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Building Information Modelling (BIM) usage among Construction Professionals in Lagos State, Nigeria

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A B S T R A C T

Building Information Modelling (BIM) has become a popular subject amongst professionals in the architecture, engineering, and construction (AEC) industry. As Nigeria develops technologically, the use of building information modeling (BIM) in delivery of building and infrastructure projects cannot be overemphasized, as it is a well-known innovative approach in project design and construction. Building information modeling (BIM) is a process of developing a virtual equivalent of the actual building that supports data exchange, management and communication during the whole building's life cycle. The BIM software gives a digital representation of how the building will be after construction. This study provide insight into Building Information Modelling (BIM) Usage among construction professionals in Lagos State. The study adopted a pragmatic research technique that uses both qualitative and quantitative research approaches. Qualitative (secondary) data were extracted from literature and analyzed by content analysis. While quantitative (primary) data were gathered with a structured questionnaire. The primary data were collected from 252 construction professionals in the study area. This study considered level of awareness of BIM, and extent of usage of BIM in the Nigerian building construction industry; respondents' perceived benefits of building information modeling (BIM); BIM Usage rates among construction Professionals in Lagos State; Challenges Impeding the Adoption and Usage of BIM in construction industry, Respondents' perceived barriers to the adoption of BIM in the Nigerian construction industry. A total number of 300 questionnaires were administered systematically to professionals in Lagos, resulting in 252 valid responses analyzed for the purpose of the study. The collected data were analyzed using Statistical Package for Social Science (SPSS) – Version 20 and Microsoft Analysis. Descriptive analysis techniques, such as frequency, percentage, mean item score, and relative importance index (RII). As a contribution to knowledge, the paper has established that there is a high level of knowledge of Building Information Modeling (BIM) in the Nigerian Construction Industry which is associated to the high level of awareness and utilization amongst stakeholders. The paper concludes with policy recommendations to promote BIM adoption in Nigeria, including financial incentives, training programs, and awareness campaigns. This study underscores the potential of BIM to revolutionize the Nigerian construction industry by addressing inefficiencies and improving project delivery outcomes.

INTRODUCTION

Building Information Modelling (BIM) is the arrangement of a modernized parametric model that portrays the physical and cognizant depiction of a design in complete detail and gives a sharing supporting of information that can be used to go with trustworthy choices during the status, and improvement cycle and all through the lifecycle of construction (Charles Eastman et al. 2011). Holness (2008) portrayed BIM as the social event of single informational collections incorporated with interoperable

information that can be utilized dependably and continuously by all the construction professionals from the design and creation gathering and, surprisingly, by the client, all through the entire season of a design. BIM can cultivate a construction, before building it according to a certified viewpoint, to sort out issues, recreate and isolate the normal effects (Smith and Tardiff 2009).

This is according to the debate of (Olugboyega and Aina 2018) that requested virtual model buildings are made in BIM and the made strategies are imitated, considered, and examined different streets concerning the progressions made where major before the essential construction is finished. By and large, the construction business avoids useful compromise of all associates at various times of the building improvement collaboration such a lot that professionals need to pass on, trade information and separate anticipated effects of the undertakings (Sugumaran. B and Lavanya M. R 2013). Through the project term, individuals ought to participate and rely on one another for a thriving projection finish which requires the need to interface with one another (Daniels, Farnsworth, and Weidman 2014). Interface issues, for example, lacking point-by-point designs, change and clashes typically occur between project associates due to awful information exchange and coordination of works, which require being followed, got a handle on and tended to (Fu et al. 2006; Sweis et al. 2008). A piece of these issues is an immediate consequence of the miserable split the difference among the architects, organizations engineers, structural engineers, and general contractors. It is seen that there is a huge piece of the time trade conflicts between the mechanical and electrical plans and that of the draftsman or primary effectively thought out plan such a lot of that sewage pipes hit or go through a piece of these underlying parts which are continually found during the improvement exercises of a building (Dim, Ezeabasili, and Okoro 2015). Project packs necessities to change their work structures to the new accommodating and worked with frameworks for working that require BIM based software (Arayici et al. 2009). Thus, BIM is perceived to be a central gadget in the Structural, Designing and Construction (AEC) industry, to make due, circle and trade information among project people (Fuet al., 2006). This study examines BIM ideas and reception both in created and agricultural nations. It covers BIM application on location and usage among different construction professionals like modelers, manufacturers, amount assessors, underlying or structural designers, and mechanical and electrical architects. Interface and joining among construction professionals, interface classes and definitions, interface issues, as well as the effect of BIM on construction professionals.

Studies have shown that BIM has helped construction professionals in diminishing the amount of information and change with demands on a project and subsequently further cultivates suitability no matter what the hardships of lacking coordinated drawings and terms, change interest and late issuance of construction plans (Chuck Eastman et al. 2008). Among two or three benefits of using BIM is that construction entertainers attracted to the procurement example of a working environment can pass on building information basically from the design accomplices to the constructors of the project (Yan, Culp, and Graf 2011). Thus, information incidents and difficulties that reliably happen during manual planning and drafting philosophies are reduced (Fadeyi 2017). In any case, affirmation from getting ready proposes that a piece of the late referred to benefits are just commonsense some of the time. For instance, planners have embraced BIM, yet they have done as such generally to work on the visual thought of their show then again different professionals continue to convey their drawings with 2D auto-creep. Consequently, organized takes a stab at BIM-based movement stay trivial (Alufohai 2012). In Nigeria, there is an essential for BIM gathering because of the design burden and the ongoing technique for construction in the Nigerian construction industry (NCI) and BIM usage has ended up being a basic improvement to reduce goofs inclined in project documentation and inconveniences looked by the NCI (Olugboyega 2016). In view of the foregoing, this study sought to investigate Building Information Modelling (BIM) usage among construction professionals in Lagos State in Lagos, southwest Nigeria with a view to understanding the current state of use and the benefits associated with this. Moreover, the existing literature on the usage of BIM globally cannot be said to have captured the usage of BIM in Nigeria as the conditions in the NCI are different due to geographic location, size and complexity of projects, and contractual process and arrangements. Hence, the need for specific Nigeria related research on the usage of BIM among construction professionals in Nigeria. For this reason, this study will attempt to answer the following pertinent research questions:

i. What is the current awareness of BIM, and extent of usage of BIM among various construction professionals in Lagos State?
ii. What are the benefits and usage rate of Building Information Modeling (BIM) among various construction professionals in Lagos State?
iii. What are the challenges impeding the adoption and usage of Building Information Modeling (BIM) among various construction professionals in Lagos State?
iv. What are the perceived barriers to the adoption of BIM among various construction professionals in Lagos State?

Aim and objectives

The central purpose of this study is to evaluate Building Information Modelling (BIM) usage among construction professionals in Lagos State, within the context of AEC (Architecture, Engineering & Construction) projects in Lagos, Nigeria. with a view to determining its level of adoption in the NCI.

The primary objectives of this paper are as follows:

i. to determine the current level of awareness and extent of usage of BIM usage among Construction Professionals in Lagos State.
ii to ascertain the perceived benefits of building information modeling (BIM) among Construction Professionals in the study area.

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iii to analyze the challenges impeding the adoption and usage of Building Information Modeling (BIM) among various construction professionals in the study area.
iv identify and analyze the perceived barriers to to the adoption of BIM among various construction professionals in the study area.

Significance of the study

The study's significance lies in providing insights for developing countries and guiding efforts to improve BIM adoption. The focus is on Lagos, examining the state of adoption, challenges, potential solutions, and the Nigerian context. Thus, this study is significant for several reasons:

- First, it provides valuable insights into the current state of BIM adoption in Nigeria, highlighting areas where improvements are needed.
- Second, by identifying the benefits and challenges associated with BIM, the study offers a comprehensive understanding of its impact on the Nigerian construction industry.
- Third, the findings can inform policy recommendations and strategic actions to promote BIM adoption, ultimately leading to improved project delivery outcomes.
- Lastly, this research contributes to the broader body of knowledge on BIM, particularly in the context of developing countries, and can serve as a reference for future studies.

Literature review

Meaning and Conceptualization of Building Information Modelling (BIM)

Building Information Modelling (BIM) is a digital representation of a building and its components. It supports collaboration among architects, engineers, and contractors by providing a platform for information sharing. BIM models include data on materials, equipment, maintenance schedules, clash detection and coordination, quantity takeoff and cost estimation, building and climate analysis, construction planning and sequencing, geometry, spatial planning and linkages, lighting, facility management and maintenance, renovation and retrofitting and energy analysis and performance evaluation. Its advantages include improved teamwork, coordination, and quality of construction, reducing errors and rework. BIM is increasingly popular in the construction sector, benefiting the design, construction, and maintenance of buildings.

Many researchers have defined building Information Modelling (BIM) with focus varying from designers to constructors and operators. To understand the limitations of BIM, it is necessary to define what is BIM (Building Information Modeling). BIM has many different definitions each indicating a partial capability of the holistic BIM philosophy. For example, it is defined as a language allowing interoperability or as a method of codifying knowledge or as a method of human machine interaction or as a method of applying parametric behaviors or as the process of creating and using digital object orientated models for design, construction and operations of projects (McGraw Hill, 2008). Also, it has been defined as a solution to building lifecycle modeling. (Suermann and Raja R A Issa 2009), defines as "BIM is the virtual representation of the physical and functional characteristics of a facility from inception onward. As such, it serves as a shared information repository for collaboration throughout a facility's lifecycle", while (Chuck Eastman et al. 2008) defines BIM as “a verb or adjective phrase to describe tools, processes and technologies that are facilitated by digital, machine-readable documentation about a building, its performance, its planning, its construction and later its operation”.

(Penttilä 2006) describes Building Information Modelling (BIM) is a set of interacting policies, processes and technologies producing a “methodology to manage the essential building design and project data in digital format throughout the building’s life-cycle”. Building Information Modeling (BIM) is defined as “a digital representation of physical and functional characteristic of a facility” by National Institute of Building Science (NIBS, 2007). BIM is getting great attention of architects and project managers as BIM can be used for the planning, execution and operations for the project. In a nutshell BIM is not just software but a process (Azhar 2011). BIM role is just like a stage where you can easily share the knowledge and communicate without difficulty with the project stakeholders (Hergunsel, 2011). BIM is the software that accomplishes the function of producing and managing the data during the complete life cycle of the building. BIM is a new technology that can be functional to the design, construction management and facility management in which digital representation helps in exchanging necessary information between all project stakeholders. While working at building project with BIM in progress, there is complexity of gathering related information, due to this some companies have developed software that work within the framework of BIM. This software is different from AutoCAD as they provide additional functional from drafting that are time, cost control and product specifications etc. Autodesk Revit is one of the greatest examples of BIM tool that software used not only by architects but also from structure engineers, mep engineers, designers and contractors as well (Latiffi et al. 2013).

The definition above depicts BIM’s capability to minimize the adverse effects of the fragmented nature of the construction industry on construction project successful execution. A BIM package is capable of containing and used to manage information or data on the design, construction, logistics, operation, maintenance, budgets, schedules, and much more depending on the extent on its deployment on the construction project (Bryde, Broquetas, and Volm 2013).

Building Information Modeling (BIM) is defined as “a digital representation of physical and functional characteristic of a facility” by National Institute of Building Science (NIBS, 2007). In 1970, first time concept of BIM is used by (Chuck Eastman et al. 2008). In the earlier times BIM was known by different names like virtual building, intelligent object and product model (Ozorhon 2017). BIM is getting great attention of architects and project managers as BIM can be used for the planning, execution and operations for the project. In a nutshell BIM is not just

software but a process (Azhar 2011). BIM role is just like a stage where you can easily share the knowledge and communicate without difficulty with the project stakeholders (Hergunsel, 2011). BIM is the software that accomplishes the function of producing and managing the data during the complete life cycle of the building. BIM is a new technology that can be functional to the design, construction management and facility management in which digital representation helps in exchanging necessary information between all project stakeholders. While working at building project with BIM in progress, there is complexity of gathering related information, due to this some companies have developed software that work within the framework of BIM. This software is different from AutoCAD as they provide additional functional from drafting that are time, cost control and product specifications etc. Autodesk Revit is one of the greatest examples of BIM tool that software used not only by architects but also from structure engineers, mep engineers, designers and contractors as well (Latiffi et al. 2013).It is on this basis that this study aimed at investigating the level of the use of BIM as a construction project planning tool and identifying the factors responsible for its use in Lagos State, Nigeria towards finding ways of enhancing effective and sustainable construction project planning techniques in Nigeria. This study is a source of empirical data to the wider band of knowledge. Its findings will be useful indicators to foster better integration of BIM in construction, as it is a key tool in achieving sustainable construction projects.

Benefits of Building Information Modeling (BIM)

Building Information Modelling (BIM) has become a crucial technology in the construction industry, offering a range of benefits that enhance the efficiency, accuracy, and sustainability of construction projects. The importance of BIM lies in its ability to integrate various aspects of project design, construction, and operation into a cohesive digital model. Below are some of the key benefits of BIM; BIM offers several key benefits that have contributed to its global adoption:

i. Enhanced Collaboration: BIM provides a centralized digital platform that facilitates seamless collaboration among various stakeholders, including architects, engineers, contractors, and owners. This integration helps in reducing miscommunication and ensures that all parties have access to up-to-date project information (Azhar 2011).
ii. Improved Visualization: The ability to create detailed 3D models enables better visualization of the project's design and structure. This aids in identifying potential issues early in the project lifecycle, thereby minimizing errors and rework (Bynum, Issa, and Olbina 2013).
iii. Cost and Time Efficiency: BIM allows for the simulation of different construction scenarios and optimization of plans, which can lead to significant cost savings and reduced project timelines. The ability to detect clashes and resolve them virtually before construction begins is particularly beneficial (Azhar, Khalfan, and Maqsood 2015).
iv. Lifecycle Management: Beyond the construction phase, BIM serves as a valuable tool for managing a building throughout its lifecycle. It provides a repository of information that can be used for maintenance, renovations, and even demolition (Aranda-Mena et al., 2009).

Table 1 below highlights the benefits of BIM throughout the building lifecycle

Source: (Mandhar and Mandhar 2013)

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METHODS

This section describes the research design and methods utilized in the study. Additionally, it also covers the tools and techniques employed during the data collection process. It specifically outlines the research design, research locale, sample and sampling techniques, data gathering methods and processes, statistical treatment of data, and limitations of the study.

Research design

Research design is basically a statement of the objective of inquiry, strategies for collection of evidence, analysis of evidence, and recording of findings. The study evaluates Building Information Modelling (BIM) usage among Construction Professionals who have used BIM on their projects in Lagos State. The methodology adopted in this study is quantitative descriptive analysis based on primary data collected through self-administered questionnaires. This research relied primarily on quantitative data because it enables the scope of the research to include a large population of participants, thereby promoting or allowing for result generalization. A field survey was conducted between August and October 2024 with the use of structured questionnaires, self-administered randomly to a sample of stakeholders within various sectors of the Nigerian Construction Industry in Lagos State. A cross-sectional survey design was used for this study through the distribution of a well-structured questionnaire to construction professionals working with either construction firms, consulting firms, government establishment or client organization in Lagos state, Nigeria.

Research locale and study population

The scope of this study was limited to Lagos due to its remarkable growth and demands for infrastructure development, and also known for highest concentration of construction activities and Lagos is also seen as one of the residences for the largest construction projects, owners, developers, consultancy, and engineering design companies. The target population in the study is composed of professionals in the construction industry in Lagos, which include the *Architects, Quantity Surveyors, Builder, Civil Engineer, Structural Engineer, Mechanical and Electrical, Facilities Managers, Geoinformatics and Land Surveyor* as they are the primary participants who have substantial involvement and responsibilities in BIM. The population is selected because they can easily provide knowledge in relation to the use of BIM in the Nigerian construction industry. The study excluded the other construction professionals because they are not among the primary participants that normally coordinate the development of information models in BIM.

Response rate, sample size and sampling techniques

A total of 300 copies of the structured questionnaire were administered. However, two hundred and fifty-two (252) copies, which represent a response rate of 84%, were the valid copies returned and used for the analysis, thus considered reasonable. It is evident from Table 4.1 that the questionnaire was shared equally among the respondents, and a total of 28 questionnaires was shared to each category of professionals. i.e., each category of professionals represented 11.1% of the respondents. These returned questionnaires were evaluated for correctness and completeness and they were all found worthy to be analyzed. The response rate achieved in this survey provides reasonable data for analysis. Using a mixed-method approach, the research combines quantitative data from surveys distributed to construction professionals with qualitative insights from interviews with industry experts and detailed case studies of BIM-implemented projects. This research employs purposive sampling in the administering of the set of questionnaires targeted at specific construction professionals that are in close contact with BIM. The purposive sampling approach, according to Maxwell (2005), is a kind of sampling in which specific participants or situations are purposefully chosen for the significant information they may supply. Self-administered questionnaires were used in the survey to collect data from the respondents. The data obtained were analyzed using Statistical Package for Social Science (SPSS) – Version 20 and Microsoft Analysis. Descriptive analysis techniques, such as frequency, percentage, mean item score, and relative importance index (RII) will be employed to rank and determine the importance of factors influencing BIM adoption, perceived benefits of BIM use, and barriers to BIM adoption. Mean item score ranking will be used to assess respondents' level of awareness and usage of BIM. The RII will be calculated based on the ratings provided by respondents using a five-point Likert Scale for perceived barriers to BIM adoption, and a four-point Likert scale for perceived benefits of BIM software usage.

RESULTS AND DISCUSSION

This section presents the results of the conducted research survey, analysis of gathered data, and interpretation and discussion of research findings.

Table 2. Which of the following construction profession do you belong to?

	Frequency	Percent	Response	Response rate (%)
Architect	28	11.1	28	11.1
Quantity Surveyor	28	11.1	28	11.1
Builder	28	11.1	28	11.1
Civil Engineer	28	11.1	28	11.1
Structural Engineer	28	11.1	28	11.1
Mechanical Engineer	28	11.1	28	11.1
Estate Manager	28	11.1	28	11.1
Urban and Regional Planner	28	11.1	28	11.1
Geoinformatics and Land Surveyor	28	11.1	28	11.1

	Frequency	Percent	Response	Response rate (%)
Total	252	100.0	252	100.0

It is evident from table 2 that the questionnaire was shared equally among the respondents, and a total of 28 questionnaires was shared to each category of professionals. i.e., each category of professionals represented 11.1% of the respondents. This was achieved through purposive sampling in order to establish a basis for comparison. This was necessary because the professionals engaged in the construction industry use BIM for different things in line with their professional duties. Having one profession more than the others could introduce bias towards their own use of BIM. Likewise, when one profession is less-dominant, their responses could also be less dominant. All questionnaire issued were returned and collated for this study. The result shows that, majority of professionals in the AEC industry in Nigeria participated in this research.

Table 3. Respondents' current level of awareness of bim, and extent of usage of BIM by the various construction professionals in Lagos State

	Identified Usage	Mean Score	Rank
Design Stage	Construction Planning	4.55	1
	Visualization	4.53	2
	Cost Estimation	4.43	3
	3D Coordination	4.43	3
	Constructability Analysis	4.34	4
	Prefabrication	4.34	4
	Sequencing	4.17	6
Construction Stage	Construction Monitoring	4.28	1
	Construction Modelling	4.23	2
	Fabrication	4.23	2
Postconstruction Stage	Maintenance Scheduling	4.21	1
	Building System Analysis	4.02	2
	Asset Management	4.02	2
	Record Modelling	3.83	3

The mean score, ranking method was used to assess the level of awareness on the uses of BIM by professionals at the different stages of the project lifecycle. BIM allows the compilation of every discipline of a project into one complete design, including 3D models and detailed floor plans. Through this approach, project stakeholders can see or imagine the project in a real-world scenario, a feature that the traditional paper or 2D design plans fail to deliver. Moreover, accurate visualization of the plans also leads to a better understanding of project proposals, according to the respondents. Table 3 shows the mean scores and ranking of the identified uses of BIM at the design, construction and post construction phases of a project. From the table, it can be inferred from the low mean scores that there is a generally low level of awareness about the use of BIM in the Nigerian Building Construction Industry. At the Design Stage, Construction planning ranked first with a mean score of 4.55 from the analysis of the data followed by Visualization, 3D Coordination and Cost Estimation which ranked 2nd and 3rd respectively with mean scores of 4.53 and 4.43. Prefabrication and Constructability Analysis both ranked 4th with a mean score of 4.34 while sequencing ranked 6th with a mean score of 4.17. This reveals that the respondents are most aware of the use of BIM in Construction planning and are least aware of its use in Sequencing at the Design stage. At the Construction Stage, Construction Monitoring ranked 1st with a mean score of 4.28 while Construction Modeling and Fabrication ranked 2nd with a mean score of 4.23. From this, it can be inferred that the respondents are mostly aware of the use of BIM in Construction Monitoring at the Construction stage. The results show that the respondents are most aware of the use of BIM in Construction Monitoring at the Construction stage. At the Post Construction stage, Maintenance Scheduling ranked 1st with a mean score of 4.21 while Building System Analysis and Asset Management ranked 2nd with a mean score of 4.02 while Record Modeling ranked 3rd with a mean score of 3.83. This reveals that the respondents most aware of the use of BIM in Maintenance Scheduling and least aware of its use in Record modeling at the Post construction stage.

Table 4. Respondents' Perceived Benefits of Building Information Modeling (BIM) Among Various Construction Professionals in Lagos State

S/N	Perceived Barriers	RII	Ranking
1	Social and Habitual Resistance to Change	0.924	1
2	Limitations facilitated by legal and contractual issues	0,891	2
3	High Cost of Training	0.883	3
4	Lack of policies and legislation to enforce the adoption of BIM	0.797	4
5	Lack of Trained Professionals to handle the tools	0.765	5
6	Clients not interested in the use of the BIM	0.757	6
7	Non-existent of proof of financial benefits	0.748	7
8	High Cost of Integrated software/Models for all professionals	0.740	8
9	Lack of Standards to Guide Implementation	0.679	9
10	Poor Internet Connectivity	0.655	10
11	Poor Power Supply/Frequent Power Failure	0.577	11
12	Lack of Awareness of the technology among industry Stakeholders	0.508	12
13	Concerns about limitations or complexity of BIM technology	0.505	13

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S/N	Perceived Barriers	RII	Ranking
14	Lack of professional bodies support for the adoption of BIM	0.501	14
15	Inadequate research and development	0.500	15

Table 4 shows the respondents' view on the most important barriers to BIM adoption in the Nigerian construction industry, with 'social and habitual resistance to change'(RII=0.924) having the highest rank of most significant barrier, followed by 'legal and contractual constraints' and 'high cost of integrated software' for all professionals with relative importance of (RII=0.883) and (RII=0.891) respectively. 'Lack of enabling environment' In form of policies and legislations of government towards the adoption was ranked fourth with a relative importance index of (0.797) and then lack of trained professionals to handle the tools coming fifth on the significance list. Another issue of importance is the fact that clients do not require the use of BIM technologies in their construction projects and this serves a significant hindrance to the adoption of BIM in the Nigerian construction industry, since clients are the drivers of change and innovations in projects, and so far, they are not ready to invest in BIM, then the technology may face a serious hindrance of implementation in the industry.

The results show that 'lack of awareness of the technology among industry stakeholders', frequent power failure and poor internet connectivity, (which are still challenging issues in Nigeria) as least significant factors hindering the adoption of BIM technologies in the country. Even though, these were found in other studies by Kigbu (2012) and (Abubakar et al. 2014) as part of the significant challenges facing the adoption of ICT and BIM in the Nigerian construction industry.

Table 5. BIM usage rates among construction professionals in Lagos State

S/N	STATEMENT	SD	D	N	A	SA	N2	FX	AVG	SHORT DARK TRIAD (SD3)	DECISION
		1	2	3	4	5					
1	I tend to use BIM more at the pre-construction stage	46	53	46	45	62	252	780	3.10	1.45	Agree
2	I tend to use BIM more at the construction stage	55	49	39	56	53	252	759	3.01	1.46	Agree
3	I tend to use BIM more at the post-construction stage	84	80	83	2	3	252	516	2.05	0.89	Disagree
4	I use BIM mostly for gathering data (monitoring, quantifying and capturing etc.)	50	61	41	46	54	252	749	2.97	1.44	Agree
5	I use BIM mostly for generating ideas (designing, arranging, prescribing, sizing etc.)	61	49	49	51	42	252	720	2.86	1.42	Agree
6	I use BIM mostly for analysis (coordination, forecasting and validating etc.)	42	44	56	48	62	252	800	3.17	1.41	Agree
7	I use BIM mostly for communication (Visualization, transforming and documentation etc.)	49	80	110	7	6	252	597	2.37	0.91	Disagree
8	I use BIM mostly for realization (fabricating, assembling, controlling and regulating etc.)	49	43	55	46	59	252	779	3.09	1.43	Agree

Key: SD = Strongly Disagree, D = Disagree, N = Neither Disagree nor Agree, A = Agree, SA = Strongly Agree

Table 5 shows the aspects of BIM usage in selected architecture, engineering and construction firms in Lagos State. The result shows that out of the 8 items listed in for aspects of BIM usage, five (5) had high mean scores above 2.5 benchmark. These items are item 1: I tend to use BIM more at the preconstruction stage ($\bar{x}$ =3.10; SD=1.45); item 2: I tend to use BIM more at the construction stage ($\bar{x}$ =3.01; SD=1.46); item 4: I use BIM mostly for gathering data ($\bar{x}$ =2.97; SD=1.44); item 5: I use BIM mostly for generating ideas ($\bar{x}$ =2.97; SD=1.44); item 6: I use BIM mostly for analysis ($\bar{x}$ =2.86; SD=1.42); and item 8: I use BIM mostly for realization ($\bar{x}$ =3.09; SD=1.43). On the other hand, two items produced low mean scores below the bench mark of 2.50 because they were not used in selected architecture and construction firms as expected. These are item 3: I tend to use BIM more at the post-construction stage ($\bar{x}$ =2.05; SD=0.89) and Item 7: I use BIM mostly for communication ($\bar{x}$ =2.37; SD=0.91).

Table 6. challenges impeding the adoption and usage of building information modeling (BIM) by the various construction professionals in Lagos State

S/N	STATEMENT	SD	D	N	A	SA	N	FX	$\bar{x}$	STANDARD DEVIATION	DECISION
		1	2	3	4	5					
1	BIM is not flexible	54	47	46	54	51	252	757	3.00	1.44	Agree
2	BIM is too advanced	41	57	61	51	42	252	752	2.98	1.32	Agree
3	BIM is very expensive to implement	46	58	50	49	49	252	753	2.99	1.39	Agree
4	BIM requires frequent maintenance	56	61	34	52	49	252	733	2.91	1.45	Agree
5	There is a shortage of BIM experts in the industry	56	40	44	50	62	252	778	3.09	1.49	Agree
6	BIM is overrated	68	76	77	14	17	252	592	2.35	1.13	Disagree
7	Most stakeholders are not knowledgeable in BIM	55	54	50	53	40	252	725	2.88	1.38	Agree
8	BIM is not a necessity for practice	76	76	42	32	26	252	612	2.43	1.31	Disagree
9	My company is not given to BIM	58	39	42	52	61	252	775	3.08	1.5	Agree
10	The construction industry in Nigeria is not mature for BIM	47	53	54	52	46	252	753	2.99	1.38	Agree
11	Computers for running BIM are very expensive	64	50	49	42	47	252	714	2.83	1.45	Agree
12	There is no support for BIM software in Nigeria	53	54	49	46	50	252	742	2.94	1.42	Agree
13	Implementing BIM will increase the cost of construction	81	58	77	12	24	252	596	2.37	1.24	Disagree
14	BIM is prone to process failures	68	81	80	8	15	252	577	2.29	1.08	Disagree
15	It is difficult to address process failure with BIM	76	79	70	12	15	252	567	2.25	1.11	Disagree

Key: SD = Strongly Disagree, D = Disagree, N = Neither Disagree nor Agree, A = Agree, SA = Strongly Agre

Fifteen barriers to the adoption of BIM were measured and the mean scores are presented in table 6 which shows the perception, knowledge and challenges of BIM in selected architecture, engineering and construction firms in Lagos State. The result shows that out of the 15 items listed in for aspects of BIM usage, ten (10) had high mean scores above 2.5 benchmark, while five (5) had low mean scores below 2.5 benchmark. The result shows that the most significant challenges impeding the adoption and usage of BIM in architectural and construction firms in Lagos are: shortage of BIM experts, lack of flexibility for BIM, lack of support for BIM software in Nigeria, lack of knowledge of BIM among stakeholders, non-adoption of BIM among architecture and construction firms, and frequency of maintenance of BIM.

It shows that lack of awareness on the use of BIM, lack of government support for the adoption, lack of educational facilities to support its use and high cost of implementation respectively are the most important barriers to the adoption of the use of BIM followed by inadequate research and development, lack of laws and policies mandating its use all rank are amongst the least important

Further research scope

This study therefore advocates that there is the need for research that will focus on new trends and processes of construction that encourage the use of BIM. It is also imperative to create more awareness on professional bodies whose visions are related to construction and its management. Important as well is that it is important for relevant regulatory bodies to develop new processes and standards that will incorporate BIM into the procedures needed for construction.

Implications of the findings of the study to the construction professionals and policy makers

This study has some key implications that are noteworthy.

- The first implication is that there is increasing awareness and use of BIM software packages among construction professionals in the study area, this is probably because, the use of BIM is currently being taught and used in schools in Nigeria offering built environment courses.
- BIM is the future and the solution to the problems of the Nigerian construction industry. However, in order to ensure widespread usage of BIM; clients should employ the usage of procurement systems with collaborative attributes.
- The study also implies that there is a limited use of BIM tools for analyses when compared to their use for design and drafting, hence, capacity building is needed in the area of optimization of the various BIM tools in architectural practice. This is very vital in maximizing the benefits associated with BIM in architectural practice this in the study area.

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- The study also implies that the benefits of BIM in construction industries are becoming more pronounced and significant than before, and thus, there is a high prospect of BIM to transform construction industries in Nigeria as it is the case in other countries of the world.
- The construction professional bodies should organize conferences and seminars for their members in order to create BIM awareness and train members on BIM technologies.
- Construction professionals on their parts should adopt and implement BIM in their work processes as it would help them to be competitive. They should also train their staff members to be BIM proficient.
- Also, clients should be demanding for BIM in all of their projects regardless of project sizes, types and values. The government as public clients should be demanding for BIM in all of their projects. Also, the government should adopt BIM formally and develop BIM implementation strategies and guidelines as other countries have done.

Expected contribution to knowledge

This study will provide information for promoting the adoption of BIM in the Nigerian Construction INCI in the following ways:

i. It will assist with giving a phase to share information and convey it between countless professionals, providers and contractors. This affiliation likewise improves and accelerates discourse between various colleagues.

ii Traditionally, project individuals consistently play out their work and barely at any point share interface information. Be that as it may, through effective trade of interface information, it permits the project group to perceive existing interfaces and work out interface issues.

iii BIM can be used by project colleagues all through the construction stage, permitting construction professionals to trail project refreshes and immediately update advanced records of finished work all through the improvement stage.

CONCLUSION

As a contribution to knowledge, the purpose of the present paper was to provide insight into Building Information Modelling (BIM) Usage among construction professionals in Lagos State. Based on the findings, the following conclusions are arrived at: (1) There is a high level of awareness of BIM in the Nigerian AEC industry which is associated to the low level of awareness and utilization amongst stakeholders; (2) The most commonly used BIM software packages by the respondents are; the Autodesk Revit Architecture, AUTOCAD and Graphisoft ArchiCAD. In line with the findings of this research, to achieve a critical mass adoption of BIM and maximize its benefit in the Nigerian AEC industry, there is a need for sensitization on the importance of BIM by professional associations such as the Nigerian Institute of Architects (NIA) and Nigerian Society of Engineers as well as other professional bodies in the building industry; (3) In driving for the adoption of BIM in the Nigerian Building Construction Industry, increasing awareness on its use and benefits is the first and most important step through government intervention, training and re-training of construction industry professionals and involvement of the various professional bodies in the field of construction; (4) More institutions of higher learning need to include the use of BIM in their curriculum. Also, there is also need for workshops, conferences and other capacity building trainings on BIM; (5) Professional Associations in the AEC industry can collaborate with training Institutes and Universities to organize such trainings for Students, Professional and other stakeholders in the industry. These can help address the issue of low knowledge base and skill in BIM. Lastly, government at all levels also need to support the industry by providing sound policy framework that favours the adoption of BIM.

Recommendations

Based on the inferences made from the study's conclusions, the following recommendations are made and in order to suggest strategies for increased knowledge of BIM towards improving productivity and increased efficiency in the Nigerian Construction Industry, the research seeks to recommend the following: (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) To ensure greater acceptance of BIM in the Nigerian construction sector, frequent training of experts in BIM technologies should be looked into. This may be done by having workshops, seminars, and other BIM-related events held by their professional associations and other organizations in the construction sector; (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; (4) Strategies should be developed to mitigate the barriers impeding BIM implementation especially in the areas of lingering societal beliefs and the absence of concrete evidence of financial benefits. This can be achieved via the objective acceptance of the technology by the contractors without any conflict of interests; (5) Finally, it is imperative that the Nigerian Government supports the implementation of BIM in all capital projects through legislation. This can be achieved through the integration of BIM into the National Integrated Infrastructure Master Plan (NIIMP).

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