Available online at www.CivileJournal.org

Civil Engineering Journal

Vol. 2, No. 12, December, 2016

BIM for Facility Management: Challenges and Research Gaps

S. Neda Naghshbandi [a*]

[a] *Payame Noor University, Sanandaj, Iran.*

Received 24 October 2016; Accepted 25 December 2016

Abstract

This writing presents research gaps in the area of Building Information Modelling (BIM) in Facility Management (FM) industry, and identifies practical challenges that facility management professionals are facing in utilizing BIM. Although this issue, BIM for Facility Management, has gained attention both in literature and practice, and it is highly demanded in FM industry, still it is far away from effective implementation. It is not clear for facility manager whether BIM is helpful to accelerate the process or it is a cost effective solution, and what skills are required for them. The key for effective BIM implementation in FM industry is to enhance collaboration among different parties in project lifecycle. However, still there is a doubt about the importance of FM in Construction industry. In other words, construction does not understand FM. Furthermore, there are issues over interoperability and data exchange. Thus, to assist BIM implementation, it is required to prove the correctness of benefits, uses, and challenges identified in the literature. This paper uses an intensive literature review and highlights the potential research issues in terms of BIM for FM to assist effective implementation of BIM in facility management phase of projects.

Keywords: BIM; Facility Management; Construction Industry; Research Gaps.

1. Introduction

Building Information Modelling (BIM) is "an IT enabled approach that involves applying and maintaining an integral digital representation of all building information for different phases of the project lifecycle in the form of a data repository" [1]. It is a set of ICT technologies able to insert, extract, update or modify information of the facility model, and supports stakeholders' collaboration over the projects life cycle. BIM is not just a 3D model and intelligent structured data of a facility, but rather it is a value–creating collaboration tool [2]. However, BIM is widely adopted in construction industry. It is an important issue in Facility Management (FM) industry as well, but it is often misconceived, and not utilized effectively [3]. In fact, BIM acts as an information backbone for FM systems, which if it combines with advanced technologies, it can enhance operational workflows efficiencies [4]. Nowadays, BIM is converting from a simple information storage to a platform which is capable of performing different kinds of analyses based on raw data [5].

On the other hand, according to [5] in the Architecture, Engineering and Construction (AEC) industry, little consideration has given to the quality of delivered facility manager services. One of the key challenges in FM industry is the intensive amount of data that should be captured and managed during the life cycle of the facility. BIM can facilitate and accelerate data accessibility to facility managers. "BIM is something that Facilities Management must engage with, and that engagement must begin as soon as possible" [6]. Although it is estimated that BIM can achieve about 20% Capital Expenditure savings, "the largest prize for BIM lies in the operational stages of the project life-cycle" [7].

BIM application in FM phase alternates the conventional methods of documentation, control, maintenance, and analysis. BIM helps facility manager accessing facility information within minutes, while it may take hours of efforts to achieve the same information without BIM. FM departments utilize BIM technology in order to reduce the

* Corresponding author: naghshbandi87@gmail.com

operations maintenance costs, enhance control systems suitability, and perform cost effective services constantly for the facility occupants [4]. Accordingly, BIM adoption has been an importance issue for FM.

However, facility managers recently have started to implement BIM, and process, standards and software are in the early stages of their developments [8]. The result of one survey shows that the adoption of BIM for FM is not spread out and facility managers do not rely on what they hear about BIM [9]. Hence, to assist BIM implementation, it is required to prove the correctness of benefits, uses, and challenges identified in the literature [8].

The rest of this paper is organized as follows. Section 2 addresses BIM benefits for facility managers. Then, research gaps and practical challenges of using BIM in FM are presented in Section 3. Several issues are discussed in this section through a comprehensive literature review and evaluating the existing case studies. Finally, Section 4 concludes the paper.

2. How Facility Managers Benefit from BIM

Building information modelling (BIM) is a novel innovation that is able to advance the construction industry product and process, due to its capabilities in information management, design integration, and interoperable project delivery [10]. Eventually, it can be said that the ultimate aim of BIM is to build a dynamic model of a facility which is applicable in the entire project life cycle [10]. BIM simulates an accurate virtual model of a building digitally. This model contains precise information to realize the building in different stages of a project – design, procurement, fabrication, construction and even operation and maintenance activities [3, 11].

Furthermore, according to [12] "Lifecycle BIM is the practice of creating, maintaining and utilizing building information to manage operations and maintenance of buildings throughout their operational lifecycles". However, FM definition and benefits of BIM for FM are discussed more in below.

2.1. FM Definition and Its Frequent Acronyms

Facility Management (FM) is defined by the International Facility Management Association [13] as, "a profession that encompasses multiple disciplines to ensure functionality of the built environment by integrating people, place, process and technology". According to this definition, various interdisciplinary functions are required in a facility management organization and its business viewpoint. The ultimate aim of facility management is to cut down operating costs, boost energy efficiency, support sustainability, and enhance the quality of the facilities. Facilities management department divides operations and maintenance practices into two major categories: reactive maintenance, and preventive maintenance [1, 4].

- **Reactive Maintenance:** In this traditional approach, a part needs replacement only if it fails, i.e. run to failure.
- **Preventive Maintenance:** In order to eliminate or diminish actual failures, a time-based scheduling of maintenance activities is performed before a failure occurs.

Some facility management information, and communication technologies have evolved to enhance the effectiveness of this process such as Computerized Maintenance Management Systems (CMMS), Computer Aided Facilities Management (CAFM) which are discussed more in below.

- **Computerized Maintenance Management Systems (CMMS):** It is a software that stores complete facility assets' information, and uses modules like inventory control, preventive maintenance, work order control, etc. The program operates as a cross linked series of databases.
- **Computer Aided Facilities Management (CAFM):** Facility managers use this software to plan and track events that take place in the department, and analyze possibility of cost savings.

2.2. How Does BIM Benefit Facilities Managers?

BIM technology brings variety of benefits in different areas for FM that is discussed more as follows.

I. **Automating the process of data transfer and update:** A 6D BIM model assists the immediate and effective access to all building components information. Hence labour-intensive data entry processes for transferring the attributes to a CMMS are avoided, and time is saved for retrieving the appropriate data [1].

II. **Stronger role for FM:** With BIM, FM professional can involve in the earlier stages of the project and impact on outcome improvement [3].

III. **Making sense of BIM data:** BIM has a large amount of data to process such as schedules, asset information, and etc. However, better data management is achievable when BIM is integrated with FM software like a CAFM system, and it is more powerful [3].

Some other benefits of BIM integration with FM software like CMMS are mentioned in more detail as follows:

- **Improved Space Management** through Visualization of spaces - 3D visualisation of the asset and its location [12]. Additionally, when space requirements or purposes change, BIM can assist conflicts identification [14].
- **Facilitating Maintainability:** BIM can automate a preventive maintenance program through a connection to the existing software package, and supply the information. With the building equipment information stored in BIM models, little efforts are required to accurately occupy maintenance systems, and it is a valuable tool in decommissioning process as well [1, 12, 14].
- **Set up Maintenance Activities Depend on Historical Trends:** all service history and specification, and contract information are available within BIM [3, 12].

IV. **Sustainability and Efficient use of Energy:** BIM facilitates building analysis, more especially in sustainability initiatives areas, like LEED-EBOM [14]. Furthermore, BIM can compare various energy alternatives to dramatically diminish environmental impacts and operating cost [12].

Facility owners face two important challenges: first to bring different sections of a fragmented industry together and secondly to invest in BIM technology that its benefits over traditional processes have to be proven. Although AEC industry rapidly has adopted BIM and contractors have benefited from its adoption, the Facility Management industry has yet to sense any noticeable benefits. BIM-FM integration is validated when it would be aligned with organizational objectives, the organisation be ready for change, and interoperability issues of data transfer be solved effectively [4]. Next section discusses challenges that FM industry faces to effectively adopt BIM technology.

3. Research Gaps and Implementation Challenges

According to [15] each object in BIM model can be linked to operation, and maintenance information systems. In other words, in an ideal situation, BIM model and FM package are linked easily and any modification in the model should be automatically updated [2]. However, in reality, this connection is not so easy, and there are many unsolved problems which researcher should work on it, in order to achieve effective BIM implementation for FM.

However, after reviewing the related literature, the areas of further potential for research on the mentioned topic are determined, and listed as follows.

3.1. Lack of Best Practice and Guidelines

Owners and facility managers lack enough knowledge of BIM. They are not sure about how BIM can be used for FM [6, 8].

There is totally a lack of best practice case study and hard evidence to show the benefits of BIM for FM [16, 17]. The existing case studies are unscientific and unreliable about opportunities and benefits, and they do not point out the challenges [16]. Facility managers need real world hard evidence to advertise BIM to owners. Also lack of approval of BIM for FM cost saving is another barrier to adoption [8].

It is shown in [1] that use of 6D BIM models in FM section lead to a possible time-saving up to 80% in operations and maintenance activities, through a case study approach. However, it is pointed out that Future large-scale studies is required to identify benefits of 6D BIM models usage in lifecycle of buildings.

3.2. Construction industry does not understand FM

There is a gap in the value that FM gives to the built environment [6]. Construction industry requires cultural change to accept FM as a part of the process [16]. A dominant barrier to BIM adoption is that facility managers are not being engaged in the early phases of a facility lifecycle. Hence, facility managers are not able to specify the required data and this results in a widely use of reactive approach [8, 18]. Studies show even if they were involved in the early stages of projects, they were not seen as valuable participants. Furthermore, facility managers shortage of BIM skills is another barrier in the adoption of BIM [7].

3.3. What Data is Required by FM Professional in the Operation and Maintenance Phase of Facilities?

Identification of FM data requirements has gained limited consideration. According to [8] "Facility managers require a data-centric repository of location asset information from BIM, and the effective use of BIM for FM hinges on who, what and how data is collected." Some research have been done in this regard, for example [19] established an integrated system to capture information and knowledge of building maintenance operations to find out how a building is deteriorating and to promote maintenance decisions. However, only some non-geometric requirements was determined in recent studies [17, 20].

Although some works are available in the literature, yet the knowledge and technology gap between designers and facility managers is considerable. Effective utilization of BIM information database depends on figuring out the data requirement of all parties through the life cycle of the project [21]. Hence, the requirement of facility management

should be explicitly clarified, so that the new technology leads the right information to the appropriate party. For example, facility managers should report the design deficiencies that are not maintenance friendly, as it prevents identical design problems in the future. Therefore, it is required to form a complete non-maintenance friendly design database, accessible to designers [22].

Furthermore, facility owners must establish their information requirements which contain essence values aligned with best practices of organization to enhance the integration of BIM and facility management system (CIC, 2012). At present there is a lack of standard methodology to determine and assess owner requirements in the construction industry.

3.4. Information Quality Issues of BIM Models (e.g. Inaccurate, Incomplete, or Unnecessary Information)

A facility life cycle encompasses different stages: initiation and planning, design, construction, closeout and commissioning, operation and maintenance. The information flow through these stages is horizontal and consecutive. Controlling the accuracy, suitability and quality of this information flow is crucial for the optimal decision making during Operation & Maintenance stage [4]. When the project is handing over, one of the challenging responsibilities of owners is to assess the information quality (IQ) of the BIM model for facility management. According to [23] "Most BIM created for design and construction phases contain significant quality issues including inaccurate, incomplete, or unnecessary information." Zadeh, et al. [23] pointed out the potential areas for further research in this regard which some of them are listed below.

- Many researchers have worked on the information incompleteness and the value inaccuracies of BIM models. They recommend different instructions and check list to prevent these issues. However, the challenge is how to process with incomplete models, how assess them in a given BIM model, how to corporate with the existing checklists, and how to link them into the owner's requirements.
- There is a research need for appraising the assurance methods of incomplete Mechanical, electrical, and plumbing (MEP) systems, and for evaluation of the relevant system components, and the attributes of required system. In fact, there is a demand for automated IQ assessment approaches in this regard.
- The AEC literature has not discussed exactly about inaccurate values for system definition. Hence, this subject has a high potential for further work to determine the effect of inaccurate system information for FM-IMSs.
- Spatial (asset placement) inaccuracy of BIM model is an important issue for producing FM-IMSs. This topic is hardly addressed in the existing works. Since modelers should pursue the accuracy of asset-space association by applying a list of generic measures, an IQ assessment approach related to this issue is needed.

In addition to the accuracy, completeness and updating of data, the ability of facility management team and facility owners to manage information is another challenge. It is essential to develop a method for identifying required information in the operation phase, in order to facilitate establishing the base rules for auditing procedure [24].

3.5. Interoperability and Language Gap

3.5.1. There are Issues Around Interoperability and Data Exchange

There is a limited compatibility between BIM and FM technologies which is more problematic because of considerable difference among life-cycle of BIM technologies, and FM technologies. In fact, standardised data libraries and open systems are required by CAFM and other asset management systems [17].

However, it seems that there is doubt about the capability of IFC as a communication protocol in BIM for FM [25]. Although in the literature, Construction Operation Building information exchange (COBie) is introduced as the primary form of data exchange, it is not widely used in practice. COBie transfers the 3D BIM information into a spreadsheet format. According to [9] only 15% of people utilising BIM are working with COBie. Furthermore, case studies expose that an extremely long time is needed to manage data in a COBie format [8, 15, 26]. It is because the spreadsheet data is entered into the FM systems manually. Furthermore, the details on what information are to be delivered, when and by whom are not provided by COBie [17, 27].

Nevertheless, as Fontana- the managing director for Bam's facilities management arm- said "The COBie spreadsheets I've seen are too complicated and technical and include architectural and structural detail that is not relevant to facility management." [8].

Some efforts have done to solve these issues about utilizing COBie. For example, the BIM Task Group's government soft landing process (GSL) wants to standardize the information enters into COBie. And BS1192-3 – a new standard- outlines the process of data transmission to CAFM. Bam FM Company has cooperated with Autodesk to transfer data directly from a 3D drawing into a CAFM system [8].

Besides, according to survey results, data have been collected and sorted as unitized items, instead of assemblies, then designers and construction personnel are forced to use unusual work flows [6, 18]. Hence, the problem is not just data format, it is the way that data is specified and classified which causing intense debate.

3.5.2. To What Extent Facility Managers Utilize FM Software?

There is a limited compatibility between BIM and FM technologies which is more problematic because of considerable difference among life-cycle of BIM technologies, and FM technologies. In fact, standardized data libraries and open systems are required by CAFM and other asset management systems [17].

3.6. Shortage of Contractual Framework for the Implementation of BIM for FM

In general, BIM implementation has contractual framework problems and this issue is more sensible for integration of BIM and FM. There is a need for developing BIM for FM specification in order to provide the topical requirements of FM function and business [17]. In other words, traditional contract processes must be revised to incorporate the BIM-FM deliverable. It is fundamental to determine what information coordinates best with the organization strategies to prevent wasting time, effort and investment.

4. Conclusion

As BIM gains significant importance in the AEC industry, and most governments aim a target of fully BIM utilization, it seems that integration of BIM and FM systems is an inevitable event. BIM is a central repository of information saved all over the projects lifecycle. Studies show that facility managers can benefit from the advantages of BIM to enhance managing the intensive amount of information. However, integration of BIM and FM systems faces serious problems. There are some technical and nontechnical barriers to adopt BIM for FM.

This paper highlighted research gaps in BIM for FM, and practical challenges of BIM implementation in facility management phase of projects via an intensive literature review. There is a need for case studies, and hard evidence to prove the benefit of BIM for FM, and clarify practical challenges. It is required to enhance the relationship among different stakeholders of the AEC industry and advance collaboration between designers, constructors, and facility managers. There are heated debates about issues around data acquisition, data exchange format, data management for FM systems, and etc. For example, it is not clear whether COBie is capable of effective data exchange for FM systems or not. However, for a proper building information model that supplies FM needs, it is essential that FM proactively defines the information requirements at the start point of the project life cycle, rather than waiting for the project closeout to collect information [4].

It is showed that further research is needed to enhance the integration of BIM and facility management systems which is aligned to fully utilization of BIM, in order to improve the construction industry productions.

5. References

[1] O. Davtalaba and J. L. Delgadob, "Benefits of 6D BIM for Facilities Management Departments for Construction Projects–A Case Study Approach," presented at the ISARC 2014, 2014.

[2] S. Talebi, "Exploring advantages and challenges of adaptation and implementation of BIM in project life cycle," in 2nd BIM International Conference on Challenges to Overcome, 2014.

[3] SWG. How Does BIM Benefit Facilities Managers? [Online]. Available: http://www.swg.com/blog/how-does-bim-benefit-facilities-managers/

[4] A. Ghosh, A. D. Chasey, and M. Mergenschroer, in Building information modeling: applications and practices, R. R. A. Issa and S. Olbina, Eds., ed: American Society of Civil Engineers, 2015.

[5] I. Motawa and K. Carter, "Sustainable BIM-based evaluation of buildings," Procedia-Social and Behavioral Sciences, vol. 74, pp. 419-428, 2013.

[6] BIFM, "BIM and FM: Bridging the gap for success," ed. http://www.bifm.org.uk/bifm/filegrab/3bim-fm-report-bridgingthegapforsuccess.pdf?type=documents&ref=4752, 2012.

[7] BIM-Task-Group, "Frequently asked questions," ed. http://www.bimtaskgroup.org/bim-faqs/, 2015.

[8] R. Williams, H. Shayesteh, and L. Marjanovic-Halburd, "Utilising Building Information Modeling For Facilities Management," International Journal of Facility Management, vol. 5, 2014.

[9] NBS, "NBS National BIM Report 2013," ed, 2013.

[10] V. Pniewski, "Building Information Modeling (BIM), Interoperability Issues in Light of Interdisciplinary Collaboration," Collaborative Modeling Ltd, Third Edition, London, UK, 2011.

[11] S. Azhar, "Building information modeling (BIM): Trends, benefits, risks, and challenges for the AEC industry," Leadership and Management in Engineering, vol. 11, pp. 241-252, 2011.

[12] B. Haines. (2016). The Benefits of Lifecycle BIM for Facility Management. Available: https://fmsystems.com/blog/the-

benefits-of-lifecycle-bim-for-facility-management/

[13] IFMA. What is Facility Management? Available: https://www.ifma.org/about/what-is-facility-management.

[14] Facilitiesnet. (2011). Five Ways BIM Can Benefit FM. Available: http://www.facilitiesnet.com/facilitiesmanagement/tip/Five-Ways-BIM-Can-Benefit-FM--23696

[15] R. Beatty, C. Eastman, K. Kim, and Y. Fang, "Texas A&M Health Science Center,[Case Study]," BIM for Facility Managers, 1st Edition, New Jersey: John Wiley & Sons, pp. 164-184, 2013.

[16] T. Lane. (2013). Tune in to BIM FM.

[17] G. Kelly, M. Serginson, S. Lockley, N. Dawood, and M. Kassem, "BIM for facility management: a review and a case study investigating the value and challenges," in Proceedings of the 13th International Conference on Construction Applications of Virtual Reality, 30-31 October 2013, London, U, 2013.

[18] Teicholz, Paul, ed. BIM for facility managers. John Wiley & Sons, 2013.

[19] Motawa, Ibrahim, and Abdulkareem Almarshad. "A knowledge-based BIM system for building maintenance." Automation in Construction 29 (2013): 173-182.

[20] Becerik-Gerber, Burcin, Farrokh Jazizadeh, Nan Li, and Gulben Calis. "Application areas and data requirements for BIM-enabled facilities management." Journal of construction engineering and management 138, no. 3 (2011): 431-442.

[21] Liu, R., and R. R. A. Issa. "BIM for facility management: Design for maintainability with BIM tools." FUTURE (2013).

[22] Liu, R., and R. Issa. "Issues in BIM for facility management from industry practitioners' perspectives." Proc., ASCE Computing in Civil Engineering (2013) (2013): 411-418.

[23] Zadeh, Puyan A., Sheryl Staub-French, and Rachel Pottinger. "Review of BIM quality assessment approaches for facility management." (2015).

[24] Kasprzak, Colleen, Ashwin Ramesh, and Craig Dubler. "Developing standards to assess the quality of BIM criteria for facilities management." In AEI 2013: Building Solutions for Architectural Engineering, pp. 680-690. State College, PA: American Society of Civil Engineers, 2013.

[25] Open, B. I. M. "Open BIM Focus: IFC/COBie validation trial." (2012).

[26] Grady, J. "Epic BIM: COBie is dead." (2013).

[27] B. East. "Construction-Operations Building Information Exchange (COBie)" (2014).

[28] Kiviniemi, Arto, and Ricardo Codinhoto. "Challenges in the Implementation of BIM for FM—Case Manchester Town Hall Complex." Computing in Civil and Building Engineering (2014) (2014): 665-672.