Adoption of Building Information Modeling (BIM) in Architectural Firms in Ibadan, Southwest Nigeria

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Abstract

The importance of building information modelling (BIM) in the execution of construction and infrastructure projects cannot be overstated as Nigeria progresses technologically. Despite the advantages of BIM for the construction industry, very little is known about how BIM affects Nigerian architectural practices. This study aims to ascertain how BIM has affected architecture firms in Ibadan, Southwest Nigeria. The study looked at the degree of BIM awareness in architectural firms, the most popular BIM software programs, the parts of architectural work supported by BIM, and its advantages in architectural practice, among other things. A qualitative questionnaire survey of 50 architects in Ibadan was used to obtain the data, which descriptive statistics were then used to evaluate. The findings indicate that architectural firms in Ibadan have a high level of understanding of BIM and that the most popular BIM software programs utilised are Autodesk Revit Architecture, AUTOCAD, and Google Sketch-up. However, the respondents utilised these software programs less for analysis and more for creating 2D drawings, 3D visualisation, architectural detailing, and modelling. The outcome showed that the adoption of BIM increased the general productivity of architecture firms in the research area. The report suggests that businesses, professional associations, and the government implement particular programs and policies to increase BIM's benefits in project delivery and encourage its widespread adoption in Nigeria.

Keywords: *Building Information Modelling, Adoption, Architecture, Construction Industry*

Introduction

In an effort to boost the sustainability and productivity profile of the construction industry, digital technologies have been utilised to facilitate the execution of procurement activities. As a result, architects can now conceptualise and translate building designs and data into detailed information thanks to new processes and techniques made possible by building information modelling (BIM).

According to Muhammad et al. (2019), BIM is a collection of linked modelling domains that contains all the information required for projects involving the design, construction, and maintenance of buildings and infrastructure. BIM is essentially a three-dimensional digital representation of a building and its inherent characteristics used in various models for architectural design, construction, schedule, cost model, fabrication, and operation (Emara, 2022).

There is an increasing agreement in the literature that the use of digital technologies, such as BIM, has tremendous potential to enhance the quality of services offered by professionals in the design, engineering, construction, and real estate industries (Charlesraj & Dinesh, 2020; Olawumi & Chan, 2019; Yin et al., 2019). In particular, the advent of computers and their related technologies to architecture has had a significant impact (M. Othman et al., 2022).

According to Samimpay and Saghatforoush (2020), architects use BIM primarily because it allows them to visualise their designs before the actual construction work begins on-site, thereby reducing ambiguities in errors and saving money for their clients, as changes made to either the digital model or the database are automatically updated with coordinated in the entire model. Furthermore, the introduction of BIM has improved effective collaborations among architects, clients, engineers, building services, manufacturers, contractors, and other consultants involved in procuring building and infrastructure projects, which was previously difficult (Usman & Ashiru, 2019).

When BIM is used, those involved in construction projects, such as architects, civil engineers, surveyors, and structural, mechanical, and electrical engineers, can virtually transfer building model information from the design team to the project's main contractors, subcontractors and suppliers. This lessens the information loss and delays that typically occurring when the design manual is used (Usman & Ashiru, 2019).

The benefits of BIM implementation in the global architecture, engineering, and construction industries are well documented. Research on applying BIM to the design, construction, and real estate professions is becoming increasingly common, but there have been few studies on its implementation in developing nations like Nigeria.

According to the existing research, several fragmented studies on BIM in the Nigerian construction industry have been conducted. The studies that have been conducted by these researchers (Abubakar et al., 2014; Hamma-Adama & Kouider, 2018; Olanrewaju et al., 2021; Abdullahi Babatunde Saka et al., 2019) sought to evaluate the awareness and implementation of BIM in the Nigerian construction industry.

However, a significant flaw in these studies is that they treated construction as a single business, ignoring the distinctions between the many fields. The architecture profession plays a significant role in the planning of construction projects. Thus, they need to know enough about the BIM adoption rate in their field. Aside from the study by Dare-abel et al. (2014), which found that there were architectural businesses with BIM knowledge available, very few studies have been conducted regarding the use of BIM by architectural firms in Nigeria.

The study was conducted in Ibadan, the capital city of Oyo State in Nigeria, which is also home to a thriving state chapter of the Nigeria Institute of Architects (NIA). This national organisation oversees the country's architectural industry. Since it is the primary centre of organised architectural practice in the State, it was selected as the study's focal point.

In addition, it is the State's only operational NIA forum or branch location. Therefore, the data acquired from the sample is most accurate in describing the local architectural practice. According to Hamma-adama and Kouider (2018), the major cities of Nigeria—Lagos, Abuja, Kaduna, and Kano—were the sites of most of the BIM studies conducted there. This was because most of the nation's professionals specialising in environmental construction were located in these large urban cities.

However, despite several other studies having been completed in other coastal states, no additional research has been conducted in Oyo State. An incomplete picture results from the lack of information regarding the circumstances in many other regions of the country, such as Oyo State. It is expected that including data from these un-researched areas will lead to a more complete knowledge base, a vital tool for decision-makers in the industry. In view of the foregoing, this study sought to investigate BIM use among architectural firms in Ibadan, southwest Nigeria, to understand the current State of use and the benefits under the following objectives:

1. to investigate the level of awareness and adoption of BIM practices in the study area
2. to identify different BIM software packages used by architects in the study area
3. to evaluate activities executed using BIM software packages by architectural practices
4. to determine the significant benefits of BIM in project delivery by architectural practices in the study area.

Literature Review

Origin and Meaning of BIM

The historical evidence suggests that the conceptualisation of BIM dates back to the earliest days of computing. Charles Eastman was the first person to create a building database known as a building description system (BDS). Based on a GUI, this system uses orthographic perspective views to explain the various library components of buildings.

Additionally, it enables users to add new data to an existing model by retrieving data depending on its properties (Aram et al., 2013). Due to its effectiveness in drafting and analysis, it might lower the design cost by more than 50% (Nur & Mohd, 2018). Based on the BDS technology, Radar CH, created in 1984 for the Apple Lisa Operating System and later evolved into ArchiCAD, is now regarded as the first BIM application used on a personal computer (Gardner et al., 2020).

In recent years, BIM has piqued the interest of writers, researchers, and practitioners (Okereke et al., 2021). As a result, BIM has been given several definitions and interpretations. According to Aram et al. (2013), the BIM is used as an information and data repository for the building's construction, erection, and maintenance.

However, other authors (Habib & Kadhim, 2020; Usman & Ashiru, 2019) refer to BIM as a design and collaboration tool used to acquire construction project proposals. BIM is also described by Autodesk (2016) as an intelligent 3D model-based approach that aids AEC professionals in the planning, design, construction, and management of building and infrastructure projects. From the definitions above, it can be inferred that the BIM was viewed from four distinct angles: a structured dataset that describes the construction, a tool for creating information about the building and the project, and a business structure or operating system that maintains activities related to the design, planning, erection, management, and operation of building and infrastructure projects.

BIM and Architectural Practice

The term "architecture" has been defined in various ways in the literature; however, in this study, it is used to refer to "the art and science of design, construction, commissioning, maintenance, management, and coordination of all professional activities involved in a building project, layout, and master plan of a building or groups of buildings, and any other organised enclosed or open space, required for human activities (Jones, 2020)."

By this definition, it is clear that architectural practice includes providing services related to the design, planning, and supervision of the construction of structures and the areas surrounding them for human activities such as residing, working, falling in love, enjoying recreation, and participating in sports. Architectural firms are described by Dare-abel et al. (2014) as businesses that were established to support the industry.

Like in other nations worldwide, architects provide their clients with a wide range of services. In Nigeria, for instance, architects are well-known for offering a range of design, supervision, coordination, and management services throughout the design, tendering, construction, and post-construction stages of building projects (ARCON & NIA, 2011).

Vantam et al. (2021) noted that the BIM tool can support the execution of various services provided by architecture in both virtual and real environments. The author went into further detail on BIM and other topics. It enables architects to produce three-dimensional design models that assist them in visualising the proposed construction. This implies that BIM is more than just a tool for design.

Additionally, it serves as a master data source for a structure and a base to guarantee that business processes are carried out in a certain location (Hamada et al., 2019). BIM is also seen as a virtual collaboration tool that enables more realistic scenarios that reflect actual problems(Olugboyega & Aina, 2018). Moreover, BIM permits the creation of virtual models of buildings and the simulation, research, and experimentation of the construction process, according to Wong and Rashidi (2020).

BIM tools can be separated into three major groups based on their tasks. These tools include visualisation, simulation, and computer-aided architectural design (CAAD) (Maina, 2018). The CAAD tools software was created to replace the conventional drafting methods, which include the use of drafting boards, paper, pens, and pencils. These tools allow architects to create architectural drawings on computers before showing them to their clients (Dare-abel et al., 2014; Lim et al., 2020; Puteri & Puspitasari, 2021).

According to Gohil et al. (2022), some examples of CAAD software programs used by architects include Abis, Allplan, ArchiCAD, AutoCAD, Accurender, Blender, Bricscad, Caddie, Maya, formZ, Spirit, Revit, Lumion, 3Ds Max, CINEMA 4D, Digital Project, SolidWorks, Rhinoceros 3D, Vectorworks, and Google SketchUp.

At the same time, a simulation tool lets architects predict, validate, and optimise their architectural drawings by employing reliable data and analysis from software packages. They can run manufacturing, computational fluid dynamics, and mechanical simulations. Examples include the following: DesignBuilder, Design Performance Viewer (DPV), Green Building Studio, bSol, DAYSIM, Ecotect, eQUEST, IDA ICE, EDG II, T*Sol, EliteCAD, IES VE, and LESOSAI.

On the other hand, visualisation tools assist architects in seeing the structural, mechanical, electrical, and plumbing components of a building (Fargnoli & Lombardi, 2020). This enables the architects to see all of the construction's components while having accurate information about their dimensions, shapes, and locations (Lim et al., 2020). A few visualisation tools were named by (Brandt & Timmermans, 2021) as being V-Ray, Artlantis, POV-Ray, YafaRay, Mental Ray, LuxRender, Flamingo, LightWave, RenderZone, RenderMan, Photoshop, Kerkythea, RenderWorks, Maxwell Render, and Adobe After Effects.

Benefits of BIM in Architectural Practice

The AEC industry has benefited in several ways from the use of BIM. For instance, according to Olanrewaju et al. (2020), the usage of BIM was linked to the advantages of eliminating unbudgeted variations, improved cost estimating, a shorter turnaround time for the production cost estimate, and quicker project delivery. Additionally, research has shown that BIM aids architects in finding solutions to design-stage problems that would not have been achievable using traditional design tools like pen, paper, and boards (Othman et al., 2021).

Furthermore, it facilitates the review of designs, results in time and cost savings during design and construction tasks, and enables the efficient integration of contractor's supplier inputs throughout the design stage, improving the constructability of projects.

The advantages of BIM, according to Ullah et al. (2019), include the instantaneous detection of conflicts between different building systems; the reduction of the construction industry's fragmentation, which encourages seamless linking of the various segments of the industry; an increase in industry efficiency; lower costs for the exchange and use of information among stakeholders in construction projects; with the provision of an alternative method for coordination.

Consequently, Yin et al. (2019) discovered the use of BIM during the conceptual development stage of a building project that facilitates quick visualisation and accurate updating of changes, increasing communication among the entire project development team. This offers improvement in architectural and engineering design quality in terms of error-free drawings, leading to a steady improvement in productivity. According to Jones (2020), the use of BIM also leads to better project coordination, a reduction in errors, and a decrease in needless delays and disputes, all of which result in cost savings of 15% to 40%.

More than 80% of BIM users in the USA acknowledged a very favourable influence on their firm's efficiency and improved project outcomes (Adeyemi & Aigbavboa, 2021). According to Olugboyega & Olugbenga (2018), building professionals in Nigeria were reportedly adopting BIM to dazzle potential customers and raise the calibre of their services. Another study by Yin et al. (2019) on the development of Eko Atlantic City in Lagos, Nigeria, showed that BIM was used to create animations of districts, water supply, drainage design models, and simulations of sea wall construction for the city. BIM was also used to develop the geometries and structural systems of the city buildings.

In addition, a recent study in Nigeria by Cai et al. (2022) found that BIM greatly impacts how well projects are planned, how disagreements are resolved, and how efficiently projects are designed and built. By enhancing information and knowledge management throughout the project life cycle, BIM has so far had a considerable positive influence on the delivery of construction and infrastructure (Elijah & Oluwasuji, 2019).

Research Methods

The research design methods used in this study were the cross-sectional survey and quantitative research technique. This led to the usage of both primary and secondary data. The former was acquired through the distribution of structured questionnaires, whereas the latter came from a survey of published literature on the topic under investigation. The nature of the study objectives and the necessity to reach as many architects in Ibadan, Oyo state, as quickly as feasible prompted the use of a questionnaire survey to gather primary data.

The target population for the survey consists of all the registered architectural firms in Ibadan Oyo State, southwest Nigeria. This is obtained from the secretariat of its professional Architects' Registration Council of Nigeria (ARCON). ARCON is the statutory body empowered by law to maintain and publish registered architectural firms and members authorised to practice in Nigeria annually. The recent register revealed that 74 registered architectural firms are situated in Ibadan. Taro Yamani's sample size method was employed to determine the appropriate sample size for this study. Taro's formula is represented as:

$$n = \frac{N}{1+Ne^2}$$

Where n represents the sample size, which in this case is the number of architectural firms to be selected; N is the total number of registered architectural firms in Ibadan (i.e. 74); e is the assumed level precision taken to be ± 5% (e=0.05), while the confidence level is 95%. Using the preceding parameters, the following shows how the sample size was determined.

$$n = \frac{57}{1+57\ (0.05)^2}$$

n = 50 registered architectural films

Based on the objectives of this study and the information from the published literature, the researchers created a structured questionnaire that was used to collect primary data for this study. There were three sections in the survey. Section 1 deals with background information on the respondents, while Section 2 was used to collect data on the respondents' use of BIM.

In this section, the participants were asked to indicate the frequency of use of 22 different BIM software packages using a 3-Point Likert type scale of "1" for Never, "2" for Occasionally, and "3" for Frequently. Then, Section 3 helped gather data on the benefits of BIM use in architectural practice, as experienced by the respondents. In this section, the participants were asked to indicate their levels of agreement with ten statements related to the benefits of BIM based on a 5-point Likert scale ranging from "1" for Strongly Disagree to "5" for Strongly Agree.

A random sampling technique was adopted in this study. A total of 50 questionnaires were administered to the respondents, all retrieved and considered valid for analysis. The Statistical Package for the Social Sciences (SPSS 2020) was used to analyse the data. Given the nature of the objectives of this study, the data were analysed using only descriptive statistics. This enabled the computation of frequencies, percentages, and means scores of the responses provided by the participants. The results are presented using frequency distributions, percentages tables, and charts for easy understanding and drawing of conclusions.

Results and Discussion

Firms' BIM Deployment

The pie chart in Figure 1 below shows the distribution of architectural firm respondents based on the year each firm started the deployment of BIM tools and processes on projects. It can be seen that firms that started BIM deployment within the past 6 to 11 years topped the list with 60% representation.

Just 5% of the sampled firms began BIM deployment within the past 12 to 17 years. 65% of the sampled firms were identified to have commenced BIM deployment tools and processes for the past 17 years. The remaining 35.7% also commenced BIM deployment within the past 5 years till date.

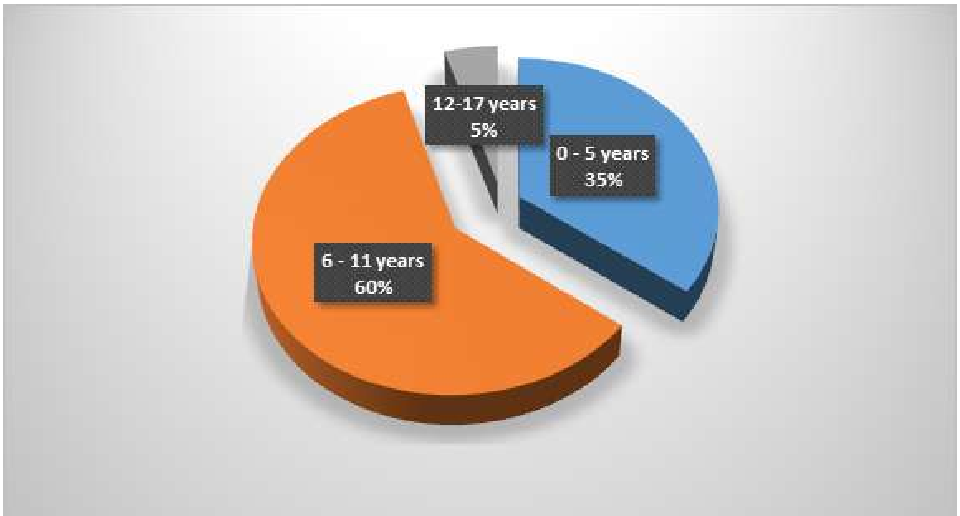


Figure 1: Year of Firm's BIM Deployment. Source: (Field Survey, 2023)

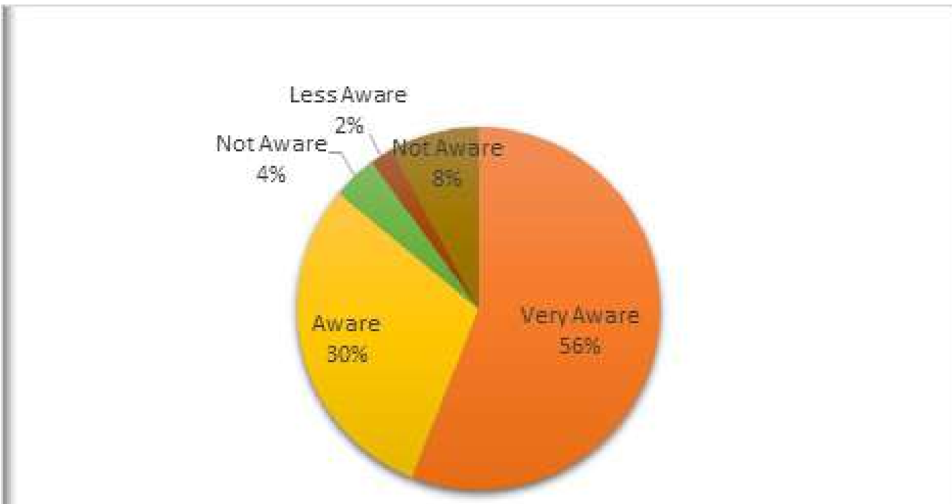


Figure 2: Respondnets' Level of awareness of BIM

Figure 2 shows the findings on the respondents' level of BIM awareness. It is clear from the result illustrated in Figure 2 that 30% and 56% of the respondents said they were 'aware' and 'very aware' of BIM, respectively. This implies that BIM knowledge is widespread among the firms surveyed. This outcome has implications for the application of BIM software.

Although this result contradicts Okereke et al. (2021) findings that professionals in the Nigerian construction industry had a generally low level of awareness about the use of BIM, this supports a previous study by Saka & Chan (2019) that found Nigerian architects are generally well-informed about the use of BIM.

BIM Software Packages used by the Respondents

The results of the survey's analysis of the frequency with which respondents utilised each of the 22 BIM software applications are presented in Table 1. The findings clearly show that 80.0% of respondents utilised Autodesk Revit Architecture, 56.0% used AUTOCAD, and 30.0 % claimed they used Google Sketchup. These three programs are acknowledged as CAAD tools that allow architects to develop architectural plans, gather layouts, and design conceptual components before providing finished design drawings to clients (Dare-abel et al., 2014; Gohil et al., 2022). However, the least used BIM software packages include Spirit, Rhinoceros 3D, Form Z, Cattia, Blender, and others. It can be inferred from this result that Autodesk Revit Architecture is the most commonly used BIM software by the participants in this research. This is not a surprise because Autodesk Revit Architecture was specifically designed and developed to meet the needs of architects.

Table 1: Frequency of use of CAAD BIM software packages

BIM software packages	Never (%)	Occasionally (%)	Frequently (%)	Mean	Standard Deviation	Rank
Revit	0 (0.00)	15 (20.00)	35 (80.00)	2.80	0.463	1st
AutoCAD	10 (20.00)	12 (24.00)	28 (56.00)	2.30	0.789	2nd
Google Sketchup	15 (30.00)	20 (40.00)	15 (30.00)	2.00	'0.782	3rd
3Ds Max	20 (40.00)	25 (50.00)	5 (10.00)	1.70	0.647	4th
Lumion	25 (50.00)	20 (40.00)	5 (10.00)	1.60	0.670	5th
ArchiCAD	30 (60.00)	20 (40.00)	0 (0.00)	1.40	0.495	6th
Digital Project	37 (74.00)	8 (16.00)	5 (10.00)	1.36	0.663	7th
Caddie	33 (66.00)	17 (34.00)	0 (0.00)	1.34	0.479	8th
Maya	35 (70.00)	15 (30.00)	0 (0.00)	1.32	0.471	9th
Lightworks	40 (80.00)	5 (10.00)	5 (10.00)	1.30	0.647	10th
Vectorworks	40 (80.00)	10 (20.00)	0 (0.00)	1.20	0.404	11th
Bricscad	41 (82.00)	9 (18.00)	0 (0.00)	1.18	0.388	12th
DDS	42	8	0	1.16	0.370	13th

Table 2 shows the frequency of use of BIM visualisation tools by the architects sampled. It is clear from the results that Photoshop, V-Ray, and Adobe After Effects were the most commonly used visualisation tools, with 72.0 %, 60.0 %, and 56.0 % of the respondents, respectively, indicating that they used them, while Flamingo, Yafaray, Lightwave, and others were the least used.

Table 2: Frequency of use of BIM Visualization tools

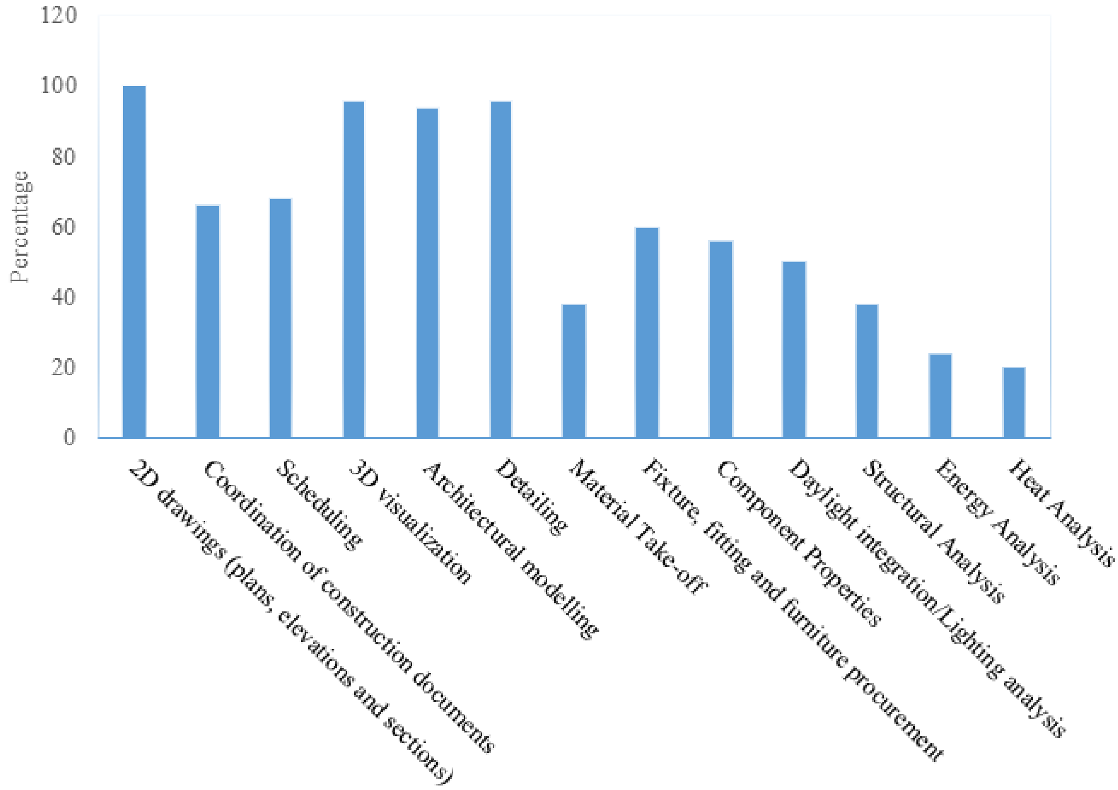
Visualisation tools	Never (%)	Occasionally (%)	Frequently (%)	Mean	Standard Deviation	Rank
Photoshop	3 (6.00)	11 (22.00)	36 (72.00)	2.66	0.593	1st
V-Ray	10 (20.00)	10 (20.00)	30 (60.00)	2.40	0.808	2nd
Adobe after effects	14 (28.00)	8 (16.00)	28 (56.00)	2.28	0.882	3rd
MentalRay	33 (66.00)	11 (22.00)	6 (12.00)	1.46	0.706	4th
Artlantis	36 (72.00)	9 (18.00)	5 (10.00)	1.38	0.667	5th
MaxwellRender7	41 (82.00)	7 (14.00)	2 (4.00)	1.22	0.507	6th
Renderworks	46 (92.00)	1 (2.00)	3 (6.00)	1.14	0.495	7th
RenderZone	46 (92.00)	2 (4.00)	2 (4.00)	1.12	0.435	8th
RenderMan	47 (94.00)	1 (2.00)	2 (4.00)	1.10	0.416	9th
Kerkythea	46 (92.00)	4 (8.00)	0 (0.00)	1.08	0.274	10th
LuxRender	46 (92.00)	4 (8.00)	0 (0.00)	1.08	0.274	10th
Lightwave	48 (96.00)	1 (2.00)	1 (2.00)	1.06	0.314	11th
Flamingo	49 (98.00)	1 (2.00)	0 (0.00)	1.02	0.141	12th

Activities Executed using BIM Software Packages

Figure 3 shows the analysis of different activities the architects sampled using the identified BIM software packages. It was found that the architects sampled utilise the selected BIM software packages to assist in the execution of various types of activities in their practices. The most common activities for which these software packages are utilised are the generation of 2D architectural drawings (i.e. plans, elevations, and sections) (99.72%); 3D visualisation (98%); architectural modelling (96.7%), detailing (96.5%), and scheduling (68.0%). When these findings are combined, revealing that the two most often used software packages are Autodesk Revit

Architecture and AUTOCAD, it is clear that these software packages are critical tools that architects employ to support the execution of their design, planning, and modelling jobs.

This finding supports prior findings by Dare-Abel et al. (2014) that architectural firms in Nigeria were developing human capability in using information technologies and BIM. Furthermore, the results appear to be consistent with the study by Othman et al. (2022), which revealed that the use of 2D and 3D BIM models was very high and that the status of BIM adoption in the construction industry in Nigeria was in the visualisation phase. Figure 1 shows that the most prevalent analysis performed by architects using BIM software programs was daylight integration/lighting analysis, followed by structural analysis, energy analysis, and heat analysis, in that order.



Benefits of BIM use in Architectural Practice

The analysis of data collected on the benefits of BIM use, as displayed in Table 4, revealed that, while participants agree that BIM use has had a positive impact on all ten aspects of architectural practice studied, the benefits are most noticeable in the productivity of the firms, the improvement of the quality of architectural design proposals, design communication, and technical specification quality. In contrast, the impact is least noticeable in the delivery of quality buildings to the client. These results can be seen in the mean scores of the responses, with the highest mean score of 4.38 being for improving the productivity of architectural firms and the lowest mean score of 3.40 being for delivering more quality buildings to clients.

Table 3 Benefits of BIM use in architectural practice

Benefits of BIM use	Strongly Disagree n(%)	Disagree n(%)	Not Sure n(%)	Agree n(%)	Strongly Agree n(%)	Mean Score
Improves the productivity of architectural firms	2 (4.0)	0 (0.0)	4 (8.0)	15 (30.0)	29 (58.0)	**4.38**
Improvement of the quality of our design proposals	1 (2.0)	2 (4.0	0 (0.0)	25 (50.0)	22 (44.0)	**4.30**
Improves design communication between professionals in a project	2 (4.0)	1 (2.0)	3 (6.0)	23 (46.0)	21 (42.0)	**4.20**
Improvement of quality of technical specifications	1 (2.0)	1 (2.0)	6 (12.0)	26 (52.0)	16 (32.0)	**4.10**
More patronage by clients	2 (4.0)	1 (2.0)	10(20.0)	19 (38.0)	18 (36.0)	**4.00**
Reduction of turnaround time for the completion of design works	5 (10.0)	3 (6.0)	3 (6.0)	19 (38.0)	20 (40.0)	**3.92**
Makes design changes and rework easy to implement	5 (10.0)	3 (6.0)	3 (6.0)	20 (40.0)	19 (38.0)	**3.90**
Reduced the cost of manpower	1 (2.0)	3 (6.0)	13(26.0)	16 (32.0)	17 (34.0)	**3.90**
Reduction in errors in design works	3 (6.0)	4 (8.0)	7 (14.0)	18 (36.0)	18 (36.0)	**3.88**
Delivery of more quality buildings to clients	18 (36.0)	2 (4.0)	1 (2.0)	0 (0.0)	29 (58.0)	**3.40**

These findings are consistent with prior research in the United States ""(Dare-abel et al., 2014; Hamma-Adama & Kouider, 2018; Seeger & Wilson, 2019), which found that BIM users in that nation had similar benefits. There is also empirical evidence in earlier research in Nigeria. The emergence of enhanced quality design proposals and firm productivity are the top two benefits of BIM, and delivering more quality buildings to clients is the least benefit, not a surprise. This is because in a building project, among the key responsibilities of the architect are the preparation of architectural design proposals and the coordination of the inputs of allied professionals, while the translation of the design proposals to buildings involves many professionals and non-professionals in the industry; thus there is a significant difference in the quality of design proposals of actual buildings constructed. It is clear from this study that the usage of BIM has substantial benefits in the study of the architectural profession.

Conclusion

This study explored the usage of BIM among architects in architectural firms in Ibadan, Nigeria, to understand the level of awareness, the present State of use of BIM, and the benefits connected with this. The following conclusions can be drawn based on the findings.

Firstly, the architects surveyed had a high level of awareness of BIM. Secondly, the most generally used CAAD BIM software packages are Autodesk Revit Architecture, AutoCAD, and Google SketchUp, whereas Photoshop and V-ray are the most regularly used BIM visualisation tools. Next, the most common tasks carried out by architects using BIM software packages are the development of 2D architectural drawings, 3D visualisation, architectural modelling, and detailing. Lastly, the top two benefits of BIM adoption are improved firm productivity and improved design proposal quality.

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