Using BIM for building maintenance management in Iraq

Karrar Abbas, Yusuf Mohamed, and Elsheikh

Abstract. Owners are responsible for performing necessary maintenance on their buildings, and they should do so whenever possible to maintain capital and ensure people's safety while using the buildings. Lack of information and data prevents construction managers from effectively managing building assets and making decisions during the operation and maintenance phases. In Iraq, a large portion of the data used from building managers is still on paper. Construction managers face challenges due to a lack of information and data when making decisions about building assets during the operation and maintenance phases. It is clear today that the construction industry is witnessing significant growth in numerous areas, particularly as the sector's demand for labor and materials grows. Building information modeling (BIM), which has grown to be closely related to all aspects of the project at various stages from planning through construction to project closing, is one of the most essential aspects of rapid development. This article presents the use of Building Information Modeling (BIM) for construction facility management. One of the purposes is helping to reduce maintenance costs and extend the life of project components. The study's aim is to determine the impact of integrating building information modeling with maintenance management by presenting a methodology utilizing BIM-FM workflow and the creation of a user-friendly comprehensive system which include information about the facility and components as well as maintenance, in addition to identify the barriers to using 6D/BIM in construction industry.

1 Introduction

Each building has a conventional life cycle begins with planning, design, implementation, operation and maintenance, and ends with demolition. During working period of any project, we need to apply maintenance regularly, because if we don't apply that the owners will spend the longest time and a lot of cost. The lack of maintenance will effect on a building life and it will increase deterioration of the fabric and finishes of a building accompanied by harmful effects on the contents and occupants. Despite of all of that there are many owners who’s ignoring the importance of regular maintenance of the building.

Maintenance can be defined as “the necessary services and activities provided to conserve, protect and maintain the structure and form of the building upon completion or...”

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after any repair or replacement of the current standard in order to function at its entire age without interfering with its features and use original” [1]. It covers the whole building which includes toilets, rooms, walls, roofs, drains, doors, windows, floors and also the fix furniture [2]. Building maintenance is a global issue and is taken into great consideration in the early construction (design) process to ensure building quality [3]. The primary objective of building maintenance is to preserve buildings in their initial functional, structural and aesthetic state [4].

An effective Building Maintenance Management must manage and integrate information such as drawings, inspections and manual, checklists, and records maintenance reports [5]. Commonly, the information consists of 2D drawings, bar charts field reports, and spreadsheets which are commonly handed over from the design and construction phase of the building [6]. This information existing as text format and kept as record papers handwritten [8]. Furthermore, information is distributed to various locations and the maintenance procedure have to deal with the various variables that are available from different systems and large data managing information. There is a vast waste of money and time for information searching or to try to decisions taking with limited information [9]. With the availability of an integrated digital database, the performance of the maintenance practice is predictable to increase [10]. There is an opportunity to develop the current use and practice of BIM as a tool of decision making [11]. Applications of BIM on maintenance process can offer an integrated historical record database of all building elements, equipment, providing information about the real components performance within the building and direct access provision to all data through an easy interface [12].

Interest in using BIM in FM is growing, especially in the UK since the government BIM initiative highlighted BIM for FM as one of its fundamental principles and required that project life cycle data, including FM phase, should be managed using BIM by 2016 (Smart Market Report, 2014). Today, it is obvious that there a huge impact of new technologies on the construction industry because of the fast development of information systems in our world that will help us to solve the traditional problems which we often face in our projects.

Building Information Modelling (BIM) is defined as a new approach that is utilized to manage project data and information through design, construction, and facility management (FM) [13][14]. BIM, when viewed from a larger perspective, is “a digital tool that facilitates data management and supports interoperability during the procurement and management of the built environment” [15].

The goal of this study is to develop a methodology for the potential using of the building information modeling technology in the facility management phase, to increase the efficiency of maintenance management work.

2 Methods

Figure 1 shows details the methodology followed to build the BIM model.
2.1 Description of case study

The existing building (School building) was chosen due to the reality of the maintenance of government buildings in Iraq is not going according to the real system of management. Furthermore, facility managers in this sector face problems such as ageing and low energy efficiency, as well as a lack of information relevant to the buildings asset and making successful decisions for maintenance works.

The school building is located in Wasit, Iraq and is owned and operated by the government. The building is composed of 6 parts, the main building including two floors and is functionally divided into class rooms, Computer room, Teachers rooms, Headmaster room, Librarian, Books store, Assistant room, Toilet rooms. The assembly hall building and other secondary parts (sanitation part, electricity room, guard room, food store with sports room) have a single storey. The building manager provided the architectural plans in 2D format, as well as service manuals and technical documentation for certain components, as well as information on the materials used on the floors, walls, and façade.

2.2 Architectural model

Until continuing with the import of plans and project modeling, it is essential to construct all types of elements or components for the construction. So, all necessary data regarding building composition can be ready during using Revit for modeling. Creating component kinds relates to creating the elements of the model, like the kind of walls and floors including the various layer, and the kind of material and the type of doors and windows.

<table>
<thead>
<tr>
<th>Table 1. The components and the level of details for architectural model</th>
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<tbody>
<tr>
<td>Model</td>
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<tr>
<td>Architecture</td>
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<tr>
<td>Construction</td>
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Construcional design.

Walls:
Internal surface treatment: The final treatment of the ground in the school includes tiles. Walls and ceilings are lined with plasterboard and for toilets with ceramics.

Joinery Doors, windows: Are classified according to documents. The accuracy of this data is very significant, in order to using this information during FM phase (O&M). In the event of failure, the owner or facility manager will directly find and access the kind and dimensions of the door or window. For the school Aluminum windows with external blinds are mounted on the façade. Interior doors are made of metal doorframes and door panels are made of Aluminum. The main entrance and exit have metal doors.

To establish a BIM model, Revit was utilized. This model is depending on establishing an accurate geometry of facility like it is built, as well as it accurately reproduces the actual plans. The facade is also meticulously designed, using the types of walls created in the prior step, and the materials and colors are meticulously respected. The school campus includes main building, assembly hall building and other secondary parts (sanitation part, electricity room, guard room, food store with sport room). All categories of these parts are constructed in the BIM model.

2.3 Mechanical, Electrical, Plumbing and fire (MEPF) Model

The MEPF (mechanical, electrical, plumbing and fire) system contains cooling/heating, ventilation, and fire protection. It plays a major role in school building. Currently the building operator has not utilized any information management system. The plumbing, cooling/heating, and ventilation systems contained technical documentation, such as equipment type and system plans.

Table 2. The components and the level of details for MEPF model

<table>
<thead>
<tr>
<th>Model</th>
<th>Method</th>
<th>Components</th>
<th>Level of detail/Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plumbing system</td>
<td>Technical documents</td>
<td>Waste Water pipes</td>
<td>Type, Dimensions, Materials, Colors</td>
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<td></td>
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<td>Cold Water pipes</td>
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<td>Hot Water pipes</td>
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</tr>
<tr>
<td>Ventilation system</td>
<td>Technical documents</td>
<td>Air vent, Extractor</td>
<td>Type, Dimensions</td>
</tr>
<tr>
<td>Fire protection</td>
<td>Technical documents</td>
<td>Fire extinguisher</td>
<td>Location, Type</td>
</tr>
</tbody>
</table>
sewage equipment. The information is incorporated into the BIM model. The building is connected to the existing water supply network. Domestic hot water is supplied centrally by a combination water heater (V = 100 l; heated with a heat pump or electricity). The building is connected to the existing sewer system. A horizontal distribution pipes is made with polypropylene tube.

Fire protection system: A fire risk assessment system is significant to prevent or reduce fire hazards and keep people safe. This should be checked and updated regularly. Therefore, the inspection and maintenance of fire equipment such as extinguishers and fire detectors must be carried out regularly. For school building model the following equipment were incorporated: emergency exits, fire alarms, and fire extinguishers.

HAVC system: In accordance with technical plans, this system was implemented. The heating of the building is supplied by the heat pump, which serves for rooms cooling in the summer. The external units of heat pumps and air conditioning are installed in the outdoor space. The equipment's BIM model was downloaded from the constructor's website.

ventilation system includes two heat recovery units, an integrated filter and an air inlet and outlet fan.

2.4 Collecting specialization models

Fig. 3. Partial view on cooling/heating system and its model in BIM

Fig. 4. Assembled the As-built BIM model from different discipline
3 Maintenance management utilizing BIM

During the operation of the school building, several types of incidents and system failures occurred, which were treated without any planning or standard procedures with the sole purpose of resolving the anomalies to what is known as corrective maintenance. In the case of preventive maintenance, a traditional flow was identified where the Facility Manager coordinated with the administrator of the educational facilities to program the preventive maintenance, after being executed and approved, these activities were registered in paper-based reports. Finally, these documents were stored in physical or digital storage. As a result, there was wasting time when the Facility Management Team needed to know the maintenance activities’ status or trying to find specific information in file boxes. It is necessary to change the approach and introduce methodologies and tools to respond to the problems associated with traditional maintenance flows.

To create an as-built BIM model of existing buildings, all necessary information/data and documentations are needed from the facility managers and other stakeholders concerned by the facility. It needs to make connection between the BIM software and the FM software. It is important to transfer the school building Revit-created BIM model to the management software in order to use it in the scope of maintenance management. For this purpose, the Ecodomus software was chosen. The ability to incorporate with the system of BIM model utilized for FM like computerized maintenance management system, and computer assisted facilities management, is the essential benefit of using FM software such as Ecodomus.

4 Results

The on-site maintenance team can navigate into the BIM model and utilize BIM functions like view, filter, and search to find the target component using the FM platform.

Fig. 5. Process of BIM-based maintenance

Fig. 6. Component location on ECODOMUS using the component ID
Using BIM, documents and information gathered from the building manager are saved in PDF format with specifications related to components and attached to the components. Types of documents used: maintenance manuals, warranties, and technical documents.

Fig. 7. Maintenance document integration for outdoor ventilation equipment by using Ecodomus.

With FM tools that incorporate BIM model information, the use of a Work Order (W.O.) system has been adopted. Work order’s function sends maintenance managers to the maintenance team when the component requires urgent maintenance. It helps to make maintenance more effective; it assists the maintenance team to access necessary information and improve task tracking. So, it provides the possibility to deal with tasks and reports directly on-site from mobile phones or tablets, with the option of sending work orders. Figure 8 presents the creation of an inspection checklist for a water tank in Ecodomus.

Fig. 8. Creating a water tank inspection checklist in Ecodomus.

Figure 9 shows several capabilities provided by a BIM-based management system and also compares it with the traditional management way.
5 Conclusion

Nowadays, much of the information utilized from facility managers in O&M phase is still based on the traditional paper-based method, and the Facility managers suffer from a shortage of information and data, that involved with building assets and make efficient decisions at the operation phase which leads to inefficient the maintenance management.

In order to show the benefits of utilizing BIM in O&M phase over traditional methods, methodology for using BIM in the O&M phase in scope of maintenance management was developed and applied to a case study of a school building. The utilize of building information modeling technology for the maintenance management of certain building components demonstrated the BIM technology’s high value in creating effective school building maintenance. The implementation of BIM tools in the operation and maintenance phase improves the productivity and efficiency of the maintenance staff in maintenance management tasks because they have ability to access to an integrated information platform, whether it is required from the office or on site instead of spending time searching for information in 2D drawings, manuals and other paper-based documents.

The ability of this system has been demonstrated by applying it to maintenance of some building component. This implementation affirmed the high performance of this framework with easy to use interface and environment. Table 3 compares the conventional maintenance workflow with the suggested BIM-FM process.

Table 3. Comparing traditional maintenance flow with the proposed BIM-FM workflow.
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