



Facility management using the Building Information Modeling (BIM) – review of solutions

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ABSTRACT:

This paper deals with the issue of building management options based on the BIM model. The benefits of using BIM for Facility Management (FM) technology were discussed. The barriers encountered when trying to use this technology during the Operations & Maintenance (O&M) phase were also presented. Potential situations that a facility manager may encounter when trying to implement BIM to FM were analyzed (no BIM model, incomplete BIM model, properly functioning BIM model with FM function). Each of these cases was discussed in detail, illustrated with examples, and the procedure for each of them was proposed. It has been shown that in each of the analyzed situations it is possible to use the BIM for FM model. The most effective solution for the facility manager is to include the FM function in the BIM model at the stage of its creation (design phase) and its updating during construction (construction phase).

KEYWORDS:

Building Information Modeling (BIM); Facility Management (FM); Operations & Maintenance (O&M)

1. Introduction

The costs associated with the operation of a building account for more than 80% of the total life cycle costs of a facility [1]. Therefore, it is important to adopt such a strategy of conduct in the O&M phase that will significantly reduce them. One of the most effective methods of property management is the use of a BIM model with the FM function. Thanks to this solution, the total cost of facility management can be significantly reduced, even by 33% [2]. Other significant benefits resulting from the use of BIM for FM are: easier data storage [3], faster access to information, especially in the case of installations and elements that are difficult to access, the inspection of which would be difficult [4], better planning of maintenance and current repairs [5], current analysis of energy consumption [6], etc.

In [7], the authors analyzed the use of BIM in FM in terms of improving the quality of life (QOL) related to the improvement of the work environment of people managing the facility. The potential benefits include: correct estimation of effective operational costs related to the operation of the facility, shorter time to make a decision due to quick access to the necessary information, a full database containing all operational information about the facility, a more effective documentation storage system (digital version available online), easier cooperation between individual stakeholders and greater flexibility of work as well as quick update of information contained in the model.

The most common barriers in the implementation of BIM technology to FM include: [8]: problems with the interoperability of the software used by all stakeholders of the FM process

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[9], lack of knowledge of the benefits of using BIM in FM [10], insufficient knowledge of people responsible for FM – promotional activities related to BIM are primarily aimed at designers and contractors [11], limiting the use of BIM for FM to objects that were designed and made in BIM technology [12], potential difficulties of facility managers unfamiliar with BIM technology in using FM software [12], no legal regulations regarding the requirements for FM phases [13], high cost of employee training [14], high cost of software and hardware [14], no integrated data storage systems (data is not stored in one place) [15], no statutory incentives to use BIM for FM with decision makers [16], lack of experience in using BIM for FM [17], high cost of implementing BIM in FM [18], etc.

Despite the numerous barriers related to the use of the BIM model for facility management during the operation phase, the benefits associated with it are indisputable. The main issue determining the use of BIM for FM is the availability and quality of the model. A facility manager who wants to use a BIM model with FM function may encounter the following situation: no BIM model, incomplete BIM model, properly functioning BIM model with FM function. Each of these cases was discussed in detail, illustrated by examples, and the procedure for each of them was proposed.

2. Lack of BIM model

The least desirable situation for a manager who wants to use BIM for FM is the lack of a building model. This happens most often in the case of existing facilities, which were designed and constructed before BIM technology was popularized, or in the case of new facilities, for which the design process was carried out using traditional methods. In such a situation, the BIM model should be made from scratch, which involves additional costs for the manager. There are two options: using 3D laser scanning or creating a model based on the existing technical documentation ("paper" or 2D CAD) and its verification with the real state.

2.1. 3D scanning

In the event that the technical documentation of the object does not exist or the actual state differs from the design state, the 3D laser scanning technique can be used. As a result, we obtain a point cloud which, after processing, allows the determination of the spatial shape of the scanned object. After supplementing the geometric information from laser scanning with operational data, we obtain a BIM model that can be used in the facility management process. The diagram of the procedure for this case is shown in Figure 1.

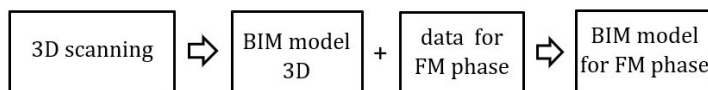


Fig. 1. Diagram of creating a BIM model for FM model using 3D laser scanning

Thanks to laser scanning, it is possible to obtain a very high accuracy of shape (up to a millimeter) and performance (up to 2 million points per second) [19, 20]. A certain barrier, in this case, may be the cost of making a BIM model using this method, but in return we get a model characterized by very high accuracy. All possible discrepancies that may have arisen during the construction are eliminated and the user gains 100% certainty as to the compliance of the BIM model with the actual condition of the object.

In [21], the authors proposed one of the methods of using 3D laser scanning and data processing, thanks to which it is possible to create a BIM model with high geometry accuracy. The examples of models analyzed by the authors confirmed that the proposed method allows for taking into account all critical geometric and semantic information buildings scanned.

2.2. Creating a BIM model based on the existing design documentation

If the facility manager has technical documentation in a traditional form ("paper" documentation, 2D CAD files), the data for the BIM model can be obtained from these sources. The information obtained in this way should be verified with the actual state of the facility, thus eliminating all deviations from the design and supplementing it with operational data used in FM. The diagram of the procedure for this case is shown in Figure 2.

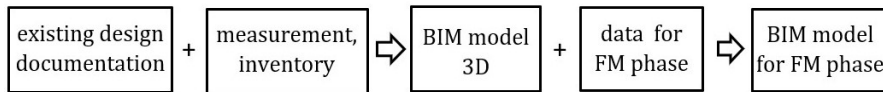


Fig. 2. Diagram of creating a BIM for FM model based on traditional documentation

In [22], attention was drawn to the need to include in the model an appropriate range of data so that it would be useful for facility management. Four basic issues have been defined that should be taken into account when creating such a model: the scope of necessary information used in the operation process, data transfer "from the model" and "to the model", management of the BIM model advancement level, uncertainty as to completeness of construction documentation. They were subjected to practical analysis on the example of the Kerr Hall East (KHE) building at the Ryerson University, for which a BIM model was prepared based on partially preserved technical documentation and information obtained in the model creation process. The author presents a set of activities aimed at creating a BIM for FM model for the analyzed building (Fig. 3).

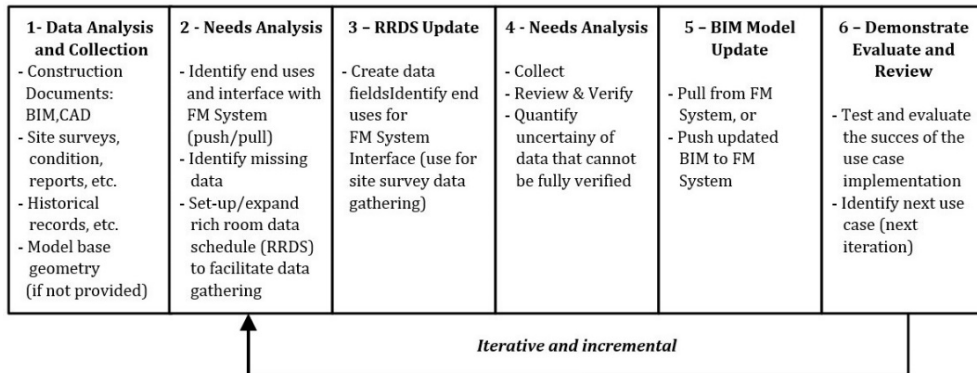


Fig. 3. Diagram for creating the BIM for Q&A [22]

The adopted scheme can be used as a model in a situation where there is no BIM model for a given object, and the information available allows for its execution, without the need for 3D laser scanning.

3. BIM model at the design and construction phase – adaptation to FM

The BIM model created during the design and construction phase of the facility usually does not take into account the needs related to its use for FM. Therefore, it requires adaptation and supplementation with information necessary for the operation phase. As noted by the authors of [23], in the models created for the design and construction phase, there is a lot of information useless in the exploitation phase (e.g. some construction details). Therefore, before supplementing the BIM model with operational data, it is worth removing from it information that is not relevant for the FM phase (Fig. 4).

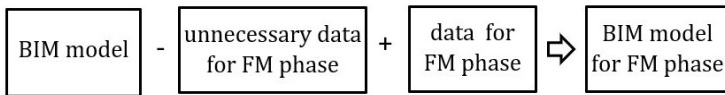


Fig. 4. Diagram of adaptation of the existing BIM for FM

In order to ensure the required quality of the model, an original checklist was developed, thanks to which it is possible to monitor the correctness of the entered data [23]. This data should be characterized by: completeness, accuracy, consistency, compliance, clarity and relevancy. Some of the aspects covered in the checklist are shown in Table 1.

Table 1

Checklist for adaptation BIM model for FM phase (excerpt) [23]

| Dimension | Product | Aspect | Item Definition |
|--------------|------------------|------------|---|
| Completeness | Elements | Object | All required elements must be included in the model |
| | | | All assets must have the correct Level of Development (LOD) |
| | Spatial Elements | Object | There should be no infant volumes (e.g., on roofs, external stairs, parking, shafts) |
| | | | In addition to spaces, zones are defined for grouping by function purpose |
| | Spatial Elements | Attributes | Spaces should have finishes in addition to materials |
| | | | Every Space should be assigned to at least one Zone |
| | System | Relations | Systems must be defined and have all their individual components assigned to them |
| | Facility | Integrity | Delivered models should be complete including plans, schedules, diagrams, and data from all disciplines |

The approach used in [23] requires constant improvement. The authors indicated the need for further research, taking into account, inter alia, issues of transferring native models to the IFC format, performing quality control directly on IFC files or data import and control on FM platforms.

4. Creating a BIM model with the FM function from the design phase

The most advantageous situation is the construction of a BIM model with the FM function already at the stage of creating the design documentation (Fig. 5). This approach is the most cost-effective. This issue is discussed in detail in [24]. This method of creating a BIM model with the FM function was presented in [24] on the example of the building of a public university recognized as a leader in research and technology development in the USA. According to the authors, successful implementation of BIM with FM functionality requires: clear definition of data used for facility management, smooth data collection throughout the design phase, interoperability of data exchange between BIM tools and facility management systems such as Computerized Maintenance Management System (CMMS).

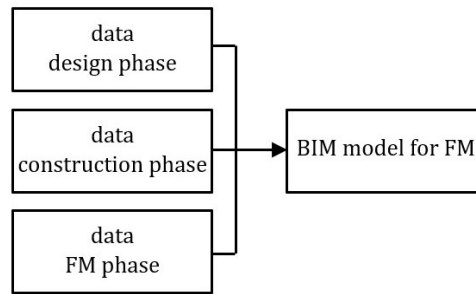


Fig 5. Diagram of the BIM model development with the FM function from the design phase

Due to the inclusion of the FM function from the very beginning of the BIM model development, it achieves its FM functionality faster.

5. Conclusions

Despite the many benefits resulting from the use of BIM for FM, facility managers encounter numerous barriers in this respect. One of them is the lack of the BIM model of the object or its incompleteness (failure to adapt to the O&M phase). The cases analyzed in the work show what steps should be taken for each of them to obtain such a model.

If the facility owner / manager considers the use of BIM for FM, it is best to include the future FM function already at the model creation stage in the design phase. In this case, the costs related to the modification and adaptation of the model to the FM function are avoided – the model has modules used in the O&M phase, which only need to be supplemented with appropriate data.

A less favorable situation is to have a BIM model that is not adapted to the FM function or not at all. In this case, the manager has to incur additional costs related to the creation of the BIM model or its adaptation to the FM function. However, taking into account the several decades-old life cycle of the building and the savings resulting from the use of BIM in FM, the amount of these costs in the overall cost balance for the O&M phase is fully acceptable.

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Zarządzanie obiektem z wykorzystaniem modelowania informacji o budynku (BIM) – przegląd rozwiązań

STRESZCZENIE:

Podjęto zagadnienie dotyczące możliwości zarządzania budynkiem z wykorzystaniem modelu BIM. Omówiono korzyści, jakie wynikają z zastosowania technologii BIM for Facility Management (FM). Zaprezentowano również bariery napotymane przy próbie wykorzystania tej technologii podczas fazy eksploatacji obiektu. Przeanalizowano potencjalne sytuacje, z jakimi może spotkać się zarządca obiektu przy próbie implementacji BIM do FM (brak modelu BIM, niekompletny model BIM, poprawnie funkcjonujący model BIM z funkcją FM). Szczegółowo omówiono każdy z tych przypadków, zilustrowano je przykładami, zaproponowano sposób postępowania dla każdego z nich. Wykazano, że w każdej z analizowanych sytuacji możliwe jest wykorzystanie modelu BIM for FM. Najefektywniejszym rozwiązaniem dla zarządzającego obiektem jest uwzględnienie funkcji FM w modelu BIM na etapie jego tworzenia (faza projektowania) oraz jego aktualizacji (faza realizacji).

SŁOWA KLUCZOWE:

BIM; zarządzanie obiektem (FM); użytkowanie i konserwacja (O&M)