Assessment of existing BIM implementation processes of a public organization to improve building assets management and maintenance

N Boufares¹, A Motamedi², I Iordanova³ and D Forgues⁴

¹ M. Eng., Department of Construction Engineering, École de Technologie Supérieure, Montréal, Quebec, nouha.boufares.1@ens.etsmtl.ca
² PhD., Professor, Department of Construction Engineering, École de Technologie Supérieure, Montréal, Quebec, ali.motamedi@etsmtl.ca
³ PhD., Professor, Department of Construction Engineering, École de Technologie Supérieure, Montréal, Quebec, ivanka.iordanova@etsmtl.ca
⁴ PhD., Professor, Department of Construction Engineering, École de Technologie Supérieure, Montréal, Quebec, daniel.forgues@etsmtl.ca

Abstract. In the lifecycle of a building, the longest phase is generally that of operation and maintenance (O&M). The data needed to support O&M is mainly generated during the design, construction, and commissioning of the built asset phases. However, the extraction and transfer of relevant O&M data from the project documents remain a major issue in that it is time consuming and error prone. Nowadays, Building Information Modeling (BIM) allows different project team members to collaborate and share building data in real time. However, as-built models handed-over to the asset management team are quite voluminous and usually lack the necessary information for the O&M phase. This is due to an absence of O&M information requirements specification, and the lack of compliance monitoring and control during the project. This paper presents an action research focused on the issues encountered by a public building owner to manage their BIM processes. It demonstrates issues of BIM readiness and capabilities, both at the project and O&M levels, by mapping the gaps in the existing processes. Building owners rely on the design professionals’ expertise to guide them but do not have the adequate resources, knowledge, and tools to ensure the quality of the models delivered regarding O&M requirements. Major issues in the management of information for O&M were identified, and some recommendations are proposed.

1. Introduction

BIM is a widely adopted solution to ensure the coordination between the various stakeholders involved in a construction project. Despite its potential for facility managers, BIM is primarily used during design and construction [1]. This paper uncovers some of the reasons for the insufficient use of BIM for operation and maintenance (O&M) and proposes initial steps asset managers can take to increase its adoption.

Regarding the collection of information generated and shared during the project lifecycle and its transfer for real estate asset management, the following two aspects were found to be problematic: (1) The contractual requirements at the design and construction stages lack the information required for asset management, resulting in additional costs and errors related to the manual retrieval of construction
documents, missing information, or loss of information; and (2) Asset information is either unavailable or of poor-quality, leading to additional costs during the building operations stage.

The question that arises from these problems is: What issues exist in the present asset management processes and how can BIM help? This action research focuses on the issues faced by the construction and building asset management department of a Canadian university in the integration of BIM for the management of its assets. The main objective of the project is to propose a production and reception framework for the digital content for new building projects. This paper reports on the efforts to identify current issues in the process of production and transfer of asset data in a BIM-based project.

2. Literature review

The use of BIM technology has a strong potential to generate cost savings in facility management (FM) operations if the data is accurate and well maintained [2]. In the AEC sector, for each new project, the main challenge is in controlling both the design process and corresponding deadlines. In addition, in every project, there is an expectation that vital high-quality information be available and promptly ready throughout the construction process. However, there is generally either too much information to maintain, or information is insufficient to ensure excellent performance. Also, the data quality is often poor, and it is difficult to locate as it is stored in various formats. To tackle these challenges, an appropriate information flow must be integrated, accessible, and transparent to all parties [3]. BIM promises to solve this problem, both by greatly improving the inherent quality of building design information and by providing mechanisms and procedures so that the information can be communicated and shared among members of a project team [4]. However, BIM is not a miracle solution. It alone cannot solve the issue of the barriers created by the design and construction phases being separate. For instance, typically, project stakeholders have no interest in sharing their intermediate models due to context conditions such as contractual framework [5]. Another problem is that BIM models delivered at the commissioning phase cannot be easily used during the operation phase, mainly because designers do not consider the potential use of such models in the operation and maintenance phase. As a result, operation-related data is usually not included in the models [1].

Building managers suffer from a lack of data regarding the building’s assets, which can lead to inefficient decisions [6]. The choice to adopt BIM for FM still requires facility managers to gain a level of awareness of its additional benefits over the status quo, namely through Computer-aided Facility Management (CAFM) [2]. There are problems observed in the adoption of BIM for FM, for example, the required O&M data is usually not present, and the file size of a model can become too large and cumbersome [7]. Additionally, the FM task requirements are not clearly included in the beginning of the project process. Therefore, the general project data transmitted from the design and construction phases should be filtered so that asset managers have access only to the data they need for their daily work [8].

Researchers innovating in the construction industry know that if their efforts are to be put into practice, they must build on existing technologies and processes, in addition to attempting to introduce new tools and workflows that require time for training and tightly allocated resources [9]. There is a demand to make processes more efficient for quick access to data and instant quality checks [10]. Data-centric organizations have learned that to have the greatest impact, data cannot be added to an organization’s current practices, but rather it must be integrated into their pre-existing mindsets and processes [9]. This process involves the direct integration of data captured in the field into an asset database and the automatic generation of reports based on pre-programmed policies and/or templates [10]. Some professionals and their organizations have been reluctant to add data to their repositories, explaining
that they were not prepared to deal with data on top of everything else, including new technologies, work processes, and workflows [9].

Rojas et al. [11] find that the use of BIM is the first step towards providing intelligent technical data regarding the state of construction. To prepare for the adoption of BIM for O&M, McArthur [7] recommends a stepwise modeling approach. This process begins with an initial analysis and data collection step, followed by five steps that will be repeated in the later implementation and development of each use case. This offers the flexibility needed to adapt the model to the changing needs of the building operations teams. A copy of the building model is saved to keep all the data, then simplified with families containing only the data needed for operations. The creation and adoption of BIM specifications and protocols can lead to a consistent and efficient method of data exchange with great benefits for construction projects. Several national standards and best practices have been developed around the world [3]. Computer design tools are growing in tandem with BIM, changing the game and changing the owners’ perspective on the value of model-based design [9].

3. Methodology
This is an action research project studying the use of BIM by a Canadian university in its project to complete two buildings. The data collection was performed through various methods, while the main researcher was part of the Client’s team as an intern. First, documents and models of the construction projects were analyzed. Then, a series of interviews were conducted with key stakeholders on the client and supplier sides, and a focus group consultation with representatives of the construction and the building asset management departments. Subsequently, current processes were mapped, analyzed, and validated by department representatives.

4. Case study
4.1. Context
The Construction Department of the Canadian university is undertaking a new BIM project (Project B). At the same time, this department and the Buildings Asset Management Department are completing the reception process of another project (Project A). Project A and B represent an interesting research opportunity: on the one hand, they allow to analyze the issues encountered in the past (Project A) in the production and transfer of digital data to the Buildings Asset Management Department for asset management. On the other hand, they offer the possibility to accompany the Construction Department and the Buildings Asset Management Department in the implementation and validation of a framework for the management of the digital data of projects (Project B and the subsequent construction projects).

This paper analyzes the practices surrounding the management of the BIM process for Project A. It aims to make a series of recommendations regarding the management and reuse of BIM model data. It is intended for the actors of the projects of the Construction Department and the Buildings Asset Management Department, to highlight the current deficiencies of the BIM practices in the management and operation phases of the project. The main objective is to help improve the efficiency and effectiveness of the realization and management of assets, to enhance the productivity and quality of future construction projects of the Canadian university.

4.2. Investigation
During the analysis of the current situation, different processes of BIM management were examined, starting with the contract and the creation of BIM management and execution plans, including the process of production and transfer of data, and the processes of reception and management of documents, and ending with an overview of the issues at stake.
4.2.1. BIM process (contract and BIM management/execution plans)

The goal is to digitize the asset data and information and to automate the capture and transfer of project information to the O&M management systems. For Project A, the client did not require BIM in a contractual manner. As a result, and without having qualified resources in BIM project management on the client’s side, many BIM management aspects were missing: there was no monitoring process of the modeling (which was done on a voluntary basis by some project participants); the construction manager did not have a contractual requirement to deliver a federated As-built model at the end of the project; and there was no requirement for an O&M model to be delivered by the responsible stakeholders.

4.2.2. Production and transfer of data process

Following the analysis of the existing process of data production and transfer during the design, execution and acceptance phases of the project shown in Figure 1, some challenges are identified such as: (1) The lack of BIM-FM Client requirements in the contract; (2) Limited client involvement in the creation of the BIM management plan and the BIM execution plan; (3) Lack of quality control of the design BIM models by the client; (4) Little involvement by the client in monitoring the evolution of the project models; (5) No validation of information by the client about the transferred As-built models; and (6) Insufficient communication between the documents received and the O&M systems.

4.2.3. Document reception and management processes

The process of receiving documents for a new building is the responsibility of the Construction Department of the Client institution. The documents and data are then forwarded to the Buildings Asset Management Department. Figure 2 shows the multiple data storage platforms used by the latter. The representation of this process highlights once again the amount of manual data entry required due to the lack of interoperability between the systems. The main identified issue is the risk that the information on the systems is not updated automatically once the work is done. The fact that multiple manual entries are needed increases the risk of errors and the potential for inconsistent or missing information. The consequences of this could be serious, not to mention that any error will lead to a loss of user confidence in the validity of the information contained in the systems.
4.2.4. Issues at hand-over

Following the analysis of the project documents and the communication with the different participants of the project through interviews, it was observed that there are several issues at the delivery level of this project that hinder the reuse of the As-built BIM models for the operation phase:

1. The client has not established a standard of information requirement to be included. There are project completion documents with all shop drawings. However, there is no quality control activity of the models by the Buildings Asset Management Department.

2. There is a lack of a standardized procedure to transfer the model data to the existing platforms.

3. The As-built models must be delivered at the final acceptance stage, which deprives the maintenance team of information sources for interventions on a building that has been in operation for several months (since provisional acceptance).

4. As there were no requirements or guidance processes from the client, the models that were delivered were not designed for reuse or to meet the information requirements for the computer-assisted maintenance management system (CMMS). The quality of these models has not been verified either.

5. Since there is no process for updating the models, new changes in the building are not reflected in the models. Soon, the models will become obsolete.

These issues stem from the fact that the models are primarily designed for 3D coordination purposes and not for use in the operational phase; no naming standard and information requirements were applied to the models; and no good modeling practices or modeling guidelines for use in the O&M phase were included. This is the result of lacking information requirements, naming convention for assets, systems, etc. and BIM-for O&M modeling best practices guide for Project A.

5. Discussion and Conclusion

In the AEC/FM industry, the use of BIM in the O&M phase is currently in progress, and it faces several challenges. This paper investigated the issues related to the production and transfer of data, the documents reception process, and the model update process. The analysis of the processes was based on a project in which the models were produced mainly for the purpose of 3D coordination, which explains the separation between the construction phase and the building management phase. The analysis confirmed the importance of specifying modelling requirements for assets management. This research aims to provide improved process maps related to the production and reception of digital content based
on the structured definition of project information requirements and the asset information requirements. The improved process flow will also include: the process of planning and tracking of model production, the process of reception and transfer of models to the asset management department, the process of data extraction and transfer to the CMMS systems, and the process of data update for major renovation projects. The workflows will be discussed in future publications.

Following the observations and analysis of the different processes and documents, here are the recommendations drawn from this research: (1) The use of a common data environment (CDE) must be operationalized for the exchange of information of models between the project office, suppliers, and the building asset management department; (2) ISO 19650 and ISO 55000 standards should be adopted as references for the migration to the digitalization of the university’s building asset management; and (3) A joint working group should be created between the major project management, the project office of Project B and the building assets management department to operationalize the recommendations in preparation for the reception of future projects.

Acknowledgements

This research was funded by the construction and the building asset management departments of the ÉTS. The authors would like to thank the technical staff of the construction and the building asset management departments of the ÉTS for their contributions in providing data for the project.

References

[1] A. Motamedi, I. Iordanova, D. Forgues, FM-BIM Preparation Method and Quality Assessment Measures (2018). https://www.researchgate.net/publication/325905180_FM-BIM_Preparation_Method_and_Quality_Assessment_Measures
[2] Y. Arayici, T. Onyenobi, C. Egbu. Building Information Modelling (BIM) for facilities Management (frM): the Mediacity case study Approach. (2012). http://usr.salford.ac.uk/id/eprint/19330/5/arayici_article_IJ3DIM_1%282%29.pdf
[3] A. Kiczkak, Guidelines for preparation of OIR (Organizational Information Requirements) document for Miatstoprojekt Wroclaw following ISO 19650. (2020). https://bimaplus.org/wp-content/uploads/2020/10/2020-AnnaKiczak-Dissertation.pdf
[4] R. Crotty, The Impact of Building Information Modelling (2013).
[5] C. Preidel, A. Borrman, C-H. Oberender, M. Tretheway, Seamless Integration of Common Data Environment Access into BIM Authoring Applications: the BIM Integration Framework (2016).
[6] L. Alileche, Use of BIM for the optimal management of existing building (2018). Université de Lille. https://pepite-depot.univ-lille.fr/LIBRE/EDSPI/2018/50376-2018-Alileche.pdf
[7] J.J. McArthur, A Building Information Management (BIM) Framework and Supporting Case Study for Existing Building Operations, Maintenance and Sustainability (2015). Procedia Engineering, vol. 118, p. 1104-1111.
[8] M. Munir, A. Kiviniemi, S. W. Jones, Business value of integrated BIM-based asset management (2019). Engineering, Construction and Architectural Management, vol. 26, no 6, p. 1171-1191. https://doi.org/10.1108/ECAM-03-2018-0105.
[9] R. Deutsch, Leveraging data across the building lifecycle (2015). International Conference on Sustainable Design, Engineering and Construction.
[10] A. S. Kachwalla, M. I. Hughes, Real Time Pavement Asset Management and Integration with Work Order Management (2019). https://ascelibrary.org/doi/pdf/10.1061/9780784482452.036
[11] E. M. Rojas, C. S. Dossick, J. Schaufelberger, B. A. Brucker, H. Juan, C. Rutz, Evaluating Alternative Methods for Capturing As-Built Data for Existing Facilities (2009). Computing in Civil Engineering (2009).