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The Integration of BIM in Later Project Life Cycle Phases in Unprepared Environment

Petr Matějka[1]*, Vít Kosina[1], Aleš Tomek[1], Radan Tomek[1], Vilém Berka[1], Dalibor Šulc[2]

[1] *Czech Technological University in Prague, Faculty of Civil Engineering, Department of Economics and Management in Civil Engineering, Prague 166 29, Czech Republic*
[2] *Československá obchodní banka, a.s. – Facility management department, Prague, Czech Republic*

Abstract

The article examines the topic of Building Information Modeling (BIM) from the perspective of the owner in an environment that was not prepared correctly for later BIM integration. The best way to utilize BIM is to use this tool from the beginning of a project, according to the concept of Integrated Project Delivery (IPD). But there are many projects, which started without the opportunity to implement BIM in the beginning. The question is, whether it is possible to utilize BIM in later project life cycle phases, especially during its operational phase, even when there is no proper BIM environment from preceding phases (i.e. no model, no BEP, no common environment etc.) The paper answers this question by explaining possible benefits of BIM in later project life cycle phases. Such benefits are especially: easier data transfer from BIM model to CAFM system, possible way to maintain live as-built documentation for future use from the beginning of any building related project and possible way of future utilization (i.e. prolongation of the moral age). The paper also presents three simple case studies of various projects in later project life cycle phases (*Building A* of *CTU in Prague, Faculty of Civil Engineering*; *Czech Institute of Informatics, Robotics and Cybernetics* of *CTU in Prague*; *SHQ* of *ČSOB*). The BIM model was utilized in these projects for various reasons. In the end of the article, lessons, which were learned during the process are presented and they are generalized for future use. The most important findings were 1) facility management (FM) cooperation is mandatory for the project purpose, 2) it is very important to specify requirements for deliverables, 3) there is a great value in the experience from BIM utilization even in later project life cycle phases, and 4) when BIM is used as a tool, it might be successfully utilized even later on in the project and existence of the model might have other future advantages for the project.

Keywords: BIM; Building Information Modeling; facility management; project life cycle; operational phase

1. Introduction

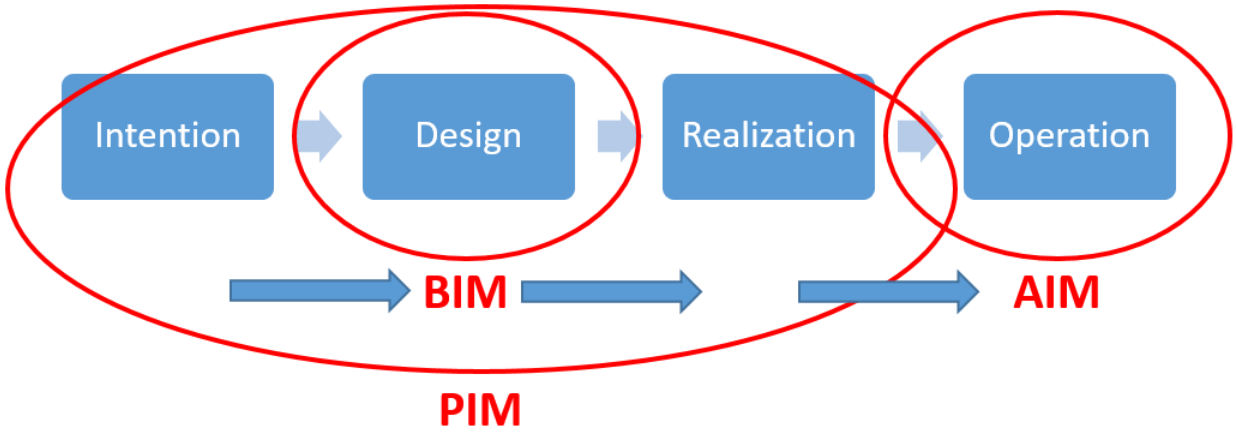
Building Information Modeling (BIM) is a worldwide topic in construction industry nowadays. As industry became more and more familiar with BIM methodology, there are new challenges and opportunities. One of such opportunities is the utilization of BIM models in facility management (FM). And this paper strives to prove that BIM is a useful tool even when used only in facility management, the last phase of project life cycle. The reasoning behind this decision is simple. From the life cycle costs (LCC) perspective, the operational phase of construction projects is often considered the most important, because life span of projects in construction industry is considerably long. During the operational phase, most costs are associated with energy consumptions, operation, maintenance, repairs and reconstruction or demolition. With the arrival of BIM, industry was given an opportunity to utilize information models during operational phase to increase its quality and efficiency, i.e. the possibility to reduce costs.

This paper will not compare these non-standard situations with typical utilization of BIM. Typical process of BIM utilization in operational phase considers creation of a model from the beginning of the project. As the project programming and design starts, the model is created and can be used throughout whole preparation and realization

* Corresponding author. Tel.: +420 607 803 814
E-mail address: petr.matejka@fsv.cvut.cz

phases. The way this is done may vary greatly based on many different project conditions and requirements. This paper does not describe these phases. Rather, it shows a model, which can be, more or less successfully, turned over to operational phase. A model which may be applied in the end of realization process (and sometimes even sooner) regardless of methods, processes or platforms. As shown in the figure 1, the building information model (BIM), which is mainly created during design process, is part of the project information model (PIM), which provides information for the asset information model (AIM) used in operational phase of the project.

Figure 1: BIM, AIM and PIM relationship (source: author)



This is the case of so called *BIG BIM* [1]. However, there are many construction projects, which were planned, designed and realized without any use of BIM. Mostly because they were started before BIM was a part of common practice, but there are also current projects which do not fully utilize BIM for various reasons. This paper aims at answering some common questions of construction industry: Is BIM still worth being applied even at the end of realization phase? And how should it be done properly? The authors were repeatedly faced with such questions. This paper is an outcome of practical case studies where the decision had to be made whether to use BIM or not. It discusses needs of projects, advantages of BIM but also problems which need to be judged before making a decision.

2. Literature review

Topic of FM and BIM is widely discussed in scientific journals. Articles usually refer to the topic from a perspective of facility manager or owner, who is the end user of information model. Such is a case of [2], for example. This article describes a framework of evaluation and presents possible ways to assess and expand technical knowledge of owners and facility managers by assessing their BIM competency. On the other hand, [3] discusses the handover issue from the data format perspective. There are also articles dealing with the topic of BIM utilization in FM in more general way, like [4], [5] or [6]. These papers present key benefits of BIM integration in facility management or points out problems connected with this topic. There are also some supporting case-study articles, like [7], [8] or [9], but more thorough case studies are usually presented in scientifically oriented books. Other relevant topic is the problem of BIM adoption into facility management (i.e. BIM transformation into AIM). Such topic is, for example, dealt with in [10] or [11], where needs of FM are identified, clarified and accepted, based on both experience and survey. In 2012, an article presenting study of Pennsylvania State University initiative to utilize BIM for FM application [12] was published. It focuses on operational requirements and their specifications from experience. Such specifications are extremely valuable for future development projects, but they are also highly dependent on project specifics and requirements.

Interesting article [13] points out, that the topic of BIM from FM perspective should not be restricted only for new construction, but also for existing buildings. Comprehensive literature review has been done in the research for this paper. Based on this research, three main challenges were identified. These challenges are [13]:

- "*High modeling/conversion effort from captured building data into semantic BIM objects*
- *Updating of information in BIM*
- *Handling of uncertain data objects and relations in BIM occurring in existing buildings*"

The topic of BIM and FM is very common in scientific publications. The operational phase is often mentioned in general BIM literature like [14] or [15], where BIM is described as opportunity, especially because it is an excellent tool for implementing integrated project delivery (IPD) approach. Other publications were written with special regard to facility managers [16] or owners [17]. Such books examine the topic more thoroughly than

general literature, using FM perspective as a central viewpoint. They address key BIM-FM issues and usually also present case studies of BIM utilization in various projects. Such projects are exclusively newly constructed projects or reconstructions. There are no case studies of projects where BIM was used for asset management without previous BIM utilization during design or realization phases.

Based on the literature review, it is possible to state that BIM has considerable advantages for FM, but the proper way of implementation (especially problems with specification of data requirements and problems with their actual use) and decision making process about BIM integration are contemporary issues. This makes sense, because the attempt to use BIM in such late phase should be considered as bad practice and failure of proper BIM utilization in a project. On the other hand, it does not reflect reality, since many such construction projects exist in the whole world and will surely continue to exist in near future. This topic is not covered in scientific literature at all.

3. Research case

The problem of BIM utilization for projects in later phases is a very complex topic. There is a big discussion in scientific literature about the value of information gathered throughout project life and how such information may be used. But there is a lack of knowledge about return value of such information (i.e. creating models) just for the purpose of facility management. It is very hard to calculate costs and benefits of these processes and when they are calculated (usually retrospectively), they are dependent on relevant projects. Attempts to use such cost calculations for different projects decrease accuracy even more.

When facility management system is implemented, it has to be supplied with necessary data. Part of such data (like design sheets, some geometrical data, revisions, manufacturer information etc.) may be included in a BIM model, but they can also be delivered without a BIM model. So the question might be why even bother with BIM for later project phases. There are three main advantages of BIM in later project phases:

- Data transfer from the model is much more efficient than manual data input; this is especially noticeable in bigger projects.
- BIM model may be maintained as current as-built documentation and used easily in future changes to construction; in an ideal scenario there may be live connection between model and computer aided facility management software (CAFM). Such model brings potential for future utilization of BIM in other similar projects.
- Modern technology is very fast in progress, which results in the fact that construction projects become obsolete much faster than in the past. The absence of a model further aggravates the problem. Mere existence of a model has therefore potential to prolong moral age of the project and might bring various synergies throughout its remaining part of life cycle.

Although mentioned advantages are clear, there is still the issue of return value and other questions. Problems of creating a model in later phases are widely discussed in [13]. Moreover, there is often the issue of contract terms and conditions (especially requirements specification), where deliverables have to be stated. This is not so much of an issue in new construction projects or general reconstructions (where there are major changes to operation of the building). According to the concept of integrated project delivery (IPD), the owner or facility management may easily specify all necessary requirements before the operation phase. Operation phase (and especially facility management system) is planned during design or realization phase of the project.

When BIM model is considered as an option, the typical approach is usually the *decision approach*. The decision whether there will be a model or not is made first. Then it is followed by realization. There is nothing wrong with this approach, as long as it is based on a qualified decision. Adequate resources are also necessary for finding proper solutions and realization of the intention. If the decision is based on both qualified judgement and adequate means, it is largely beneficial. Unfortunately, this is often not the case. On the other hand, the decision approach is straightforward and is often the only viable way of initiating BIM adoption process. There is also the *requirement approach*, which is based on the possible use of modern technologies. The use of such technologies often has specific requirements. Also, the use of such technologies results in specific deliverables, which might or might not be used (this is often an issue in traditional delivery systems, for example when project is designed as BIM model but supplier is not able to use BIM data). Decision approach may be utilized without preparation in advance, requirement approach cannot. If we want to specify requirements, we need to be familiar with expected outcome.

The paper examines described issues from the owner perspective. The case scenario considers larger construction project in later life cycle phase (late realization or operational phase) and how the decision making process concerning any kind of BIM implementation works in such projects.

4. Methodology

The research is based on literature review and practical experience of authors. This knowledge defines the system in which specific projects are examined. For the examination, three projects were chosen and comprehensive case studies were created. Structured questions were asked to key project personnel and answers were analyzed. Analyses were then used for deduction, which resulted in mapped decision-making process with commentaries. These decision maps were then synthesized into generalized schematics and best/worst practices, which are presented in the results section of this paper.

5. Results

This chapter of the article contains case studies of three projects. These projects are similar in their approach to BIM modeling and possible following use of models in project operational phases. Each project has a different motivation for BIM model creation with different results. In the last subchapter named Outcomes, lessons learned are summarized.

5.1. *Case studies*

For the purpose of the paper, only brief information is presented, because of the article extent restrictions. Also, many of the data cannot be published due to legal restrictions. The emphasis was put on such parts of case studies, which are the most relevant for the paper.

5.1.1. FCE A

The Czech Technical University in Prague (CTU), Faculty of Civil Engineering (FCE) decided to upgrade its facility management system in the future. This decision is connected with a big reconstruction of some faculty buildings which was planned. There is a possibility to use BIM during this reconstruction and model should then be used for FM after reconstruction. The problem of requirements specification was identified as a part of preparation phase, when the model of existing building (*building A*) was created. This model was meant to be created according to requirements of new facility management system. Unfortunately, due to time pressure, it was not possible to specify all requirements in the contract. The new facility management system is not operational yet and there are still some decisions waiting to be made. Regardless, this was an extremely important milestone for the FCE. If a model of *building A* was not to be created, the necessity to create requirements would arise during the reconstruction of other faculty buildings, and they would not be prepared properly. As a result of the contract, not only was the model created, but also requirements for the future models were defined, according to the specific needs of faculty FM. Model of *building A* was also used for demonstration of possible functionalities of new FM system. The investment into model creation was supported by the fact that model can also be used as an educational tool for BIM oriented classes at FCE.

5.1.2. CIIRC

There is an ongoing big reconstruction of former canteen and administrative building of CTU in Prague. The reconstruction will create new spaces for Czech Institute of Informatics, Robotics and Cybernetics (CIIRC) and other facilities. The information model was created during design process, but there was no level of detail (LOD) or level of information (LOI) specified. Therefore, the model is merely a 3D model of the building. There was not any logical structure of the model and it was not a part of project preparation or contracting. A model of the building brings a significant advantage as other information for FM can be added later into an already existing tool. CTU decided to implement FM that can utilize BIM as a part of its future strategy. Additional information will therefore be gathered in the end of realization process of CIIRC project on CTU expenses. It was necessary to specify required information on general level (i.e. not to stick to one selected CAFM tool) first, so that additional information in later phases is endorsed. Unfortunately, this was not possible in the beginning of the project, due to lack of expertise. Also, an old FM system was used, which does not support any BIM import. Furthermore, some decisions about specific FM tools for CTU were not made yet, so it was not clear how information exchange would continue and what information should have been included in the model. The communication between FM experts and project team was important to specify requirements for the model on general level, so there will be less additional work and changes to the model in the future.

5.1.3. SHQ

Compared to CTU projects, *Československá obchodní banka, a.s.* (ČSOB) is not bound by public contract legislation. As a part of preparation phase for the construction of the new headquarters building (South HQ – SHQ), it was necessary to specify requirements for the whole project (to prepare BEP, to define LOD and LOI,

solve many security issues etc.) ČSOB made strategic decision to use modern CAFM system in the past, but BIM was not common practice in the Czech Republic by that time. To prepare for the construction of new headquarters, ČSOB identified possible savings when BIM is properly utilized. To be able to specify relevant requirements for SHQ, ČSOB decided to create BIM model of current headquarters (North HQ – NHQ). Existing documentation was partly transformed into BIM and then used for FM purposes and for education of FM staff. This way, FM department of ČSOB was able to actively participate in the SHQ project. This cooperation was mandatory for proper BIM utilization in ČSOB. The project of SHQ will be one of the biggest BIG BIM project in the Czech Republic.

5.2. *Outcomes*

From the experience and case studies of mentioned projects, following outcomes were formulated:

- Requirements for PIM and AIM have to be defined, according to the project goals. These requirements should be defined in the most specific way possible, but even if they are not, the whole process of their defining is an extremely valuable lesson for future projects.
- FM participation is mandatory. Even though IPD principles are best applicable from the beginning of the project, it is also possible to gain added value from later collaboration. End user participation is very important for proper specification of requirements, and risk management.
- Even a simplified BIM model for an already existing building may be used as a tool and knowledge base for the future BIM implementation into FM. The value of experience is extremely high for BIM related projects. It is very hard to successfully implement BIM without prior experience in similar environment, and every project in construction industry is different.
- The integration of BIM in later project life cycle phases is possible, but it is not necessary to stick to BIG BIM. BIM should be used as one of many tools, which may achieve desired goals but also has future potential.

6. Conclusion

The article examined the topic of BIM from the perspective of FM in projects, where BIM model was not created during design and realization. Opportunities of BIM utilization during operational phase of project life cycles are widely known, but that does not necessarily justify creation of a model in later project phases. Still, when such decision is made, it might be beneficial for the owner. But it is extremely important to model efficiently, i.e. follow requirements and not end up in doing BIM for its own sake. When requirements are to be followed, they must be specified beforehand. Although there are many predefined specification formats we can use or guidelines we can follow, these standards are usually country-specific or very general (like COBie for example). To fully utilize benefits of BIM, requirements have to be specified according to relevant project needs. To specify such project dependent requirements, facility management integration is necessary. Simply put – it is very hard to specify what we want, if we do not know what we will use it for. It is good practice to use any kind of general reconstruction or new construction as an opportunity to modernize FM system with or without BIM. For existing buildings, the main aim should always be defined by needs and possible information utilization. BIM model might not always be necessary, but could be useful in many ways and its creation should be considered. Return value should be calculated and decisions should be made with enough information, which might often be hard to get. Information regarding FM needs and future development is especially valuable, as well as information regarding BIM and its key aspects.

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