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Application of Building Information Modeling in Facility Management: A Case Study of a Commercial Project

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Abstract

Adoption of Building Information Modeling (BIM) in Facility Management (FM) is effective for integrating Architecture, Engineering, and Construction (AEC) for providing better services to the end-users of a project for a whole lifecycle. Real estate sector in India has witnessed high growth in recent times with the rise in demand for commercial as well as residential spaces. Most of them are facing issues related to AEC and are not been able to manage such on-site problems resulting in delaying of projects. It is better to develop proper coordination to provide integrated information about AEC in advance to reduce conflicts occurring during the construction and operational phase. The operational phase of a building is the main contributor to the building lifecycle cost and estimates show that the lifecycle cost is five to seven times higher than the initial investment costs and three times the construction cost. There is a lack of real-life case studies on BIM in FM especially for existing assets even though new constructions representing only 1-2 percent of the total building stock in a typical year. So a case study of a commercial project is taken for Facility Management using BIM as a tool and analyzed for probable solutions for mitigating AEC conflicts. The findings from the study demonstrate that BIM value in FM stems from improvement to current manual processes of information handover; improvement to the accuracy of FM data, to the accessibility of FM data and in work order execution ultimately improving the sustainability of building construction projects.

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1. Introduction

Building Information Modeling (BIM) is an intelligent 3D model-based process that gives architecture, engineering and construction (AEC) professionals the insight and tools to more efficiently plan, design, construct and manage buildings and infrastructure. BIM is a process of creating and managing 3D building data during its development and works as three-dimensional, real-time, dynamic building modeling computer program in which you can increase productivity throughout building design and construction. [1] Facilities management (FM) is an umbrella term under which a wide range of property and user-related functions are brought together for the benefit of the organization and

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its employees as a whole [2] also it is holistic in nature, covering everything from real estate and financial management to maintenance and cleaning. [3]

Building lifecycle cost depends mainly upon the operational phase of the building. Estimates show that the lifecycle cost is five to seven times higher than the initial investment costs and three times the construction cost. [2, 4] BIM as a tool enables efficient management of facilities which leads towards improved lifecycle cost of a project. Due to the inefficiencies in the building construction industry, several governments around the world mandate the use of BIM for improving productivity. For example, the UK Government has mandated BIM level 2 – federated models held in separate discipline “BIM” tools with attached data – on all centrally procured projects from 2016, including the handover of digital data required for the operational phase. [2]

In this paper, the applications of BIM in FM for building construction industry are explored for implementing in planning, designing, construction, and operational processes. In investigating BIM applications in FM have mainly focused on new buildings, even though new works making up only 1-2 percent of the total building stock in a typical year [5] and yet not been raised in today’s construction industry. There is also a lack of real-world cases on BIM applications in FM. [6] So, the applicability of BIM in FM for is being identified through a real-world case study of a commercial project named Eden Ceramic City situated at Morbi, Gujarat, India.

2. Literature Review

2.1. The scenario of Building Information Modeling for Facility Management in developing countries

Building Information Modelling (BIM) is widely seen as a catalyst for innovation and productivity in the construction industry. Over the last few years, there has been an ascending push for Building Information Modeling across the built environment sector because BIM is changing the construction and infrastructure industries. The information collected through a BIM process and stored in a BIM-compliant database could be beneficial for a variety of FM practices, such as commissioning and closeout, quality control and assurance, energy management, maintenance and repair, and space management. [6] However, the potential of BIM technology to facilitate design-construction collaboration and to reduce the construction coordination costs, schedule and request for information (RFI)s has not yet been achieved. [7]

Building information modeling (BIM) in facilities management (FM) applications is an emerging area of research based on the theoretical proposition that BIM information, generated and captured during the lifecycle of a facility, can improve its management. BIM value in FM stems from improvement to current manual processes of information handover; improvement to the accuracy of FM data, improvement to the accessibility of FM data and efficiency increase in work order execution. [2]

In developing countries majorly, the building construction industry is dealing with a low-income group (LIG) and a medium income group (MIG) where BIM can assist a more sustainable construction process that in turn may contribute to exterminating poverty in developing countries. [8] Research has established how construction firms struggle from several limitations having to do with the socio-economic and technological environment found in developing countries. Examples of issues preventing BIM adoption include a shortage of IT-literate personnel as well as an absence of national BIM implementation programs. Findings include that construction firms of developing countries rely on outsourcing of IT services or developing tweaks or workarounds, like using fake IT licenses, for saving cost and enabling BIM. [9]

2.2. Applicability of Building Information Modeling in Facility Management

The FM industry is quite rigid in its approach to new technology, and unless benefits of BIM in FM is clearly proven, its acceptance in the FM industry will continue to be low. [6] Indeed, there is a lack of demand from clients for BIM [10], which is exacerbated by a general lack of collaboration between project stakeholders for modeling and model utilization. [6] The lack of awareness by clients is exacerbated by a shortage of BIM skills and understanding by FM professionals [4] and therefore, these two factors together are creating a challenge for BIM adoption in FM applications. The lack of processes for updating the designed model with as-built information is considered among the

top challenges for BIM in FM applications [11] where roles and responsibilities for providing the data and maintaining the model are not well defined. [6]

Facility managers have traditionally been included in the building lifecycle in a very limited way and at the late phase of facility handover to clients. [12] Additionally, design decisions are not usually challenged for their impact on operational cost or maintenance. [13] Current facility maintenance contractors are paid to survey the existing building to capture as-built conditions and the owner will have to pay over and over – once for the construction contractor to complete the documents at the end of construction – and again for the maintenance contractor survey and the start of every contract. [14] As a result of these challenges, BIM data for FM is either lacking or inadequate. “The FM field relies heavily on getting usable data from a BIM to do anything meaningful with it. All too often, this data is not really there or is inaccurate, as the model has not been updated with any design changes made after the design phase and is therefore not an accurate model of the facility as it is built”. [15] Because of the duplication of information there is a need for improvement in handover data and maintenance of that data throughout its lifecycle.

Current information transformation system is manual which is based on the paper documents containing lists of equipment, product data, warranties, spare parts, maintenance schedules, etc. and essential to support the management of the facilities by the owner and facilities managers. In this system information handed over is often incomplete and inaccurate. [16] The industry is spending lots of resources in terms of money and manpower in recreating such information and working with inefficient workflows. [17]

However, using BIM in FM can improve the current information handover processes [18] because BIM data and information collected during the building lifecycle will reduce the cost and time required to collect and build FM systems. [19] For example, data regarding spaces, systems, finishes, etc., can be captured in digital format within a BIM and do not require to be re-created in downstream FM systems. [20] The ability to capture manufacturers information within 3D parametric objects reduces the need for duplicating asset information. [21] BIM is considered as an enabler of improved data quality and reliability which will, in turn, result in increased workforce efficiencies. [19]

The ability to extract and analyzing views from BIM, specific to various needs and users, will provide information to make decisions and improve the delivery of facilities. [12] For example, 3D visualization can help FM technicians to better utilize their cognitive and perceptual reasoning for problem-solving. [22] BIM visualization provides accurate geometrical data that has never been possible before and can support the analysis of building proposals and the simulation and benchmark of performance. [3] For example, intelligent algorithms could be created to automate decision making for FM applications that have never been possible before the addition of digital data. [23]

Another important BIM in FM applications outlined literature is in space management, emergency management, energy control, and monitoring and personnel training and development ([24] [25] [19] [26] [22]). There are also suggestions that adopting BIM in FM will facilitate the future involvement of facility managers at a much earlier design stage, in order to convey their input and influence on the design and construction of a building. [12] The adoption of BIM in FM is also expected to provide ways for managing knowledge about building operation which can be utilized in future designs. [4]

3. Methodology

This paper aims to identify the application of BIM in FM for a commercial project. A likely application of BIM in FM has been explored in the literature review. However, there is also a need to test this value and also explore further how BIM can add value in FM of existing assets. A case study was conducted to investigate the value of BIM in managing utilities, spaces selected as a specific FM function. Also through a questionnaire and interviews with AEC professionals derived applications is being verified. The flow of methodology is shown in Fig. 1.

Fig. 1. Flow of Methodology

4. Case Study

The case study was conducted on a commercial project named Eden Ceramic City situated in Morbi, Gujarat, India. This project is made up of 48 Corporate Display Centres (CDCs) and 12 Corporate Houses (CHs) with a built-up area of about 50,000 m² (Fig. 2). For creating a BIM model, existing floor plans in DWG format, scans of the original elevations, sections in JPEG format, and utility information in Excel databases are used. As the case study involves an existing asset, there are key challenges that the application of BIM for FM purposes has to consider. Discussing with AEC involved in this project the strategic issues and the business case for migrating from the current FM processes to BIM-based FM processes in managing the existing utilities of a project is identified. The developer was interested in updating drawings and details for this project to prepare an effective operation and maintenance strategy for a lifecycle of a building. In the traditional technique, this process requires a manual update which leads towards duplication of work and the efficiency of work is not been achieved yet.

Fig. 2. From traditional drawings to integrated BIM of Eden Ceramic City

5. Results and Outcomes

The outcomes from the case study demonstrated with practical examples of how BIM can add benefits in planning, designing, operation and maintenance and management of information. Discussion with AEC professionals conducted during the case study revealed a further challenge which is inherent in the significant differences of lifespans in BIM

technologies, FM technologies, and buildings. FM organizations have to take care of working with different information and data standards in the mid and long terms instead of adapting their business processes to fit a specific technology. The applications explored are currently theoretical and will be used by the AEC in order to implement an integrated BIM strategy in the following ways:

5.1. Effectiveness in working with Building Information Modeling

The efficiency of processes associated with managing spaces, and utilities such as updating geometric and non-geometric information, came immediately while the functionalities of BIM for FM were explored in the project. Using BIM in FM, the creation of geometric information and the inclusion of specific FM information allows automatic updating of required schedules; producing instant sections, elevations, three-dimensional visuals and renders, and generating drawing sheets from a single integrated model shown in Fig. 3. Additional information relating to essential maintenance, emergency equipment, escape routes, accessibility, etc. can be easily traced, updated and reported in schedules. Moreover, the AEC identified that BIM in FM can enlarge the available BIM functionalities which enhance FM services such as root finding, fault reporting, development, and refurbishment option generation, and assessment of building performance ultimately leads towards a reduction in response times, with detailed knowledge assigned to specific buildings, levels, rooms, etc. The developed BIM for FM was used to trial option appraisal for redevelopment and refurbishment as floor plans, sections, elevations, and 3D rendered views that could be quickly displayed and assessed in Fig. 3. Such functionalities provide time and costs efficiency as a future FM alternative and represent a platform for more accurate strategic decision making from a management perspective.

Fig. 3. Working with BIM as the integration of sectional details, floor plans, elevations and schedules

5.2. Identification of mismatched geometry in traditional 2D drawings

The creation of a BIM has revealed that some areas of the building failed to line up when the two-dimensional drawings. AEC agreed that through BIM the maintenance of geometric records will be accomplished in a more efficient way from both economic and quality perspective. In Fig. 4. Geometric mismatch in 2D CAD drawing is identified and indicated with a blue circle.

Fig. 4. Mismatch in geometry identified after implementing BIM (Indicated with blue circles)

5.3. Implementation challenges derived from questionnaire and interview

Once the aspects of a case study had demonstrated the application of BIM in FM discussed with the AEC and understanding of the challenges associated with migrating from current FM processes to BIM-based processes. Several implementation challenges were identified as follows:

- The FM staff must also have the skills to be in the position of understanding, maintaining and controlling the BIM. A concise BIM for FM specification must be developed to define the information required to suit the particular requirements of the business and FM functions.
- It was also acknowledged that there are still industry-wide challenges related to technologies and processes. FM professionals wishing to implement BIM for FM in the immediate future should be willing to adapt to such challenges.
- One of the major concerns was the limited compatibility between BIM technologies and FM technologies which can be exacerbated by the huge difference amongst the lifecycle of updates of BIM technologies, FM technologies, and buildings. This means that data standards and interoperability will remain critical for the adoption of BIM for FM technologies in the mid and long term.
- It was also identified that due to the evolving nature of the BIM for FM field, and the differences in the lifespans of technologies, FM organizations must not fit their FM business processes to suit a particular technology which would otherwise result in a continuous effort of adaptation.

FM organizations can presently attain the benefits of BIM for FM through the development of a personalized BIM specification and templates that suit their particular business requirements. It has been found on live projects the geometry data on FM models are of a lower level of development, it is necessary to update and link particular data to the model time by time. Several consultancy works conducted on BIM for FM projects, especially for existing assets, suggests that the FM data are stored in several disparate databases and is likely to be and methodologies that link BIM to these databases are needed. Therefore, FM organizations wishing to implement BIM for FM in the immediate term should take a long-term view and be willing to work with different standards and information formats.

6. Conclusion

BIM applications have been comprehensively discussed throughout the planning, designing, construction, and operation and maintenance phases. BIM in FM application is still considered as an emerging area of upgradation for AEC associated with building construction industry. The challenges and value-adding potential of BIM in FM has to be understood in an early stage of any project for successful implementation. To explore these areas, a literature review and a real-life case study were used in this research. The adoption of BIM in building construction industry will lead to greater productivities through increased collaboration between AEC which helps FM professionals in planning and providing better services throughout the life cycle of the project. The application of BIM in many aspects of Building operations and maintenance can result in more sustainable, efficient and well-managed buildings. It is also found that the amount of data required varies from stage to stage over the lifecycle of the building. The importance of graphical information decreases once the design is complete, while attribute data become more important during the construction and operation phases. So having more accurate data from the early project phases bring in long-term benefits in the operational phase, expanding into shorter response time, improved effectiveness and productivity.

It is also found that BIM for planning and designing is better understood while the value for BIM in construction, and operation and maintenance phase has yet to be demonstrated for a building construction industry. A BIM in FM should meet the requirements of a building owner, meaning that clients need to understand and articulate their BIM requirements including the level of detail needed. A further improvement in this area is to develop specifications for the successful implementation of BIM in FM for a building construction industry as there is a need for a higher level of development during the execution phase. Proper guidelines for LOD will also help in operating and managing facilities for a whole lifecycle of a building thus FM organization is in need of a more automated data management tool and is potentially suitable for BIM implementation.

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