BUILDING INFORMATION MODELING (BIM) FROM THE PERSPECTIVE OF FACILITIES MANAGEMENT (FM) IN MALAYSIA

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ABSTRACT

Purpose – Building Information Modelling (BIM) is a new adaptation of computer-aided technology used in Architecture, Engineering and Construction (AEC). Presently, BIM is one of the most talked-about concepts within the Built Environment (BE) sector. BIM comprises of 3D digital representation of a building system or subsystem, and it contains visual models of building integrated with database of building information especially the building fabrics and its components. Interestingly, with this particular function, BIM can definitely be integrated with Facilities Management (FM). However, the view of BIM within the Malaysia's FM arena is mixed as FM is seen slowly to engage with the development of BIM across the country. Though BIM might have emerged from the construction side of the built environment sector, but it must not be ignored by the FM stakeholders in any building life cycle project particularly after the construction project completed (Post-Construction Phase).The integration between BIM and FM have many positive effects and benefit as it capable of helping Facilities Managers to efficiently manage building, assets and facilities. Thus, this paper is trying to discuss definition and context of BIM in Malaysia; its benefits to close the computer-aided BIM-FM gap as well its impediments toward FM best practice excellence.

Keywords – *Building Information Modeling (BIM); Facilities Management (FM); BIM and FM Integration.*

Introduction

Building Information Modeling (BIM) is a set of interactions between policies, processes and technology to produce a "*method for managing importance of building design and project data in digital format or virtual through the building life cycle*" (Penttilä, 2006). Hardin (2009) stipulates that BIM is not just a clever use of 3D models, but it also is making significant changes in work flow and project delivery process while NBIMS (2010) states that BIM as a tool for digital representation comprising physical characteristics and function of a facility. Thus in other words, BIM is a process of drawing and design, construction of a building by using technology approach, and it involves a procedure in the Architecture, Engineering, Construction and Operations (AECO). BIM approach allows an object or model is defined in terms of elements and building systems such as space , beams, pillars and columns (Kymell, 2008) . These models are equipped with all the data associated with a building, including its physical characteristics, functions and information of life-cycle project, which is called *smart objects* (CRC Construction Innovation, 2007).

The adoption of BIM in a building will support the Facilities Management (FM) with more successful and outstanding (CRC Construction, 2007). FM can be classified in many things, from financial and asset management through to operations and maintenance facilities, and even to the measures of fast track management and planning (Sabol, 2008). By using BIM software, the FM methods can easily be generated in a centralized network database. In this network databases, the data or information that is not needed will be removed and the 3D geometric data building will be connected via FM function and usefulness in supporting the operations of a building (Sabol, 2008).

Building Information Modeling (BIM)

Building Information Modeling (BIM) is an important knowledge in the industry of AECO (Succar, 2008). Consequently, various definitions have been given to its term in order to show the importance of BIM. Some consider BIM is an extension of the *Computer Aided Design* (CAD) while others think it is a series of models with different elements of a project (Azhar, 2011). **Table 1** will show the list of definitions of BIM that have been made by individuals or organizations through the sequence of years:-

Table 1: Definition of BIM from Individuals/Organizations Throughout the Years
(Researcher's Study, 2014)

Individuals/ Organizations	Definition of Building Information Modeling (BIM)
Amor and Faraq (2001)	A single project database that serves as a model for electronic data where all parties involved refer to it in the course of the design, construction, operation and maintenance
Construct-IT (2002)	An nD model that combines various aspects of design information required at each stage of the life cycle of building facilities

to be continued....

Table 2.1: Definition of BIM from Individuals/Organizations Throughout the Years
(Researcher's Study, 2014)

Continued....

Individuals/ Organizations	Definition of Building Information Modeling (BIM)
The Associated General Contractors of America (AGC) (2005)	The development and use of computer software model to simulate the construction and operation of a facility. Produced models are equipped with a variety of data, object-orientation, digital data representation of intelligent and parametric facilities, whose views and data needs of multiple users can be extracted and analysed to produce information that can be used to make decisions and improve process delivering building services
American Institute of Architects, (AIA) (2007)	A project delivery approach that integrates people, systems, structures and practices in the process together and take advantage of the views of all stakeholders in order to optimize the production of projects, increase value to the owner, reduce waste, and maximize efficiency through all phases of design, fabrication and construction.
Kymell (2008)	BIM acts as a simulation project that consists of the components of 3D model of a project that has to do with all the necessary information relating to project planning, design, construction or operation.
Glick and Guggemos (2009)	A novel approach of project delivery to integrate people, systems, business structures and practices into collaborative processes to reduce waste and optimize efficiency through all phases of the project life cycle, which also supports the concept of *Integrated Project Delivery* (IPD)
National Building Information Modeling Standards (NBIMS) (2010)	A digital representation tools include physical characteristics and function of a facility. BIM also is a source of knowledge about the shared facilities as further information in order to form a solid foundation in determining the outcome of the building during its life cycle; defined as existing from the initial concept to demolition. A basic premise of BIM is collaboration of many different stakeholders at different phases of the life cycle of a facility to insert, remove, update or modify information in the BIM to support and reflect the roles of the various stakeholders
Mastering Autodesk Revit Architecture (2011)	BIM refers to a 3D parametric model used to produce plans, sections, elevations, perspectives, details, schedules for which all the components required for documenting the design of the building
Reddy (2012)	An improvement methodology process that leverages data to analyse and predict outcomes through different phase of the building life-cycle.
Newman (2013)	A process of generating and managing building data during a structure's life cycle.

Based on the definitions mentioned above, it can be concluded that BIM is not just a technology, but it also encompasses the process by using product of the right kind of software (Azhar, 2011). BIM application connects all parties such as architects, contractors, surveyors, designers and owners to work together on a common information system (Eastman *et al.*, 2009). Thus, this allows all parties to share the information with each other and increasing the confidence and consistency among them. A BIM model contains a representation of the actual parts used in the construction process to build a building, in which case it contains the geometry, spatial relationships, geographical information, the number and nature of the building components, cost estimating, project schedule and material inventory (Bazjanac, 2006). The life cycle of a building can also be simulated by using BIM from the beginning of construction of the system up to operating facilities (Sabol, 2008).

Concept of Building Information Modeling (BIM)

According to Eastman *et al.* (2011), these types of digital models are not categorized as BIM: -

(1) The model contains 3D data only and no object attributes.

(2) A model with no support of behaviour.

(3) The model consists and composed of a variety of 2D CAD reference files that need to be combined to determine the building.

(4) The model allows changes to the dimensions in one view only that are not automically reflected in other views.

The main difference in the application of BIM technology with conventional 3D CAD is that a 3D CAD depicts a building with free 3D looking like a plan, section and elevation alone (CRC Construction Innovation, 2007). Editing one of the 3D visual perceptions requires the involvement of other visual standpoint to be checked and updated. Errors often occur at this stage which also acts as a major cause in the production of 3D CAD poor documentation. Furthermore, the data available in 3D CAD drawings are only graphical entities, such as lines, curves and circles (Azhar and Richter, 2009). These situations are different if it is seen from the intelligent contextual semantics of BIM model, where the objects in the system are defined in terms of building elements and systems such as space, walls, beams and column. Data on a building will be incorporated into the BIM model and thus allow the objects in the system 'knows' how to communicate with each other as well as to the design of the building model (CRC Construction Innovation, 2007; Azhar and Richter, 2009).

BIM can be look from two perspectives; process and technology. From the point of processing, BIM can be defined as a virtual process that encompasses all aspects, areas and systems of a facility in a virtual model that allows all parties involved as owners, architects, contractors, engineers, sub-contractors and suppliers to collaborate in a more systematic and efficient when compared to traditional systems (Azhar *et al.*, 2011). Carmona and Irwin (2007) stated that in line with the production of a model, all parties will continue to improve, coordinate and adjust their roles according to project specifications and design changes to ensure that the model is complete and accurate as possible before the construction started. Thus, the basis of the application and success of BIM is situated on two pillars, 'communication' and 'collaborations' that require the involvement of all parties from the beginning of a project (Azhar, Khalfan and Maqsood, 2012).

In terms of technology perspective, Kymmell (2008) stated that BIM is a project simulation consisting of the 3D models of the project components with links to all the required information connected with the project planning, design, construction or operation as depicted. The BIM technology hailed from the object-oriented parametric modeling technique (Azhar *et al.*, 2008). The term 'parametric' describes a process by which an element is modified and an adjacent element or assembly (e.g. a door attached to a wall) is automatically adjusted to maintain a previously established relationship (Stine, 2011). **Figure 1** shows the structure of BIM based on the perspective of technology.

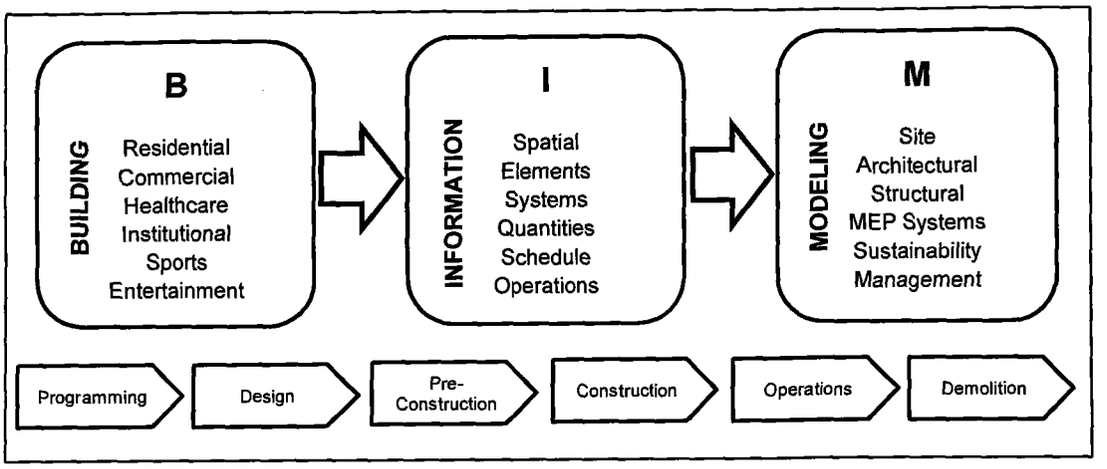

Figure 1: A Visual Representation of BIM Concept
(Azhar, Khalfan and Maqsood, 2012)

Building Information Modeling (BIM) Stages – Level of Development (LOD)

BIM has 5 stages of development, which are the Level of Development (LOD) 100, 200,300, 400 and 500. This development levels help determine the consistency of expectations through the building's lifecycle from planning through design and construction, and in particular the building's lifecycle. LOD 100-300 has a background of traditional project delivery methods 2D and LOD 400 and 500 are specific to the BIM process (Bedrick, 2013):

(1) **LOD 100** includes the concept of a building, which usually involves the overall design of the building to carry out the entire analysis of various buildings, including building orientation and space, square foot cost of construction and so on.

(2) **LOD 200** describes the building design model, where the model will have a centralised system, including estimated quantity, size, shape, location and orientation. LOD 200 is typically used for system analysis purposes and objectives set.

(3) **LOD 300** is about building models. In this LOD, the elements of the model are equivalent to traditional construction documents and shop drawings. LOD 300 models are well suited for estimating construction as well as coordination for clash detection, scheduling, and visualization. Should LOD models include the attributes and parameters defined by the owner in the BIM deliverable standards.

(4) **LOD 400** is also about the production or fabrication of model building. LOD is normally used by special trade contractors to build and create the components of the project include the MEP system.

(5) **LOD 500** is the latest development in BIM and it is about building models that are ready and equipped with facilities management system. Model building will be configured to be a data storage centre to integrate into the operation and maintenance of building systems.

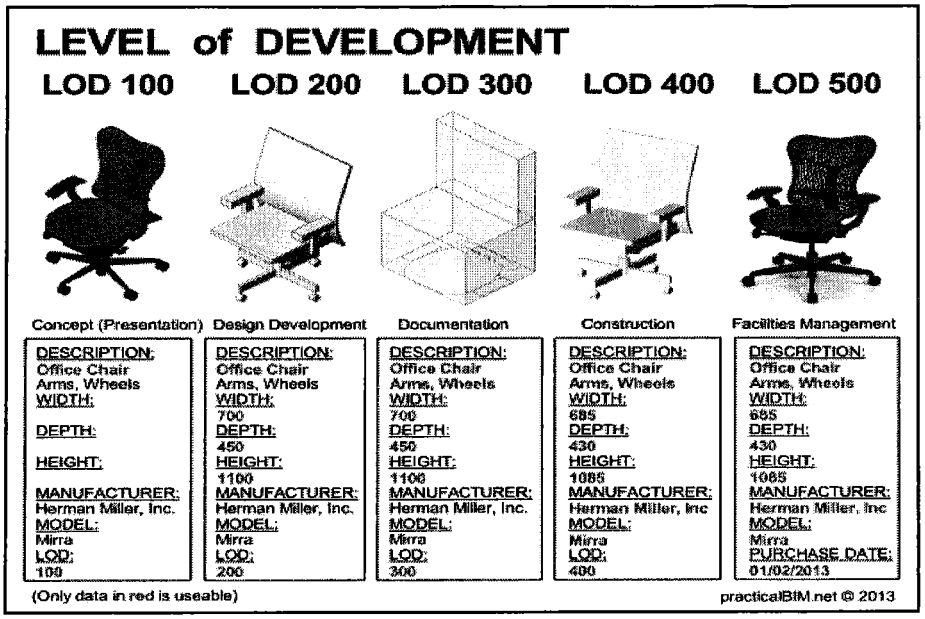

Figure 2: Sample of LOD BIM by using A Chair
(McPhee, 2013)

Figure 2 shows an example of a project BIM using LOD, taking a sample of a chair. The scheduling of LOD is to inform all parties that involved about the information or data that can be used in a project development. In other words, it is a measure of certainty or confidence about that information (McPhee, 2013). Therefore, the purpose of specifications of scheduling is to explain the framework of LOD and standardize its uses so that it becomes as a more useful communication tool. This scheduling is not set for which LOD level can be achieved in a project but leaves the specification of development model to the users of these documents. (Bedrick, 2013).

Building Information Modeling (BIM) in Malaysia: The Current Scenario

BIM is still not yet widely used in construction and civil engineering projects in Malaysia. However, some clients such as developers have started using BIM in the design of their buildings, particularly during discussions with consultants (1bina, 2012). According to the Honorary Secretary of the *Association of Consulting Engineers Malaysia* (ACEM), Ir. Looi Hip Peu, the used of BIM is usually being imagined as easy as buying software and because of the perception; it is not used effectively. He added that local contractors, ranging from the smallest class (Class F) up to medium sized project contractor (Class B) is not ready yet to apply BIM in this country because of the use of IT among them is still low, in addition to the standard format of BIM which still not explained completely to the public. However, Ir. Looi noted that it is the hope of the ACEM that BIM can be practiced in a suitable method by all the players of the construction industry, where it gives beneficial in the improvement and implementation of construction projects with more quality and efficiently (1bina, 2012).

In addition, he also added that if BIM is used wisely since the beginning of the project, BIM can assist the local contractors in a variety of work problems. Among the problems that can be addressed is that BIM is able to solve problems and help to improve the construction project planning. Besides that, BIM also help to avoid wastage of unproductive work at the construction site, such as analysis of overlapping often occurs in the oil and gas sector. In contrast, BIM also ensures quantities of materials are measured precisely; project cash flows expected to be more accurate, bills of quantities or BQ are issued effectively to material suppliers and made the construction work schedule became more structured (1bina, 2012).

Facilities Management (FM)

Facilities Management (FM) is a diverse profession and was born in United States of America (USA) in the year 1970s in conjunction with business sector of outsourced services (Alexander, 1996). It is often associated with the administration of the blocks and office buildings, arenas, schools, shopping centers, convocation center, etc. FM facilitates the coordination of organization's activities broader than just business services. FM has developed to become more competitive, which is based on innovation and sustainable development apart from adding value to the core of many business organizations (Mudrak, Wagenberg and Wubben, 2004).

In Malaysia, FM began and started its development in the second half of 1990's (Pillay, 2002). The first FM Masters programed was introduced in Malaysia by the Universiti Technology Malaysia (UTM) in the year 1999 (Sulaiman, Baldry and Ruddock, 2008). Later on, UTM hold the first conference in FM which took place at Kuala Lumpur with the theme of "FM-KL. Where are We Heading?". This was considered as the first step of FM program held at international level in Malaysia where the conference succeeded in introducing FM to the country. The awareness of the importance of FM then created the launching of the next FM academic program in 2002, which the other public university known as Universiti Teknologi MARA (UiTM) also began at the Shah Alam Campus. In 2004, another public university known as Universiti Tun Hussein Onn Malaysia (UTHM) crafted its proposal for the development of its FM master's program to be approved by the Ministry of Higher Education (MoHE). Interestingly, Centre of Excellence for Facilities Management (CEFM) and Malaysian Association of Facilities Management were also established by UTHM at the same year (Sulaiman, Baldry and Ruddock, 2008).

Due to the fact that FM is becoming more mature in Malaysia, the first inaugural National Asset and Facility Management Convention (NAFAM) was held in August, 2007 to address the current issues and future challenges in managing national assets and facilities. This convention showed that the FM profession matures and adapts to meet the demands of a fast growing built and human environment industry. Agreeing to have an annual convention on NAFAM, the Prime Minister urged the public and private sectors to come up with a more effective and efficient procedural framework to continuously improve the management of national assets and facilities.(Sulaiman, Baldry and Ruddock, 2008). Since then, Malaysia has put great determination, focus and emphasis on the development of FM, particularly in public sector. Holistic approach towards integrating effort and collective responsibility is now the main agenda for greater performance of FM in Malaysia (Kamaruzzaman and Ahmad Zawawi, 2010).

Definitions and Concept of Facilities Management (FM)

As of today, there is no specific definition used by the professionals in regards to the implementation of FM in their profession. The followings are the definition or interpretation of FM that has been discussed: -

Table 2: Summarised Definition of FM from Individuals/Organizations
(Researcher's Study, 2014)

Sources	Definitions of Facilities Management (FM)
Barett & Baldry (2003)	FM is an integrated approach to maintain, improve and adapt the buildings of an organization in order to create an environment that strongly supports the primary objectives of that organization. Barrett (1995) provides a more robust FM definition but restricts the FM paradigm to buildings, while neglecting the diverse nature of the FM nature.
BIFM (2003)	An integration of processes within an organization to maintain and develop the agreed services which support and increase in effectiveness is the main thing. FM encompasses multi-disciplinary activities in developing and managing the environment that affect human and workplace.
Chotipanich (2004)	The support function coordinating physical resources and workplace, and support services to user and process of works to support the core business of the organization.
US Legal Definitions (2005)	FM is the integration of business administration, architecture, and the behavioural and engineering sciences. In the most basic terms, facility management encompasses all activities related to keeping a complex operating. Facilities include grocery stores, auto shops, sports complexes, jails, office buildings, hospitals, hotels, retail establishments, and all other revenue-generating or government institutions.
International Facility Management Association (2005)	Profession that encompasses integration of multiple disciplines activities to ensure the functionality of the integrated environment management of human capital, work, process and technology.
Bernard Williams Associates (2006)	FM covers not just land and buildings (which are considered as premises), but other support services established as well as infrastructures such as telecommunications, equipment, furniture, security, childcare, catering, stationery, transport and satellite work environments. Premise and support service that are available in an organization with the facilitating information and communication technology are claimed to be the two important elements of the definition.
Pitt & Tucker (2008)	The integration and alignment of the non-core services, including those relating to premises, required to operate and maintain a business to fully support the core objectives of the organization.
Royal Institution of Chartered Surveyors (2009)	A discipline that improves and supports the productivity of an organization by delivering all needed appropriate services, infrastructures, etc. that are needed to achieve business objectives.
Global Facilities Management Association (2012)	The basic concept of FM is to provide integrated management on a strategic and tactical level to coordinate the provision of the agreed support services (facility services).
Sulaiman (2013)	FM is an integrated of a wide spectrum of organizational core business and support service devoted to the coordination of people, property, business process and technology in achieving sustainable facilities management best practice excellence.

If to be understood in depth, the definition of FM emphasises the same trend and repeated to form an identity and concept of FM. The first aspect is the work space, the second role of providing services to support and enable the organization to grow and achieve their core business while the third is the coordination of human capital, premises, processes and technology in the workplace. See **Figure 3**:

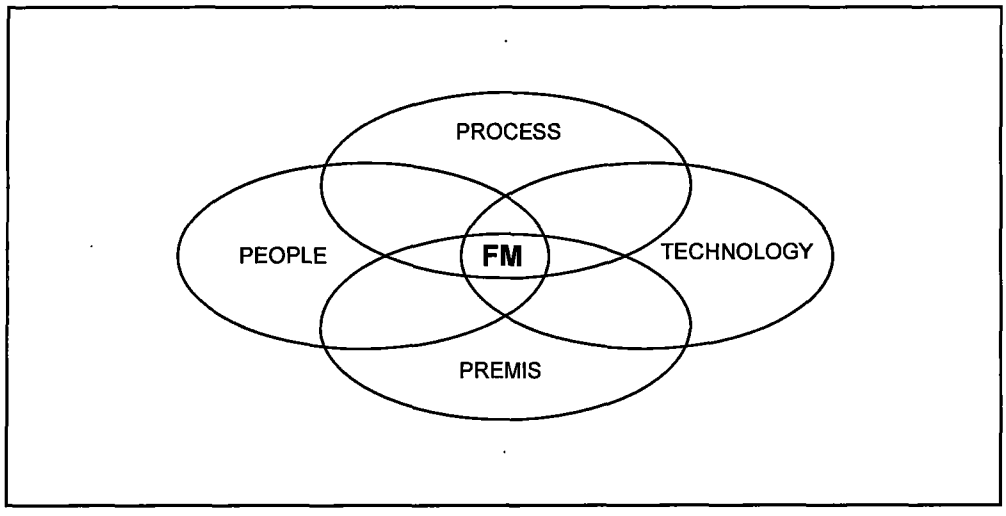

Figure 3: Illustration of FM Concept in Organisation
(IFMA, 2005; Sulaiman, 2013)

From **Figure 3**, it shows the concept of FM in an organization. As stated by Tay & Ooi (2001), FM can be summarised as an integrated management or integration of work to improve the performance of the organization and by taking all of the above definition, hence it can be concluded that FM involves multi-disciplinary activities that have integration between people, property, business process and technology, which as stated by IFMA (2005) and Sulaiman (2013).

Integration of Building Information Modeling (BIM) and Facilities Management (FM)

In an era of increasingly sophisticated and modern technology, BIM is set to offer a new level of functionality for FM of a building as well as the physical assets in it. However, in order to implement the use of BIM in FM industry, some things should be emphasized and addressed, according to BIM Implementation (2012);-

(1) Current FM Strategy
Need to look into the way information is currently being stored, retrieved and shared.

(2) Requests for Proposals
Ensure that the requests for proposals not only demand data that being needed today, but take into account a comprehensive and long term demand need. Data that may not look useful today may become valuable in the future.

(3) Degrees of Integration

Need to consider how digital information will be integrated for facility management. The extent of integration will be significantly impacted by the level of interoperability and the use of industry-wide standards within the organization. The transfer of data between the model and the FM system will be challenging and involve significant time and cost in the absence of industry-wide standards.

(4) Accessing BIM Data

It is important to plan for database management as a critical aspect of the total FM strategy. Early users may find it very challenging to not be able to readily access all the information they require.

(5) Target Specific Objectives for BIM Adoption

Consider the objectives like equipment tagging. This would make it easier to access information for scheduled maintenance and breakdowns. The information may include specifications about the particular equipment, warranty period, vendor, etc. Information about the equipment could also be used for energy control. Other objectives could be space management, security, tracking personnel and their activities.

(6) Understanding the Interface Required

It is critical to understand the necessary information interfaces for the successful implementation of BIM. The interface would depend upon the requirement to connect to any existing or new software, the number of people who would be using the technology, what kind of information is being shared, what naming conventions are being used and others.

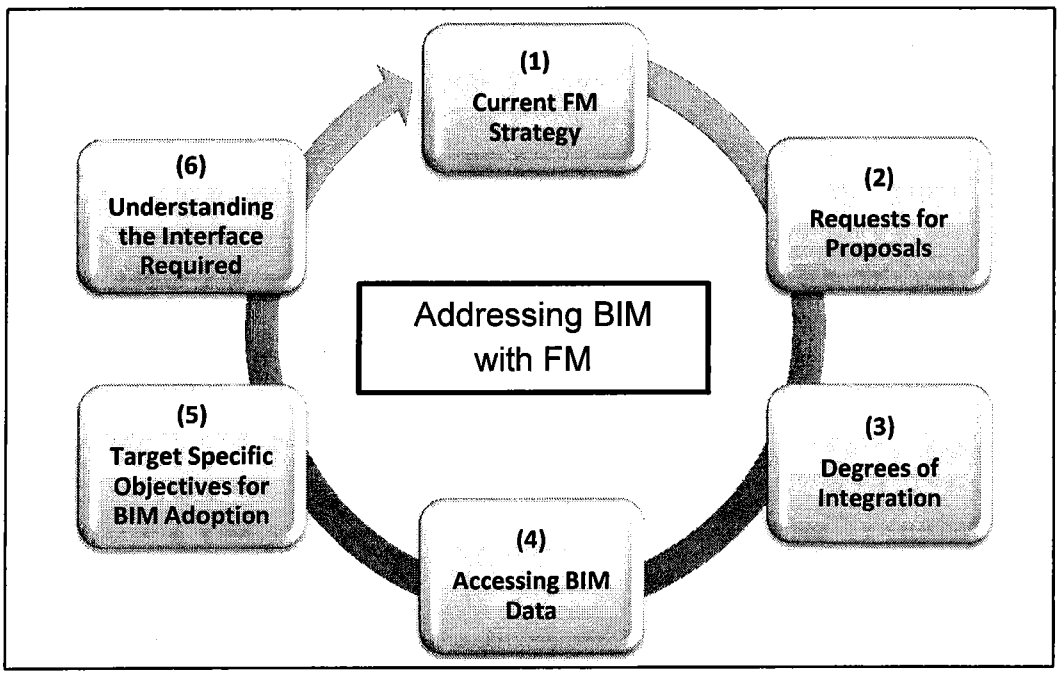

Figure 4: Addressing BIM with FM
(Adopted from: BIM Implementation, 2012)

The lack of smoothness in the FM data and information system design of the building can be completely eliminated by using BIM (BIM Implementation, 2012). It is undeniable that BIM offers a higher standard of functionality for FM of a building and other fixed assets to be as integrated digital repository for each component in the facility (Jordani, 2010). As a full platform of 3D model, BIM display and showcase these elements with the kind of clarity and explanation that are difficult to be understand, unless that person is a professionally trained and experienced in interpreting the standard building drawings 2D (Philips and Azhar, 2011).

The use of BIM started at the beginning of construction of a facility (Sabol, 2008). It was then used in all stages of design and construction smoothly. This makes the task of making strategic decisions become smoother and more scientific, which is used in both at the stages of conceptual and implementation (Jordani, 2010). In addition, BIM has the real potential to take the next step and continue to play an important role in the final stage which involves the maintenance and upkeep of a facility through the life cycle, until finally it destroyed or demolished. The expansion of FM engagement involves significant implications for the industry FM (BIFM, 2012).

An integrated and coordinated system is also able to attach a variety and range types of data that are not limited to building model components, both whether in the design and the database from outside - such as *Oracle* (Sabol, 2008). This helps create an information bank which has utilities and facilities far beyond the mere documentation of construction (Reddy, 2012). The space component of BIM for example, can be used to detect the altered data as a measure of the area, room location and occupant information as well. Some equipment objects can also be equipped with detector features such as manufacturer's identification, equipment and others specifications of a construction material (Azhar *et al.*, 2011).

Building Information Modeling (BIM) + Facilities Management (FM): The Benefits

In general, there are many benefits of using BIM for Facility Managers generally according to Ruiz (2010), Reddy (2012), Masons (2013), MacDonald (2013) and Sulaiman (2013) as below: -

(1) Building Lifecycle Management

For a model created by the designer and updated over time by the construction phase, it will have the capacity to be a model 'Built' or 'As Built', which can also be delivered to the owner. The model will be able to contain all the specifications, operating manuals and maintenance (O & M) and information assurance, which is useful for future maintenance. This enables the elimination of problems that can be experienced now if the O & M manual has been mislaid or stored in a remote location (Masons, 2013 and Sulaiman, 2013).

(2) Better Space Management

Facility managers can build inventory space and use existing building property in an efficient manner with reference to BIM models. This will reduce unnecessary costs (Ruiz, 2010 and Reddy, 2012)

(3) **Building Equipment Management**
Maintain an appropriate inventory of building equipment with reference to building equipment information from BIM models, in order to avoid a time-consuming task and expensive in developing a coordinated program of maintenance (Ruiz, 2010)

(4) **Faster, Effectively and Efficiently of FM**
This is done by providing information that can be shared easily and efficiently by the contractors working in the Architecture, Engineering, Construction and Operations (AECO) industry (McDonald, 2013).

(5) **The Performance of A Simpler Simulation**
For projects to upgrade and refurbish, BIM helps to analyse carefully design and as a result, implement simulation more easily and orderly (Masons, 2013 and MacDonald, 2013).

(6) **Streamlined Maintenance**
The key challenge in developing a maintenance program is entering the product and asset information required for preventive maintenance. The Information about building equipment stored in BIM models can eliminate months of effort to accurately populate maintenance systems (Sulaiman, 2013).

(7) **Efficient Use of Energy**
Facility managers can analyze and compare the various alternative energy using BIM technology in order to reduce environmental impact and operating costs (Reddy, 2012).

(8) **More Economical and Easier Modifications**
BIM models presents one way or the easy steps to represent the 3D characteristics of a building. Information about existing conditions to reduce the cost and complexity of building renovation (MacDonald, 2013).

(9) **Reduced Waste**
Materials are not over-ordered. Precise programmed scheduling enables effective delivery of materials and equipment, thus reducing potential for damage. Automated fabrication of equipment with components enables more efficient materials handling and waste recovery (McDonald, 2013 and Sulaiman, 2013).

(10) **Reduced Safety Risk**
Crowd behaviour and fire modeling capability enable designs to be optimised for public safety. Assets +FM managers can use the 3D model to enhance the simulation of operational safety (McDonald, 2013 and Sulaiman, 2013).

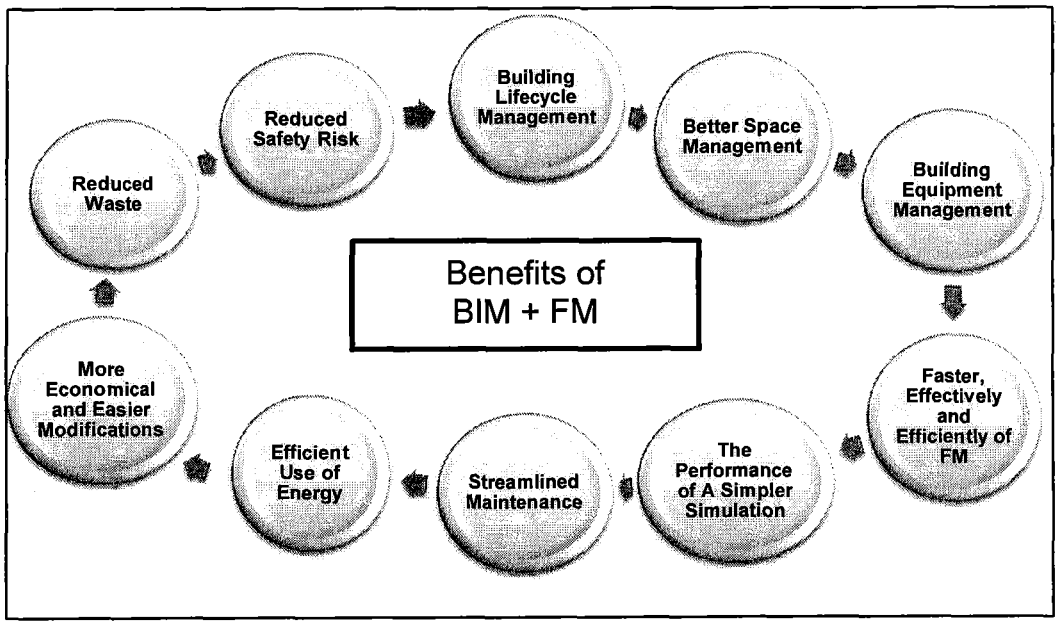

Figure 5: Benefits of BIM + FM
(Researcher's Study, 2014)

Conclusion

BIM is emerging as an innovative way to manage construction and development projects and can change the way the buildings are designed, built and operated. The appearance of this BIM has led to a positive effects of which are able to increase profits, reduce costs, time management, performance and better forecasting and also enhance the relationship between the parties involved. BIM is a representation of a new paradigm in the Architecture, Engineering, and Construction (AEC), which has facilitated the integration of all the roles of the stakeholders in a project. Until now, BIM has greatly expanded from the construction up to the design of buildings that can be built. But if BIM is about the life expectancy and lifetime costs of a building, knowledge and expertise in the profession FM must be applied in the development of this technology.

FM can be classified in many things, from financial and asset management through to operations and maintenance facilities, core and support services, especially when it involves the integration of people, premise, business process and technology. In the AEC industry, many organizations have been involved in developing strategies to overcome the problems that exist in the industry of FM, which previously should be resolved by FM professionals for years. These problems include dealing with large amounts of data and related buildings, places, people, equipment, sensors, controls, and so on. Thus, by integrating with BIM and FM, these problems can be reduced effectively and efficiently.

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