Facilities management in high rise buildings using building information modeling

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A B S T R A C T

The facilities management (FM) is getting more attention in the recent years due to the fast grown in some high-rise buildings, especially in Vietnam. Currently, there are many problems for the FM processes such as the inconsistent hand-over information, the difficulties in organizing, managing, updating information during the Operation and Maintenance (O&M) phase, and the old management technology. The principal purpose of this research is to evaluate the status of technology implementation in the FM processes and propose the frameworks to build up BIM to support the FM operations. By conducting surveys to FM experts, the research explored the current hand-over processes and the needs for implementing the information platform (IT) to support for FM tasks. The new BIM- FM integrated frameworks were proposed to replace the current hand-over processes and to manage the information for the O & M phase.

1. Introduction

Real estate is one of the fastest grown industries in Vietnam for the last decade. The number of high-rise building in the big city such as Ha Noi and Ho Chi Minh City is increasing very fast every year. However, still the Facilities Management (FM) technology is left behind the Construction technology with more modern and complexity of the building systems. The lack of effective management in high-rise building causes many concerns from customers who did not receive their required quality services (Ullah et al., 2016).

BIM (Building Information Modelling) is "a new approach to design, construction and facilities management, in which a digital representation of the building process is used to facilitate the exchange and interoperability of information in digital format" (O'Conor et al., 2004; Gerber et al., 2011). BIM is raising much attention in the design and construction industry during the last few years, but still due to the lack of support from the government law and the fragmentation of BIM users, the implementation of BIM is facing many difficulties.

Currently, BIM is used in some task in design and construction phase, but the information transfer process between stakeholders is not effective enough and need more cooperate between parties. However, with the powerful, rich data stored capability; BIM could be beneficial for various FM practices, such as commissioning and closeout, quality control and assurance, energy management, maintenance and repair, and space management. Although there are many potential BIM applications for FM phase, like much other Information Technologies (IT), it is still unclear about how to apply BIM for FM phase and the required information to build up BIM process support for FM. The purpose of this paper is to demonstrate the level of IT implementation in FM tasks, which hand-over information, was collected and used in the FM phase. With the current hand over information process, the research will illustrate new BIM-FM integrated frameworks to build up BIM as the central database for FM phase.

2. Research objectives

The rapid development of technology in the last few year brings the good chance to apply BIM processes in many fields of the construction

industry. Many architecture and construction firms in Viet Nam are getting familiar with some BIM tools such as Revit and Tekla. However, still the FM experts are using the old management method with the lack of information technology implementation (include BIM). This research aims to provide an overview of the level of information technology implementation in FM and tries to outlines the advantages and disadvantages of the current information management process in the FM phase.

The specific goals of this research are (1) to explore the status of IT implementation and information used in the FM processes, and (2) to build up the framework to create BIM for FM phase.

3. Research methodology

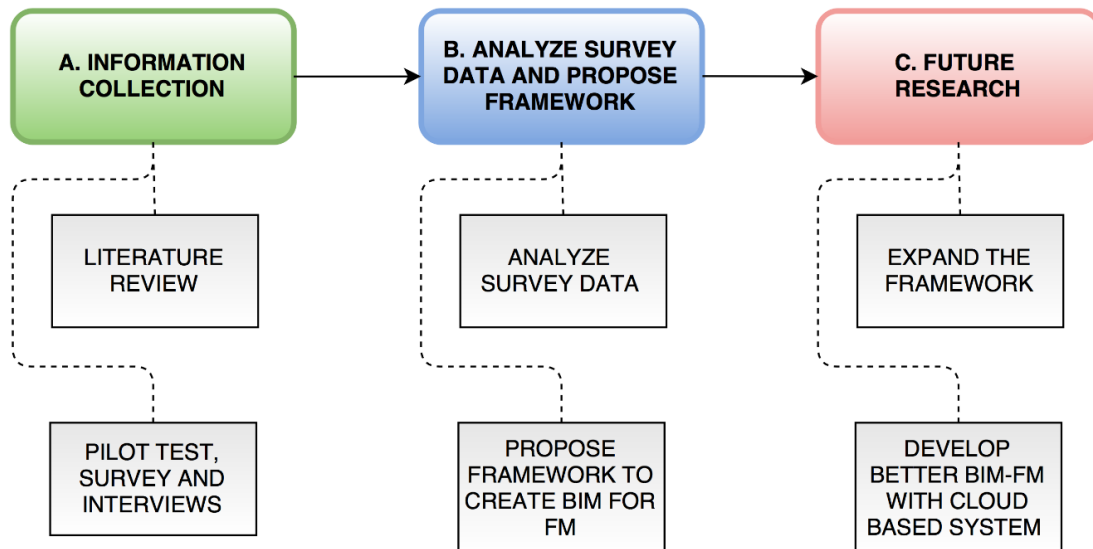The research includes three main steps as shown in Fig. 1.

Fig. 1: Research methodology

3.1. Information collection

The first period of this research is the depth literature review of the current BIM implementation in the Facility Management (FM) phase. The literature is the suggestion of the study, and the survey will be modified and adjust during the pilot test and interview process. The purpose of the survey is to understand the status of IT implementation in O&M and identify the needed information for FM staff from the hand-over data.

The survey includes a variety of multiple choices, Likert scale and the optional question that provided both quantitative and qualitative information (Brooks and Lucas, 2014). The direct interview has conducted the questionnaire. The objects for this research are the FM staff members from many high-rise buildings in Ho Chi Minh City. The survey will clarify the following information:

- The data handover from design and construction phase to the operation and maintenance phase.
- The areas that the FM team is involved.
- The information technology is applied in the operation and maintenance phase.
- The advantage and disadvantage of using technology information into FM.

3.2. Analyze survey data and propose framework

Following the information collection period, the survey data will be analyzed to identify the needed

input information for FM staff. This information is very vital to define the information is required to add to BIM and the information that need to be manage, update, and maintenance during the O&M phase. From the analysis result, the research will propose the following frameworks:

- The framework for collecting handover data and build up the BIM models.
- The framework to integrate BIM into the current facility management processes and manage data throughout the project management life cycle.

The proposed frameworks will be represented by BPMN (Business Process Model and Notation) diagrams (White, 2008) (Fig. 2).

Future research: After the basic framework has finalized in this research, further research will develop the framework in more detail and wider application fields. In this research, the data from BIM model is only for viewing and updating the data in O&M phase, but the future research will analyze the data during the O&M activities to provide the better decision solution, which enables the FM staff adequately, control the building data. With the rapid development of the cloud database technology, the future research will develop more applications for the BIM cloud-based system that provide the smoother and more efficient solution for the FM tasks.
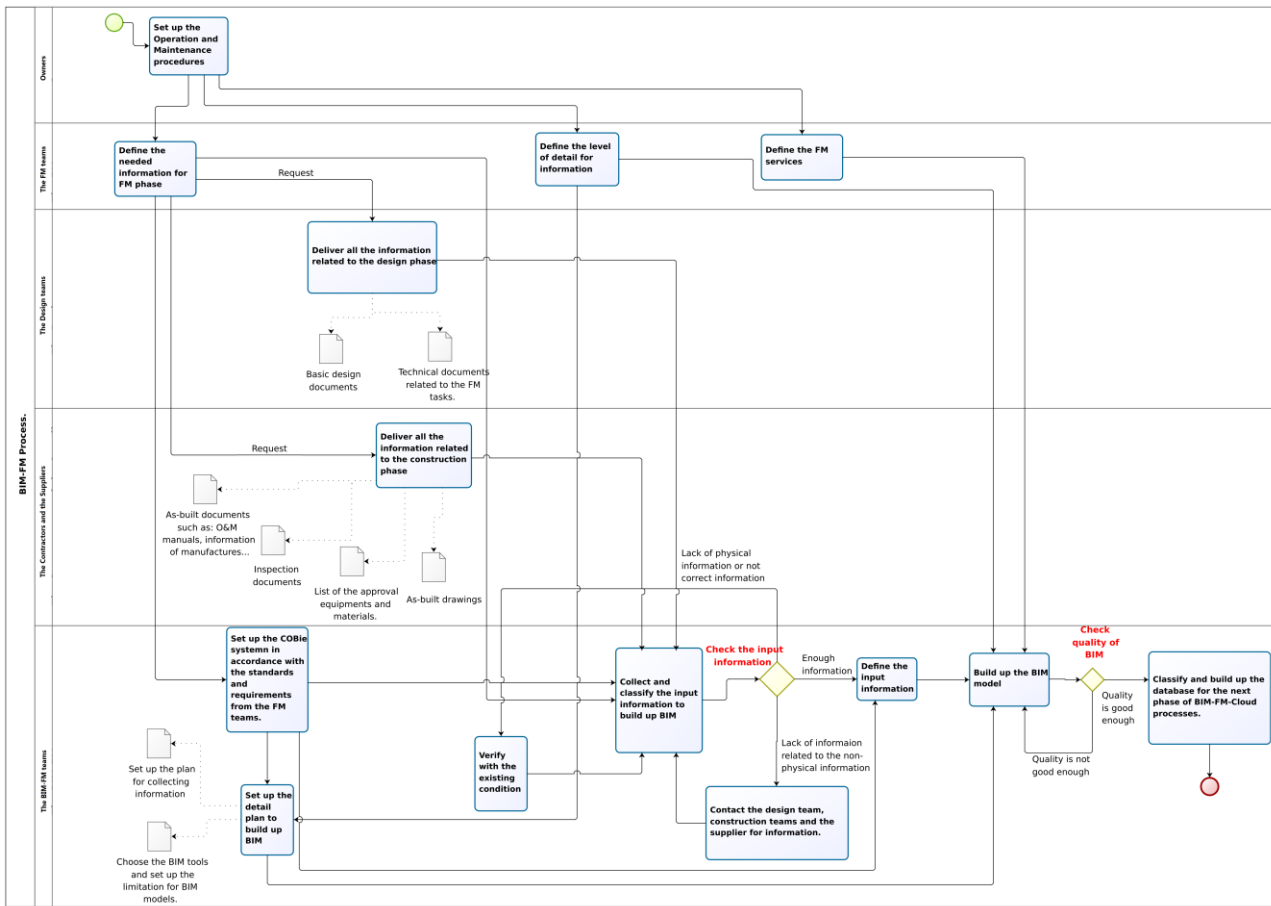
Fig. 2: The proposed framework to build up BIM model for FM phase

4. Result and analysis

4.1. Survey structure

The eleven main survey questions were developed with information from the literature review. The surveys were conducted through a direct interview with FM staffs. The list of FM staffs was generated through contact with social network (Facebook and LinkedIn), personal contact and the FM associations. The survey started from January 2016 until now. During this period, 50 FM staffs were contacted, but only 12 staffs accepted the interview. The study is undergoing so the new result will be updated in the next version of this research.

4.2. Survey results

Question 1: Which information was transferred to the FM team at the hand-over process (Fig. 3)?
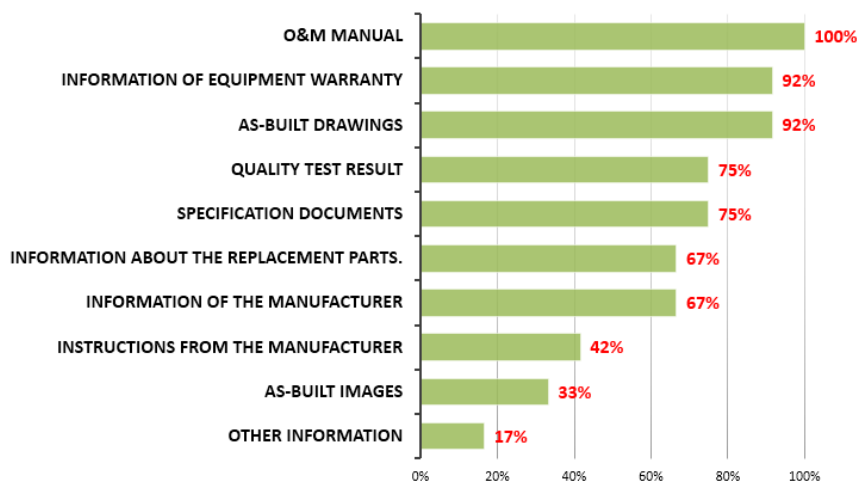

Fig. 3: The information was transfer to the FM team at the hand-over process

The result shows some general information was transfer to FM team at hand-over process include O&M manual, Information of equipment warranty, As-built drawings, Quality test result, Specification

documents, Information about the replacement parts and Information of the manufacturer (over 50%).

Some additional information is also mentioned: Legal document of environment quality and fire protection procedures.

Question 2: Which hand-over information is used by the FM team for their task in the FM phase?

The result shows that not all hand-over information has been used for FM stage. O&M manual, Information of equipment warranty, As-built Drawings and Specification documents are regularly used (over 50%). This is a suggestion for further analysis of the useful hand-over information for FM phases (Figs. 4 and 5).

Question 3: Is there any software used to support for FM tasks?

The result shows the much higher rate of using IT application (83%) compares to the manual method (17%). This result proves the important role of the IT application in the FM phase (Fig. 6).

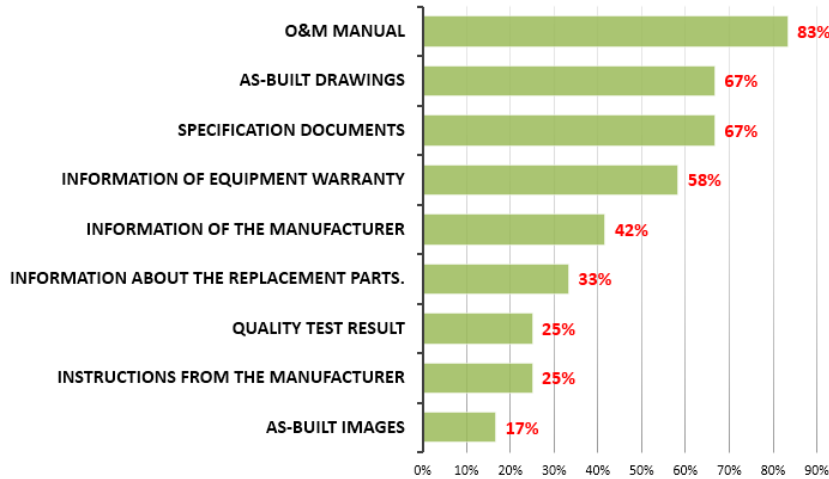Question 4: Which software is used for FM tasks?

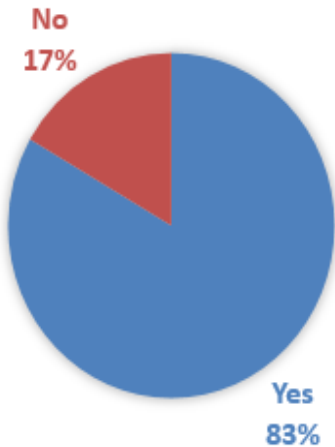**Fig. 4:** The information was used for FM stage

Fig. 5: The percentage of using IT application in FM phase

The result shows that the most common tools for FM tasks are Microsoft Office and AutoCAD. However; software are not designed specific for FM management purposes. There is the only small percent of FM teams using some modern management system (BMS) and some custom program design specific for specific company purposes. This result proves the lack of professional FM management software or BIM integrated software to support for FM tasks.
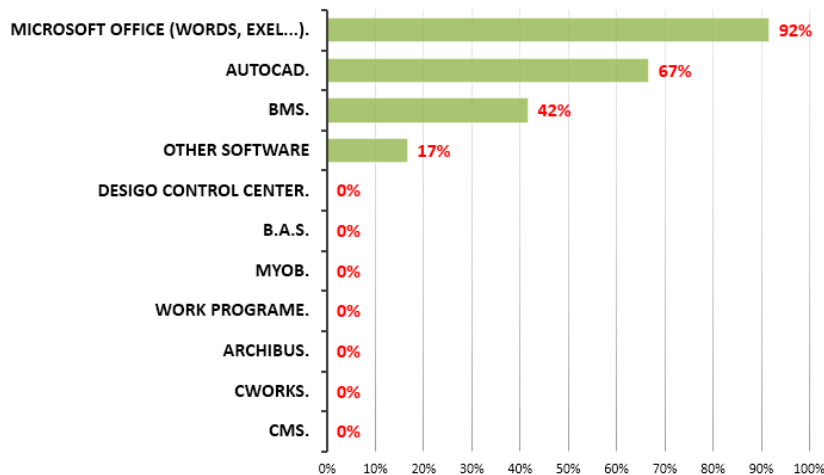
Question 5: Which kind of database is used for FM phase?

Fig. 6: The IT applications in the FM phase

The result shows the lack of using the database in FM phase. Only a small percent (33%) of FM teams are using the Microsoft Access as the database. With the complexity of building system in the high-rise building, the database should be considered to use along with the professional software to manage the building more efficiently (Figs. 7 and 8).

Question 6: When was information collected for FM phase?

The result shows there are no different large percentage between phases. It means the information for FM phase was collected throughout all the project phases (Fig. 9).

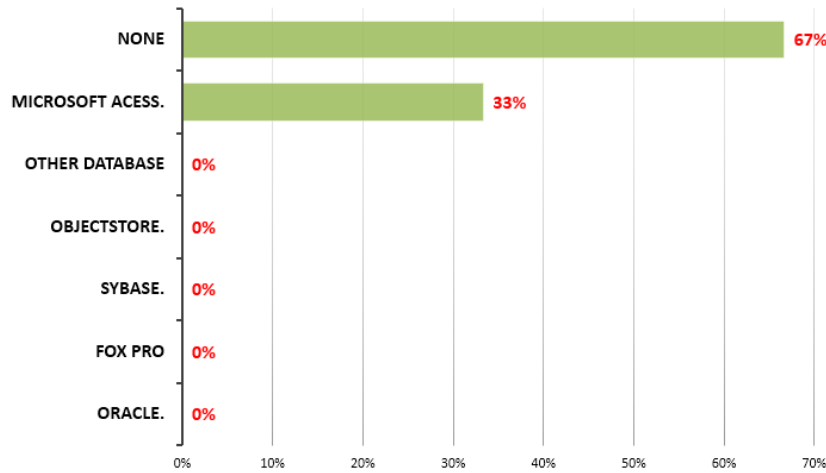Question 7: Which areas in FM are supported by IT application?
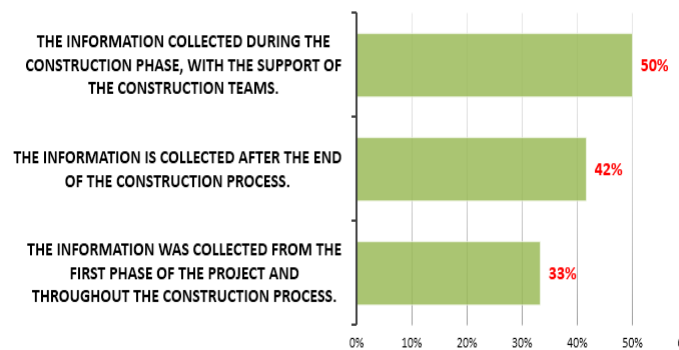

Fig. 7: The database in the FM phase
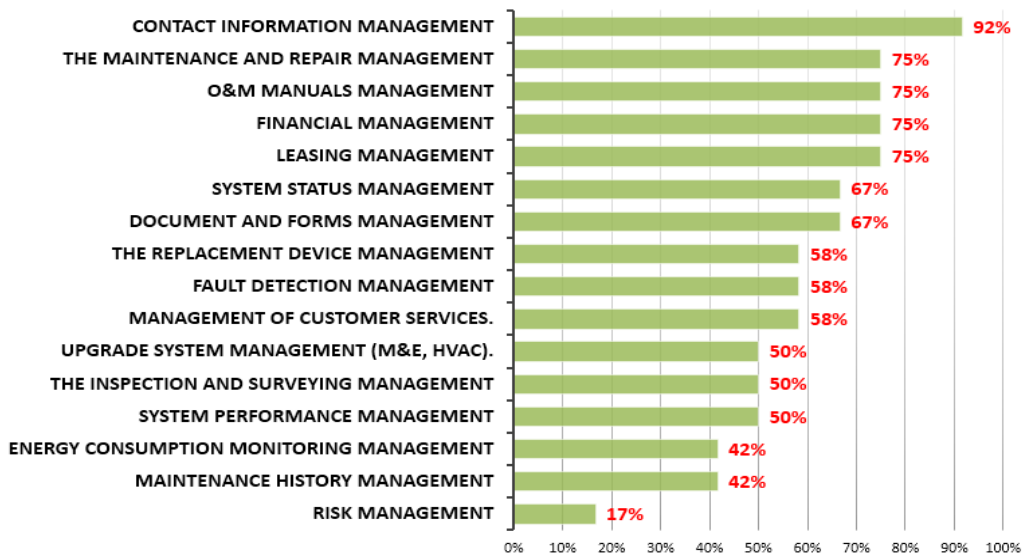

Fig. 8: The information collection phase

Fig. 9: The FM areas with IT implementation

The result shows there are many fields in FM that using IT application to manage. However, as the result of question 4 above, the most common tool to manage all these areas is just Microsoft Office, which is not designed for FM tasks.

Question 8: The benefits and the degree of effectiveness of the IT application for the FM tasks?

This question is designed in Likert scale type. The result shows there are many benefits of IT application for FM tasks such as Store the O&M manuals, fast access and search for data, store the reports and documents, personnel management and others (average score more than 3.0). However, the highest average score is just 3.67; it proves the IT application is not fully meet the requirements of the FM teams (Figs. 10 and 11).

Question 9: What factors make it difficult for the implementation of IT systems in the FM phase?

This question is designed in Likert scale type. The result shows many factors affect the IT implementation for FM. However, the highest average score is just 2.92; it proves all these factors do not affect too much on the IT implementation. So these factors will not be the sufficient barriers for the IT implementation in the future.

Question 10: What are the disadvantages of the current IT application in FM tasks?

The result shows many difficulties in the current IT application for FM such as the manual data entry, difficult to monitor the system performance, missing documents. These defects might be caused by using the unspecific FM software (Microsoft Office, AutoCAD) (Fig. 12).

4.3. Proposed framework to build up BIM for FM

The current hand-over processes regarding the Vietnamese construction law require the participation of many stakeholders in the project:

• The design teams: plan and delivers the maintenance procedures of all the system within the project, and all the design documents.

• The suppliers: deliver the operation guide of all the equipment in the project.

• The contractors: deliver all the as-built documents, operation and maintenance manuals, equipment list, replaceable equipment and all other related documents.
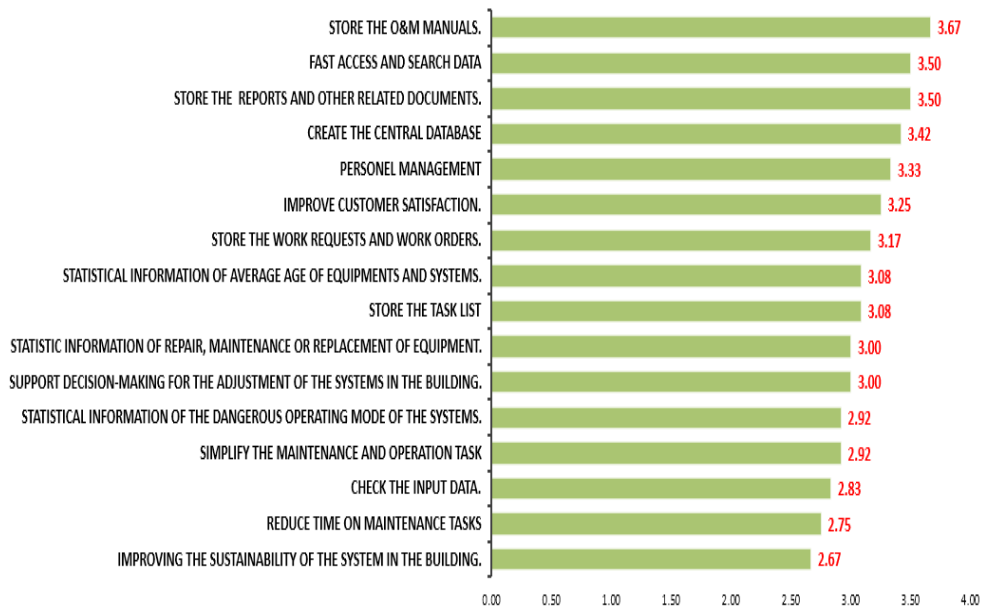

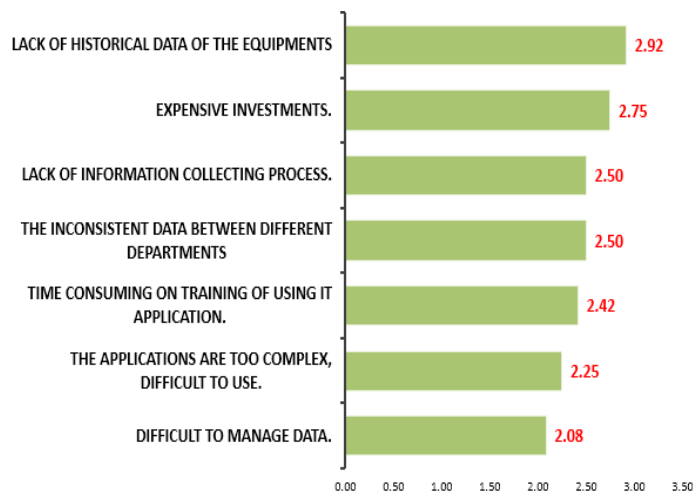**Fig. 10:** The benefits of IT implementation

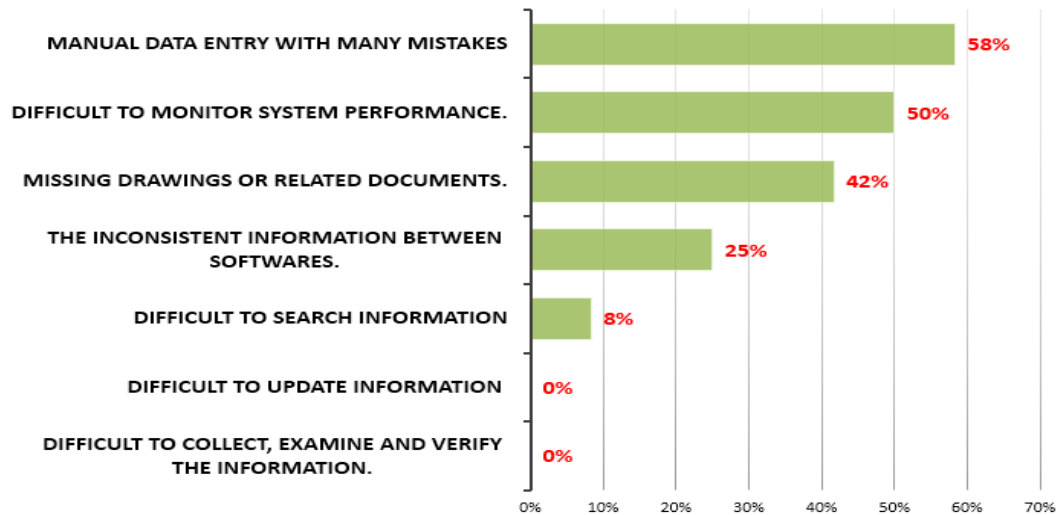**Fig. 11:** The factors hinder the IT implementation

Fig. 12: The disadvantages of the current IT application in FM tasks

With the current processes, the hand-over information is delivered to the FM team after the project is finished. The hand-over processes are described in Fig. 12. From the current hand-over information process, we suggest the new approach using BIM to collect all the data for the FM phase. The detail of new process is shown in Fig. 13.

4.3.1. The owner

In the proposed process, the owners play the first action to set up the Operation and Maintenance procedures or standards for the projects. There are some FM standards for this process such as the ISO/TC 267 for facilities management; BS EN 15221-2 Guidance of FM Agreements standard, etc. These standards are the guidelines for the FM team to set up all the necessary procedure for the FM phases.

4.3.2. The FM team

From the requirements of the owners, the FM teams will define the needed information for FM stage to satisfy the different FM standards. This task is the most important tasks of the FM team in this proposed process. This work will relate directly to the request information to other teams in the process include the design teams, the constructors, suppliers and the BIM-FM teams. Therefore, the FM teams must define this information carefully to make sure all the other teams will deliver the correct information. There is a new task for the FM team in this process is to define the level of detail (LOD) for information (Fig. 13).

4.3.3. The design teams

With the request from the FM group, the design teams are responsible for transferring all the information related to the design phase: design and technical documents related to the FM phase. All the information will be transfer to the BIM-FM team to collect and classify the input information.

4.3.4. The contractors and suppliers

With the request from the FM team, the contractors and suppliers are responsible for transferring all the information related to the construction phase: As-build documents and drawings, O&M manuals, information of manufacturers, approval equipment, and spare parts list and other related documents. Similar to the design teams, the contractors and supplier have to transfer all the information to the BIM-FM team.

4.3.5. The BIM-FM team

In the current hand-over information processes, the FM team is responsible for collecting and classifying all the information from other teams, but in the new proposed process, the BIM-FM will replace the FM team to be in charge of this task.

As the survey result, there was much information transferred to the FM teams, but not all of them were used. Therefore, BIM-FM team needs to classify the right information to put in the BIM models. COBie (Construction Operations Building Information Exchange) system is recommended for this task. The Construction-Operations Building information exchange (COBie) format is the international standard for the sharing of information about managed facility assets. COBie does not add new requirements to contracts; it simply changes the format of existing deliverables from paper documents and proprietary formats to an open, international standard format (East and Carrasquillo Mangual, 2013). COBie is usually used to collect data through the entire project phase of the BIM project, but for the building in this research (not using BIM in design and construction phase), COBie can be utilized as the template to collect the right information about BIM model.

When to gather and classify the input information, the BIM-FM team needs to set up a plan to verify the missing information in the received handover data or false as-built document compares to the condition. After finishing the collection and

verification tasks, combine with the required LOD (level of detail) and the predefined FM services, the BIM-FM teams can build up the BIM-FM models. This

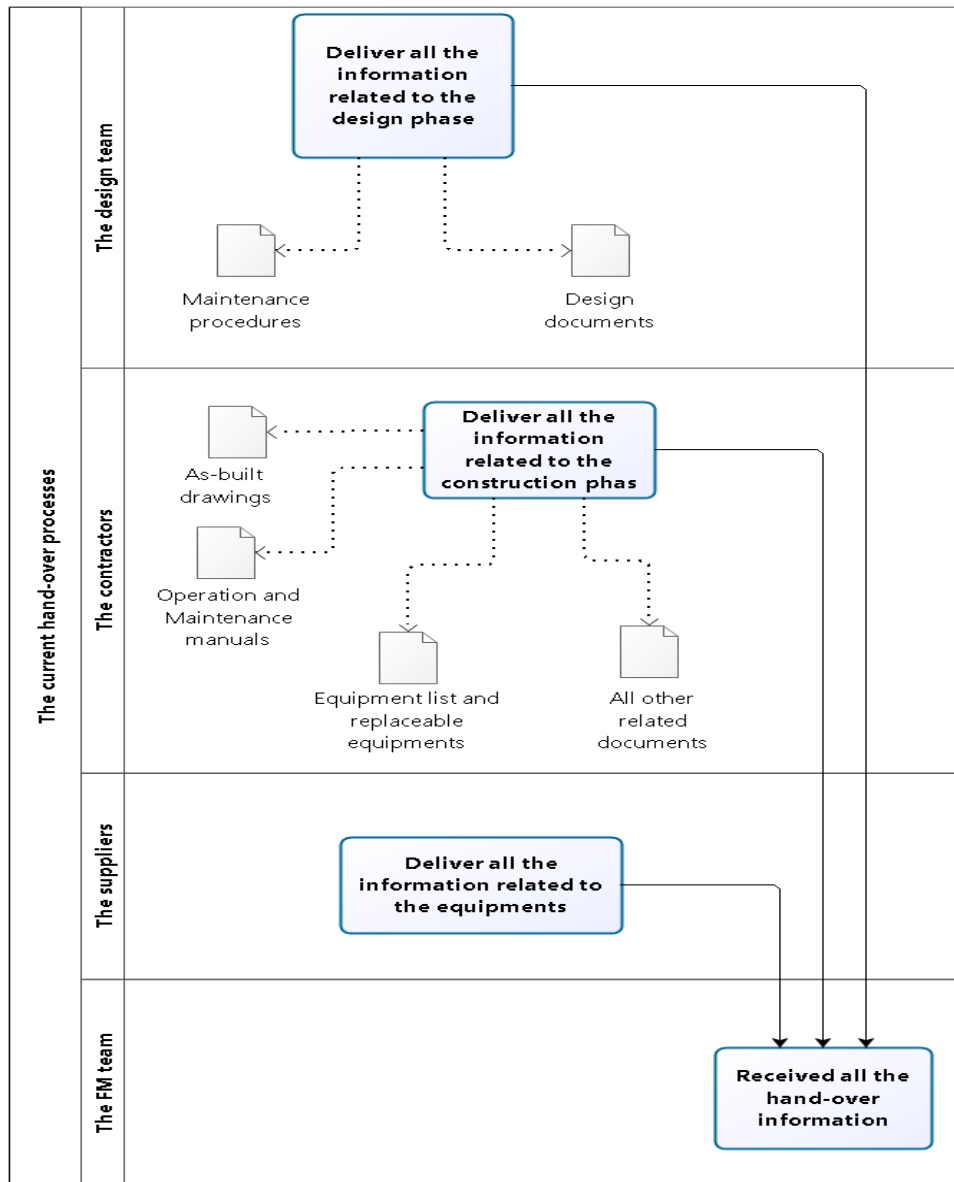BIM-FM model will be a central database to create other application to support the FM phase.

Fig. 13: The current hand-over procedures

5. Conclusion and recommendations

The result of this investigation shows some aspect of the current hand-over information processes and the current status of the IT implementation in the FM phase of high-rise building as following:

There is much information from the design phase and construction phase transferred to the FM phase, but not all of the information are used. There are the needs to classify which information should be delivered to the FM team to use for FM tasks more efficiently.

The IT applications for FM tasks are not designed specific for FM, and there is a lack of a database of information for this phase.

The current IT application for FM is not sufficient for the FM tasks.

The knowledge of BIM and BIM for FM of the FM staffs is very limited.

The new proposed BIM-FM framework is developed based on the current hand-over information process and needs to be tested in the future research to check the applicable of this framework. The future research will extend the framework to use BIM as the new database to build up the BIM-FM application and manage all the project lifecycle data.

Acknowledgments

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