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Effects of Utilization of Building Information Modelling on FacilitiesManagement Performance in Abuja

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***Abstract**: Building Information Modeling (BIM) is a process that uses three-dimensional (3D) models to represent a building's design, construction, and operation. BIM has the potential to revolutionize the facility management (FM) industry by providing FM professionals with a more comprehensive and accurate view of the building. This paper examines the awareness and utilization of BIM in FM companies in the Federal Capital Territory (FCT) of Abuja, Nigeria. The study used quantitative design and data were collected through questionnaire survey from real estate professionals, the study adopted purposive simple random sampling technique and SPSS software version 22 was used for data analysis and the results were presented in tables. The study found that there is a low level of awareness and utilization of BIM among FM companies in Abuja. The paper also found that there are a number of barriers to the adoption of BIM in FM practices, including lack of awareness of the benefits of BIM, lack of training and expertise in BIM, concerns about the security and compatibility of BIM data. The paper concludes that there is a need to increase awareness of the benefits of BIM among FM professionals in Abuja. The study also recommends that FM companies in Abuja invest in training and expertise in BIM, and that the government provide financial support for the adoption of BIM in FM practices. The paper also found that BIM can be beneficial to FM practices in a number of ways, including improved communication and collaboration between FM professionals and other stakeholders, increased efficiency in FM tasks such as preventive maintenance and asset management, reduced risk of errors and omissions, improved decision- making, increased sustainability of buildings and that BIM has the potential to revolutionize the FM industry in Abuja. However, there is a need to increase awareness of the benefits of BIM and to address the barriers to its adoption.*

***Keywords**: Building Information Modeling, Facility Manager, Awareness, Professional*

Introduction

Facilities management has been in existence for a quite long period of time, it is considered by many as the modern way of management and maintenance of facilities in workplaces, organizations as well as private entities, it is an easier and more efficient way of handling and managing daily and periodic operational activities carried out in organizations and workplaces. With day-to-day activities of life, management of facilities are enhanced and upgraded in order to function and serve better. Despite the fact that 85% of the life-cycle cost of a building occurs after construction is completed (Arayici, Onyenobi & Egbu 2017;

Jordani, 2015; Lewis, Riley & Elmualim, 2014), facility managers are hardly involved in the building planning process, thereby making maintenance strategy to be based on "as built" condition when building is delivered. Meanwhile, valuable information required for proper facility management (FM) goes unrecorded during construction, thereby leading to inefficient management of the facilities and high operational cost (Mendez, 2006; Ryal-Net & Kaduma, 2015). This problem is borne out of poor information management among stakeholders in the construction industry (Mendez, 2006; Newton & Chileshe, 2016). To allow facilitation of construction knowledge by stakeholders during the full life cycle of a building, a new innovative approach to building design referred as building information modelling (BIM) is being implemented around the globe (Arayici *et al*., 2012; Ryal-Net & Kaduma, 2015). When BIM is integrated to FM, it can be classified as 6D modelling (Pärn, Edwards & Sing, 2017) which is useful in augmented manual processes of information handover, and generally, result into more efficient and better-managed facilities after completion. It is therefore not out of place that Underwood and Isikdag, (2011) opined that to get the greatest benefit from BIM, it must be used as FM tool. However, irrespective of the benefits of integrating BIM with FM, utilizing of BIM for FM is at infancy especially in developing countries like Nigeria where BIM is mainly used by architects in design preparation, presentation and implementation (Alufohai, 2012). In view of the foregoing, this study aims at the importance to assess the level of awareness and utilization of building information modelling for facility management in the property and facility management industry in Nigeria.

Over time, FM has proven to be an efficient way of managing facilities ranging from janitorial and cleaning services to non-core services such as security, lighting, heating, plumbing etc. FM is a multi-disciplinary field that ensures the functionality of built environment by integrating people, place, process, and technology (Cotts, Roper & Payant, 2013; Arayici *et al.*, 2017). The role of FM, therefore, transcends maintenance management butalso includes emergencies preparedness, communication, business continuity, human factors, leadership environmental stewardship and sustainability, finance and business, strategy, project management, quality, real estate and property management and technology (International Facility Managers Association IFMA, 2016). However, irrespective of the benefits of integrating BIM with FM, utilizing BIM for FM is at infancy especially in developing countries like Nigeria where BIM is mainly used by architects in design preparation, presentation and implementation (Alufohai, 2012). In view of the foregoing, it is important to assess the level of awareness and utilization of BIM for facility management in the property and facility management companies in Abuja Nigeria. Therefore, there is need to determine the level of awareness and utilization of BIM by Facilities management companies and also look into the effect of utilizing it in FM services.

Literature

Definition and Concept of BIM

Building Information Modeling (BIM) is a set of interactions between policies, processes and technology to produce a "method for managing importance of building design and project data in digital format or virtual environment through the building life cycle (Ammari, El & Hammad, 2014). Meganathan and Nandhini, (2018) stipulate that BIM is not just a clever use of 3D models, but also making significant changes in work flow and project delivery process. On the other hand, NBIMS (2010) states that BIM as a tool for digital representation comprising physical characteristics and function of a facility. BIM also is a source of knowledge about the shared facilities as further information in order to form a solid foundation in determining the outcome of the building during its life cycle; defined as existing from the initial concept to demolition.

In other words, BIM is a process of design drawings and construction of a building by using technology approach, and it involves a procedure in the Architecture, Engineering, Construction and Operations (AECO) and a basic premise of BIM is collaboration of many different stakeholders at different phases of the life cycle of a facility to insert, remove, update or modify information in the BIM to support and reflect the roles of the various stakeholders. BIM approach allows an object or model is defined in terms of elements and building systems such as space, beams, and columns. These models are equipped with all the data associated with a building, including physical characteristics, functions and information life-cycle project, which is called 'smart objects' CRC Construction Innovation, (2017).

Facility Management

FM is a multi-disciplinary field that ensures the functionality of built environment by integrating people, place, process, and technology (Cotts, Roper & Payant, 2009; Arayici, Onyenobi & Egbu, 2012). The role of FM, therefore, transcends maintenance management but also includes emergencies preparedness, communication, business continuity, human factors, leadership environmental stewardship and sustainability, finance and business, strategy, project management, quality, real estate and property management and technology (International Facility Management Association IFMA, 2016). Facilities Management (FM) is a diverse profession and was born in United States of America (USA) in the year 1970s in conjunction with business sector of outsourced services. Its main objectives are to provide quality environment and to answer to companies‟ demand in order to have a qualified and specialized single-handed point of reference, being able to optimize all the activities concerning the management of internal services which support the business organization (Cao, Song & Wang, 2015).

Utilization of BIM in FM

The demand of Building Information Modelling (BIM) is increasing recently as much international organization and government taking the initiative to promote BIM in all industry life-cycle. The life cycle in BIM is primary sets it apart from preceding digital technologies, which were designed in specific phases of the building life cycle for specific sectors of the building industry, such as design, construction and Facility Management (FM) (Azhar, Khalfan & Maqsood, 2012; Smith & Tardif, 2009; Takim, Harris, & Nawawi, 2013). In macro life cycle, BIM provide benefit: overlap, reduce real project risks; irrelevant document eliminated; waste reduces; productivity increase; costs decrease; profit increase as improve product, improve services deliver, or expand market share (Smith & Tardif, 2009). The fundamental of BIM implementation are: cash flow, productivity, profit and revenue though different types of businesses use BIM for different purpose (Smith & Tardif, 2009), (Weygant, 2011). The success of BIM implementation will depend on how well streamline the workflow and information flow BIM are widely use in design and construction; the benefit of the parametric modelling technology that enable to store semantic information about the facility (Akcamete, Akinci, Garrett & Jr, 2010), (Smith & Tardif, 2009). The goal of BIM improves product delivery, which includes quality, reliability, timeless and consistency of the process made (Ani, Johar, Tawil, Razak & Hamzah, 2015). Most information created during the design and construction process that is of value to facility managers can only be found elsewhere

and in scattered sources: in written construction specifications, warranty certificates and operations and maintenance manuals (Smith & Tardif, 2009).
However, the current practice BIM in scope of FM, stakeholders are not entirely implementing BIM in FM industry and in current FM operations that applied BIM, most functions still done manually even facilities manager knowing by adopting BIM during operational building can decrease chance of errors and increase efficiency (Becerik-Gerber, Jazizadeh, Li & Calis, 2012 and Motamedi, Hammad & Asen, 2014).

Opportunities to be considered by Facility Manager for Quality of Life (QOL)

According to (Linderoth, 2010) of macro-BIM practice are Rapid visualization, better decision support upstream in the project development process, rapid and accurate updating of changes, reduction of man-hours required to establish reliable space programs, increased communication across the total project development team (users, designers, capital allocation decision makers, contracting entities, and contractors), increased confidence in completeness of scope. However, when we talk about QOL and BIM in FM, we related about sustainable workplace integrated with 3P and 1T for built environment. The benefit of integrating BIM in FM for the Effective operational cost, shorter time for decision making, resource for decision making, better documentation system, collaboration and work flexibility, updated information and clash

detection.

Methodology

A descriptive and exploratory survey research methodology was used. Since this paper was collected and analyzed numerical data, a quantitative method was thought to be the most suitable. This paper also employed survey research approach, which collects data using questionnaires. The sample frame for this paper is the total registered facilities managers in Abuja metropolis which are twenty-six (26) FM Abuja office, 2024. The study adopted purposive simple random sampling technique. Statistical Package for Social Science (SPSS, version 22) was used for statistical analysis of the data generated from the questionnaire survey. The data achieved using questionnaire survey was a thoroughly screened, analyzed and sorted out for analysis depicting the information responses from the respondent. As the study contained inferential method for the analysis of results.

Finding

Linear regression analysis was used to determine the effect of BIM utilization on facilities Management Performances. The following tables show how effective BIM utilization is on each of the performance variables.

Table 1: Service Outcome

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R square Change	F Change	df1	df2	Sig. F Change
1	.876[a]	.767	.453	.917	.767	19.220	1	21	.000

a. Dependent Variable: the use of BIM

b. Predictors: (Constant), BIM in FM can improve service outcome

Table 19 provides the R and R^2 values. The R value represents the simple correlation and is 0.876 (the R column) which indicates a high degree of correlation according to Cotts, (1992). The R^2 value (the R^2 column) indicates how much of a total variation in the performance of facilities management companies can be explained by the improvement of service outcome. In this 76.7% can be explained, which is very large. In another study, Becerik-Gerber *et al,* (2012) explored how BIM can be beneficial to FM practices. The study used online survey and interview to assess the current status of BIM implementations in FM, potential applications, and the level of interest in the utilization of BIM.

Table 2: ANOVA; Service Outcome

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	16.164	1	16.164	19.220	.000[b]
	Residual	17.662	21	.841		
	Total	33.826	22			

a. Dependent Variable: the use of BIM

b. Predictors: (Constant), BIM in FM can improve service outcome.

Table 2 is the ANOVA table, which reports how well the regression equation fits the data (i.e. predicts the performance of facilities management companies). It indicates that the regression model predicts the performance of facilities management companies significantly well. This can be known through looking at the "Regression" row and then on the "Sig" column. This indicates the statistical significance that was run. Here P<0.000, which is less than 0.05 and indicates that, overall, the regression model statistically and significantly predicts the outcome variable (i.e. it is good fit for the data).

Table 3: Facilities Understanding

Model	**R**	**R Square**	**Adjusted R Square**	**Std. Error of the Estimate**	**Change Statistics**				
					R square Change	F Change	df1	df2	Sig. F Change
1	.944[a]	.891	.309	1.917	.891	10.845	1	21	.000

a. Dependent Variable: the use of BIM
b. Predictors: (Constant), BIM in FM enhances understanding of facilities

Table 3 provides the R and R^2 values. The R value represents the simple correlation and is 0.944 (the R column) which indicates a high degree of correlation according to Cotts, (1992). The R^2 value (the R^2 column) indicates how much of a total variation in the performance of facilities management companies can be explained by the improvement of service outcome. In this 89.1% can be explained, which is very large**.** This is in line with the British Institute of Facilities Management, (2012). BIM allows communication with FM needs in the early stages of the projects. The positive contribution of adopting BIM in FM is identified as a significant value addition (Gu and London, 2010). Eddie *et al,* (2013) explain that facilities managers and clients benefit the most out of BIM implementation.

Table 4: ANOVA; Understanding Facilities

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	11.519	1	11.519	10.845	.003[b]
	Residual	22.307	21	1.062		
	Total	33.826	22			

a. Dependent Variable: the use of BIM
b. Predictors: (Constant), BIM in FM enhances understanding of facilities

Table 4 provides the R and R^2 values. The R value represents the simple correlation indicates that the regression model predicts the performance of facilities management companies significantly well. This can be known through looking at the "Regression" row and then on the "Sig" column. This indicates the statistical significance that was run. Here $P<0.03$, which is less than 0.05 and indicates that, overall, the regression model statistically and significantly predicts the outcome variable (i.e. it is good fit for the data). It is important toto consider the effect size, which is a measure of how much variation in the data is explained by the model. A large effect size means that the model is able to explain a lot of the variation in the data. A small effect size means that the model is not able to explain much of the variation in the data.

Table 5: Productivity

Model	**R**	**R Square**	**Adjusted R Square**	**Std. Error of the Estimate**	**Change Statistics**				
					R square Change	F Change	df1	df2	Sig. F Change
1	.851[a]	.724	.454	.917	.724	19.256	1	21	.000

a. Dependent Variable: the use of BIM
b. Predictors: (Constant), implementation can increase productivity

Table 5 provides the R and R^2 values. The R value represents the simple correlation and is 0.851 (the R) which indicates a high degree of correlation according to Cotts, (1992). The R^2 value (the R^2 column) indicates how much of a total variation in the performance of facilities management companies can be explained by the improvement of service outcome. In this 72.4% can be explained, which is very large. Volk *et al*., (2014) summarized the increase in productivity as: identifying the critical information required, the high level of effort to; develop; maintain the BIM; and information exchange between the BIM and FM systems. Another study, (Eastman *et al*., 2011) on improved data accessibility and accuracy stated that BIM models provide a single source of truth for all building data, including information about the building's physical structure, assets, and systems. This data is accessible to all members of the FM team, which can help to improve communication and collaboration. Also Golabchi Akula and Kamat, (2016) on Streamlined maintenance and operations is of the opinion that BIM models can be used to plan and schedule preventive maintenance tasks, track the condition of assets, and generate work orders. This can help FMs to improve the efficiency of maintenance and operations and reduce downtime.

Table 6: ANOVA; Productivity

Model		Sum of Squares	df	Mean Square	F	Sig.
	Regression	16.181	1	16.181	19.256	.000b
1	Residual	17.646	21	.840		
	Total	33.826	22			

a. Dependent Variable: the use of BIM
b. Predictors: (Constant), implementation can increase productivity

Table 6 indicates that the regression model predicts the performance of facilities management companies significantly well. This can be known through looking at the "Regression" row and then on the "Sig" column. This indicates the statistical significance that was run. Here $P<0.00$, which is less than 0.05 and indicates that, overall, the regression model statistically and significantly predicts the outcome variable (i.e. it is good fit for the data). Overall, a P-value of 0.00 is very strong evidence to suggest that the data is well-fit by the ANOVA model. However, it is important to consider the effect size as well as to determine how well the model is able to explain the variation in the data.

Table 7: Overall Project Cost

Model	**R**	**R Square**	**Adjusted R Square**	**Std. Error of the Estimate**	**Change Statistics**				
					R square Change	F Change	df1	df2	Sig. F Change
1	.714[a]	.510	.486	.889	.510	21.816	1	21	.000

a. Dependent Variable: the use of BIM
b. Predictors: (Constant), utilization can reduce overall project costs

Table 7 provides the R and R^2 values. The R value represents the simple correlation and is 0.714 (the R column) which indicates a high degree of correlation according to Cotts, (1992). The R^2 value (the R^2 column) indicates how much of a total variation in the performance of facilities management companies can be explained by the improvement of service outcome. In this 51.0% can be explained, which is average. A study Lewis, Riley and Elmualim, (2015) explained that the value of facility management-based building information model FM-BIM provides operational benefits such as utility cost reductions, comfort management, space optimization and improved inventory management, and supports enhanced FM tasks through visualization and analysis capabilities.

Table 8: ANOVA; Overall Project Cost

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	17.235	1	17.235	21.816	.000[b]
	Residual	16.591	21	.790		
	Total	33.826	22			

a. Dependent Variable: the use of BIM
b. Predictors: (Constant), utilization can reduce overall project costs

Table 8 indicates that the regression model predicts the performance of facilities management companies significantly well. This can be known through looking at the "Regression" row and then on the "Sig" column. This indicates the statistical significance that was run. Here $P<0.00$, which is less than 0.05 and indicates that, overall, the regression model statistically and significantly predicts the outcome variable (i.e. it is good fit for the data).

Table 9: Financial Benefits

Model	**R**	**R Square**	**Adjusted R Square**	**Std. Error of the Estimate**	**Change Statistics**				
					R square Change	F Change	df1	df2	Sig. F Change
1	.696[a]	.485	.227	1.090	.485	7.466	1	21	.012

a. Dependent Variable: the use of BIM
b. Predictors: (Constant), perceived financial benefits of BIM

Table 9 provides the R and R^2 values. The R value represents the simple correlation and is 0.696 (the R column) which indicates a high degree of correlation according to Cotts, (1992). The R^2 value (the R^2 column) indicates how much of a total variation in the performance of facilities management companies can be explained by the improvement of service outcome. In this 48.5% can be explained, which is below average. In a previous study (Smith & Tardif, 2009) opined that with regards to guidance for the implementation of BIM at strategic and operational stage, including the support it provides to design, production management or to achieve improved sustainability and interoperability, costs seem to be higher at the initial stage but subsequently declines as the operation continuous.

Table 10: ANOVA; Financial Benefits

Model		Sum of Squares	df	Mean Square	F	Sig.
	Regression	8.872	1	8.872	7.466	.001[b]
1	Residual	24.955	21	1.188		
	Total	33.826	22			

a. Dependent Variable: the use of BIM
b. Predictors: (Constant), perceived financial benefits of BIM

Table 10 indicates that the regression model predicts the performance of facilities management companies significantly well. This can be known through looking at the "Regression" row and then on the "Sig" column. This indicates the statistical significance that was run. Here $P<0.01$, which is less than 0.05 and indicates that, overall, the regression model statistically and significantly predicts the outcome variable (i.e. it is good fit for the data). However, it is important to note that a good fit does not necessarily mean that the model is perfect. There is still some variation that is not explained by the model.

Conclusion

there is a need to enhance BIM awareness among Abuja facility managers. There is also a need to provide training and tools to assist facility managers in implementing BIM. If more facilities managers in Abuja use BIM, it might have a substantial impact on the efficiency and efficacy of facility management. The use of BIM by facility managers in Abuja, Nigeria, has the potential to dramatically increase facility management efficiency and effectiveness. However, there are other obstacles to BIM adoption, including a lack of knowledge, a lack of training, and a high cost. FM companies need to ensure that they have an acceptance of BIM from the team and the various facilities stakeholders. The decision to transition to BIM is an elaborate process. Another way to increase the possibility of their consideration is to align BIM implementation with the organization's goals. Once there is top-level support, they can move on to the next step. The FM companies should develop a plan to create a structured BIM implementation because BIM is a new process, so it will take time for the FM companies to adjust.

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