owners have a clear overall vision of their projects when this information is kept current and accessible in an integrated digital environment. They also have the ability to make better decisions more quickly, which raises project quality and profits.

The use of BIM can bring about a number of advantages. These are some better coordination, synchronization, and sequencing of tasks, and permitting all venture participants to access and question project data. Better clash detection is made possible by BIM at a more advanced level (Howell, 2017). Added advantages include the ability to visualize the building in a simulated setting, increased predictability of actual field conditions, and the chance to prefabricate more materials off-site (Oladepo, 2017). With the provision of automatic bills of

material and the generation of automatic shop drawings for the fabrication of structural steel, sheet metal ducts, fire protection and piping, electrical cabling, and bus duct layouts, the building design process can continue (Umar, 2019).

BIM has the potential to improve construction projects' productivity, quality, and efficiency. This can accomplish by providing a more illustrative and accessible exposition of a building, reducing the number of errors and incompatibilities, providing information that is more precise and up-to-date, and so on (Latham, 2019). The company's design process is streamlined by BIM, as is the automation of emails through the use of a knowledge database.

The benefits and key advantages that BIM confers include:

1. Increased speed of delivery (time saved)
2. Better coordination (fewer errors)
3. Decreased costs (money saved)
4. Greater productivity
5. Design visualization
6. Reduction of Errors
7. Collision Detection
8. Quantity Take Off
9. 4D Constructability
10. 5D Cost Estimating
11. Asset/Equipment Inventory
12. Facility Operations
13. Space assignment
14. Maintenance/Repair
15. Emergency response,

16. Higher-quality work
17. New revenue and business opportunities

2.6 Barriers to Building Information Modelling (BIM) Application in the Nigeria Construction Industry

Despite the emergence of BIM, numerous AEC firms continue to employ established construction work procedures. In a similar vein, the integrated BIM concept increases the liabilities and risks faced by various parties. When consultants and other vendors add to the BIM, this causes issues. The BIM system transfers manage and create massive files. However, due to issues with Nigeria's power supply and internet facilities, doing so is typically challenging.

The use of BIM is constrained in many ways. Key of the obstructions is the absence of a talented workforce in the development business, most planners train themselves or learn at work. As a result, they are frequently unaware of emerging technological trends, particularly software capabilities. The "Fear of Change" is another obstacle to BIM adoption (Yusuf, 2020). Developing drawings in three dimensions, including walls, windows, doors, and other building components, requires a shift in mindset when employing BIM.

The output of work in the offices is impacted by the absence of internet connectivity and constant electricity (Capstone, 2020). The constant use of generators also raises office operating costs. A connection to the Internet is required in order to use BIM effectively. Drawings from a vendor site, for instance, need to be accessible via the internet. However, internet access is limited in Nigeria. Therefore, if it is made available, it will raise production costs. Additionally noteworthy is the fact that many construction professionals are unaware of the most recent technological advancements.

Most of the time, BIM involves a lot of data input, highly skilled staff, and a series of activities. The conditions for its operation must be provided in order to guarantee its

effectiveness. There must likewise be institutional help from the Modelers and the Architects. Despite the development of new technology, the industry's fragmentation will continue without this. In Europe and USA, Planners and Designers have had the option to coordinate their works in a similar BIM model. In Nigeria, this is not the case. Building Information Modelling (BIM) is a cutting-edge technology that has addressed prominent issues in the Architecture, Engineering, and Construction (AEC) industries in most developed nations (Mac Adams, 2017). Fragmentation still exists in the construction industry. Due to identified obstacles and a lack of clear understanding of best practices, construction industries in developing nations are debating whether to implement this technology (Sahil, 2016).

Over the years, various research studies have highlighted a number of obstacles that hinder BIM implementation, including the following authors: Ahmad 2016).BIM challenges were identified by Ahmad (2016) as follows: Problems with teamwork and collaboration, legal changes to ownership and production of documentation, changes in information use and practice, and implementation issues are just a few examples. According to the Chartered Institute of Building (2017), major obstacles to the implementation of BIM technologies include a lack of education and training, a lack of IT infrastructure, a lack of a standard to guide implementation, and a lack of government direction. As a result of rework, construction projects in developing nations that still make use of traditional technology face difficulties in their respective construction industries (Sahil, 2016).

To empower the application and execution of BIM by associations, planners, and chiefs, need a top to bottom comprehension of variables that lead to and prevent BIM use must be accomplished. Individual, organizational, and institutional factors can all be examined in relation to BIM application (Ahmed, 2016).

The following barriers affect the application of BIM in the Nigeria construction industry

1. Learning curve
2. Lack of executive buy-in
3. The shift of liability among
4. project participants
5. Poor collaboration among BIM software
6. Management problems with the BIM master model
7. Lack of collaboration management tools,
8. An organizational structure that does support BIM,
9. Security risk, Lack of industry standards,
10. Shortage of BIM implementation data in the construction phase,
11. Difficulties in measuring the impacts of BIM,
12. Lack of knowledge and awareness,
13. Unavailability of standards and guidelines,
14. Lack of demand

2.7 Review of Related Empirical Study

Yusuf (2020) examined the level of awareness and utilization of building information modeling in the Nigerian construction industry. In light of this, the paper concluded that Building Information Modelling (BIM) has the potential to enhance sustainability, end-user satisfaction, transparency and accountability in decision-making, improved quality, and time and cost savings across the entire value chain. Many developed nations in North America and Europe are aware of BIM and have adopted it. However, traditional building methods are still in use in developing nations like Nigeria. The study aims to evaluate the current level of BIM awareness and utilization in Abuja and Kaduna State. Structured, closed-ended

questionnaires were used to collect primary data from building construction professionals in architectural firms in Abuja and Kaduna. According to the study, professionals are aware of BIM but do not use it extensively in construction. In a related development, the low level of usage was caused by a lack of government support, high hardware and software costs, inadequate knowledge of BIM tools, technical expertise, and clear standards and guidelines. As a result, the Federal Government should, among other things, make BIM mandatory for projects that exceed certain threshold values to encourage construction professionals to use it.

A study on the assessment of building information modeling (BIM) knowledge in the Nigerian construction industry was carried out by Mohammad (2018). He stated in this work that Building Information Modeling (BIM) is a novel strategy that is gradually being implemented worldwide. In order to identify potential issues with a facility's design, construction, or operation, BIM facilitates the visualization of the things that will be built in a simulated environment. In spite of the well-known advantages that BIM provides, the Nigerian construction industry has adopted BIM relatively slowly.90 structured questionnaires were used to conduct a field survey;self-administered by stratified random sampling of construction industry stakeholders in Kaduna State, Nigeria's northwest; all designed to determine the respondents' level of BIM awareness and utilization.43 surveys were appropriately filled and returned. The results were analyzed using the Percentile and Relative Index (RI) techniques with a response rate of 44.77 percent. The paper has established, as a contribution to knowledge, that stakeholders in the Nigerian construction industry are unaware of and do not use Building Information Modeling (BIM). This lack of awareness and utilization is linked to the low level of knowledge about BIM. As a result, the paper suggested that relevant professional bodies should participate to raise awareness of and use of BIM; the incorporation of BIM into the educational program; what's more, for the Nigerian Government to work with the execution of BIM in Framework projects, to

guarantee satisfactory information on BIM towards further developing efficiency and productivity in the Nigerian Development Industry.

Anuimba (2019) investigated the state of building information modeling in the Nigerian construction industry at the present time. Building Information Modelling (BIM) has been used to study various aspects of construction processes in developed nations, but Nigeria has yet to take advantage of its full potential. Because it increases construction productivity, it has a greater impact on the public and commercial sectors. The current state of BIM in the Nigerian construction industry is the subject of this research. A questionnaire was used to collect primary data for the study, which took a quantitative approach. It was sent to 150 people, of whom 90 returned it and were deemed valid for further analysis. Pearson correlation and the mean item score were used to analyze the data. It was found that building information modeling (BIM) awareness is lowest during the construction and facility management phases of a building's life cycle, while awareness is highest during the design phase. Additionally, the following software packages, are BIM compliant and are widely used in the Nigerian construction industry: Sketch Up, Revit Architecture, and Quantity Takeoff from Autodesk. However, the study recommends policy development, investment in BIM research, stakeholder education, and openness to new technologies.

Oladepo (2017) conducted research on the difficulties associated with implementing building information modeling in the Nigerian construction industry. Against this backdrop, the paper looked into how building information modeling (BIM) could be incorporated into the building design and development cycles to address project development challenges and the need to innovatively integrate the construction process. However, the Nigerian construction industry's adoption of BIM is not encouraging, and its implementation is poor. A questionnaire was used to collect the data, which identified the obstacles to BIM implementation and the various strategies for overcoming them in the Nigerian construction

industry. Utilizing the Relative Importance Index (RII), simple percentages, pie charts, and bar charts, the data were analyzed and ranked. According to the findings of the study, two very significant obstacles to the implementation of BIM in the Nigerian construction industry are a lack of BIM education (RII value 0.79) and information (RII value 0.76). It additionally uncovers that Increment research for BIM innovation in Organizations of Higher learning with an RII of 0.78, Direct BIM abilities improvement programs with RII upsides of 0.76 are exceptionally critical ways to deal with conquering the difficulties of BIM execution in Nigeria. According to the findings, the Nigerian construction industry should have access to information on BIM and prioritize BIM education.

2.8 Summary of Literature Review

Building Information Modelling (BIM) is one of the most prominent aspects of a significant and rapid shift in the global construction industry. According to Zigurat (2018), it is the platform that fosters collaboration among project stakeholders and enhances project outcomes. A paradigm shift toward an integrated digital information infrastructure that will ultimately revolutionize almost all aspects of the construction industry is represented by the growing worldwide application and implementation of BIM for its powerful data-based modeling, visualization, analysis, and simulation capabilities. Building Information Modelling (BIM) has the potential to improve information sharing across the entire value chain, time and cost savings, improved quality, transparency, and accountability in decision-making, increased sustainability, and improved end-user satisfaction (Umar, 2019). Many developed economies around the world have recorded impressive results by implementing BIM in their construction practices. Several developed nations in North America and Europe are aware of, widely accepted, and employ BIM. Notwithstanding, agricultural nations like Nigeria are as yet utilizing customary development rehearses.

Also looked at was the fact that professionals are aware of BIM, but they don't use it much in construction (Enegbuma, 2018).In a related development, the low level of BIM application was caused by a lack of government support, high hardware and software costs, inadequate knowledge of BIM tools, technical expertise, and clear standards and guidelines. Idrus and Sodangi (2017), examined the actual and potential roles of BIM in improving designs for public construction projects, which continue to dominate Nigeria's construction industry. It starts by talking about the BIM tools and practices that construction projects use, especially those that are relevant to designs. Due to the process and technological changes it brings to an organization, education and training were identified as crucial components of BIM implementation (Abubakar, 2020). Professional organizations and relevant government agencies should also initiate awareness-raising programs to involve all stakeholders, eliminate resistance to change, and encourage project parties to implement BIM processes.

CHAPTER THREE

3.0 RESEARCH METHODOLOGY

This chapter describes Research design, Area of study, population of the study, Instrument for data collection, Validation of the instrument, Administration of the instrument, Method of data analysis and Decision rules respectively.

3.1 Research Design

The descriptive survey research method with the use of a structured questionnaire was used to collect the required information from the respondents. The survey research was adopted because survey design generally can be used to effectively investigate problems in realistic settings. Nworgu (2016) described survey research as that which a group of people or items is studied by collecting and analyzing data from only a few people or items considered to be representative of the entire group.

3.2 Area of the study

The study was conducted in Federal Capital Territory Abuja Nigeria which was formed in 1976 from parts of former Nasarawa, Niger and Kogi state. The territory is bordered by the states of Niger to the west and North, Kaduna to the Northeast, Nasarawa to the east and South and Kogi to southwest. It is lying between latitude 8.25°and 9.20° north of the equator and longitude of 6.45° and 7.39° east of the Greenwich meridian, Abuja is geographically located in the central region of the country.

This study covers five (5) building construction firms in Federal Capital Territory Abuja Nigeria.

3.3 Population of the Study

The target population for this study comprises of building professionals and the non-professional. Which comprises of 85 registered builders and 35 non-professional builders (labourers, carpenters, storekeeper, masons, iron benders) practicing with the construction

company in 5 construction companies in Abuja. This sum up to be 120 building practitioners. There was no need of sampling since all the population in their companies were used

3.4 Instrument for data Collection

The instrument used for data collection is questionnaire. The questionnaire is to determine the opinion of the respondents that comprises of the project managers, site engineers and architects in the Federal Capital Territory Abuja Nigeria. The questionnaire is divided into two parts (i and ii). Part i consist of respondents "personal data", containing information about gender, age, qualification and part ii is grouped into (A,B,C and D) were question A consist of 10 items which sought to elicit information about the impacts of building information modelling (BIM) on building project in the construction industry in the federal capital territory Abuja Nigeria, sub-section B consist of 10 items which sought to elicit information about the constrains to the application of building information modelling (BIM) in the construction industry in the federal capital territory Abuja Nigeria, sub-section C consist of 10 items which sought to elicit information on the level of awareness in the application of building information modelling in the construction industry in the federal capital territory AbujaNigeriaand sub-section D consist of 12 items which sought to elicit information on the barriers to the application of building information modelling (BIM) in the construction industry in the federal capital territory Abuja Nigeria.

3.5 Validation of the Instrument

The instrument had been validated by three experts from the Department of Industrial and Technology Education, Federal university of technology minna. These experts' suggestions and corrections was used in modifying the instrument, to ensure that the items are clearly stated and appropriate for the stated research questions and hypotheses. The validated questionnaire items by the validators was used for data collection and data analyses.

3.6 Administration of the Instrument

The instrument use for data collection will be administered to the respondent by the researcher and a researcher assistant within the study area selected for this research.

3.7 Method of Data Analysis

Data relating to the research questions was analyzed using mean and standard deviation while the t-test statistic was used for testing the hypotheses at 0.05 level of significance. For calculating the mean and standard deviation for the items, the response modes were assign numerical value as follows: SA - Strongly Agreed - 5 points, A - Agree - 4 points, U – Undecided- 3 points, D – Disagree - 2 points, SD - Strongly Disagree - 1 point. For answering the research question, any item with a mean response of 3.50 and above was considered as Agree while those below 3.50 was regarded as Disagree. This is because 3.50 is the lower true limit of Agree. For testing the hypotheses, if the calculated t-value is equal or greater than the t-table value (t-critical), the null hypothesis was rejected at 0.05 level of significance. Otherwise accepted.

Alternative value		Abbreviation	Rating
Strongly Agree	=	“SA"	4
Agree	=	“A”	3
Disagree	=	“D”	2
Strongly Disagree	=	"SD"	

$\frac{4+3+2+1}{4} = \frac{10}{4} = 2.5$

The mean response of each item was obtained by using the following formula

$$\overline{X}_1 \frac{\sum FX}{N}$$

Where

£ = Summation of

X = normal value of option (mean)

N = number of response of an item

F = frequency of response of each option

$\overline{X}_2$=Grand mean of each item

Decision Rule

To determine the level of acceptance, mean response. 2.50 And above was considered agreed or accepted. While mean response of 2.49 and below was equally considered disagreed or rejected. For testing hypothesis ± 1.68 will be the critical value, any item that has its t- value equal or less than t- critical was considered not significant, and any item that has its calculated t- value above t-critical was considered significant.

CHAPTER FOUR

PRESENTATION AND DATA ANALYSIS

This chapter deals with the presentation and analysis of data with respect to the research questions formulated for this study, the result of this data analysis for the research questions are presented first, followed by those of the hypotheses tested for the study.

4.1.1 Research Question One

What are the impacts of building information modelling (BIM) application on building projects in the construction industry in Abuja?

Table 4.1.1: mean response on the impacts of building information modelling (BIM) application on building projects in the construction industry in Abuja. N1=85, N2=35.

S/NO	ITEM STATEMENT	X_1	X_2	X_t	Remark
1	Administrative management	2.8	2.8	2.8	Agreed
2	Data collection	2.6	2.5	2.6	Agreed
3	Information dissemination	3.4	3.2	3.3	Agreed
4	service delivery	2.0	2.4	2.2	Disagreed
5	Less paper work	2.3	2.4	2.3	Disagreed
6	Budget control	3.7	3.6	3.6	Agreed
7	organizational productivity	3.5	3.3	3.4	Agreed
8	time management	2.7	2.5	2.5	Agreed
9	working drawings	3.7	3.6	3.6	Agreed
10	construction management	3.2	3.1	3.1	Agreed

KEY:

X1= average mean responses of building professional,

X2= average mean responses of non-building professional,

N1= number of building professional,

N2= number of non-building professional.

Table 4.1.1 reviews that the respondents agreed with item 1,2,3,6,7,8,9 and10 with a mean score above 2.50 respectively. While item 4,5 and 11 disagreed with a mean score below 2.50. this means that item 1,2,3,6,7,8,9,10,12,13,14 and 15 agreed to the impacts of building information modelling (BIM) application on building projects in the construction industry in Abuja. While item 4 and 5 disagreed.

4.1.2Research Question Two

What are the constrains to the application of building information modelling (BIM) in the construction industry in Abuja?

Table 4.1.2: mean response on the constrains to the application of building information modelling (BIM) in the construction industry in Abuja. N1=85, N2=35.

S/N	ITEM STATEMENT	X_1	X_2	X_t	Remark
1	Cost of acquisition of both hardware and software	2.5	2.6	2.5	Agreed
2	Inadequate software expert in the building sector	2.8	3.1	2.8	Agreed
3	Lack of proper planning among the construction industry	2.3	2.8	2.5	Agreed
4	Inadequate communication among the staff	2.9	2.9	2.9	Agreed
5	Software manuals are not provided to staff	3.2	3.1	3.1	Agreed
6	High cost of using and maintaining software in the industry	3.3	3.0	3.1	Agreed
7	Security and privacy fear	2.9	2.6	2.7	Agreed
8	Inadequate staff training and retraining to be updated with new technology	2.6	2.5	2.5	Agreed
9	Inadequate power supply	2.5	2.6	2.5	Agreed
10	Inadequate supervision or monitoring of staff	2.1	2.0	2.0	Disagreed

KEY:

X1= average mean responses of building professional,

X2= average mean responses of non-building professional,

N1= number of building professional,

N2= number of non-building professional.

Table 4.1.2 shows that both respondents agreed on the constrains to the application of building information modelling (BIM) in the construction industry in Abuja, the item 1,2,3,4,5,6,7,8 and 9 as reflected by their own mean score greater than 2.50 respectively. While item 10 disagreed with the mean score below 2.50.

4.1.3Research Question Three

What are the mechanism that could be adopted to enhance effective application building information modelling (BIM) in the construction industry in Abuja?

Table 4.1.3: mean response on the level of awareness in the application of building information modelling (BIM) in the construction industry in Abuja. N1=85, N2=35.

S/NO	ITEM STATEMENT	X_1	X_2	X_t	Remark
1	Cost management	3.4	3.2	3.3	Agreed
2	Construction Drawings	3.3	3.0	3.1	Agreed
3	Risk management	2.9	2.7	2.8	Agreed
4	Communication management	3.9	3.5	3.7	Agreed
5	Budget in project planning	3.5	3.1	3.3	Agreed
6	Quality management	3.9	3.0	2.9	Agreed
7	Maintenance Programme	3.4	3.3	3.3	Agreed
8	Safety management	2.9	3.0	2.9	Agreed
9	Programme Scheduling	3.0	3.0	3.0	Agreed
10	Time management	2.6	2.5	2.5	Agreed

KEY:

X1= average mean responses of building professional,

X2= average mean responses of non-building professional,

N1= number of building professional,

N2= number of non-building professional.

Table 4.1.3 shows that both respondents agreed on the level of awareness in the application of building information modelling (BIM) in the construction industry in Abuja, the item 1,2,3,4,5,6,7,8,9 and 10 as reflected by their own mean score greater than 2.50 respectively. Which none disagreed.

4.1.4Research Question Four

What are the barriers to the application of building information modelling (BIM) in the construction industry in Abuja?

Table 4.1.4: mean response on the impacts of building information modelling (BIM) application on building projects in the construction industry in Abuja. N1=85, N2=35.

S/NO	ITEM STATEMENT	X_1	X_2	X_t	Remark
1	Social and Habitual Resistance to Change	2.7	2.8	2.8	Agreed
2	Legal and Contractual Constraints	2.5	2.5	2.5	Agreed
3	High Cost of Training	2.5	2.8	2.7	Agreed
4	Lack of Enabling Environment (Government policies and legislations)	3.0	3.0	3.0	Agreed
5	Lack of Trained Professionals to handle the tools	2.3	2.2	2.2	Disagreed
6	Clients not requesting the use of BIM on projects	3.1	3.1	3.1	Agreed
7	No proof of financial benefits	3.5	3.3	3.4	Agreed
8	High Cost of Integrated software/Models for all professionals	2.2	2.3	2.3	Disagreed
9	Lack of Standards to Guide Implementation	2.0	2.4	2.2	Disagreed
10	Poor Internet Connectivity	3.3	3.2	3.2	Agreed
11	Frequent Power Failure	2.6	2.5	2.5	Agreed
12	Lack of Awareness of the technology among industry Stakeholders	2.7	2.8	2.7	Agreed

KEY:

X1= average mean responses of building professional,

X2= average mean responses of non-building professional,

N1= number of building professional,

N2= number of non-building professional.

Table 4.1.3 shows that both respondents agreed on the barriers to the application of building information modelling (BIM) in the construction industry in Abuja, the item 1,2,3,4,6,7, and 10 as reflected by their own mean score greater than 2.50 respectively. While 5,8 and 9 disagreed.

4.2 Testing of Hypotheses

4.2.1 Hypotheses 1:

There will be no significant difference in the mean response of professional builders and non-professional builderson the impact of building information modelling (BIM) application on building project in the construction industry in Abuja.

Table 4.2.1: t-test analysis of the respondents of professional builders and non-professional builders on the impact of building information modelling (BIM) application on building project in the construction industry in Abuja.

S/NO	ITEM STATEMENT	SD_1	SD_2	t-test	Remark
1	Administrative management	0.34	0.37	-0.40	A
2	Data collection	0.49	0.78	0.89	A
3	Information dissemination	0.80	0.73	1.19	A
4	service delivery	1.06	1.13	-0.81	A
5	Less paper work	0.43	0.48	0.16	A
6	Budget control	0.60	0.52	1.40	A
7	organizational productivity	0.56	0.75	1.52	A
8	time management	0.65	0.61	1.47	A
9	working drawings	0.45	0.42	0.17	A
10	construction management	0.65	0.59	1.63	A

table 4.2.1: presents test of this hypotheses

Key

SD1= Standard deviation of professional builders

SD2= Standard deviation of non-professional builders

A= Accepted

NA= Not Accepted

The result shown in table 4 above indicates the Comparism between the professional builders and the non-professional builders in the construction industry. Data revealed that items 1,2,3,4,5,6,7,8,9 and 10 has a calculated t-value less than the t-critical value of ±1.68, hence hypothesis for these items were upheld at 0.05 level of significance. While none agreed to the t-calculated value above the t-critical value ±1.68, thus HO was accepted for these items.

4.2.2 Hypotheses 2:

There will be no significant difference in the mean response of professional builders and non-professional builderson the constrains to the application of building information modeling (BIM) in the construction industry in Abuja.

Table 4.2.2: t-test analysis of the respondents of professional builders and non-professional builders on the constrains to the application of building information modeling (BIM) in the construction industry in Abuja.

S/N	ITEM STATEMENT	SD_1	SD_2	t-test	Remark
1	Cost of acquisition of both hardware and software	0.90	0.60	0.91	A
2	Inadequate software expert in the building sector	0.96	1.04	0.51	A
3	Lack of proper planning among the construction industry	1.21	0.96	1.04	A
4	Inadequate communication among the staff	1.07	1.21	1.25	A
5	Software manuals are not provided to staff	0.90	0.80	1.44	A
6	High cost of using and maintaining software in the industry	0.90	1.13	1.63	A
7	Security and privacy fear	0.45	0.46	0.16	A
8	Inadequate staff training and retraining to be updated with new technology	0.66	0.73	0.52	A
9	Inadequate power supply	0.83	0.77	1.74	A

10	Inadequate supervision or monitoring of staff	0.45	0.48	1.47	A

table 4.2.2: presents test of this hypotheses

Key
SD1= Standard deviation of professional builders
SD2= Standard deviation of non-professional builders
A= Accepted
NA= Not Accepted

The result shown in table 4 above indicates the Comparism between the professional builders and the non-professional builders in the construction industry. Data revealed that items 1,2,3,4,5,6,7,8,9 and 10 has a calculated t-value less than the t-critical value of ±1.68, hence hypothesis for these items were upheld at 0.05 level of significance. While none agreed to the t-calculated value above the t-critical value ±1.68, thus HO was accepted for these items.

4.2.3 Hypotheses 3:

There will be no significant difference in the mean response of professional builders and non-professional builderson the barriers to the application of building information modelling (BIM) in the construction industry in Abuja.

Table 4.2.3: t-test analysis of the respondents of professional builders and non-professional builders on the barriers to the application of building information modelling (BIM) in the construction industry in Abuja.

S/NO	ITEM STATEMENT	SD_1	SD_2	t-test	Remark
1	Social and Habitual Resistance to Change	0.30	0.70	0.36	A
2	Legal and Contractual Constraints	0.82	0.77	-0.60	A
3	High Cost of Training	1.12	0.88	-0.68	A
4	Lack of Enabling Environment (Government policies and legislations)	0.67	0.60	0.26	A
5	Lack of Trained Professionals to handle the tools	1.04	0.82	0.33	A
6	Clients not requesting the use of BIM on projects	0.99	0.78	-0.55	A
7	No proof of financial benefits	0.47	0.54	0.51	A
8	High Cost of Integrated software/Models for all professionals	0.30	0.70	0.36	A

9	Lack of Standards to Guide Implementation	0.82	0.77	1.60	A
10	Poor Internet Connectivity	0.90	1.13	-0.63	A
11	Frequent Power Failure	0.45	0.46	-1.16	A
12	Lack of Awareness of the technology among industrystakeholders	0.30	0.70	0.36	A

table 4.2.3: presents test of this hypotheses

Key
SD1= Standard deviation of professional builders
SD2= Standard deviation of non-professional builders
A= Accepted
NA= Not Accepted

The result shown in table 4 above indicates the Comparism between the professional builders and the non-professional builders in the construction industry. Data revealed that items 1,2,3,4,5,6,7,8,9,10,11 and 12 has a calculated t-value less than the t-critical value of ±1.68, hence hypothesis for these items were upheld at 0.05 level of significance. While none agreed to the t-calculated value above the t-critical value ±1.68, thus HO was accepted for these items.

Findings of the study

The following are the principle findings of the study, they are organized based on the research questions and hypothesis.

The findings related to the impacts of building information modelling (BIM) application on building projects in the construction industry in Abuja.

1. Administrative management
2. Data collection
3. Information dissemination
4. Budget control
5. organizational productivity
6. time managementworking drawings
7. construction management

The findings related to the constrains to the application of building information modelling (BIM) in the construction industry in Abuja.

1. Cost of acquisition of both hardware and software
2. Inadequate software expert in the building sector
3. Lack of proper planning among the construction industry
4. Inadequate communication among the staff
5. Software manuals are not provided to staff
6. High cost of using and maintaining software in the industry
7. Security and privacy fear
8. Inadequate staff training and retraining to be updated with new technology
9. Inadequate power supply

The findings related to the level of awareness in the application of building information modelling (BIM) in the construction industry in Abuja.

1. Awareness of 3D Modelling/Presentation
2. Awareness of construction Drawings
3. Awareness of engineering Analysis
4. Awareness of As-Built Drawings
5. Awareness of Budget in project planning
6. Awareness of Clash Detection
7. Awareness of Maintenance Programme
8. Awareness in Master Planning
9. Awareness in Programme Scheduling
10. Awareness in Quantity Take-off

The findings related to the barriers to the application of building information modelling (BIM) in the construction industry in Abuja.

1. Social and Habitual Resistance to Change
2. Legal and Contractual Constraints
3. High Cost of Training
4. Lack of Enabling Environment (Government policies and Legislations)
5. Clients not requesting the use of BIM on projects
6. No proof of financial benefits
7. Poor Internet Connectivity
8. Frequent Power Failure
9. Lack of Awareness of the technology among industry stakeholders

Discussion of the finding

The discussions of findings are based on the research questions posed for the study and the hypothesis. The findings in table 1 related to research question 1 revealed that the respondents agreed with the majority of items on the impacts of building information modelling (BIM) application on building projects in the construction industry in Abuja.Administrative management, Data collection, Information dissemination, service delivery, less paper work, Budget control, organizational productivity, time management, working drawings, construction management, are the impacts of BIM application in building projects in the construction industry in Abuja. According to (Alufohai, 2018). This software is used for administration, communication, marketing, desktop publishing, presentation and project management (Ahmed, 2016). While architects, engineers and contractors use CAD mostly for design, drawing and presentation.

The findings in table 2 related to research question 2 revealed that the respondents agreed the majority of items on the constrains to the application of building information modelling (BIM) in the construction industry in Abuja. The findings revealed thatCost of acquisition of both hardware and software, Inadequate software expert in the building sector, Lack of

proper planning among the construction industry, Inadequate communication among the staff, Software manuals are not provided to staff, High cost of using and maintaining software in the industry, Security and privacy fear, Inadequate staff training and retraining to be updated with new technology, Inadequate power supply are the constrains to the use and application of BIM in the construction industry in Abuja.

The findings in table 3 related to research question 3 revealed that the respondents agreed with the majority of items on the level of awareness in the application of building information modelling (BIM) in the construction industry in Abuja. The findings revealed that Awareness of 3D Modelling/Presentation, Awareness of construction Drawings, Awareness of engineering Analysis, Awareness of As-Built Drawings, Awareness of Budget in project planning, Awareness of Clash Detection, Awareness of Maintenance Programme, Awareness in Master Planning, Awareness in Programme Scheduling, Awareness in Quantity Take-off are the levels of awareness in the application of BIM in the construction industry in Abuja.

The findings in table 3 related to research question 3 revealed that the respondents agreed with the majority of items on the barriers to the application of building information modelling (BIM) in the construction industry in Abuja. The findings revealed that Social and Habitual Resistance to Change, Legal and Contractual Constraints, High Cost of Training, Lack of Trained Professionals to handle the tools, Clients not requesting the use of BIM on projects, no proof of financial benefits, Poor Internet Connectivity, Frequent Power Failure, Lack of Awareness of the technology among industry stakeholders are the barriers to the application of BIM in the construction industry in Abuja.

CHAPTER FIVE

5.0 SUMMARY, CONCLUSION AND RECOMMENDATIONS

This chapter deals with summary, conclusion and recommendations based on the findings. Suggestions for further studies were also highlighted.

5.1 Summary of the Study

The research was conducted to assess the application of building information modelling (BIM) in the Nigeria construction industry in F.C.T Abuja, the study used a survey design method and sought to assess the application of building information modelling in the construction industry. four research questions were formulated based on the purpose of the study, the literatures related to the study were also reviewed. A structured questionnaire was developed by the researcher. The instrument was in four sections and it was validated and used to get information from respondents. The population of the study was 120 professionals in the construction industry which consist of 85 professionals and 35 non-professionals in the construction industry in Abuja. A total of 120 questionnaires were distributed with a 100% return rate.

The data collected was analyzed using mean standard deviation and t-test. A mean response of 2.50 was used as a cut-off point, t-test however was employed to test the null hypotheses at 0.05 level of significance.

5.2 Implication of the Study

From the findings, it is expecting that professional builders and non-professional builders in the construction industry in Federal Capital Territory. (F.C.T) Abuja, will adhere to the impacts of BIM in the construction industry as these is of tremendous important to them.

Finding of this study reveals that the application of BIM in the construction industry will lead to creativity among the professionals in the construction industry; these will enhance their productivity by saving time and reduction of work as well as the formulation of new ideas.

Secondly, BIM also improves construction management, as professionals in the construction industry control each stage of the construction process and these help to employ the fastest method of data processing, increase productivity, effective decision making and better service to humanity.

Thirdly, the result will assist the professional builders to examine the constraints to the use of BIM and to provide solution to them, by producing BIM manuals to staff, supervising or monitoring staff, staff training and retraining to be updated with new technology, organization of workshops and seminars for the constructional staffs to be aware with any latest development in the software that is consigned with the construction industry.

5.3 Contribution to Knowledge

The study will bring about the assessment of building information modeling application in the construction industry, and also add knowledge to the construction industry on the assessment of building information modeling application.

5.4 Conclusion

Based on the findings of the study, it is clear and precise that, BIM has great impact on the professional builders in the following areas: easy understanding of the work plan, reduce degree of difficulty in each stage of the construction process, help in administrative work, Aid in monitoring each stage of the construction process. One other significant important of software to the professional builders include: time management, effective and efficient Design and organizational productivity.

However, there are some constraints to the use of BIM in the construction industry such as inadequate power supply, since most BIM software are electronically operated. Use of non-standard applications, wherever standard applications are used it brings out the best of any construction work, BIM manuals are not provided to staff, lack of funds to BIM personnel

are not involved in the purchase of BIM software equipment, inadequate staff training and retraining to be updated with new technology.

5.4 Recommendations

Based on the findings and implication the following recommendations are made;

1. The need for increased awareness of the benefits of the adoption of BIM as an approach towards increased productivity and efficiency should be encouraged in the Nigerian Construction Industry. This will be achieved through the participation of relevant professional bodies.
2. There is also the need for well trained professionals in the utilization of BIM in order to ensure increased knowledge of BIM in the Nigerian Construction Industry.
3. The full integration of BIM into the curricula of Academic Institutions has been highlighted as a necessary step towards increased knowledge of BIM. This will ensure that Graduates have the background knowledge of the concept and implementation of BIM in the Nigerian Construction Industry.

5.5 Suggestion for Further Study

Base on the finding of the study the following topics were identified for further study:

1. Strategies for Adopting building information modelling (BIM) in the construction industry for effective and efficient service delivery.

2. Factors affecting the successful implementation of building information modelling (BIM) in the construction industry.

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APPENDIX I

REQUEST LETTER TO VALIDATORS

Industrial and Technology Education Department
Federal University of Technology,
P.M.B. 65,
Minna,
1th April,2023.

Dear Sir,

REQUEST FOR FACE VALIDATION OF INSTRUMENT FOR ASSESSING OF BUILDING INFORMATION MODELLING (BIM) APPLICATION IN THE NIGERIA CONSTRUCTION INDUSTRY IN ABUJA NIGERIA.

I am an undergraduate student of the above named address currently undertaking a study on the topic: **ASSESSMENT OF BUILDING IN FORMATION MODELLING (BIM) APPLICATION IN THE NIGERIA CONSTRUCTION INDUSTRY IN ABUJA NIGERIA.**

Attached is the draft copy of the instrument. As an expert in this area, your assistance is hereby solicited to enable me accomplish this task. Kindly go through the item to verify their clarity, relevance and appropriateness in the use of language. In addition to this you can also make further suggestions that will improve the status and quality of the instrument. Your contribution to this work is highly appreciated.

Thanks

Yours faithfully,

HOSEA SHABA KOLO
2018 /3 /74382TI

APPENDIX II

Department of Industrial and Technology Education,
Federal University of Technology,
P.M.B. 65,
Minna,
1th April, 2023.

Dear Respondent,

REQUEST FOR RESPONSE TO QUESTIONNAIRE

I am a final year student of the above mentioned institution, undertaking a study titled: "**Assessment of the Application of building information modeling (BIM) Application in the Nigeria construction industry Abuja Nigeria".** Your objective responses are highly needed in ascertaining the facts under investigation. Please feel free and open to share your mind objectively, for your responses have great impact on the findings. All collected responses will be used only for this research and treated confidentially.

Thank you

Yours faithfully

APPENDIX III

FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA

DEPARTMENT OF INDUSTRIAL AND TECHNOLOGY EDUCATION

RESEARCH QUESTIONNAIRE

ON

ASSESSMENT OF BUILDING INFORMATION MODELLING (BIM) APPLICATIO N IN THE NIGERIA CONSTRUCTION INDUSTRY IN ABUJA, NIGERIA

PART I

INSTRUCTION AND PERSONAL DATA

Please, complete the questionnaire as faithfully and sincerely as possible by ticking the column that best represent your perception about the above topic: the questionnaire is for research purpose and your view will be treated confidently.

MALE ☐ FELMALE ☐

AGE: 26-30 ☐ 30-35 ☐ 35-40 ☐ 40-45 ☐ 45-50 ☐ 50-55 ☐

Guide on how to respond to the questionnaire: use the following rating scale to indicate your opinion by ticking the phase that best describe your level of agreement to the items

Strongly Agree = SA

Agree = A

Disagree = D

Strongly Disagree = SD

PART 2

SECTION A

RESEARCH QUESTION 1

What are the impacts of building information modelling (BIM) application on building projects in the construction industry in Abuja, Nigeria?

S/NO	ITEM STATEMENT	SA	A	D	SD
1	Administrative management				
2	Data collection				
3	Information dissemination				
4	service delivery				
5	Less paper work				
6	Budget control				
7	organizational productivity				
8	time management				
9	working drawings				
10	construction management				

SECTION B

RESEARCH QUESTION 2

What are the constrains to the application of building information modelling (BIM) in the construction industry in Abuja, Nigeria?

S/N	ITEM STATEMENT	SA	A	D	SD
1	Cost of acquisition of both hardware and software				
2	Inadequate software expert in the building sector				
3	Lack of proper planning among the construction industry				
4	Inadequate communication among the staff				
5	Software manuals are not provided to staff				
6	High cost of using and maintaining software in the industry				
7	Security and privacy fear				
8	Inadequate staff training and retraining to be updated with new technology				
9	Inadequate power supply				
10	Inadequate supervision or monitoring of staff				

SECTION C

RESEARCH QUESTION 3

What are the level of awareness in the application of building information modelling (BIM) in the construction industry in Abuja, Nigeria?

S/NO	ITEM STATEMENT	SA	A	D	SD
1	Awareness of 3D Modelling/Presentation				
2	Awareness of construction Drawings				
3	Awareness of engineering Analysis				
4	Awareness of As-Built Drawings				
5	Awareness of Budget in project planning				
6	Awareness of Clash Detection				
7	Awareness of Maintenance Programme				
8	Awareness in Master Planning				
9	Awareness in Programme Scheduling				
10	Awareness in Quantity Take-off				

SECTION D

RESEARCH QUESTION 4

What are the barriers to the application of building information modelling (BIM) in the construction industry Abuja, Nigeria ?

S/NO	ITEM STATEMENT	SA	A	D	SD
1	Social and Habitual Resistance to Change				
2	Legal and Contractual Constraints				
3	High Cost of Training				
4	Lack of Enabling Environment (Government policies and legislations)				
5	Lack of Trained Professionals to handle the tools				
6	Clients not requesting the use of BIM on projects				
7	No proof of financial benefits				
8	High Cost of Integrated software/Models for all professionals				
9	Lack of Standards to Guide Implementation				
10	Poor Internet Connectivity				
11	Frequent Power Failure				
12	Lack of Awareness of the technology among industry Stakeholders				