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BIM AS FACILITIES MANAGEMENT TOOL: A BRIEF REVIEW

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Abstract: Facilities management supports operation and maintenance of a building and its services. Facilities management is multi-faceted complex task often challenged by lack of updated information. The implementation of BIM has improvised facilities management tasks by providing relevant information throughout the building lifespan. BIM creates a platform for information exchange between stakeholders of architectural, engineering and construction industries. Otherwise, the conventional information exchange among the systems of the stakeholders lead to incompatibility between software, ends up in deficient information. This paper presents a comprehensive literature review of the abilities of BIM as facilities management tools, which would be helpful for predicting an accurate performance of the building.

Keywords: BIM; Building Performance; Facilities Management; Operation & Maintenance

1. Introduction

A building consumes maximum energy and cost in its operation and maintenance (O&M) phase. Around 60-85% of total life cycle cost is spent in the O&M phase leaving the rest for design and construction phase [1]. Hence, the resources used in the buildings during O&M phase should be optimized. The optimization of the resources can be achieved by efficient performance of the buildings with efficient Facilities management (FM). FM is an approach to reduce the operational cost as well as prolong the lifespan of the building. The success of FM is based on accurate and reliable dataset of buildings and its attributes [2]. BIM equips a facilities manager with precise information about the buildings for supporting FM process efficiently in fulfilling the organizational goals [3].

2. BIM for Facilities Management

Worldwide, recent rise of FM in architectural, engineering and construction (AEC) industries is attributed to increase in construction demand, advancement in technologies, changes in users' requirements and efficient use of spaces to increase productivity [4]. This efficiency can be observed in the longest period of the life cycle i.e. during O&M, which have seen the paradigm shift from mere breakdown maintenance to FM. The reduction in the operation cost was the main goal. Gradually it was implemented in real estate, project management, and lease management as well as in sustainable measures [5]. Thus, the effective management of a built facility ultimately determines the all-round performance of a building [6]. The developing countries adopt FM in this decade for development of infrastructure and optimizing the resource usages. The successful implementation of FM tools can ensure the success of projects. So, the appropriate tool should be chosen [3].

BIM finds application in FM through generation of accurate building-related data; and other features such as energy analysis, time schedule for project, etc. because the integrated efforts of all stakeholders can bring more success and efficiency for projects if the environmental aspects are considered from the pre-construction phase.

3. Information for BIM model

Information plays very vital role in case of building maintenance. Many of the maintenance jobs become frustrating 'hit or miss' due to lack of as-built drawings and missing maintenance history. BIM gives opportunity to integrate information throughout the building life cycle right from the design stage. This information helps in achieving different BIM dimensions as described in Table 1.

Table 1: Different dimensions of BIM

BIM	Definition	Source
3D	A 3D model, which includes material information and can be simulated in the virtual environment resembling actual environment conditions.	[7]–[11]
4D	A 3-D BIM that has objects and assemblies that have schedule and time constraint data added to them. The information can be contained in the BIM or can be linked or otherwise associated (integrated and/or interoperable) with project design and construction activity scheduling and time sensitivity estimating and analysis systems.	[7], [9]–[12]
5D	A 4-D BIM that has objects and assemblies that have a cost dimension added to them. The cost information can be contained in the BIM or can be linked or otherwise associated to the building objects.	[7], [9]–[12]
6D	Deals with everything concerning sustainability of a building, such as energy analysis	[7], [10], [13]
7D	Project components in all aspects of the building's life. Usually issued at the end of construction, as-built model 7D contains all necessary information to the owner for the use and maintenance of the building.	[10], [13]
XD/nD	The X is here every conceivable additional data that may still be additional to other dimensions.	[9], [13]

The different dimensions of BIM are dependent on the level of the details (LOD) integrated in the model in the various stages of the building life cycle. Table 2 shows the various LOD of the BIM model with respect to the various stages, which results to elevates 'Building Information Modelling' to 'Building Knowledge Modelling'. A case based reasoning (CBR) module can also be developed for ensuring the better system maintenance as facilities managers can prioritize maintenance based on the building maintenance history. However, these information/knowledge requires continuous update and can be achieved by 'data capturing technologies such as RFID' [14]. The use of textual information increases with decrease in graphical information as the building evolves from design phase. For example, warranty certificates, O&M manuals, test and balance records etc. vs. plans, sections, views etc. [15]' The information accumulated throughout the lifespan of the building is collated in [3].

The different stakeholders are gradually adopting BIM for accomplishing their own purposes [16]. To make this process easy, it is recommended to define BIM guidelines related to new construction and renovation projects for AEC teams and to promote the awareness of BIM implementation in context of building information.

Table 2: Classification of LOD

LOD	Model type	Description	Design stage	Building design elements	Source
LOD 100	Conceptual information model	Basic information regarding the building, site, the shape of the building. Helps to choose the best alternate solution based on basic analysis	Conceptual design	Site plan	[18]–[20]
LOD 200	System/component-oriented modeling	Detail layout of building and spaces with structural details, schedules, and specifications	Basic design	Building plan	
LOD 300		Verifies the details and helps to rectify any clash if detected. More detailed physical environment and energy analysis are done	Detailed design	Interior & exterior decoration plan	
LOD 400	Element-oriented modeling	With more intrinsic details about the systems.	Fabrication and assembly	System plan	
LOD 500			As-built	Operation & maintenance	

BIM aims to decrease the economic, social, and environmental costs throughout a building lifecycle by efficient and transparent information interchange among key stakeholders. The main issue is to know, how to use the parametric and logical data stored in a BIM model for such successful collaboration [15], [17].

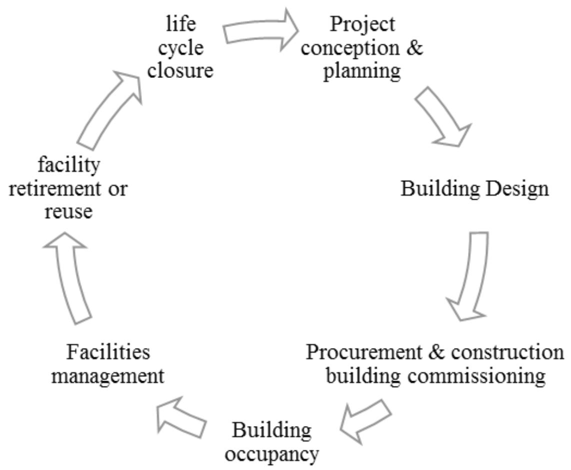

Figure 1: Life cycle of information [3]

Cost cutting relies on continuous up-grading of information, its sharing and maintenance of a comprehensive databases. The changes in information can be exported or imported by one system to another via a standard file format and also can be synchronized by bi-directional data transfer to cater to the varying needs of different stakeholders. For example, real estate personnel needs to know the rentable area of the building while facility manager is interested in the usage type of the room, its occupancy and furniture, equipment etc. [15], [17], [21].

The common data formats are construction operations building information exchange (COBie) derived from industry foundation classes (IFC) and extensible mark-up language (XML). Cobie is a representation of the building attributes such as equipment lists, warranty information etc. in a spreadsheet format [22]. The information is exchanged by import or export form or by synchronization i.e. changes in one system will automatically make changes in another systems. This helps to generate an actual picture during handover of the building to owner. Any alternation after this should be recorded for efficient FM services [15], [17]. As per facilities managers, it can save 8.7% of time in operation and maintenance phase [23].

Yet to retain the competitiveness of BIM softwares, the companies use different file formats for developing their products and as a result BIM softwares are not compatible with one another. Therefore, a third-party software such as COBie is used to transfer files/information related to buildings from one format to another, which ends up either in inaccurate and incomplete information or redundant repetitions. So, a standard file format is mandatory for accurate information [9].

The information required by the facility managers from the different stakeholders varies so the filtration of unnecessary dataset is required to be done for FM purposes. Besides the effort required to develop the BIM model is quite high and the necessity of the data modification for FM purposes is considerable. The exported IFC or XML file from BIM model has erroneous and incomplete dataset that leads to re-inserting the requisite information in the COBie dataset [22]. Therefore, using BIM model for FM purposes saves the considerable time and efforts to segregating and cross feeding the information in the FM tools for efficient FM services.

4. BIM as FM Tools

Facilities managers consider BIM as a facilitator for achieving their service goals. The integration of FM tools (e.g. Computer-Aided Facility Management or CAFM) with BIM would accelerate the FM purpose as BIM deals with energy management and sustainability issues along with building management systems [24]. Nevertheless, the major concern of BIM is the implementation cost and training.

Soft Tasks

- Office Space Management
- Cleaning, waste disposal and recycling
- Reception service
- Security
- IT/Switchboard operation
- Value analysis for goods or services
- Change management to minimize disruption of core business
- Poeple managment
- Performance management to meet service levels agrrement
- Emergency responce
- Managing essential central services

Hard Tasks

- Maintenance of normal and emergency power systems
- Maintenance of building automation system (BAS), security and locks
- Maintenance of active and passive fire protection system Maintenance of mechanical elements
- Maintenance of door and windows
- Monitoring of FM work

Figure 2: BIM application in FM Tasks [16]

Brinda & Prasanna [15] describes the ability of BIM to serve as FM tools through: (a) programming; (b) record modelling; (c) preventative maintenance scheduling; (d) building systems analysis; (e) asset management; (f) space management and tracking; (g) disaster planning and response.

Similarly Arayici et al. [16] has summarized the capability of BIM as FM tool in comparison to the conventional tools (e.g. CAFM) using a case study in terms of:

- Space planning – BIM was proved to be more efficient. The difference lies in the need of BIM model for constantly upgraded dataset libraries. The benefits of BIM depend on the quality of model maintenance. Virtual reality can work in synergy with BIM database to produce a single all-in-one tool. This can benefit FM with regards to visual space planning and data storage for O&M.
- Addressing both hard and soft tasks: BIM addresses both hard and soft tasks associated with FM, to cater relocation and building life cycle FM. The list of typical FM task is presented in the Figure 2. [16]

Therefore, the BIM has the capability of acting as FM tool. The reduction of information lose in the process of exporting information can be checked. Figure 3 shows the schematic diagram of the various FM tasks supported by BIM [15], [16].

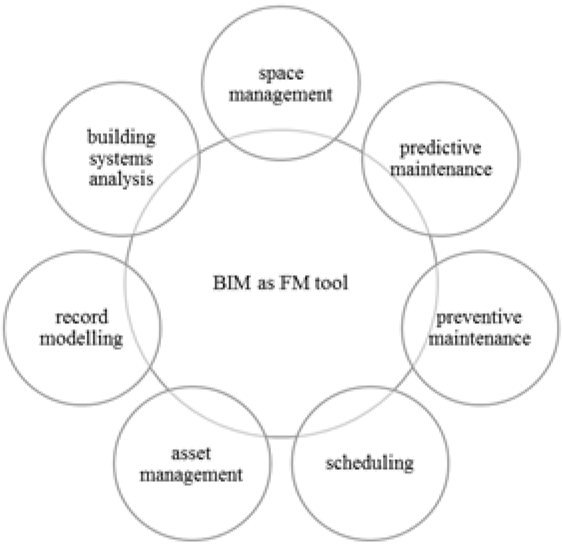

Figure 3: Various FM tasks supported by BIM [25], [26]

5. Discussion

Since its inception BIM has developed from information management strategy to construction management method while the focus has changed to create an integrated environment of up-to-date distributed building information, which is flexible for accumulate new information [27]. Therefore, BIM has the ability to track the changes and update the same in the form of accurate information for FM purposes. As a result, BIM can address the information deficiency inherently tagged to FM profession, or in other words, emergence of BIM as FM tools would reduce information loss by standardizing the data format. However, to manage information throughout the lifespan requires considerable large library directories for different building components, equipment based on the type of services.

6. Conclusion

BIM is accelerating the development process in AEC industries. It is a platform for collaborating and coordinating information from stakeholders such as architects, engineers, contractors, clients etc. Developing BIM as a FM tool ensures the reduction in inaccuracy and incomplete information. It also saves man-power, cost and time for inserting information in FM tools. With it, BIM ensures the maintainability of the building and its facilities. This promotes the optimized use of energy, lifecycle costs and durability.

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