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Evaluation of Factors Influencing the Adoption of Building Information Modelling for Facility Management in Abuja, Nigeria

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Abstract

Previous studies have shown that very little research have been on the implementation of BIM in each of the application areas of Facilities Management (FM). These pose challenges for the effective management of facilities. This study therefore evaluated the factors influencing the adoption of BIM for FM in Abuja, Nigeria with a view to improving the adoption of BIM in FM. In view of this, a quantitative research approach was employed for the study. Data were collected from 356 randomly selected construction professionals in Abuja with the use of structured questionnaire. The data collected were analysed with the use of frequency count, percentage and Mean Item Score (MIS). Results of data analysis revealed that the factors influencing the adoption of BIM for FM are important (Group MIS = 3.87); the drivers to the implementation of BIM for FM are important (Group MIS = 3.99); the level of BIM awareness in all the FM application areas in Abuja is high (Group MIS = 3.72); the level of BIM implementation in the FM application areas is high (Group MIS = 3.32) but requires more improvement; and the most effective measures for enhancing the adoption of BIM for FM are Incorporation of BIM to academic curriculum and Embarking on intensive awareness of BIM by software vendors and training institutes (MIS = 4.22 each). It was concluded that the factors influencing the adoption of BIM for FM in Abuja are important and requires to be put into consideration for the successful management of facilities. It was thus recommended that stakeholders should work collaboratively to set up a mechanism for the effective implementation of the measures for enhancing the adoption of BIM for FM. This will in turn enhance the level of adoption of BIM for FM and hence the successful management of facilities.

Keywords: Facilities Management, Building Information Modelling, Implementation, Adoption.

INTRODUCTION

Building Information Modelling (BIM) application in the Facility Management (FM) sector is drastically lagging behind those of design and construction phases; hitherto a scarcity of research studies has been carried out on BIM in FM. Also, the merits derived from the involvement of FM from the design stage have been well researched (Chong *et al.*, 2014; Nical & Wodyński, 2016). Furthermore, there have been many studies on the implementation of BIM for FM in several countries of the world. Anifowose *et al.* (2018) revealed that BIM adoption in Nigeria is at its infancy stage because majority of the knowledge of BIM is only in theoretical form. Similarly, Olapade and Ekemode (2018) stated that there is low level of awareness of BIM for FM in the Nigerian construction industry and this have large effect in the implementation of BIM for FM in the construction industry.

Ryal-Net and Kaduma (2015) and Akerele and Etiene (2016) established that there is low level of awareness of BIM in the Nigerian construction industry. Jordani (2010) revealed that 85% of the life cycle costs of a facility occur at the post construction stage. Similarly, the National Institute of Standard and Technology (NIST) (2002) revealed that two third of a sum of $15.8billion lost annually is borne by the owners and operators with the majority occurring during the post construction stage (Anderson *et al.*, 2012). These show that the facility

management is an important aspect of a building lifecycle, and application of BIM is of ... [illegible] ... The BIM application in FM still holds lot of undeveloped opportunities (Liu & Issa, 2013; Kensek & Mortimer, 2013).

The BIM model which contains life-cycle data about the building information is of immense advantage to the facility managers, as it would enable them to carry out their responsibilities with more than enough information at their fingertip (Ashcraft, 2008; Eastman *et al.*, 2008; Lee *et al.*, 2012). There is growing interest in the use of BIM in FM (Becerik Gerber *et al.*, 2011; BIFM, 2012) reported that it was agreed upon that having building information through BIM holds immense benefits to the facilities managers, and it would make the maintenance easier, improve collaboration, and saves time and cost. The application of BIM in FM practices is still lagging behind that of design and construction (Akcamete *et al.*, 2010; Fuller, 2010; Construction, 2012; Liu & Issa, 2013; Brooks & Lucas, 2014). This could be attributed to the lack knowledge and expertise of how the BIM is of benefits and lack of demand by the owners clients (Mayo *et al.*, 2012; Aibinu & Venkatesh, 2013; Brooks & Lucas, 2014). These pose challenges for the effective management of facilities. In order to address this problem, this study evaluated the factors influencing the adoption of BIM for FM in Abuja, Nigeria with a view to improving the adoption of BIM for FM. In order to achieve the aim, the objectives of the study were to: identify and examine the factors influencing the adoption of BIM; evaluate the drivers to BIM implementation; determine the awareness level of BIM for FM; establish the level of BIM implementation in FM application areas; and suggest measures for improving the adoption of BIM for FM in Abuja, Nigeria.

Factors Influencing the Adoption of BIM for FM in the Nigerian Construction Industry

It is a known fact that all of the perspectives of the BIM model highlight its significance in using it for the entire lifecycle of building projects, though scholars defined BIM differently, but its advantages support its application in project facilities management. The use of BIM is being considerably identified across all phases of project life cycle (Shou *et al.*, 2015). While advantages and the beneficial deliverables of BIM has become evident, it is worth mentioning that most scholars had oriented their research on the design-construction phases instead of the facility management in its entirety.

Therefore, integrating BIM into FM is facing certain challenges which act as barriers to BIM adoption, particularly in building construction industry. Kassem *et al.* (2015) pointed out the existence of two factors creating difficulties that prevent BIM adoption in FM applications. First, the various stakeholders of the project do not intend to collaborate during modelling or in optimum utilization of the BIM model, and second, lack of awareness by clients which is aggravated by the shortage of BIM skills and absence of understanding by finance management professionals. This is therefore a major challenge for the reason that for the building itself, as well as its owners, BIM processes and models in use, need sustained efforts by facility managers so that they remain effective.

Onungwa *et al.* (2017) discovered that there is low level of awareness and technical know-how of BIM in Nigeria. This was linked to lack of adequate BIM training and inadequate exposure to BIM concept; Inaccessibility to suitable technology and framework; Low level of BIM technical know-how and awareness; Individual perception/ point of view; Absence of appropriate BIM guidelines; Industry/working environment; and Initial BIM huge capital outlays. Furthermore, Aldowayan and Dweiri (2020) identified seven (7) major factors influencing the adoption of BIM for FM. These factors are categorised as: Cost-related factors, Employee-related factors; Information-related factors; Project Plan-related factors, Equipment and Technology-dependent factors; Time-related factors; and Operation and maintenance-related factors. All these factors indicate that the whole of a project is at stake if facility

managers are not updated with the right information at the right time. Therefore, to maintain the assets in use, Facility Managers are depended on real-time updated data, which is a matter of concern for them, in addition to other related issues such as the which equipment to use, when to phase out, and what to purchase for the project.

METHODOLOGY

This study was carried out using the quantitative research approach. This research was broadly divided into two parts; the first part of this work includes literature survey which was undertaken to provide the background information required for this research while the second part comprise the use of questionnaire to obtain data from construction professionals.

The target population in the study is composed of the Quantity Surveyors, Architects, Facilities Managers, Civil and Structural Engineers, Building Services Engineers (Mechanical and Electrical) and Builders as they are the primary participants who have substantial involvement and responsibilities in FM processes.

There exists high concentration of construction activities on going in Abuja, coupled with increasing construction professionals within the FCT, hence the choice of Abuja as a study area.

Method of Data Collection

Data were obtained with the use of structured questionnaire of the close ended response format. Being a quantitative research approach, a structured questionnaire became imperative as method for collection. The questionnaire was designed on a five-point Likert Scale format. The questionnaire contains six sections. The first section addresses issues concerning the general profile of respondents. The other sections address issues concerning the research objectives respectively.

Method of Data Analysis

The data collected for this study were analysed with the use of descriptive statistical techniques. The use of frequency counts and percentage were employed to analyse the profile of respondents. Mean Item Score (MIS) was employed in order to analyse the data collected on the research objectives. The use of Microsoft Excel was employed to aid the analysis of data in this study. The decision rule adopted for the MIS analysis is shown in Table 1.

Table 1: Decision Rule for MIS Analysis

Scale	Cut-off points	Remarks/ Decision			
	MIS	Importance	Awareness	Implementation	Effectiveness
5	4.50 -5.00	Very important	Very High	Very High	Very Effective
4	3.50 -4.49	Important	High	High	Effective
3	2.50 -3.49	Fairly Important	Average	Average	Fairly Effective
2	1.50 -2.49	Less Important	Low	Low	Less Effective
1	1.00 -1.49	Least important	Very Low	Very Low	Least Effective

Source: Adapted and modified from Morenikeji (2006); Agumba and Haupt (2014); Shittu et al., (2016)

RESULT AND FINDINGS

Analysis of Respondents' Profile

The study collected data from 356 respondents who are professionals in the construction industry. The profile of these respondents is presented in Tables 2 and 3. Table 2 shows that 20.22% of the respondents are Architects; 12.64% are Builders; 14.89% are Civil/Structural Engineers; 19.94% are Quantity Surveyors; 16.85% are Building/Services Engineers; and 15.45% are from other construction-related professions. It can be seen from Table 3 that 8.99%

of the respondents are holders of Higher National Diploma; 57.81% are holders of Bachelor's Degree (BSc, BTech); and 32.30% are holders of Master's Degree (MSc/MTech).

Table 2: Respondents' Profession

Profession	Frequency	Percentage (%)
Architect	72	20.22
Builder	45	12.64
Civil/Structural Engineer	53	14.89
Quantity Surveyor	71	19.94
Building Services Engineer	60	16.85
Others	55	15.45
Total	**356**	**100.00**

Source: Researcher's Field Survey (2021)

Table 3: Respondents' Highest Academic Educational Qualification

Academic Qualification	Frequency	Percentage (%)
HND	32	8.99
BSc/BTech	209	58.71
MSc/MTech	115	32.30
Total	**356**	**100.00**

Source: Researcher's Field Survey (2021)

Results and Discussion on the Factors Influencing the Adoption of BIM

The result of the MIS analysis is on the factors influencing the adoption of BIM summarised in Table 4.

Table 4 revealed the result of the sixteen (6) factors influencing the adoption of BIM for FM identified in this study. The most important factors influencing the adoption of BIM in Abuja are Lack of adequate BIM training and inadequate exposure to BIM concept; Low level of BIM technical know-how; Inaccessibility to suitable technology and framework; Industry/working environment; Lack of policy and standardisation; and Initial BIM huge capital outlays with high MIS values of 4.19; 4.10; 4.09; 4.07; 4.03; and 4.01 respectively. The other factors are also important. These range from Stakeholders do not intend to collaborate in the optimum utilization of BIM model (MIS = 3.52) and Clients' shortage of BIM skills (MIS = 3.98). Except one factor that is fairly important. This is Lack of case study as a precedent (to demonstrate BIM benefits) with MIS value of 3.48. On the average, the factors influencing the adoption of BIM for FM in Abuja are important (Group MIS = 3.87). This result corroborates the findings of Eastman *et al.* (2008); Hardin (2011) and Becerik-Gerber *et al.* (2011). Eastman *et al.* (2008) and Hardin (2011) consider BIM as a tool that offers a solution to the problematic information handling within facility management. While Becerik-Gerber *et al.* (2011) affirmed that in spite of the fact that the greatest influences of BIM has been seen in the design and construction phase, owners have in recent years begun to see the potential benefits even in the buildings later stages. The factors influencing the adoption of BIM for FM are therefore important as they can make or mar the successful management of facilities.

Table 4: Factors Influencing the Adoption of BIM

CODE	FACTORS INFLUENCING BIM ADOPTION	MIS	RANK	DECISION
B5	Lack of adequate BIM training and inadequate exposure to BIM concept	4.19	1st	Important
B7	Low level of BIM technical know-how	4.10	2nd	Important
B6	Inaccessibility to suitable technology and framework	4.09	3rd	Important
B10	Industry/working environment	4.07	4th	Important
B13	Lack of policy and standardisation	4.03	5th	Important
B11	Initial BIM huge capital outlays	4.01	6th	Important
B3	Clients' shortage of BIM skills	3.98	7th	Important

[illegible]	[illegible]	3.90	8th	Important
[illegible]	[illegible]	3.81	9th	Important
[illegible]	[illegible]	3.79	10th	Important
[illegible]	[illegible]	3.78	11th	Important
[illegible]	[illegible]	3.78	11th	Important
[illegible]	[illegible]	3.72	13th	Important
[illegible]	[illegible]	3.70	14th	Important
B5	Stakeholders do not intend to collaborate in the optimum utilization of BIM model	3.52	15th	Important
B14	Lack of case study as a precedent (to demonstrate BIM benefits)	3.48	16th	Fairly Important
	Group MIS	*3.87*		***Important***

Results and Discussion on the Drivers to BIM Implementation

The MIS analysis on the drivers to the implementation of BIM for FM is summarised in Table 5.

Table 5: Drivers to BIM Implementation

CODE	DRIVERS TO BIM IMPLEMENTATION	MIS	RANK	DECISION
C11	The need for effective facilities management of completed projects	4.23	1st	Important
C13	The need to achieve lifecycle BIM uses	4.19	2nd	Important
C8	The need for timely delivery	4.14	3rd	Important
C4	Reformation of design activities and improvement of design quality	4.07	4th	Important
C12	The need for integrating people, place, processes and technology	4.05	5th	Important
C7	The need to secure more financial savings and monitoring	4.04	6th	Important
C3	Improvement of capacity to provide whole life cycle value to client	3.98	7th	Important
C9	The need for more precise order of construction and clash detention	3.98	7th	Important
C5	Incorporation of health and safety in the construction process	3.94	9th	Important
C2	Urge to meet client's needs and competitive nature of the industry	3.90	10th	Important
C10	Enhancing increased pre-fabrication	3.88	11th	Important
C6	The need to enhance communication with workmen	3.86	12th	Important
C1	Government pressure	3.56	13th	Important
	Group MIS	*3.99*		***Important***

Table 5 shows the result of thirteen (13) drivers of the implementation of BIM for FM as identified from this study. The most important drivers to the implementation of BIM for FM in Abuja are The need for effective facilities management of completed projects (MIS = 4.23); The need to achieve lifecycle BIM uses (MIS = 4.19); The need for timely delivery (MIS = 4.14); Reformation of design activities and improvement of design quality (MIS = 4.07); The need for integrating people, place, processes and technology (MIS = 4.05); and The need to secure more financial savings and monitoring (MIS = 4.04). The remaining drivers to the implementation of BIM for FM are also important. These range between Government pressure (MIS = 3.56) and Improvement of capacity to provide whole life cycle value to client (MIS = 3.98). On the average, all the identified drivers to the implementation of BIM for FM in Abuja are important (Group MIS = 3.99). The result of this study is in line with the studies of Kassem

et al. (2015) and Onungwa *et al.* (2017) because these studies also gave higher importance to the most important drivers in this study. For instance, Kassem *et al.* (2015) identified the need for various stakeholders of a project to collaborate during modelling or in optimum utilization of the BIM model, and the need for awareness by clients as the main drivers to enhancing BIM adoption in FM applications. Onungwa *et al.* (2017), on the other hand, discovered that there is a need for improving the level of awareness and technical know-how of BIM in Nigeria. It is therefore imperative to determine the current level of awareness and implementation of BIM.

Results and Discussion on the Level of Awareness of BIM-FM in Abuja

Table 6 presents the result of the MIS analysis on the level of awareness of BIM for FM in twenty-one (21) core FM application areas.

Table 6: Level of Awareness of BIM-FM in the Nigerian Construction Industry

CODE	LEVEL OF AWARENESS	MIS	RANK	DECISION
D21	Technology	3.97	1st	High
D13	Communication; Project Management;	3.96	2nd	High
D1	Design Stage	3.95	3rd	High
D4	Information handling	3.93	4th	High
D20	Real estate and property management	3.91	5th	High
D19	Quality management	3.85	6th	High
D3	Operation / Facility Management Stage	3.76	7th	High
D14	Process/workflow	3.76	7th	High
D2	Construction/Building Stage	3.74	9th	High
D12	Checking maintainability	3.72	10th	High
D18	Leadership and strategy	3.70	11th	High
D15	Emergencies preparedness and business continuity	3.68	12th	High
D5	Strategic management	3.67	13th	High
D11	Visualization and marketing	3.64	14th	High
D17	Environmental human factors	3.64	14th	High
D16	Stewardship and sustainability	3.63	16th	High
D9	Locating building components	3.59	17th	High
D7	Financial Application (rental management, procurement and accounting)	3.57	18th	High
D6	Governance of the resources and services	3.55	19th	High
D8	Technical Application (operation and maintenance of the property)	3.50	20th	High
D10	Facilitating real-time data access	3.50	21st	High
	Group MIS	***3.72***		***High***

Table 6 revealed that the level of awareness of BIM in all the application areas of FM is high. The FM application area with the highest level of BIM awareness is Technology (MIS = 3.97) while the FM application areas with the least level of BIM awareness are Technical Application (operation and maintenance of the property) and Facilitating real-time data access (MIS = 3.50 respectively). On the average, the level of BIM awareness in all the FM application areas in Abuja is high (Group MIS = 3.72). The result of this study here differs from finding from the study of Onungwa *et al.* (2017). This is because Onungwa *et al.* (2017) discovered that there is low level of awareness and technical know-how of BIM in Nigeria. In view of this, it is important to determine the level of implementation of BIM in all the application areas.

Results and Discussion on the Level of BIM Implementation in FM Application Areas in Abuja

Table 7 shows the result of the MIS ranking on the level of BIM implementation in FM application areas in Abuja.

Table 7: Level of BIM Implementation in FM Application Areas in the Nigerian Construction Industry

CODE	BIM IMPLEMENTATION LEVEL	MIS	RANK	DECISION
[illegible]	[illegible]	3.77	1st	High
[illegible]	[illegible] property management	3.70	2nd	High
[illegible]	[illegible]	3.68	3rd	High
[illegible]	[illegible] Facility Management Stage	3.68	3rd	High
[illegible]	[illegible] and strategy	3.65	5th	High
[illegible]	[illegible] management	3.60	6th	High
[illegible]	[illegible] handling	3.57	7th	High
[illegible]	Process workflow	3.56	8th	High
[illegible]	Emergencies preparedness and business continuity	3.56	8th	High
[illegible]	Assessing maintainability	3.54	10th	High
[illegible]	Environmental human factors	3.54	10th	High
E9	Locating building components	3.53	12th	High
E5	Strategic management	3.49	13th	Average
E8	Technical Application (operation and maintenance of the property)	3.49	13th	Average
E16	Stewardship and sustainability	3.49	13th	Average
E13	Communication, Project Management,	3.47	16th	Average
E2	Construction/Building Stage	3.43	17th	Average
E11	Visualization and marketing	3.42	18th	Average
E10	Facilitating real-time data access	3.37	19th	Average
E7	Financial Application (rental management, procurement and accounting)	3.26	20th	Average
E6	Governance of the resources and services	3.15	21st	Average
	Group MIS	***3.52***		***High***

Table 7 shows that the level of BIM implementation is high in thirteen (13) of the twenty-one (21) core FM application areas. These FM application areas range from Locating building components (MIS = 3.53) to Technology (MIS = 3.77). On the other hand, the level of BIM implementation is on the average in eight (8) FM application areas. These range between Governance of the resources and services (MIS = 3.15) and Strategic management (MIS = 3.49). On the average, the level of BIM implementation in the FM application areas is high (Group MIS = 3.52). The finding of this study here agrees with findings from past studies to a great extent. This because Marcus *et al.* (2015) that examined BIM in the Nigerian construction industry found that there is a low level of knowledge of BIM which is related to the low utilization among the stakeholders. Also, Olanrewaju *et al.* (2020) found that BIM has been applied to various aspects of construction processes in developed countries but Nigeria is yet to realize the full potentials of BIM. In addition, Babatunde *et al.* (2020) reported that BIM adoptions have not been generally embraced by many Architecture, Engineering, and Construction (AEC) firms, particularly in developing countries. It can be seen from the result of this that in spite of the fact that the Group MIS revealed high level of implementation, some of the FM application areas still have average implementation level and all of the areas have MIS values less than 4.00 on a five – point scale. It is therefore necessary to propose measures for enhancing the level of adoption of BIM for FM. This will bring about improved level of awareness and implementation of BIM for FM.

Results and Discussion on the Measures for Improving the Adoption of BIM for FM in Abuja

The result of the MIS analysis employed to rank the identified measures for improving the adoption of BIM for FM in order effectiveness is presented in Table 8.

Table 8: Measures for Improving the Adoption of BIM for FM in the Nigerian Construction Industry

CODE	MEASURES FOR IMPROVING BIM-FM ADOPTION	MIS	RANK	DECISION
F1	[illegible] BIM to academic curriculum	4.22	1st	Effective
F6	[illegible] should embark on intensive awareness of BIM	4.22	1st	Effective
F17	[illegible] provides an enabling environment for BIM [illegible]	4.19	3rd	Effective
F7	[illegible] training and promotion among [illegible]	4.13	4th	Effective
F9	[illegible] BIM guideline and regulation	4.13	4th	Effective
F*	[illegible] appropriate technology and [illegible]	4.11	6th	Effective
F11	Developing improved data exchange standards	4.10	7th	Effective
F12	Mandate BIM on public projects	4.10	7th	Effective
F2	Public sector to establish regulatory approval	4.04	9th	Effective
F5	Public sector to remove impediments by building BIM capability and capacity	4.03	10th	Effective
F11	Build trust between professionals	4.01	11th	Effective
F15	Consider government and professional societies as a team to lead BIM implementation	3.97	12th	Effective
F13	Splits the software cost over projects as well as sharing the cost with a client	3.96	13th	Effective
F16	Push-pull strategy between the AEC stakeholders	3.88	14th	Effective
F4	Public sector to incentivize early BIM adopters	3.79	15th	Effective
F14	Customise the local building components for objects libraries	3.78	16th	Effective
F8	Setting up BIM council	3.72	17th	Effective
	Group MIS	***4.02***		***Effective***

Table 8 shows the MIS ranking of the seventeen (17) measures for enhancing the adoption of BIM for FM as identified from the review of literature in this study. It was revealed that all the measures identified are effective. The most effective measures for enhancing the adoption of BIM for FM are Incorporation of BIM to academic curriculum and Software vendors and training institutes should embark on intensive awareness of BIM with MIS values of 4.22 each. The least effective measure is setting up BIM council with MIS value of 3.72. On the average, all the identified measures for enhancing the adoption of BIM for FM in Abuja are effective (Group MIS = 4.02). The result of this analysis is in line with the findings of Alufohai (2012), Poole (2014), Ezeokoli *et al.* (2016) and Hamma-Adama (2020). This is as a result of the fact that Poole (2014) identified collaboration, training and promotion as the way forward for BIM implementation. In addition, Isa (2015) identified strategies for overcoming BIM barriers to include improve BIM awareness and understanding, outsourcing BIM experts, provision of training by employers, provision of BIM education at higher institutions, government legislation supporting the use of BIM, clients demand for BIM, government support, developing BIM guidelines and improved data exchange standards. These measures identified by Isa (2015) are similar to the highest ranked measures in the result of this study. Finally, the studies of Alufohai (2012), Ezeokoli *et al.* (2016) and Hamma-Adama (2020) also supported these findings. It is therefore important to come up with recommendations for ensuring the effective implementation of measures to overcome barriers in implementation of BIM.

CONCLUSION AND RECOMMENDATIONS

The study found that Lack of adequate BIM training and inadequate exposure to BIM concept; Low level of BIM technical know-how; Inaccessibility to suitable technology and framework; Industry working environment; Lack of policy and standardisation; and Initial BIM huge capital outlays are the most important factors influencing the adoption of BIM for FM in Abuja. The most important drivers to the implementation of BIM for FM in Abuja are The need for effective facilities management of completed projects; The need to achieve lifecycle BIM uses; The need for timely delivery; Reformation of design activities and improvement of design quality; The need for integrating people, place, processes and technology; and The need to secure more financial savings and monitoring. These drivers are important to the successful adoption of BIM for FM. The level of BIM awareness in all the FM application areas in Abuja is high. The level of BIM implementation in the FM application areas is also high but requires improvement for the successful management of facilities in Abuja. Incorporation of BIM to academic curriculum and Software vendors and training institutes should embark on intensive awareness of BIM are the most effective measures for enhancing the adoption of BIM for FM. It can therefore be concluded that the factors influencing the adoption of building information modelling for facility management (BIM-FM) in Abuja are important and requires to be put into consideration for the successful management of facilities.

In view of the findings and conclusion of this study, it is strongly recommended that sstakeholders in the construction industry and facility managers should adopt the strategies of incorporating BIM to academic curriculum and organising intensive awareness programme on BIM to improve the level of adoption of BIM. The study also recommends that in order to improve the level of awareness and implementation of BIM for FM, stakeholders should work collaboratively to set up a mechanism for the effective implementation of the measures for enhancing the adoption of BIM for FM. This will in turn enhance the level of adoption of BIM for FM and hence the successful management of facilities.

REFERENCES

Agumba, J. N. and Haupt, T. C. (2014). Implementation of Health and Safety Practices: Do Demographic Attributes Matter? *Journal of Engineering Design & Technology*. Emerald Group Publishing Limited. 12(4): 531 – 550. Available on www.emeraldinsight.com/1726-0531.htm

Aibinu, A., and Venkatesh, S. (2013). Status of BIM adoption and the BIM experience of cost consultants in Australia. *Journal of Professional Issues in Engineering Education and Practice*, *140*(3), 04013021.

Akcamete, A., Akinci, B., and Garrett, J. H. (2010). Potential utilization of building information models for planning maintenance activities. In *Proceedings of the International Conference on Computing in Civil and Building Engineering*, June 2010. (pp. 151-157).

Akerele, A. O. and 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.

Aldowayan, A. and Dweiri, F. T. (2020). A Review on Current Status of Facility Management Practices in Building Industry and Prospective BIM Intervention to Manage the Facilities Effectively during its Service Life. *Proceedings of the 5th NA International Conference on Industrial Engineering and Operations Management*. IEOM Society International, Detroit, Michigan, USA. August 10 – 14. 831-846.

Alufohai, A. (2012). "Adoption of Building Information Modeling and Nigeria's Quest for Project Cost Management", *Journal of Nigerian Institute of Quantity Surveyors*. 1(1): 6- 10.

Anderson, A., Marsters, A., Dossick, C. S., and Neff, G. (2012). Construction to operations exchange: Challenges of implementing COBie and BIM in a large owner organization. In *Construction Research Congress 2012: Construction Challenges in a Flat World* (pp. 688-697).

Aanuoluwa, O. M., Babatunde, S. A. and Olanrewaju, O. I. (2018). Adoption Level of Building Information Modelling by Selected Professionals in Kwara State. *Environmental Technology and Science Journal* 9(2), pp. 42 - 44. doi: https://doi.org/10.13140/RG.2.2.17530.34247

Allerall, D. W. (2008). Building information modeling: A framework for collaboration. *Construction Law*, 28, 3.

Babatunde, S. O., Ekundayo, D. O. and Adekunle, A. O. (2019, September). Analysis of BIM maturity level among AEC firms in developing countries: a case of Nigeria. In *Proceedings of the 35th Annual ARCOM Conference* (pp. 225-234). Association of Researchers in Construction Management.

Babatunde, S., Ekundayo, D. O., Adekunle, A. and Bello, W. (2020). Comparative Analysis of Drivers to BIM Adoption among AEC Firms in Developing Countries: A Case of Nigeria. *Journal of Engineering, Design and Technology*, Emerald. University of Salford. Manchester. 1-29. Available on line: usir.salford.ac.uk/id/eprint/56104/

Becerik-Gerber, A. M., Jazizadeh, F., Li, N. and Calis, G. (2012). Application Areas and Data Requirements for BIM-Enabled Facilities Management. Case Study. *Journal of Construction Engineering and Management*, ASCE. 431-442.

Becerik-Gerber, B., Jazizadeh, F., Li, N. and Calis, G. (2011). Application areas and data requirements for BIM-enabled facilities management. *Journal of Construction Engineering and Management*, 138, 431-442

BIFM (2012). *BIM and FM: Bridging the gap for success*. British Institute of Facilities Management. Bishop's Stortford, Hertfordshire, UK.

Brooks, T. J., and Lucas, J. D. (2014). A study to support BIM turnover to facility managers for use after construction. In *Computing in Civil and Building Engineering (2014)* (pp. 243-250).

Chong, H. Y., Wang, J., Shou, W., Wang, X., and Guo, J. (2014). Improving quality and performance of facility management using building information modelling. In *International Conference on Cooperative Design, Visualization and Engineering* (pp. 44-50). Springer, Cham.

Construction, M. H. (2012). The Business Value of BIM in North America: Multi-Year Trend Analysis and User Ratings—Smart Market Report.

Eastman, C., Teicholz, P., Sacks, R. and Liston, K. (2008). Frontmatter. Wiley Online Library.

Eastman, C., Teicholz, P., Sacks, R. and Liston, K. (2011). BIM Handbook: A Guide to Building Information Modelling. 2nd ed. John Wiley & Sons Inc., New Jersey, USA.

Fuller, S. (2010). Life-cycle cost analysis (LCCA). *National Institute of Building Sciences, An Authoritative Source of Innovative Solutions for the Built Environment (www. WBDG. org, Washington)*

Hamma-Adama, M. (2020). Framework for Macro Building Information Modelling (BIM) Adoption in Nigeria. Robert Gordon University, PhD Thesis. Hosted on OpenAIR [online]. Available from: https://openair.rgu.ac.uk

Hardin, B. (2011). BIM and construction management: proven tools, methods, and workflows. John Wiley & Sons

Isa, M. (2015). Developing a Roadmap for the Implementation of Building Information Modeling (BIM) in the Nigerian Construction Industry. MSc. Thesis, Ahmadu Bello University, Zaria, Nigeria.

Jordani, D. A. (2010). BIM and FM: The portal to lifecycle facility management. *Journal of Building Information Modeling*, 6(Spring), 13-16.

Kassem, M., Graham, K., Nashwan, D., Michael, S. and Steve, L. (2015). BIM in Facilities Management Applications: A Case Study of a Large University Complex. *Built Environment Project and Asset Management* 5(3): 261-277

Korpela, J., and Miettinen, R. (2013). BIM in facility management and maintenance—the case of Kaisa library of Helsinki University. In *Proceedings of 29th Annual Association of Researchers in Construction Management Conference, ARCOM* (pp. 47-56).

Lee, S. K., An, H. K., and Yu, J. H. (2012). An extension of the technology acceptance model for BIM-based FM. In *Construction Research Congress 2012: Construction Challenges in a Flat World* (pp. 602-611).

Liu, R. and Issa, R. R. A. (2013). Issues in BIM for Facility Management from Industry Practitioners' Perspectives. In *Computing in Civil Engineering (2013)*(pp. 411-418)

Mayo, G., Giel, B. and Issa, R. R. A. (2012). BIM use and requirements among building owners. In *Computing in Civil Engineering (2012)* (pp. 349-356).

Morenikeji, W. (2006). Research and analytical techniques (for social scientist, planners and environmentalist) Jos University Press, Jos.

Nicał, A. K. and Wodyński, W. (2016). Enhancing facility management through BIM 6D. *Procedia Engineering*, 164, 299-306.

Ogunsemi, D. R., Babarinde, S. O. and Saliihu, C. (2020). Current State of Building Information Modelling in the Nigerian Construction Industry. *Journal of Sustainable Architecture and Civil Engineering*, 2(27): 63-77. DOI: 10.32732/jsace.20.2.25142

Olanrewaju, O. I., Idiake, J. E., Oyewobi, L. O. and Akanmu, W. P. (2018). Global Economic Recession: Causes and Effects on Nigeria Building Construction Industry. Journal of Surveying, Construction and Property. (ISSN: 1985-7527). Vol. 9, No. (1), p. 9-18. DOI: https://doi.org/10.22452/jscp.vol9no1.2.

Olapade, D. T. and Ekemode, B. G. (2018). Awareness and utilisation of building information modelling (BIM) for facility management (FM) in a developing economy: Experience from Lagos, Nigeria. *Journal of Facilities Management*, 16(4), 387-395.

Onungwa, I. O., Uduma-Olugu, N. and Igwe, J. M. (2017). Building Information Modeling as a Construction Management Tool in Nigeria", *WIT Transactions on the Built Environment*, 169, 25-33.

Ryab-Nci, M. B. and Kaduma, L. A. (2015). Assessment of Building Information Modeling (BIM) Knowledge in the Nigerian Construction Industry. *International Journal of Civil & Environmental Engineering IJCEE-IJENS*. 15(06): 60-69.

Shittu, A. A., Ibrahim, A. D., Ibrahim, Y. M., Adogbo, K. J. and Mac-Barango, D. O. (2016). Impact of organisational characteristics on health and safety practices of construction contractors. *Nigerian Journal of Technological Research (NJTR)*. Federal University of Technology, Minna, Nigeria. 11(1): 60 – 67.

Shou, W., Wang, J., Wang, X. and Chong, H. Y. (2015). A Comparative Review of Building Information Modelling Implementation in Building and Infrastructure Industries. Archives of Computational Methods in Engineering. 22. 291-308.