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Benefits of Applying Building Information Modeling (BIM) in Property Maintenance by Estate Surveyors and Valuers

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Abstract

The traditional reactive approach to property maintenance by estate surveyors and valuers presents huge limitations in today's data-driven world. However, building information modeling (BIM) has emerged as a global transformative technology, offering a proactive, data-centric framework for optimizing maintenance operations. Presumably, the application of this model should be evident in Uyo, Akwa Ibom State as in other countries like United States (US) and United Kingdom (UK), but sadly, the reverse is the case in spite of the enormous benefits accrued from its usage. Hence, this study aimed at evaluating the benefits for applying BIM in property maintenance by estate surveyors and valuers in Uyo, Akwa Ibom State, the population for this study comprised 80 head of practicing estate surveyors and valuers firms in Uyo, Akwa Ibom State or their representative, using random sampling technique, 66 respondents from the study area were sampled with frequency table as method of data analysis. The findings revealed that efficient facility management (4.00) being the paramount, predictive maintenance (3.84), cost saving and sustainability (3.71), providing accurate and up-to-date information about buildings and their assets (3.65) exist. Inferring from the findings, the study concluded that efficient facility management, predictive maintenance, cost saving and sustainability, regulatory compliance, enhanced collaboration among others are the benefits of applying BIM in property maintenance, generally. Hence, it was recommended that estate surveyors and valuers should learn to apply the contemporary model through seminars and workshops as it will equip them to harness the benefits of applying BIM in property maintenance activities.

Keywords: Building Information Modeling, BIM, Property Maintenance, Estate Surveyors and Valuers

Introduction

Building Information Modeling (BIM), which is a process involving the generation and management of digital representation of the physical and functional characteristics of building, has been gaining much popularity in the real estate industry, but its application in property maintenance is a relatively new area of research. Perhaps, many researchers such as Fazli, Fathi, Enfreradi and Fazlib (2014) had acknowledged that countries who had applied this BIM model in their property maintenance activities had obtained improved communication, collaboration and efficient decision-making maintenance practices, despite its inherent challenges (Sampaio and Simoes, 2014). To this end, Wang, Li, Wang and Mao (2013) confirmed that BIM is a new approach to real estate design, construction and facilities management, in which a representation of the building process is used to facilitate the exchange and interoperability of digital information to achieve efficient result. Further, Azhar (2011) viewed BIM as a virtual process that encompasses all real estate aspects,

disciplines and systems of a facility within a single and virtual model, allowing all the designing team members such as architect, engineers and other construction workers to collaborate more effectively and efficiently in comparison to traditional processes. The author also emphasized that the model is not just a software, but both a process and software, meaning that it serves a dual purpose and hence performs more than expected. Base on this school of thought, Gu and London (2010) stated that BIM means not only using 3D intelligent model, but also making significant changes in the workflow and project delivery process. More so, since it represents a new paradigm shift within the contemporary architects, engineers and construction workers, the author showed that it encourages the integration of roles of all stakeholders on a real estate project. Observably, one would say that it has the tendency to promote greater efficiency and harmonize players who in the past saw themselves as rivals. Summarily, BIM has become increasingly prevalent in the field of property maintenance due to its ability to streamline and optimize real estate maintenance processes and this was in line with the thoughts of Succar (2009). According to BIM Think Space (2013), record shows that BIM has been globally used in a variety of ways, with eight major countries among whom are China, Singapore and South Korea adopting it at different rates from year 2000. For example, the United States of America (USA), which is one of the early adopters had applied BIM on about 85% of all federal real estate projects, and since they have identified the benefits, it is now being adopted in the private sector-application. Further on evaluation, in that same country, BIM enabled seamless collaboration and communication among various stakeholders involved in property maintenance, and also provided a centralized platform for sharing and accessing information, thus, leading to better coordination and reduction of 35% errors in its real estate sector. In Europe, the government had developed a number of standards for the applications of BIM so as to enable it facilitate its applicability across the continent on 65% real estate projects. Hence, all these reports on the application shows that BIM has integrated with sensor technologies and Internet of Things (IoT) devices to allow real-time monitoring of building systems, equipment and environmental conditions in the country. Observably, this application has been enabled by analyzed data collection from sensors embedded in the application on one hand and predictive maintenance strategies has been developed by reducing maintenance costs within a framework on the other hand. Also, its application is embraced by countries such as Australia, Canada and the United Arab Emirates where historical data for maintenance decision-making are applied to store and manage historical data relating to maintenance activities, maintenance logs, repairs and replacements. This data has been leveraged for informed decision-making by identifying recurring issues, optimizing maintenance schedules and estimating maintenance costs (Eastman, Teicholz, Sacks and Liston, 2011).

In Nigeria, the application of BIM for property maintenance is still in the early stages of adoption. However, there is a growing recognition of its benefits in improving maintenance practices and overall asset management because of its effective data management (Federal Ministry of Power, Works and Housing, Nigeria, 2016 and Jambil, 2020). Babatunde, Udeaja and Adekunle (2020) opined that some information on the national view of BIM and its relevance to property maintenance are that BIM enhances real estate project delivery, reduces costs and improved the overall quality of real estate products. Federal Ministry of Power, Works and Housing (2016) had also recognized the importance of BIM and its benefits in the Nigerian real estate industry in general and specifically, as they had applied it to the maintenance of the presidency and national secretariat. With this purview, they had initiated effort to promote BIM in the real estate sector and to every State of the federation. However, it is sad to note that its application within the industry is still in its low level by other interested parties.

Based on this premise, Olanrewaju, Babarinde and Salihu (2020) asserted that many real estate professionals in Nigeria are not aware of BIM nor do they understand its benefits. Also, the cost implication of applying BIM and its training is another major contribution to the set-back. Furthermore, there is no government regulatory policy that has specifically promoted the application of BIM in the real estate sector. This lack of support has continually made it difficult for real estate firms to justify the cost of investing in the application of BIM. Hence, there is a shortage of skilled BIM professionals in Nigeria. This makes it difficult for real estate firms to find people who could apply BIM effectively, especially in the area of property maintenance.

Evaluation of the Benefits for Applying BIM in Property Maintenance

Many researchers postulate that BIM gives much benefit in property maintenance and its implementation increased the quality of projects as it is useful in assisting construction and development players to develop small or high-risk projects successfully (Noor, Junaidi and Ramly, 2018) According to Becerik-Gerber, Jazizadeh and Li (2011),

BIM data is mostly useful at the operational stage for commissioning, space management, locating building components, quality control, energy management, security management and maintenance and repairs. Furthermore, information and data about a facility, including its construction, materials and maintenance schedules is stored, accessed and exchanged through BIM, thus acting as a reliable shared knowledge resource that assists the decision-making process for facility managers throughout the life cycle of a building (Stanley and Thurnell, 2014). All these school of thoughts are summarized into improved data accessibility and accuracy, enhanced collaboration, efficient facility management, predictive maintenance, cost saving and sustainability, regulatory compliance and historical documentation.

On the part of improved data accessibility and accuracy, BIM offers numerous benefits to estate surveyors and valuers. Eastman *et al.,* (2011) asserted that BIM offers several benefits in property development, one of which is improve data accessibility and accuracy. This improvement is observed in various aspects of the development process, from design and planning to maintenance and operations. The authors further show that BIM enhances data accessibility and accuracy through the centralized data repository. In his explanation, BIM serves as a centralized repository for all project-related information by integrating various data sources into a single model. This centralization ensures that all stakeholders has easy access to the most up-to-date and accurate project information. Gu and London (2010) further stated that BIM fostered real-time collaboration among project participants. Architects, engineers, contractors, and other stakeholders are able to work concurrently on the same model, reducing errors and discrepancies that often occurred when using traditional paper-based methods. Also, Fischer and Kunz (2004) reiterated that BIM enforces standardized data formats and protocols by ensuring data accuracy and consistency across the entire project lifecycle. This consistency helps to prevent errors that arise from using disparate data sources and incompatible formats. Azhar, Nadeem, Mok and Leung (2013) stated that for data accessibility for facility management, beyond the construction phase, BIM provides enhanced accessibility to building data for facility managers. The authors show that it allows them to access detailed information about the building's components, maintenance schedules, and historical data, and aided efficient in facility management. Lastly, El-Mekawy, Kandil and Hosny (2015) stated that in the area of improved decision-making, BIM's data accessibility facilitated better decision-making throughout a project's lifecycle. Architects and engineers are able to analyze different design options, contractors optimized construction sequences, and owners make inform choices about maintenance and renovations based on accurate data.

Another significant benefit of BIM is its ability to enhance collaboration among various stakeholders involve in the design, construction, and maintenance of a building by estate surveyors and valuers. In a study conducted by Azhar, Nadeem, Mok and Leung (2008), BIM provides a centralized platform where all project-related information, including 3D models, specifications, schedules, and cost data are stored and accessed by relevant parties. This integrated data sharing ensures that all stakeholders, such as architects, engineers, contractors, and facility managers, are working with the most up-to-date information. Hence, this streamlines communication and minimized errors caused by information discrepancies. Further, Eastman *et al*. (2011) showed that BIM allows for real-time updates and revisions to the project's digital model. This means that any changes made by one stakeholder will immediately reflects in the shared model, enabling all team members to stay informed about the project's status. This feature significantly reduces the time and effort requires for coordination. More so, Azhar, Khalfan and Maqsood (2015) opined that BIM automatically detects clashes and conflicts within the building model, such as clashes between structural elements and mechanical systems. This feature helps in identifying issues early in the design phase, facilitating interdisciplinary collaboration to resolve conflicts before they became costly problems during construction. Kassem, Succar, Dawood and Kassem (2017) further showed that BIM supports visual communication through 3D models than traditional 2D drawings. This visual representation fostered clearer communication among stakeholders with different backgrounds and expertise, reducing misunderstandings and enhances collaboration. Dossick and Neff (2010) acknowledge that BIM enables remote collaboration. Hence, remote collaboration tools integrated into BIM platforms through enhanced communication and coordination. Lastly as discuss by Miettinen and Paavola (2014) showed that BIM generates a wealth of data related to the project's performance, costs, and sustainability. This data-driven approach encourages evidence-based decision-making, enabling stakeholders to make informed choices and collaborate on optimizing project outcomes.

On the part of efficient facility management, BIM enables estate surveyors and valuers to visualize and understand a property's systems and components in details. On this premise, Becerik-Gerber *et al.* (2011) showed that BIM assists in identifying maintenance issues early, resulting in cost savings and reduces downtime. Hence, efficient facility management is achieved through accurate and comprehensive data, enhances space management, energy analysis cost reduction and data accessibility. Eastman *et al.* (2011) posited that through accurate and comprehensive data, BIM enabled the creation of a digital representation of a facility, including detailed

information about its components and systems. This rich data repository serves as a single source of truth for all facility information. Azhar *et al.,* (2013) showed that facility managers access up-to-date information on the condition and performance of building elements, allowing for predictive maintenance and reducing downtime. Succar and Kassem (2015) also showed that BIM assists in efficient space allocation and utilization, helping facility managers optimize space for different functions and adapt to changing needs. Attia and DeHerde (2013) asserted that by energy efficiency, BIM facilitates energy analysis and modeling, allowing facility managers to identify areas for energy savings and implement energy-efficient strategies. Fischer and Kunz (2004) opined that BIM fosters better collaboration and communication among stakeholders, reducing errors and delays in facility management activities. Motamedi and Alizadeh (2016) opined that by optimizing maintenance schedules, energy consumption and space utilization, BIM led to significant cost savings over the lifecycle of a facility. Lastly, Gu and London (2010) postulated that facility managers access BIM data on various devices, making it easier to monitor and manage facilities remotely.

Also, on predictive maintenance, many researchers show that BIM integrates sensor data and historical maintenance records are used to predict when equipment fails. Ma, Liu, and Wei (2016) emphasized the use of BIM for predictive maintenance to minimize unexpected breakdowns and optimize asset performance. The author further show that predictive maintenance is an essential aspect of facility and asset management that aims to predict when equipment is likely to fail so that maintenance is performed just in time to prevent those failures. Yu, Kim and Kim (2019) opined that BIM provides a comprehensive digital representation of a building's physical and functional characteristics. This data is integrated with real-time sensor data and historical maintenance records to create a holistic view of the building's health. These simulations predict how changes or failures in specific building components affected the overall performance and maintenance needs. This led to cost savings and efficient use of maintenance personnel.

On the part of cost savings and sustainability, BIM is a digital representation of the physical and functional characteristics of a building or infrastructure. Oo and Aouad (2009) stated that BIM allows for better resource allocation by optimizing maintenance schedules and resource utilization. Eastman *et al*. (2011) opined that BIM allowed for 3D modeling, clash detection, and virtual construction, which helped identify clashes and conflicts early in the design phase. This reduces the need for costly rework and design changes during construction, saving both time and money. Azhar *et al.* (2011) showed that BIM facilitates better project planning and scheduling through 4D and 5D simulations. These tools helped optimize construction sequences and resource allocation, reducing downtime and labor costs. Also, Yan and Damin (2015) observed that BIM promotes collaboration among project stakeholders, leading to better communication and coordination. This reduces delays, misunderstandings, and disputes that inflated project costs. Lastly, Kassem *et al.* (2016) opined that BIM allowed for accurate quantity takeoffs and materials tracking. This enables efficient procurement and reduces waste, leading to cost savings. This contributes to reduce energy consumption and greenhouse gas emissions. This aligns with sustainable construction practices.

Regulatory compliance is another factor discussed by many researchers. For example, Akcamete, Akinci, and Garrett (2015) highlighted BIM's role in managing regulatory compliance and minimizing legal risks in property maintenance by ensuring that properties remain compliant with changing regulations and codes over time. This level of detail helps project teams identify and rectify design and construction errors early in the process. Eastman *et al.* (2011) opined that BIM models are integrated with regulatory databases and compliance standards. This integration enables real-time monitoring of compliance with relevant regulations throughout the design and construction phases. Succar and Kassem (2015) opined that BIM facilitates the generation of detailed and accurate documentation. This helps streamline the approval process and ensures that all necessary information is readily available for regulatory agencies. Further, Giel and Issa (2017) opined that BIM assists in compliance with environmental and sustainability regulations by providing tools for energy analysis, materials tracking, and lifecycle assessments. This helps project teams make informed decisions that align with green building standards and regulatory requirements. This ensures that buildings remain in compliance throughout their operational lifespan.

For historical documentation, many researchers show that BIM serves as a valuable historical record of a property's design, construction and maintenance history (Kymmell, 2008). For example, Eastman *et al.* (2011) stated that BIM enables the creation of a comprehensive digital archive of a building's design, construction, and operational data. This historical documentation allowed stakeholders to make informed decisions based on the past performance and modifications of a facility. Equally, Azhar *et al.* (2013) opined that BIM records changes and revisions made during the building's lifecycle. This documentation aids in tracking alterations, maintenance, and renovations, reducing errors and conflicts in project management. Also, Succar (2009) opined that BIM's historical

documentation capabilities assists facility managers in understanding the building's evolution over time. This information streamlines maintenance and helps predict when equipment and systems need replacement. Bryde, Broquetas, and Volm (2013) showed that BIM provides a record of compliance with building codes, regulations, and permits throughout a building's history. This documentation is valuable in the event of legal disputes or audits. Wang and Chong (2015) further opined that BIM's historical documentation serves as an educational tool for construction and design professionals. It is also used for training, knowledge transfer, and lessons learned from previous projects.

Data and Methodology

Research design is described as the planning of scientific inquiry or designing a strategy for finding out something (Dixon, 1994). In this study, cross-sectional research design type was applied. Cross-sectional study design is a type of observational study design, the investigator measures the outcome and the exposures in the study participants at the same time.

The population for this study comprised head of practicing estate surveyors and valuers firms in Uyo, Akwa Ibom State or their representative. According to Nigeria Institution of Estate Surveyors and Valuers (NIESV), Akwa Ibom Branch (2022), there were eighty (80) practicing estate surveyors and valuers firm in Uyo, Akwa Ibom State. Using sample size determination by Krejcie and Morgan (1970) who provided a formula for determining sample size for a given finite population as follows;

$S = X^2NP (1-P) – d^2(N-1) + X^2P (1-P)$……Equation 4.1

where S = required sample size, X^2 = the table value of chi-square for 1 degree of freedom at the desired confidence level (3.44), N = the population size, P = the population proportion (assumed to be 5.48) since this would provide the maximum sample size) and d = the degree of accuracy expressed as a proportion (0.05).

Applying this formula, the result was 66 respondents. So the questionnaires were administered on 66 head of practice or their representatives. Random sampling was adopted, in which Maxwell (2005), defined it as a type of sampling where a respondent is chosen from among the list at random.

Result and Discussion

Questionnaire Administrated

Table 1: Questionnaire Administered

Number of Questionnaire Administered	Number Returned	Percentage of Return	Number of Not Returned	Percentage Not Returned
66	63	95.45	3	4.55

Source: Researcher's Computation (2023)

Analysis from Table 1 showed that out of 66 questionnaire administered, 63 (95.45%) questionnaire was returned, while 3 (4.55%) questionnaires were not returned. The 63 questionnaires were used for the study.

Professional Status

The study sought to find out the professional status of the respondents by asking question The responses were tabulated on Table 2.

Table 2: Professional Status

Items	Number of Responses	Percentage (%)
Associate	55	87.3
Fellows	8	12.7
Total	**63**	**100.00**

Source: Researcher's Fieldwork (2023)

Analysis from Table 2 shows that there were 55(87.3%) respondents were Associates, while 8(12.7%) respondents were Fellows in the profession. So, the study comprised more of Associates than Fellows.

BIM Improve Communication and Collaboration between Property Managers and other Stakeholders

The study sought to find out if BIM could improve communication between property managers and other stakeholders by asking the question – would BIM improve communication between property managers and other stakeholders leading to faster issue resolution and reduced costs? The responses were tabulated on Table 3.

Table 3 BIM Improve Communication and Collaboration between Property Managers and other Stakeholders

Items	Number of Responses	Percentage (%)
Not at all	4	6.35
A Little	12	19.05
Averagely	11	17.46
Considerably	17	26.98
To a very large extent	19	30.16
Total	**63**	**100.0**

Source: Researcher's Fieldwork (2023)

Analysis from Table 3 shows that 19 (30.16%) respondents shows that to a very large extent, BIM could property managers and other stakeholders, 17 (26.98%) respondents considerably agreed 12 (19.05%) respondents opted for a little, 11 (17.46%) respondents were on an average opinion agreed while 4 (6.35%) respondents opted for not at all. The analysis showed that BIM could improve communication and collaboration between property managers and other stakeholders leading to faster issue resolution and reduced costs as seen in the analysis.

BIM data can be used to Generate Reports and Insights that Inform Better Decision-Making about Property Maintenance

The study sought to find out if BIM data can be used to generate reports and insights that inform better decision-making about property maintenance by asking the question – can BIM data be used to generate reports and insight for better decision-making on property maintenance? The responses were tabulated on Table 4.

Table 4: BIM data can be used to Generate Reports and Insights that Inform Better Decision-Making about Property Maintenance

Items	Number of Responses	Percentage (%)
Not at all	2	3.17
A Little	4	6.35
Averagely	15	23.81
Considerably	18	28.57
To a very large extent	24	38.10
Total	**63**	**100.0**

Source: Researcher's Fieldwork (2023)

Analysis from Table 4 shows that 24 (38.10%) respondents show that to a very large extent, BIM data can be used to generate reports and insights that inform better decision-making about property maintenance, 18 (28.57%) respondents considerably agreed, 15 (23.81%) respondents were on average, 4 (6.35%) respondents opted for a little while 2 (3.17%) respondents opted for not at all. The analysis showed that to a very large extent, BIM data can be used to generate reports and insights that inform better decision-making about property maintenance.

Benefits of BIM in Property Maintenance Activities

The study sought to find out from the respondents the benefits of BIM in property maintenance. The responses were tabulated in Table 5.

Table 5: Benefits of BIM in Property Maintenance Activities

Variables	N	1	2	3	4	5	Sum	Mean	Rank
Efficient facility management	63	4	5	9	14	31	252	4.00	1st
Predictive maintenance	63	3	8	12	13	27	242	3.84	2nd
Cost saving and sustainability	63	4	6	15	17	21	234	3.71	3rd
Providing accurate and up-to-date information about buildings and their assets	63	3	9	13	20	18	230	3.65	4th
Enhanced collaboration	63	4	6	18	21	14	224	3.56	5th

Historical documentation	63	4	9	16	19	15	221	3.51	6th
Improve communication	63	4	8	17	21	13	220	3.49	7th
Regulatory compliance	63	6	9	14	18	16	218	3.46	8th
Simulating different maintenance scenarios	63	8	12	15	19	9	198	3.14	9th
Identifying potential problem early on	63	9	13	16	18	7	190	3.02	10th
Providing a central repository of information	63	12	14	16	15	6	178	2.83	11th
Facilitating visualization	63	11	15	17	15	5	177	2.81	12th
Providing a single source of truth for all information about building and its assets	63	12	14	19	12	6	175	2.78	13th

Source: Researcher's Fieldwork (2023)

Analysis from Table 5 shows that efficient facility management has the highest mean of 4.00 and is ranked 1st, predictive maintenance with the mean of 3.84 is ranked 2nd, cost saving and sustainability with the mean of 3.71 is ranked 3rd, Providing accurate and up-to-date information about buildings and their assets with the mean of 3.65 is ranked 4th, Enhanced collaboration is ranked 5th with the mean of 3.56, Historical documentation with the mean of 3.51 is ranked 6th, Improve communication is ranked 7th with the mean of 3.49, Regulatory compliance with the mean of 3.46 is ranked 8th while Simulating different maintenance scenarios is ranked 9th having a mean of 3.14, Identifying potential problem early on with the mean of 3.02 is ranked 10th, Providing a central repository of information is ranked 11th with the mean of 2.83, while Facilitating visualization is ranked 12th with the mean of 2.81 and Providing a single source of truth for all information about building and its assets with the mean of 2.78 is ranked 13th. Hence, from the above analysis from the respondents, the benefit of BIM in property maintenance in efficient facility management. Analysis from Table 5 showed that the efficient facility management is the upmost benefit of BIM as confirmed by Becerik-Gerber *et al.,* (2011). Efficient facility management was achieved through accurate and comprehensive data, enhanced space management, energy analysis cost reduction and data accessibility. Thus, Eastman *et al.,* (2011) posited that through accurate and comprehensive data, BIM enabled the creation of a digital representation of a facility, including detailed information about its components and systems. This rich data repository served as a single source of truth for all facility information. According to Azhar *et al.,* (2013), facility managers accessed up-to-date information on the condition and performance of building elements, allowing for predictive maintenance and reducing downtime. Furthermore, Succar and Kassem (2015) showed that BIM assisted in efficient space allocation and utilization, helping facility managers optimize space for different functions and adapt to changing needs.

Conclusion

It was concluded that efficient facility management, predictive maintenance, cost saving and sustainability, regulatory compliance, enhanced collaboration, historical documentation, providing accurate and up-to-date information, identifying potential problems early on, improving communication, providing a central repository of information, facilitating visualization and simulation and providing single source of truth for all information about building and its assets and simulating different maintenance scenarios and assessing the cost and impact of each scenario are all benefits of applying BIM in property maintenance by estate surveyors and valuers in the study area. It is recommended that estate surveyors and valuers should learn to apply the contemporary model through seminars and workshops as it will equip them to harness the benefits accrued from applying BIM in undertaking property maintenance activities.

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