JCBM (2023) 6(2) 27-37

University of Cape Town

Journal of Construction Business and Management

http://journals.uct.ac.za/index.php/jcbm

Usage of Building Information Modelling in Quantity Surveying Firms in Nigeria

[1]Omobolanle Ogunseiju, [2]Henry Agboola Odeyinka and [3]Anthony Olukayode Yusuf
[1]School of Building Construction, Georgia Institute of Technology
[2]Department of Quantity Surveying, Obafemi Awolowo University, Ile-Ife
[3]Myers-Lawson School of Construction, Virginia Tech.

Received 25 August 2022; received in revised form 04 September 2022, 27 October 2022 and 19 January 2023; accepted 16 March 2023
https://doi.org/10.1564/jcbm.6.2.1378

Abstract

Despite the enormous benefits of building information modelling (BIM) in the project delivery process, quantity surveying (QS) firms have the lowest level of BIM usage among other professionals in Nigeria. Also, beyond the generic importance of BIM to project delivery, in the context of developing countries, not much attention has been paid to investigating the importance that QS firms place on the benefits of BIM usage. Hence, it is necessary to assess the importance of BIM usage by QS firms in Lagos State, Nigeria to improve BIM adoption and consequently enhance project delivery. Primary data were collected using well-structured questionnaires that were self-administered to QS firms. The respondents were asked to assess the level of importance attached to the benefits of BIM usage. Eighty-six (86) valid questionnaires were used for analysis. The data collected were analyzed using mean ranking analysis and Student t-test. The results showed that only a small proportion of QS firms had adopted BIM. Also, all QS firms place considerable importance on the benefits of BIM usage, but QS firms that have adopted BIM attached greater importance to its usage at the post-contract stage. The essential benefits of BIM usage to QS firms are those related to the preparation of bills of quantities (BOQ), such as 'faster generation of quantity take-off' and 'ease of pre-estimation'. QS are often tasked with generating accurate and reliable BOQ, which can be mentally demanding and challenging. The recognized significance of BIM for BOQ preparation highlighted in this study can revolutionize QS tasks and motivate other QS firms yet to adopt BIM to invest in BIM. The study highlights the need for increased promotion of BIM adoption among QS firms, recognition of the varying importance of BIM benefits at different project stages, and the potential for BIM to enhance the capabilities and efficiency of QS firms in the construction industry. These implications can guide future efforts in promoting BIM adoption and its effective utilization within the QS profession.

Keywords: BIM usage, building information modelling, construction professional, quantity surveying firm, questionnaire.

1. Introduction

The fragmentation of the construction industry, resulting from the traditional method of project delivery, has been identified as the bane of the construction industry in many countries (Yusuf *et al.*, 2022b). However, building information modelling (BIM) has yielded positive outcomes in dealing with fragmentation for improved project delivery (Eadie *et al*., 2015; Sawhney *et al*., 2014). BIM has been described as a medium for developing an electronic model of a facility for better visualization, budgeting, engineering analysis, code criteria checking, and conflict analysis. This affords different construction professionals the privilege to make decisions considering the constructability and maintainability of the building (Kreider and Messner, 2013; Nagalingam *et al*., 2013). After so many years of working mainly with paper and, lately, Computer Aided Design (CAD) to develop plans and drawings (a process seen to be error-prone), the construction industry is switching to the adoption of BIM (Kugbeadjor *et al*., 2015). According to Sahil (2016), BIM is now the global standard for assessing efficiency in building design, construction, and maintenance. BIM offers a variety of benefits, such as a drastic reduction in errors during the design and construction phase, automation of construction activities, which effectively reduces inefficiencies, and improved collaboration among construction professionals (Ryal-Net and Kaduma, 2015). For Quantity Surveyors (QSs), BIM has the potential to eradicate many mundane elements of traditional quantity surveying by automating tasks, removing errors, and

[1] Corresponding Author
Email address: omobolanle@gatech.edu

increasing efficiency (Naamane and Boukara, 2015). Many countries in the developed world have been reaping the benefits of embracing BIM (Yusuf *et al*., 2022a). For example, the UK government regulated that any public sector project over £5milllion must adopt the BIM technology for its execution (Eadie *et al*., 2013). However, in Nigeria, the usage of BIM is low, especially among quantity surveying (QS) firms, when compared with other professionals (Olugboyega, 2015; Owadokun, 2017; Aluko, 2017).

In the developed world, the importance of BIM in project delivery has been shown to cut across the entire project lifecycle (Subhi and Uma, 2018). Studies such as Franco *et al*. (2015) and Ismail *et al*. (2016) further emphasized the benefits of BIM usage. However, Smith (2016) indicated that some QS firms still use traditional quantification and have not adopted the new trend in technology. QS firms in Nigeria are still lagging in adopting automated quantities (Babatunde *et al*., 2019). However, the role of QSs would be reformed drastically from their current duties as BIM allows for the analysis of buildings, including the structure, materials, and performance, in real-time as they are being designed. The reliance on the production of bills of quantities as the main role of QSs is gradually increasing due to the automation of this task (Okereke *et al*., 2021). Akinsiku (2016) opined that BIM is a big confrontation with traditional QS services. QSs that can defeat these challenges will be at an upper hand in the future in this technologically growing industry (Nagalingam *et al*., 2013).

BIM was conceived to solve the challenge of fragmentation and common errors in managing information required by construction professionals throughout the project lifecycle (Egwunatum *et al*., 2016). One of the many advantages of BIM is that as a project develops, project drawings are consistently updated upon every alteration in the model. BIM has been said to contribute immensely to the three strong pillars of the construction industry: cost, time, and quality (Raphael and Priyanka, 2014; Ismail *et al*., 2016). More so, BIM has been found to significantly impact the estimating practices found in the industry, which was often observed to be prone to errors and inaccuracies. One of its most significant benefits is the swift, secure and accurate generation of quantities from a digital model (Ismail *et al*., 2016). Considering this, it is expected that the QS firms saddled with the cost and contract management of construction projects will be at the forefront of BIM usage. Olugboyega (2015) and Akerele and Etiene (2016) showed that QSs' awareness of BIM was satisfactory. Still, the use of BIM by QS firms ranked the least among other professionals in Nigeria.

Although studies (Olugboyega and Aina, 2016; Ugochukwu *et al*., 2015) have investigated BIM usage in the Nigerian construction industry, there is scarce evidence on studies investigating BIM usage by QS firms. Therefore, an in-depth understanding of the usefulness of BIM to QS firms in the construction industry cannot be overlooked. Hence, it is expedient to know the level of importance QS firms ascribe to the benefits of BIM usage in Nigeria. This will reveal their attitude towards adopting BIM for executing their traditional duties.

2. Background

2.1 Concept of BIM

BIM is a means to create a data-enriched, object-oriented, intelligent, and digital illustration of the project in which drawings and important information for different stakeholders can be extracted for project delivery and decision-making (Rogers et al., 2015). The concept of BIM is to build a building virtually before constructing it physically so that potential problems can be seen, analyzed, and resolved (Haron, 2013). Shen and Issa (2010) found an increase in speed and efficiency when using 3D models compared to traditional 2D. This innovative technology provides extensive support to project management via its capacity to integrate building models and finished projects, which reveals the high potentiality of BIM in project lifecycle management (Gourlis and Kovacic, 2017). BIM also nullifies distance barriers among the key players in the project (Ede, 2014). Aouad et al. (2013) stated that BIM has seven dimensions. This begins a three-dimensional (3D) model (i.e., X, Y and Z) with parametric properties. This extends to scheduling and sequencing, cost estimating, green/sustainable design, and facility management, which are 4D, 5D, 6D and 7D, respectively. An nth dimension (nD) is allowed for further model development.

2.2 Benefits of BIM to Quantity Surveying Practice

The roles of QSs span from the pre-contract stage to the post-contract stage; these include preliminary costing, cost planning, quantities measurement, preparation of bills of quantities, preparation of final accounts, and insurance valuation, amongst others (Wu et al., 2014). As BIM's usefulness and advantages span the construction industry, it has been observed that BIM poses several advantages to QSs in pre- and post-contract activities. BIM makes it possible to achieve precision in estimating and take-offs (Gourlis and Kovacic, 2017). Ali et al. (2013) asserted that at the feasibility stage, BIM can help achieve pre-estimation in a shorter time, and it could help automatically update changes in the design. BIM also helps to develop a better integration between designers and clients; thus, clients will make sound decisions using the anticipated model (Ali et al., 2013). BIM enables QSs to be more involved in the early design stages of a construction project through automation in producing bills of quantities, early management of costs, and more reliable cost estimation (Raphael and Priyanka, 2014). BIM also ensures ease in understanding building requirements at the design stage (Ali et al., 2013).

BIM has many benefits at the construction stage, which include curtailing construction waste, reduction in construction time duration, moderation of variation orders, extension of time due to variation, and synchronization of the design and construction phases (Ali et al., 2013). Sahil (2016) stated that BIM helps to create a smooth and easy transition from the design phase of a project to the construction phase. Ali et al. (2013) discovered some benefits of BIM in the maintenance stage, including its ability to preserve historical information as a benchmark for new projects, obtain a pre-estimation of the maintenance cost, and faster execution of maintenance. McGraw-Hill Construction (2014) reported after an online investigation that benefits of utilizing BIM in construction operations are observed in error reduction and omissions, increased profits, aided collaboration, enhanced image, better cost control, reduced cost, reduced time, reduced rework, better marketing opportunities, new services, minimized workload duration, accelerated client's approval, better safety, and quicker governing permission cycles.

5D BIM mainly entails the cost aspect being added to the BIM model. QSs should adopt 5D BIM to ease the workload and provide a more effective and accurate service, improved value management services to the client, and quick notification of design changes (Harrison and Thurnell, 2015). Greater exactitude can be achieved through the adoption of an automatic estimating method (Franco et al., 2015). Working with blueprints makes it easier to do quantity take-off in a shorter period (Ali et al., 2013). Harrison and Thurnell (2014) concluded that 5D BIM improves decision-making, limits the incorrect interpretation of the drawings, and limits assumptions made by QSs. 5D BIM gives a better knowledge of the construction fundamentals and helps to reduce the possibility of omitting important building items while costing (Sampaio, 2017). Harrison and Thurnell (2015) revealed that BIM allows for collecting information for preliminary estimation. Furthermore, BIM measurement is reported to impact preconstruction activities (Monteiro et al., 2014). This is also evident according to the findings of Aluko (2017), who found a remarkable reduction in the final account sum, final project duration, and time taken for BOQ preparation after BIM was adopted on projects.

According to Harrison and Thurnell (2014), 5D BIM improves coordination by integrating clash detection and specification, as centralized BIM models can consequently update changes and disburse these data to stakeholders. This differs from the regular process whereby a QS uses corrected documentation to find modifications or changes. According to Choi and Kim (2016), to achieve clash detection, tools like Solibri (also operable in tools like Navisworks and VICO Office) can detect potential complications in construction, search for overlaps, clashes, connections, et cetera to redesign before construction.

BIM offers an accurate quantity take-off and cost estimate early in the design stage and provides cost effects of additions and modifications with the ability to save time and money and reduce exceeding of budget to the barest minimum or altogether remove such (Ibrahim and Abdullahi, 2016). Sharing the BIM model with the contractor drastically reduces the time used in detailed estimations and ensures precision (Dossick and Neff, 2010). Cost planning is essential in any project as it makes the contract sum available by accurately allocating costs to target areas of the project, which, in the long run, serves as a basis for cost control (Kirkham, 2014). Unlike the conventional method, BIM offers a 5D cost-planning model with several advantages. Aside from cost planning, BIM aids with an automated cost estimation system via quantity allocation, which tends to be faster and more reliable. Mouflard (2013) states that real 5D results from 4D, 3D and 2D data. Defining 5D as only an embodiment of cost data and parameters is a shallow definition. This capability of BIM provides a real-time option for modelling and facilitates project simulations and testing, which aid building designs, cost, efficiency, and performance (Monteiro et al., 2014).

Several QS tasks can be carried out more efficiently using BIM. Harrison and Thurnell (2015) stated some of these QS tasks as data extraction for detailed estimation, efficient data extraction for producing schedules and bills of quantities, communication and access to information in the project team, improved coordination and detection of clashes and many more. Although Aibinu and Venkatesh (2012) concluded that many QSs have migrated from manual taking off to electronic quantification of quantities, nevertheless, Akerele and Etiene (2016) revealed that several QSs in Nigeria still do taking-off manually. It is forecasted that in the near future, many duties will have to be redefined due to the implementation of BIM. Furthermore, according to Beukes (2014), various BIM tools exist for different QS tasks. Several BIM tools can be used for taking-off and estimating, some for planning and scheduling, and some for material estimation. Beukes (2014) reported some sets of QS tasks and the appropriate BIM tools that can be used to execute them. This is summarised in Table 1.

Table 1: Quantity Surveying Tasks and the BIM Tools for Their Execution

Traditional Quantity Surveying Task	BIM tools capable of performing the task
Quantity Take-off	Autodesk QTO, BIM Measure from Causeway
BOQ Preparation	CostOSTM, Nomitech
Cost Estimation	DProfiler, Beck Technology
Cost Planning	Vico Cost Planner
Cost Reporting	Vico Office Client
Cost Control	Vico Cost Explorer
Material Procurement	Quantities of material extracted using BIM tools for QTO
Payment Applications	Bentley
Value management	BIM estimating packages can be used to get the cost for the different design alternatives
Life Cycle Costing	Integrated Environmental Solutions Virtual Environment

Adapted from: Beukes (2012)

2.3 Barriers to BIM Adoption

Despite the numerous benefits of BIM, several barriers are preventing construction professional organizations (QS firms inclusive) from adopting the innovation. BIM adoption requires a network of activities, and the necessary conditions, resources and expertise for its adoption must be provided (Onungwa *et al.*, 2017). According to Yusuf (2021), adopting BIM requires specific organizational capabilities such as adequate power supply, speedy internet connection, data sharing skills, adequate information technology infrastructure, process redesign and collaborative team culture. The required competence, resources, and enabling environment are barriers to BIM adoption (Yusuf *et al.*, 2022a). For example, lack of understanding and trust among project stakeholders, absence of required expertise, poor awareness, and cost of BIM adoption are barriers to the adoption of BIM (Hardin and McCool 2014).

Adekunle *et al.* (2021) identify the high cost of adoption, lack of demand for BIM usage by clients, poor government support, and lack of support by top management as primary barriers to BIM adoption among quantity surveyors. Amuda-Yusuf *et al.* (2017) revealed barriers to BIM adoption from the perspective of architects, QS, engineers, and builders. The study showed that lack of knowledge about BIM technology by construction professionals, poor awareness, fragmented nature of the industry, absence of financial support and lack of collaborative culture in the industry are primary barriers to BIM adoption among construction professionals. Eadie *et al.* (2014) highlighted disparities in the perceived barriers to BIM adoption between contracting organizations that have adopted BIM and those that have not. For organizations yet to adopt BIM, the most significant barriers include a lack of support from the supply chain, a substantial cultural shift required, a shortage of technical proficiency, and the expense associated with software. Conversely, the primary barriers among firms that have adopted BIM are a limited understanding of BIM benefits, the magnitude of cultural adjustment needed, and the costs associated with training.

3. Methodology

To assess the usage of BIM amongst QS firms in Nigeria, this study considered only QS firms in Lagos State. Lagos is a former Federal Capital and is now the country's commercial hub. Lagos is also the most populous city in Africa and the sixth-largest city in the world (Ojuri and Bankole, 2013). Therefore, the study adopted a total enumeration method considering the relatively small size of the study population. Kumar (2018) defined total enumeration as a complete selection of all items in a population under study. Respondents were randomly selected to prevent bias and ensure that every member of the population had an equal chance of being selected. With a target of one respondent per firm and according to the 2019 directory of the Nigerian Institute of Quantity Surveying (NIQS) Lagos State chapter, 125 QSs of varying positions in QS firms in Lagos were considered for this study. The target respondents were identified by their positions/roles in QS firms within Lagos State.

3.1 Data Collection

Primary data were collected using self-administered questionnaires (Easterby-Smith *et al.*, 2021). The questionnaire was well-structured and designed as a close-ended type to facilitate anonymity, freedom of expression, and confidentiality (Patten, 2016). The questionnaire has two parts and was developed based on the review of extant studies. The first part of the questionnaire was designed to gather data on the respondents' demographics, and the second part was designed to assess the importance of BIM usage by QS firms in Lagos State, Nigeria. To measure the level of importance attached to the benefits of BIM usage amongst QS firms in Lagos State, Nigeria, the benefits of BIM were scored on a six-point Likert–type scale of 0-5, where 0 = no importance, 1 = very low importance, 2 = low importance, 3 = moderate importance, 4 = high importance, 5 = very high importance.

3.2 Data Analysis

The collected data was analyzed using descriptive and inferential statistics, including frequency distribution, percentage, and mean score analysis. A further analysis was carried out using a Student *t*-test to compare the mean response of firms that have adopted BIM with those that have not adopted BIM at a 5% significance level. The data set shows normality and homogeneity of variance. A total of 86, which represent a response rate of 68.88%, were the valid questionnaires returned and used for the analysis. The total retrieved questionnaires made the breakdown of the study sample to be 75 (87.21%) from QS firms yet to adopt BIM and 11 (12.79%) from QS firms that have already adopted BIM. The response rate of 68.88% for a questionnaire survey is considered adequate by Naoum (2012). Similar sample sizes have been used in prior studies (Amuda-Yusuf *et al.*, 2017; Babatunde *et al.*, 2019).

Cronbach Alpha was used to test the internal consistency and reliability of the responses provided for the level of importance attached to BIM benefits by QS firms since the Likert scale was adopted for the study. Cronbach's Alpha for the importance of BIM benefits by the QS firms is 0.95. Cronbach's Alpha ranges between 0 and 1. Bonett and Wright (2015) stated that Cronbach's Alpha (α) > 0.9 is excellent. This implies that the responses provided are reliable for carrying out this research.

4. Results

4.1 Respondents Demographics

An analysis of the respondent's background information, as shown in Table II, reveals that the highest proportion is from organizations with employees ranging from 6 to 10, representing 48.84% of the total respondents. This was followed by respondents with organization sizes of 1 to 5 employees, representing 26.74% of the total respondents, and respondents from organizations with 11 to 15 employees, 13.95% of the total respondents. Lastly, respondents from organizations with 16 to 20 employees accounted for 10.47% of the total respondents. This shows that all the firms surveyed are small to medium firms, typical of practicing QS firms, as Ogunsemi *et al*. (2013) stated. It is evident from Table II that the respondents with B.Sc./B. Tech had the most significant proportion (56.98%). This was followed by respondents with M.Sc./M.Tech/MBA (27.91%). While respondents with HND represented 6.98% of the total respondents, those with PGD represented only 5.81%. Respondents with MPhil/Ph.D. had the lowest proportion, 2.33%. This shows that the respondents are well-educated, and the responses provided could be relied upon for this study.

Regarding professional qualification, Table II also shows that the respondents were professionally qualified, as 59.3% of them were members and fellows of the Nigerian Institute of Quantity Surveyors (MNIQS/ FNIQS). In comparison, 31.4% were probationer members of NIQS. Only 9.3% were members and fellows of the Royal Institution of Chartered Surveyors (MRICS/FRICS). The distribution of respondents by their position shows that respondents who were senior QSs constitute 66.27% of the total respondents. This is followed by respondents who were graduate QSs (17.44%). Respondents with the position of principal QS and partner QS were 9.30% and 6.98%, respectively. About 12.79% of the respondents were from QS firms that have adopted BIM, while 87.21% of the respondents were from QS firms that have not adopted BIM. This further buttressed the low adoption of BIM by QS firms, as established by previous research (Babatunde *et al*., 2019).

The respondents' years of experience, as evident from Table 2, show that those 6-10 years are the highest, with 51.16% of the total respondents. This is followed by those with 11-15 years of experience (27.91%). Respondents with 16-20 years of experience constitute about 11.63%, while respondents with 0-5 years of experience have the lowest percentage, which is 5.81%. The preceding background information implies that the respondents surveyed were academically and professionally qualified. They are also well-experienced and work with well-established QS firms. As a result, they are considered competent to provide reliable responses to the questionnaire survey, and it is adjudged that their responses could be trusted.

Table 2: Respondents Demographics

Background Information	Frequency	Percentage (%)
Size of Organization		
1-5	23	26.74
6- 10	42	48.84
11- 15	12	13.95
16-20	9	10.47
Total	**86**	**100.00**
Highest Academic Qualification		
HND	6	6.98
PGD	5	5.81
B.Sc/B.Tech	49	56.98
M.Sc/M.Tech/MBA	24	27.91
MPhil/PhD	2	2.32
Total	**86**	**100.00**
Professional Qualification		
Probationer	27	31.40
MNIQS/ FNIQS	51	59.30
MRICS/FRICS	8	9.30
Total	**86**	**100.00**
Position of Respondents		
QS	15	17.44
Senior QS	57	66.27
Principal QS	8	9.30
Partner QS	6	6.98
Total	**86**	**100.00**
Years of Experience		
0-5	5	5.81
6-10	44	51.16
11-15	24	27.91
16-20	10	11.63
21-25	3	3.49
Total	**86**	**100.00**
Type of QS Firms		
Already adopted BIM	11	12.79
Yet to adopt BIM	75	87.21
Total	**86**	**100.00**

4.2 Importance attached to benefits of BIM usage by QS firms

Data were collected to assess the importance of BIM usage by QS firms in the study presented in Table 3, which shows the mean scores (MS) and the rank of each BM benefit. The five (5) top-ranking BIM benefits considered most important are 'faster generation of quantity take-off (MS = 4.30)', 'ease of pre-estimation (MS = 4.29)', 'better design management through easy detection of clashes (MS = 4.28)', 'efficient data extraction for preliminary estimation (MS = 4.24)', and 'design visualization (MS = 4.21)'.

Benefits of BIM usage include 'automatic corrections when changes are made to design (MS = 4.06)', 'better collaboration with other professionals in the industry (MS = 4.02)', 'synchronization of the design and construction phases (MS = 4.02) ', which had moderate ranking. The low-rated benefits of BIM usage are 'promotes the implementation of lean construction techniques (MS = 3.72)', 'reduction in variation orders (MS = 3.68)', 'reduction in extension of time due to variation orders and disputes (MS = 3.61)', 'improved commissioning and handover of project's information (MS = 3.45)', and 'streamlining workloads (MS = 3.23)'.

QS firms that have adopted BIM have only 7 out of 33 benefits, with MS below 4.0. Meanwhile, QS firms that have yet to adopt BIM have 18 (more than 50%) benefits of BIM with MS below 4.0. QS firms that have adopted BIM attached greater importance to 'reduction in variation order' as a benefit of BIM usage, with a rank of 17th and MS of 4.18, while QS firms that have not adopted BIM rated it 30th with MS of 3.61. Similarly, QS firms that have adopted BIM attached greater importance to 'reduces discrepancies between drawings and bill of quantities' and 'data storage throughout the building's lifecycle as references for new projects', rated 7th with an MS of 4.36. In contrast, QS firms yet to adopt BIM rated the same 22nd with an MS of 3.81. This is also the case with 'automatic corrections when changes are made to design', rated 2nd by QS firms that have adopted BIM but rated 14th by QS firms that have not adopted BIM. In addition, as shown in Table 3, 'data storage throughout the building's lifecycle as references for new projects', 'reduction in construction wastage' and 'reduction in variation order' which are all post-contract related benefits of BIM were ranked 7th, 11th, and 17th respectively by QS firms that have adopted BIM while same were rated 22nd, 28th and 30th by QS firms that have not adopted BIM.

QS firms that have adopted BIM ascribed the highest importance to 'affirm all items are considered when taking off (MS = 4.73)' as the benefit of BIM usage, while QS firms that are yet to adopt BIM rated it 24th (with MS = 3.80). This is followed by 'faster generation of quantity take-off', 'ease of pre-estimation', 'accurate BOQ preparation', 'reduces tendering process due to faster generation of quantity take-off', and 'automatic corrections when changes are made to design (MS = 4.45). These benefits of BIM usage, which are all critical factors required to produce an accurate bill of quantities (BOQ) early in the project delivery process all ranked 2nd for QS firms that have adopted BIM. On the other hand, QS firms that are yet to adopt BIM ascribed highest importance to 'faster generation of quantity take-off (MS = 4.28)', then 'ease of pre-estimation' and 'better design management through easy detection of design clashes (MS = 4.27)'. This is followed by 'efficient data extraction for early stage (preliminary) estimation (MS = 4.23) and 'design visualization (MS = 4.21)'.

4.3. Comparisons of BIM benefits between QS firms **adopting BIM and QS firms yet to adopt BIM**

Further analysis was conducted using a Student t-test at a 95% confidence level to compare the MSs of QS firms that have adopted BIM and those yet to adopt BIM on the level of importance attached to the benefits of BIM usage. Table III, which shows the t-statistics and p-values, revealed no significant differences in the MSs of the two categories of respondents except for 'affirming all items are considered while taking off' (p-value = 0.000). This benefit of BIM usage ranked 18th overall, 1st for QS firms that have adopted BIM, and 24th for QS firms that are yet to adopt BIM.

5. Discussion

The five (5) top BIM benefits considered most important are 'faster generation of quantity take-off', 'ease of pre-estimation', 'better design management through easy detection of clashes', 'efficient data extraction for preliminary estimation', and 'design visualization'. These BIM benefits are all associated with the planning and design stages of the project delivery process, indicating that QS firms perceive BIM as very important for carrying out their pre-contract duties. This corroborates the findings of (Hellum, 2015), who stated that more emphasis is placed on the benefits of BIM at the early stages of a project. Although the emergence of BIM arose due to the demand for a better and more efficient way of running pre-contract activities (Ibrahim and Abdullahi, 2016), its usage cut across all stages of project delivery (Egwunatum *et al*., 2016).

The high ranking of 'faster generation of quantity take off' among benefits shows that the QS firms identified BIM as necessary for generating take-off quantities and preparing BOQ. This is supported by the findings of Stanley and Thurnell (2014) and Ibrahim and Abdullahi (2016), who opined that BIM offers an accurate quantity take-off and cost estimate early in the design stage, which is very important during the preparation of cost estimates at the early stages of a project lifecycle. The high importance attached to 'ease of pre-estimation' as shown by the result is in accordance with previous researchers such as Harrison and Thurnell (2015) and Ali *et al*. (2013), who opined that with BIM, pre-estimation can be achieved in a lesser time, and the changes in the design will affect pre-estimation.

The high ranking of 'better design management through easy detection of clashes', 'efficient data extraction for preliminary estimation', and 'design visualization' shows that BIM enables QSs to be more involved in the early design stages of a construction project through clashes detection, early management of the costs and design visualization. This finding aligns with the assertions of Raphael and Priyanka (2014), Fung *et al*. (2014), and Harrison and Thurnell (2014). Notably, most top-ranking benefits of BIM belong to the planning and design stages of the project delivery process, which are used mainly for in-house duties peculiar to QS firms (Adekunle *et al*., 2021).

This suggests that the state of BIM usage in Nigeria is still mainly at the 'sole-BIM' level, where individual professionals use BIM within their organization while industry-wide implementation for collaboration and interoperability is still grossly lacking (Yusuf *et al*., 2022b, Yusuf *et al*., 2022a). Thus, individual professionals benefit from BIM usage, but fragmentation persists in the industry. This agrees with Hamma-Adama and Kouider (2018), who asserted that the present adoption level of BIM in Nigeria is still at the individual and organizational level, representing BIM Stage 1, called "lonely BIM". However, the moderate ranking of other benefits of BIM usage, such as 'automatic corrections when changes are made to design', 'better collaboration with other professionals in the industry', and 'synchronization of the design and construction phases' could suggest that some level of collaboration is already taking place among built environment professionals even with the current state of usage at individual, organizational level.

Furthermore, QS firms rated BIM usage highly for enhancing collaboration among professionals. This implies that they perceive BIM as having the ability to improve communication in the construction industry due to smooth information flow. This is supported by the study of Chimhundu (2016), who identified improving communication or collaboration within project teams and better design management as the most important benefits of BIM. The low ranking of benefits of BIM usage such as 'promotes implementation of lean construction techniques', 'reduction in variation orders', 'reduction in extension of time due to variation orders and disputes', ''improved commissioning and handover of project's information', and 'streamlining workloads' is reflective of the low uptake of BIM among QS firms as earlier opined by Olugboyega (2015), Owadokun (2017), and Aluko (2017). In addition, these benefits of BIM usage are those peculiar to the construction and commissioning stages of the project delivery process; if QS firms are yet to deploy BIM at these stages of project delivery, it would be difficult to appreciate BIM usage. Also, the low ranking of 'promotes the implementation of lean construction techniques' could suggest that implementing methods and techniques like lean construction is still in the infancy in the Nigerian construction industry, as opined by Hamma-Adama and Kouider (2018). More so, the low importance attached to 'reduction in variation order' could result from the fact that most QS firms have not used BIM during the construction stage. This is perhaps the case because most respondents (87.21%) are from QS firms that have not adopted BIM, which could have significantly influenced the result. It is evident from the result that QS firms that have adopted BIM attached greater importance to the core benefits of BIM usage beyond the pre-contract stage when compared with QS firms that have yet to adopt BIM usage.

Although only 12.79% of the QS firms have adopted BIM, it is noteworthy that none of the benefits of BIM usage has an MS of less than 3. This reveals that QS firms, regardless of whether they have adopted BIM or not, ascribed a considerable level of importance to all benefits of BIM. However, the result shows that generally, QS firms that have adopted BIM attached greater importance to the benefits of BIM usage. The differences in the importance attached to the benefits of BIM usage by these categories of firms are unsurprising. This is because firms adopting BIM are expected to understand better and appreciate the benefits of BIM usage. This finding further underscores the importance of BIM to quantity surveying practice and how it can significantly improve the discharge of QSs' responsibilities in construction projects. In addition, the results reveal that all post-contract-related benefits of BIM were rated higher by QS firms that have adopted BIM. It could be inferred that QS firms that have adopted BIM are already using it in the construction phase and not only at the pre-contract stages. Also, the benefits of BIM usage, which are all critical factors required to produce an accurate bill of quantities (BOQ) early in the project delivery process, were ranked very high by QS firms that have adopted BIM. This shows that these QS firms also prioritized the ability of BIM to help carry out their duties at the pre-contract stages. This agrees with Beukes's (2014) findings that BIM benefits are significant to QSs because they greatly assist in carrying out their traditional services. The higher ranking of 'design visualization' by firms that have not adopted BIM is probably due to the preponderance of BIM usage among construction professionals in Nigeria for 3D visualization, as opined by Onungwa *et al.* (2017), which is also what previous 3D CAD systems can help to do.

The results further reveal that QS firms that have adopted BIM and those yet to adopt BIM were unanimous in their scoring of the importance attached to the benefits of BIM usage except for 'affirming all items are considered while taking off', which was perceived differently. This suggests that BIM has helped to provide a more accurate take-off for QS firms that have adopted BIM. This supports the findings of Boon and Prigg (2012), who stated that it is expedient for QS to identify cost items missing from the model when taking off, which BIM helps to achieve. Hence, QS firms adopting BIM consider it the most important benefit of BIM usage. This is not unrelated to the fact that these QS firms have started using BIM and have hereto experienced a more accurate quantity take-off.

Given that only a small proportion of QS firms have adopted BIM, there is a need for increased efforts by professional organizations, regulatory bodies, and other stakeholders to promote and encourage BIM adoption among QS firms, as it is a technology that can potentially enhance their cost and contract management capabilities (Babatunde *et al.*, 2019). Also, the study reveals variations in how QS firms perceive the importance of different BIM benefits depending on whether they have adopted the technology. This suggests that tailored approaches may be necessary when advocating BIM adoption, addressing the specific needs of different groups of firms. Also, QS firms need to consider the potential advantages of BIM for their core functions and explore ways to integrate BIM practices into their workflows to improve efficiency and effectiveness. In addition, QS firms that have adopted BIM also need to explore how BIM can be leveraged for pre-contract activities and post-contract management to maximize its benefits.

6. Conclusion

This study assessed the importance attached to the benefits of BIM usage by quantity surveying firms. The result shows that regardless of whether BIM has been adopted, QS firms are aware of BIM and attach a reasonable level of importance to the benefits of its usage. However, the study concluded that only a small fraction (12.79%) of the QS firms sampled had adopted BIM.

Table 3: Importance Attached to BIM Usage by QS Firms

Benefits of BIM Usage	Overall		Adopt BIM		Not Adopt BIM			
	Mean Score	Rank	Mean Score	Rank	Mean Score	Rank	T- statistics	*P* Value
Faster generation of quantity take-off	4.30	1	4.45	2	4.28	1	0.805	0.423
Ease of pre-estimation	4.29	2	4.45	2	4.27	2	0.923	0.359
Better design management through easy detection of design clashes	4.28	3	4.36	7	4.27	2	0.346	0.730
Efficient data extraction for early-stage (preliminary) estimation	4.24	4	4.36	7	4.23	4	0.531	0.597
Design visualization	4.21	5	4.18	17	4.21	5	-0.138	0.891
Easy update of cost plan as more detailed design develops	4.14	6	4.18	17	4.13	6	0.190	0.850
Makes Value management easier and faster	4.10	7	4.27	12	4.08	7	0.733	0.466
Accurate BOQ preparation	4.09	8	4.45	2	4.04	10	1.743	0.085
Cost checking for better and faster and good design choices	4.09	8	4.27	12	4.07	8	0.837	0.405
Reduces tendering process due to faster generation of quantity take-off	4.08	10	4.45	2	4.03	12	1.817	0.073
Automatic corrections when changes are made to the design	4.06	11	4.45	2	4.00	14	1.326	0.189
Better collaboration with other professionals in the industry	4.02	12	4.00	23	4.03	12	-0.079	0.937
Synchronization of the design and construction phases	4.02	12	3.91	27	4.04	10	-0.368	0.714
Efficiency in energy usage	4.01	14	3.73	31	4.05	9	-1.010	0.315
Improves planning and scheduling	4.00	15	4.00	23	4.00	14	-0.000	1.000
Cost reduction and cost controlling	3.99	16	4.27	12	3.95	16	1.010	0.315
Ability to obtain pre-estimation on maintenance cost.	3.98	17	4.18	17	3.95	16	0.813	0.419
Affirm all items are considered when taking off	3.92	18	4.73	1	3.80	24	3.644	0.000*
Improved communication among construction participants	3.92	18	4.00	23	3.91	18	0.796	0.259
Improved information sharing	3.91	20	4.27	12	3.85	19	1.385	0.169
Effortless outlining of materials and resources required for the project	3.89	21	4.18	17	3.85	19	1.061	0.291
Reduces discrepancies between drawings and bills of quantities	3.88	22	4.36	7	3.81	22	1.817	0.073
Data storage throughout the building's lifecycle as references for new projects	3.88	22	4.36	7	3.81	22	1.793	0.077
Improves site coordination	3.87	24	4.09	22	3.84	21	0.782	0.437
Sustainability of the facility	3.83	25	4.27	12	3.76	26	1.415	0.161
Reduction in construction wastage	3.82	26	4.30	11	3.76	28	1.636	0.106
Reduction in construction duration	3.81	27	4.00	23	3.78	25	0.655	0.514
Improves facility operation and management system	3.77	28	3.82	29	3.76	26	0.159	0.874
Promotes implementation of lean construction techniques	3.72	29	3.91	27	3.69	29	0.519	0.605
Reduction in variation orders	3.68	30	4.18	17	3.61	30	1.576	0.119
Reduction in extension of time due to variation orders and disputes	3.61	31	3.82	29	3.59	31	0.931	0.355
Improved commissioning and handover of project information	3.45	32	3.72	32	3.41	32	0.908	0.367
Streamlining workloads	3.23	33	3.64	33	3.17	33	1.139	0.258

"*" = significant at p-value ≤ 0.05

This is quite subpar and appalling, considering that BIM can improve the cost and contract management of construction projects, which are critical functions of QS firms. Therefore, among other professional firms, QS firms are expected to be more proactive in BIM usage. The study further highlighted that the benefits of BIM usage that are most important to QS firms yet to adopt BIM are those in the pre-contract stage, such as faster generation of quantity take-off and ease of pre-estimation. However, from the comparison, it can also be concluded that QS firms that have adopted BIM regarded the capacity of BIM to affirm that all items are considered when taking off to avoid omission as the most important benefit of BIM usage. Also, these QS firms attached greater importance to the benefits of BIM usage during the post-contract stage of the project delivery process than QS firms that have not adopted BIM. Therefore, generally, QS firms that have adopted BIM attach greater importance to the benefits of BIM usage than QS firms that are yet to adopt BIM.

Therefore, QS firms that have adopted BIM should explore its usage in other areas, such as value engineering and risk management, which they have not considered very important. Given that the number of QS firms that have adopted BIM is low, this study recommends that professional organizations and regulatory bodies should provide greater sensitization to QS firms on the need to transition into BIM adoption. Also, the government should provide policies and interventions that could enhance the BIM adoption level by QS firms. It is also recommended that principal partners of QS firms invest in their workforce to acquire the necessary skills and competence required for BIM adoption. While this study provides insights into the perception of BIM benefits by QS, it does not investigate the difference in the performance of QS firms that have adopted BIM and those that are yet to adopt BIM, which can be explored in future studies.

References

Adekunle, S. A., Aigbavboa, C., Ejohwomu, O., Thwala, W., & Efiannayi, N. (2021). Key constraints to optimal BIM penetration among Nigerian Quantity Surveyors. In CM50 Conference (pp. 66-73).

Aibinu, A., & Venkatesh, S. (2012). The rocky road to BIM adoption: quantity surveyors perspectives. In CIB Joint International Conference on Management of Construction: Research to Practice (pp. 539-554).

Akerele, A. O., & Etiene, M. (2016). Assessment of the level of awareness and limitations on the use of building information modeling in Lagos State. *International Journal of Scientific and Research Publications*, *6*(2), 229-234.

Akinsiku, E. O. (2016). The Impacts of Building Information Modelling (BIM) on Quantity Surveying Practice. *Lagos Journal of Environmental Studies*, *8*(1), 1-7.

Ali, K. N., Syed Ibrahim Al-Jamalullail, S. N. N., & Tan, C. B. (2013). *Building Information Modelling Awareness and Readiness-Among Quantity Surveyors and Quantity Surveying Firms*. Selangor, Malaysia: Royal Institution of Surveyors Malaysia (RISM).

Aluko, M. O. (2017). *Impact of Building Information Modelling on the Performance of Quantity Surveying Firms in Lagos State, Nigeria*. A Bachelor of Science Thesis submitted to Quantity Surveying Department, Ile-Ife, Nigeria, Obafemi Awolowo University.

Amuda-Yusuf, G., Adebiyi, R. T., Olowa, T. O. O., & Oladapo, I. B. (2017). Barriers to building information modelling adoption in Nigeria. *Journal of Research Information in Civil Engineering*, *14*(2), 1478-1495

Aouad, G., Wu, S., Lee, A., & Onyenobi, T. (2013). *Computer-aided design guide for Architecture, Engineering and Construction*, Routledge.

Babatunde, S. O., Perera, S., Ekundayo, D., & Adeleye, T. E. (2019). An investigation into BIM-based detailed cost estimating and drivers to the adoption of BIM in quantity surveying practices. *Journal of Financial Management of Property and Construction*, *25*(1), 61-81.

Beukes, S. (2014). How a quantity surveyor in South Africa can use building information modeling (BIM) to stay relevant in the construction industry. Retrieved from https://repository.up.ac.za/handle/2263/41068

Bonett, D. G., & Wright, T. A. (2015). Cronbach's alpha reliability: Interval estimation, hypothesis testing, and sample size planning. *Journal of Organizational Behavior*, *36*(1), 3-15.

Boon, J., & Prigg, C. (2012). Evolution of quantity surveying practice in the use of BIM–the New Zealand experience. In *Proceedings of the CIB International Conference on Management and Innovation for a Sustainable Built Environment* (pp. 84-98).

Chimhundu, S. (2016). *A study on the BIM adoption readiness and possible mandatory initiatives for successful implementation in South Africa* (Doctoral dissertation, University of the Witwatersrand, Faculty of Engineering and the Built Environment, School of Architecture and Planning).

Choi, J., & Kim, I. (2016). Development of a BIM-based Quality Checking System through Building Code Criteria. *Asia-Pacific Proceedings of Applied Science and Engineering for Better Human Life*, Vol. 2, 78-81.

Dossick, C. S., & Neff, G. (2010). Organizational divisions in BIM-enabled commercial construction. *Journal of Construction Engineering and Management*, *136*(4), 459-467.

Eadie, R., Browne, M., Odeyinka, H., McKeown, C., & McNiff, S. (2015). A survey of the current status of and perceived changes required for BIM adoption in the UK. *Built Environment Project and Asset Management*, *5(*1), 4-21.

Eadie, R., Odeyinka, H., Browne, M., Mahon, C., & Yohanis, M. (2014). Building information modelling adoption: an analysis of the barriers of implementation. *Journal of Engineering and Architecture*, *2*(1), 77-101.

Eadie, R., Odeyinka, H., Browne, M., McKeown, C., & Yohanis, M. (2013). An analysis of the drivers for adopting building information modelling. *Journal of Information Technology in Construction, 18*(17), 338-352.

Easterby-Smith, M., Jaspersen, L. J., Thorpe, R., & Valizade, D. (2021). *Management and Business Research*, Sage.

Ede, A. N. (2014). Building Information Modeling: Case Study of a Duplex Building Project Nigeria. *International Journal of IT, Engineering and Applied Sciences Research* (IJIEASR), *3*(4), 25-28.

Egwunatum, S., Joseph-Akwara, E., & Akaigwe, R. (2016). Optimizing energy consumption in building designs using building information model (BIM). *Slovak Journal of Civil Engineering, 24*(3),19-28.

Franco, J., Mahdi, F., & Abaza, H. (2015). Using building information modeling (BIM) for estimating and scheduling adoption barriers. *Universal Journal of Management*, *3*(9), 376-384.

Fung, W. P., Salleh, H., & Rahim, F. A. M. (2014). The capability of building information modeling applications in quantity surveying practice. *Journal of Surveying, Construction and Property*, *5*(1), 1-13.

Gourlis, G., & Kovacic, I. (2017). Building Information Modelling for analysis of energy efficient industrial buildings–A case study. *Renewable and Sustainable Energy Reviews*, 68, 953-963.

Hamma-Adama, M., & Kouider, T. (2018). A review on building information modelling in Nigeria and its potentials. *International Journal of Civil, Environmental, Structural, Construction and Architectural Engineering*, *12*(11),1113-1119

Hardin, B., & McCool, D. (2014). *BIM and Construction Management: Proven Tools, Methods and Workflows* (1st ed.). John Wiley & Sons.

Haron, A. T. (2013). *Organizational Readiness to Implement Building Information Modelling: A Framework for Design Consultants in Malaysia* (Order No. 28465051). Available from ProQuest Dissertations & Theses Global.

Harrison, C., & Thurnell, D. (2015). BIM implementation in a New Zealand Consulting Quantity Surveying Practice. *International Journal of Construction Supply Chain Management*, *5*(1), 1-15.

Hellum, M. E. (2015). *Increasing Utility Value of BIM in All Project Phases*. A Master of Science Thesis submitted to the Department of Civil and Transport Engineering, Norwegian University of Science and Technology.

Ibrahim, Y., & Abdullahi, M. (2016). Introduction to building information modelling. In *Proceedings of the 3-day Workshop/Annual General Meeting of the Nigerian Institute of Quantity Surveyors*, Nigerian Institute of Quantity Surveyors, Lagos, Nigeria (pp. 8-12).

Ismail, N. A. A. B., Drogemuller, R., Beazley, S., & Owen, R. (2016). A Review of BIM capabilities for Quantity Surveying practice. In *Proceedings of the 4th International Building Control Conference 2016 (IBCC 2016)* [MATEC Web of Conferences, Volume 66], (pp. 1-7).

Kirkham, R. (2014). *Ferry and Brandon's Cost Planning of Buildings,* John Wiley & Sons.

Kreider, R. G., & Messner, J. I. (2013). *The uses of BIM: Classifying and Selecting BIM uses*. The Pennsylvania State University, (pp. 0-22).

Kugbeadjor, W., Suresh, S., & Renukappa, S. (2015). BIM awareness and readiness of postgraduate built environment students in West Midlands universities, UK. In CIB International Conference Proceedings. *Going North for Sustainability: Leveraging Knowledge and Innovation for Sustainable Construction and Development*, (pp. 531-543).

Kumar, R. (2018). *Research methodology: A step-by-step guide for beginners*, Sage.

McGraw-Hill Construction, M. (2014). *The Business Value of BIM For Construction in Major Global Markets: how contractors around the world are driving innovation with building information modeling*. McGraw-Hill Construction Bedford, MA.

Monteiro, A., Mêda, P., & Martins, J. P. (2014). Framework for the coordinated application of two different integrated project delivery platforms. *Automation in Construction*, 38, 87-99.

Mouflard, C. (2013). *Bringing 5D to the Jobsite with Production Control*. Trimble Navigation, Ltd.: Sunnyvale, CA, USA.

Naamane, A., & Boukara, A. (2015). A Brief Introduction to Building Information Modeling (BIM) and its interoperability with TRNSYS. *Renewable Energy and Sustainable Development*, *1*(1), 126-130.

Nagalingam, G., Jayasena, H. S., & Ranadewa, K. (2013). Building information modelling and future quantity surveyor's practice in the Sri Lankan construction industry. In *Second World Construction Symposium*, 2013, vols. 14–15, June 2013, (pp. 81–92).

Naoum, S. G. (2012). *Dissertation research and writing for construction students*, Routledge.

Ogunsemi, D. R., Awodele, O. A., & Oke, A. E. (2013). An Examination of the management of quantity surveying firms in Nigeria. In Annual Conference of Registered Quantity Surveyors. At a 2-Day *QSRBN Seminar and Workshop* held at REIZ Continental Hotel, Abuja, on 26 - 27 September 2013.

Ojuri, O. O., & Bankole, O. T. (2013). Groundwater vulnerability assessment and validation for a fast-growing city in Africa: a case study of Lagos, Nigeria. *Journal of Environmental Protection*, *4*(5), 454-465.

Okereke, R. A., Ihekweme, N. M., & Awodele, I. A. (2021). Building information modeling (BIM) and quantity surveying consultancy services in Nigeria. ITEGAM-JETIA, 7(32), 44-49.

Olugboyega, O. (2015). *Evaluation of building information modelling usage in the construction industry in Lagos State, Nigeria*. A Master Thesis submitted to the Department of Building Obafemi Awolowo University, Ile-Ife.

Olugboyega, O., & Aina, O. O. (2016). Analysis of building information modelling usage indices and facilitators in the Nigerian construction industry. *Journal of Logistics, Informatics and Service Sciences*, 3(2), 1-36.

Onungwa, I. O., Uduma-Olugu, N., & Igwe, J. M. (2017). Building information modelling as a construction management tool in Nigeria. *WIT Transactions on The Built Environment,* 169, 25-33.

Owadokun, E. O. (2017). *Assessment of the Adoption of Building Information Modelling by Quantity Surveying Firms in Lagos State Nigeria*. A Bachelor of Science Thesis submitted to Quantity Surveying Department, Obafemi Awolowo University, Ile-Ife, Nigeria.

Patten, M. L. (2016). *Questionnaire research: A practical guide*, Routledge.

Raphael, V., & Priyanka, J. (2014). Role of building information modeling (BIM) in quantity surveying practice. International *Journal of Civil Engineering and Technology*, *5*(12), 194-200.

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

Ryal-Net, M. B., & Kaduma, L. A. (2015). Assessment of building information modelling (BIM) knowledge in the Nigerian construction industry. *International Journal of Civil and Environmental Engineering*, *15*(6), 60-69.

Sahil, A. Q. (2016). *Adoption of building information modeling in developing countries: A phenomenological perspective*. Colorado State University.

Sampaio, A. Z. (2017). BIM is a computer-aided design methodology in civil engineering. *Journal of Software Engineering and Applications*, *10*(2), 194-210.

Sawhney, A., Kapoor, A., Kamthan, S., Agarwal, N., Bhakre, P., & Jain, S. (2014). State of BIM adoption and outlook in India. *RICS School of Built Environment*, *1*(1), 1-30.

Shen Z, Issa R R A (2010) Quantitative evaluation of the BIM-assisted construction detailed cost estimates, *Journal of Information Technology in Construction* (ITcon), *15*, 234-257

Smith, P. (2016). Project cost management with 5D BIM. *Procedia-Social and Behavioral Sciences*, *226*, 193-200.

Stanley, R., & Thurnell, D. (2014). The benefits of, and barriers to, implementation of 5D BIM for quantity surveying in New Zealand. *Australasian Journal of Construction Economics and Building*, *14*(1), 105-117.

Subhi, M., & Uma, R. (2018). Modelling and Project Planning Of a Two two-storied building by Implementing 5D BIM. *International Journal of Scientific Research and Review*, *7*(5), 310-315.

Ugochukwu, S., Akabogu, S., & Okolie, K. (2015). Status and perceptions of the application of building information modeling for improved building project delivery in Nigeria. American Journal of Engineering Research (AJER), 4(11), 176-182.

Wu, S., Wood, G., Ginige, K., & Jong, S. W. (2014). A technical review of BIM-based cost estimating in UK quantity surveying practice, standards and tools. *Journal of Information Technology in Construction* (ITCon), *19*, 534-562.

Yusuf, A. O. (2021). *Assessment of organizational capabilities of the public sector for implementation of Building Information Modelling in construction projects in Lagos, Nigeria*. Unpublished Master of Science thesis, Obafemi Awolowo University, Ile-Ife, Nigeria.

Yusuf, A. O., Opawole, A., Musa, N. A., Kadiri, D. S., & Ebunoluwa, E. I. (2022a). Capability improvement measures of the public sector for implementation of Building Information Modeling in construction projects. *Organization, Technology and Management in Construction: an International Journal*, *14*(1), 2710-2730.

Yusuf, A. O., Opawole, A., Musa, N. A., Kadiri, D. S., & Ebunoluwa, E. I. (2022b). Factors influencing the organizational capabilities of the public sector for implementation of building information modelling in construction projects. International *Journal of Building Pathology and Adaptation*, Ahead-of-print.