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Building Information Modelling (BIM) in Facilities Management: Opportunities to be considered by Facility Managers

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Abstract

The demand of Building Information Modelling (BIM) is increasing recently as much international organisation and government taking the initiative to promote BIM in building life-cycle. Although the implementation of BIM is not an easy thing, BIM promising to benefits of efficient Information Management (IM) in Facilities Management (FM). There will be the improvement of the quality of life (QOL) in the workplace when adopting BIM in FM that encompasses multiple discipline to ensure higher functionality of the built environment by integrating people, place, processes and technology. In this studies, the opportunities acquire by the organisation implement BIM in FM for the benefit of QOL in the workplace are reviewed.

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Keywords: Building Information Modelling (BIM); opputunities; Facilities Management (FM); technology

1. Introduction

The demand of Building Information Modelling (BIM) is increasing recently as much international organization and government taking the initiative to promote BIM in all industry life-cycle. The life cycle in BIM is primary sets it apart from preceding digital technologies, which were designed in specific phases of the building life cycle for specific sectors of the building industry, such as design, construction and Facility Management (FM) (Azhar,

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Khalfan, & Maqsood, 2012; Smith & Tardif, 2009; Takim, Harris, & Nawawi, 2013). In macro life cycle, BIM provide benefit: overlap, reduce real project risks; irrelevant document eliminated; waste reduces; productivity increase; costs decrease; profit increase as improve product, improve services deliver, or expand market share (Smith & Tardif, 2009). The fundamental of BIM implementation are: cash flow, productivity, profit and revenue though different types of businesses use BIM for different purpose (Smith & Tardif, 2009; Weygant, 2011). The success of BIM implementation will depend on how well streamline the workflow and information flow BIM are widely use in design and construction; the benefit of the parametric modelling technology that enable to store semantic information about the facility (Akcamete, Akinci, Garrett, & Jr, 2010; Barlish & Sullivan, 2012; Smith & Tardif, 2009). The goal of BIM improve product delivery, which includes quality, reliability, timeless and consistency of the process made (Ani, Johar, Tawil, Razak, & Hamzah, 2015). Most information created during the design and construction process that is of value to facility managers can only be found elsewhere and in scattered sources: in written construction specifications, warranty certificates and operations and maintenance manuals (Smith & Tardif, 2009).

However, the current practice BIM in scope of FM, stakeholders are not entirely implementing BIM in FM industry and in current FM operations that applied BIM, most functions still done manually even facility manager knowing by adopting BIM during operational building can decrease chance of errors and increase efficiency (Becerik-Gerber, Jazizadeh, Li, & Calis, 2012; Motamedi, Hammad, & Asen, 2014). Managing facilities failure will raise the issues that occur repeatedly including assets not are registered, asset are not labelled as government asset, weaknesses on disposal and maintenance, asset does not be used or being wasted and asset misappropriation (Berahim, Jaafar, & Razali, 2013; Mahadi & Hussin, 2007). Indeed, BIM has vast implications for the FM phase of buildings (Smith & Tardif, 2009; Volk, Stengel, & Schultmann, 2014) with regard the owner and facility managers are in need of computerized supports that will improve how they operate and maintain their facility (Akcamete et al., 2010). Adopting BIM in mainstream in FM that encompasses multiple discipline to ensure higher functionality of the built environment by integrating people, place, processes and technology. Essentially, BIM mostly used for operations phase and commercially available technologies focus on transferring information from the design and construction phase to the operation phase by enabling creation and capturing of digital facility information throughout the facility lifecycle (Akcamete et al., 2010; Volk et al., 2014).

There will be the improvement of the quality of life (QOL) if the building owner willing to adopt BIM in FM. The concept of QOL is a broad notion and is difficult to have the single definition (Subramaniam, Tan, Maniam, & Ali, 2013). Although sustainability concerns both the achievement of human needs satisfaction and the preservation of environmental resources, in the last two decades, the environmental impact of human products and processes has received a growing attention, while few researchers have addressed the consequences on human satisfaction of product modifications conceived for a lower consumption of resources (D'Anna & Cascini, 2016). The job satisfaction in the workplace among FM employee will increase when the adopting BIM in FM. One of the example that integrated BIM for better QOL in workplace is working flexibilities evolving as professionals spend less time at their desk and require mobile or flexible working models and technologies for communications and collaborative working (Shelbourn & Bouchlaghem, 2012). The necessity of BIM in FM should be apparent to attract the interest of BIM adoption. Organizations involved in FM have the opportunities to use BIM as a knowledge repository to document evolving facility information and to support the decision made by the facility manager during the operational life of a facility. Even though BIM able to improve QOL in the workplace, resistance to change is a result of perceived different in ideas, motives, plan or priorities that found related to five area: the need for change, risk, goal and targets, leaders and treat of status (Takim et al., 2013). Although the implementation of BIM not the as easy thing as the worksheet, BIM promising to benefits of efficient resource management in Facilities Management (FM).

The BIM topic in FM has become one of vital subject of the study recently, and numerous of the publication produced in the academic journal and this paper review diversity recent paper and book on the topic. In this studies, the opportunities gain by the organization that needs to implement BIM in FM for the QOL in the workplace are reviewed.

2. Literature review

1.1. Definition of Building Information Modelling (BIM) and Facility Management (FM)

BIM has many definition by many scholar as they describe in different view and perspective of life cycle (refer Table 1). However, according to Azhar (2012) the overall goal of BIM is transferring the data into the FM operations. Hence, BIM provide repository model integrated with database for storing all the information. BIM functionalities covered all the application in life cycle that can exchange information between their differing software platforms. We can assume that the 'collection' of database known as repository specific for the final FM in operational of building. Therefore BIM in FM perspective can be define as a collection living document tool in repository to manage accurate building information over the whole life cycle that at the FM stage, owner can use to manage facilities.

Table 1. Definition of BIM

Author and year	Definition
(Ashcraft, 2008)	A living document that owner can use to manage their facilities, as well as build them which is to be a 'repository' of data for FM
(Smith & Tardif, 2009)	BIM is a powerful technology that integrated project delivery; scenario planning; rapid; iterative design; virtual design and construction; value engineering; sustainability; real property asset management; preventive maintenance; energy conservation; environmental stewardship; life cycle costing
(Akcamete et al., 2010)	Building Information Modelling is an approach that supports process such as design, estimating, and coordination during different phases of the building life-cycle
(Weygant, 2011)	BIM is a technology that allows relevant graphical and topical information related to the built environment to be stored in a relational database for access and management
(BuildingSMART Alliance, 2013)	The National Building Information Model Standard Committee defines BIM as a digital representation of physical and functional characteristics of a facility
(A. Golabchi, M. Akula, 2013)	BIM is a value creating processes that involves the generation, management and exchange of knowledge of a facility forming a reliable basis for decision making throughout its life cycle-from the conceptual, design and construction phases, through its operational life and subsequent closure.
(Volk et al., 2014)	A tool to manage building information over the whole life cycle, it is adequate to support data of maintenance and the construction process

FM often misunderstood that task limited tactical level, but FM is competencies include in strategic level. In 2009, the Global Job Task Analysis (GJTA) done a comprehensive survey that included facility managers in 62 countries categorized 11 core competencies (refer Table 3) in FM that can view in narrow or broader perspective. Indeed, FM definition from IFMA is considered to be defined that FM is a profession that encompasses multiple disciplines to ensure functionality of the built environment by integrating people, place, process and technology. The integration of 3P and 1T created the sustainable built environment by appreciating professional.

Table 2. Definition of FM

Author and year	Definition
(RICS, 2010)	FM is a discipline that improves and supports the productivity of an organisation by delivering all needed appropriate services, infrastructures, etc that are needed to achieve business objectives.
(Noor & Pitt, 2009)	Creating an environment that is cohesive to carry out an organisation's primary operations, taking an integrated view of the infrastructure services and use it to give customer satisfaction and value for money through support for an enhancement of the core business.

(IFMA, 2013)	FM is a profession that encompasses multiple disciplines to ensure functionality of the built environment by integrating people, place, process and technology.
(BIFM, 2010) and BSI (2007) (known as BS EN15221-1:2006)	FM is the integration of processes within an organisation to maintain and develop the agreed services which support and improve the effectiveness of its primary activities.
(Kamaruzzaman & Zawawi, 2010)	A balance between technical, managerial and business acumen that may be related to operational, tactical and strategic decision-making processes.
(MAFM, 2013)	FM is the total management that integrates all services to support the core business of an organisation.

Table 3. Core competencies in Facilities Management (IFMA, 2013)

Scope	Core Competencies
Facilities Management (FM)	Communication Emergencies Preparedness and Business Continuity Environmental Stewardship and Sustainability Finance and Business Human Factors Leadership and Strategy Operations and Maintenance Project Management Quality Real Estate and Property Management Technology

2.1. Opportunities to be considered by Facility Manager for Quality of Life (QOL)

According to Linderoth (2010) of macro BIM practice are 1) Rapid visualization; 2) better decision support upstream in the project development process; 3) rapid and accurate updating of changes; 4) reduction of man-hours required to establish reliable space programs; 5) increased communication across the total project development team (users, designers, capital allocation decision makers, contracting entities, and contractors); 6) increased confidence in completeness of scope. However, when we talk about QOL and BIM in FM, we related about sustainable workplace integrated with 3P and 1T for built environment. The benefit of integrating BIM in FM for the 1) effective operational cost; 2) shorter time for decision making; 3) resource for decision making; 4) better documentation system; 5) collaboration and work flexibility; 6) updated information and clash detection

2.1.1 Effective operational cost

The highest national expenditure in context of building life cycle is allocated to operational building. The cost of the facility itself is typically a small fraction of the cost of the operations or the value of the activities that its houses (Smith & Tardif, 2009). US National Institute of Science Technology (NIST) interoperability study indicate that two-third of the estimated cost is lost in the US due to inefficiencies during operation and maintenance phase (Arayici, Onyenobi, & Egbu, 2012; Azhar et al., 2012). The largest fraction in the expenses in life-cycles occurs in operation phase (Akcamete et al., 2010). The cost of operating and maintaining facilities would become far more predictable, which would improve their financial performance as investment instruments (Kans, 2008; Smith & Tardif, 2009). FM practice contribute 5-10% of the gross domestic product in developed countries (refer figure 1) and the total life cycle costs of a facility could be as much as 7 times higher than the initial investment costs (A. Golabchi, M. Akula, 2013). A major set of activities during operations is related to the maintenance and repair (M&R) of the facility and the excessive expenses occur when reactive maintenance and repair are perform (Akcamete et al., 2010). Over the typical twenty-year life of a commercial building, for example 90 percent of its total facility cost can be attributed to the payroll cost of the people who occupy it 9:1 ratio which the remaining 10% is evenly divided between the original construction cost and twenty years of operations and maintenance (including energy consumption) (Smith & Tardif, 2009).

Worse, incapacity to manage the building in operational building level can cause overspent a substantial amount on top of the operational budget allocated by the government. (Myeda & Pitt, 2014). The repetition of recurring issue resolved as a result of the failure of compilation. In addition, the wastage among stakeholder in handling cost will be reduce as the technology take over most of handling issue. Yet, handling cost is part of operational cost which some cases become the hidden cost in operational.

BIM allows incorporate environmental considerations and life cycle operating and maintenance costs into the design process cost festively, BIM will enable workplace productivity factors to be taken into account in equally methodical ways based on reliable statistical workplace performance data. (Smith & Tardif, 2009). BIM can help improve the quality and accuracy of financial forecast, which can lead to greater complex endeavours that will inevitably result in mistakes, regardless of the competence and diligence of everyone involved (Smith & Tardif, 2009). With aid of BIM in operational building can significantly reduce these loses (Azhar et al., 2012). These savings will help reduce operating costs in the future. The financial can be used in other exercise for organization benefit. This can improve QOL in workplace to avoid the pressure form top management on how the money spent wisely. Yet, financial constraint influence workplace productive and work environment. The fully use of BIM implementation may also technically, give an advantages to the asset management more transparent and efficient which at the same time achieve Malaysia Government Asset Management Policy (GAMP) in third objective. The systematic inventories can impact of more effective national financial planning.

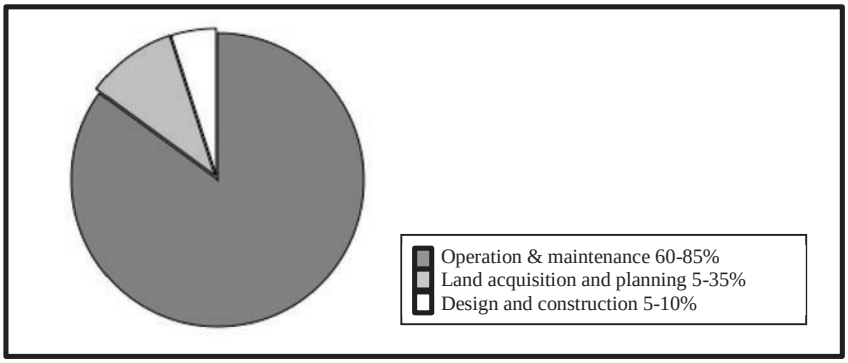

Fig.1. life cycle cost budget division of a building
(Source: Hardin, 2009)

2.1.2 Shorter time for decision making

The adoption of BIM model can be designed to provide quick information and database for required analysis and evaluation (Ani et al., 2015). A US Coast Guard Facility Planning case study reported 98% time saving for creation and updating of facility data in database when BIM is used (Akcamete et al., 2010; Eastman, Teicholz, Sacks, & Liston, 2008). FM models could be integrated with building system controls for monitoring building performance in real time, enabling facility managers to fine-tune building equipment for optimal performance (Smith & Tardif, 2009). Reduction of cycle time whenever and wherever possible to reduce or eliminate manual data entry whatever possible (Smith & Tardif, 2009). The implementation of BIM greatly assist facility manager to access quickly the information in need. Implementation refers to the wilful activities of a single identifiable Player as it adopts a novel system/process to improve its current performance (Succar & Kassem, 2015)

2.1.3 Resource for decision making

Organizations involved in FM have the opportunities to use BIM as a knowledge repository to document evolving facility information and to support decision made by the facility manager during the operational life of a facility. (A. Golabchi, M. Akula, 2013). Current method of planning and execution of facility maintenance are mainly based on personal knowledge and experience of facility operator and tradespersons (Akcamete et al., 2010). BIM promise to provide a reliable facility information database and integrated views across all facility system so

that facility managers can retrieves and analyse information about the whole system. (Akcamete et al., 2010). BIM can provide a new way of analysing how buildings have been behaving/ deteriorating over time to help support decisions made to plan maintenance work and to perform repairs in facilities. (Akcamete et al., 2010; Volk et al., 2014). Information technology should never be equated or confused with BIM, which is/or will become an integral part of your revenue-generating value added business operations (Smith & Tardif, 2009). Such information is necessary for analyses of patterns and relationship of breakdown/ repairs that can provide insights (e.g., root causes, possible impacts) which not gained from traditional databases or CMMS system (Akcamete et al., 2010).

2.1.4 Better documentation system

Opportunities for utilizing BIM for facility management lave also been investigated with focus on supporting maintenance planning and identifying useful information in a BIM model needed by facility managers (A. Golabchi, M. Akula, 2013). A remarkable history of thousands of renovation and maintenance projects in BIM database (Smith & Tardif, 2009). Maintenance tasks can cause three to four times more than the same repair activity if it were to be performed as planned maintenance (Akcamete et al., 2010). In order to support maintenance planning decision, a reliable maintenance database that store history of M&R work and the associated change information is necessary. FM model that included comprehensive warranty information, routine equipment maintenance information able to increase the actual operations and facility maintenance (Smith & Tardif, 2009).

Facility Maintenance staff experiences difficulty in preserving facilities when relying on paper-based document (Ani et al., 2015). The current manual data management create irregular space management for data management storage. The BIM repository allowed paperless environment and the data can be captured or modified using ICT device. The reduce space for data storage created sustainable environment for the better QOL in workplace. By using BIM models instead of paper blueprints, FM personnel can reconcile real components with corresponding 3D models and guide themselves through the system to promptly execute the plan of action. (A. Golabchi, M. Akula, 2013). BIM repository is a tangible asset that can increase the value of a property (Smith & Tardif, 2009)

2.1.5 Collaboration and work flexibility

BIM able to compiling comprehensive, reliable, accessible and easily exchangeable building information for anyone who needs it throughout the life cycle of a building (Smith & Tardif, 2009). To access to the same information in real time, BIM able to every team member become clear to everyone who is responsible for what, which team members area meeting their obligations (Smith & Tardif, 2009). BIM allow collaborative, improving communication, improving service delivery, improving commutation among business partner, reducing cycle time, energy efficiency, cost efficiencies and workplace productivity (Motawa & Almarshad, 2013; Smith & Tardif, 2009). BIM has the potential to improve communication and interoperability in FM by eliminating inefficiencies and streamlining the O&M system for facilities (A. Golabchi, M. Akula, 2013; Akcamete et al., 2010). BIM has been proposed as a platform for multi-disciplinary collaboration (A. Golabchi, M. Akula, 2013). User-defined elements can be assigned data, and exported for analysis and collaboration in buildingSMART's the International Alliance for interoperability, neutral and open IFC format (Levy, 2012). The collaboration merits of ICT tools are usually associated with their capabilities in supporting a high level of interaction, many to many communication and information sharing, in a group of known users, across the hierarchical, divisional, time and geographical boundaries (Bouchlaghem & Shelbourn, 2012)

The nature of work is constantly changing as professionals spend less time at their desk and require mobile or flexible working models and technologies for communications and collaborative working (Koseoglu & Bouchlaghem, 2012). Indeed, this created work flexibility by changing the work culture from desktop become mobile. Mobile technologies are becoming key enabler for collaborative decisions making supported with the instant and remote access to data (Koseoglu & Bouchlaghem, 2012; Son, Park, Kim, & Chou, 2012). However, the important obstacle in the way implementing mobile technologies is related to user's resistance and lack of knowledge. (Erdogan, Koseoglu, Bouchlaghem, & Nielsen, 2012). The total cost of equipment, capacity, security, technical support, installation, setting up and maintenance has to be determined before selecting and installing the network component (Koseoglu & Bouchlaghem, 2012). The integration of BIM and wireless Sensor Networks have been chained to monitor physical and environmental conditions during the FM. (A. Golabchi, M. Akula, 2013; Eastman et al., 2008). Moreover, the innovation of cloud computing technologies can reduce the maintenance and

development costs of mobile services and applications, promote research on efficient methods and promising solutions for ubiquitous environments and green IT systems, and provide users with various mobile services at low cost (Son et al., 2012).

2.1.6 Updated information and clash detection

In a single respiratory in life cycle, BIM able to do compiling and maintain information of a building and BIM is useful to individual players only to the extent that it supports the many individual business processes (Smith & Tardif, 2009). BIM software able to do checking or clash detection which identify the locations of two elements are in conflict others (Levy, 2012; Weygant, 2011). BIM able become a possible medium to and store changes happening to as-is conditions and track of a facility. (A. Golabchi, M. Akula, 2013; Akcamete et al., 2010). Unlike in building design and construction phase, BIM can ensure that facility remain in use for one purpose or another for as long, by allowing facility managers and building owner to conduct detailed analyses (Smith & Tardif, 2009)

3. Review approach

3.1. Methodology

To review this topic, we approach 3 scope of study in related with topic; book, proceeding paper, journal & applied/official webpage (refer table 4). We search in three main scope (1) Introduction, (2) BIM opportunities and (3) Definition. In order to limit our searching, we search wording QOL, BIM for FM, FM, ICT and BIM. Not all the publication we choose as we filtered the information that has been structured related to the topic. However, some of the information need to review with books and applied/official webpage. We believe the some of the current information for ICT related of BIM opportunities still less in publication journal/ proceeding. We reviewed webpage for the definition of term by professional body as we believe the definition will be updated

Table 4. Resource for general review

Source	Content	Quantity
Proceeding paper	General review	1
	General review and case study	5
	General review and survey	2
Journal	General review	6
	General Review and case study	7
	General Review and survey	2
Webpage	General review	5
Book	General review	5
Book section	General review	5

3.2. Data analysis

We gathered the literature review of keyword QOL, BIM for FM, FM, ICT and BIM (refer figure 2). Once we done collected the sources, we divided three (3) main scope namely (1) QOL, (2) BIM opportunities and (3) Definition (refer figure 2). However, we identify that some of the publication, can be review again the for other scope.

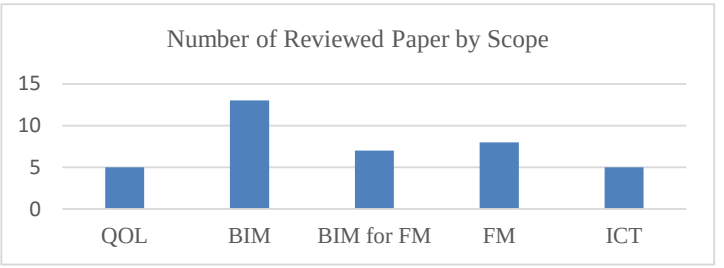

Fig.2. Number of reviewed publication

4. Findings and future needs

Considering the topic is regarding to QOL and opportunities enjoy offered by BIM in FM we review 38 academic and publication book, proceeding paper, journal & applied/official webpage. We search wording related with topic and theme of QOL, BIM for FM, FM, ICT and BIM. We believe the some of the current information for ICT related of BIM opportunities still less in publication journal/ proceeding. We reviewed webpage for the definition of term by professional body as we believe the definition will be updated. Nevertheless, some of the publication might have been overlook due our searching

In this study, the greater improvement in the quality of life (QOL) become easier achieve if the building owner willing to adopt BIM in FM. The concern of QOL in job satisfaction in the workplace among FM employee will increase when the adopting BIM in FM. In this review, we discuss not only QOL in FM workplace, but also regarding the opportunities obtain by facility manager if they adopt BIM in the organization, and the gap between studies. The benefits expected to be achieved by facility managers are:

4.1. Effective operational cost

BIM allows incorporate environmental considerations and life cycle operating and maintenance costs into the design process cost festively, BIM will enable workplace productivity factors to be taken into account in equally methodical ways based on reliable statistical workplace performance data. (Smith & Tardif, 2009). BIM can help improve the quality and accuracy of financial forecast, which can lead to greater complex endeavours that will inevitably result in mistakes, regardless of the competence and diligence of everyone involved (Smith & Tardif, 2009).

4.2. Shorter time for decision making

The adoption of BIM model can be designed to provide quick information and database for required analysis and evaluation (Ani et al., 2015). A US Coast Guard Facility Planning case study reported 98% time saving for creation and updating of facility data in database when BIM is used (Akcamete et al., 2010; Eastman et al., 2008).

4.3. Resource for decision making

BIM promise to provide a reliable facility information database and integrated views across all facility system so that facility managers can retrieves and analyse information about the whole system. (Akcamete et al., 2010). BIM can provide a new way of analysing how buildings have been behaving/ deteriorating over time to help support decisions made to plan maintenance work and to perform repairs in facilities. (Akcamete et al., 2010; Volk et al., 2014).

4.4. Better documentation system

By using BIM models instead of paper blueprints, FM personnel can reconcile real components with corresponding 3D models and guide themselves through the system to promptly execute the plan of action. (A. Golabchi, M. Akula, 2013). Using ICT device for data captured or modified, BIM allowed paperless environment.

4.5. Collaboration and work flexibility

BIM allow collaborative, improving communication, improving service delivery, improving commutation among business partner, reducing cycle time, energy efficiency, cost efficiencies and workplace productivity (Motawa & Almarshad, 2013; Smith & Tardif, 2009). The collaboration merits of ICT tools are usually associated with their capabilities in supporting a high level of interaction, many to many communication and information sharing, in a group of known users, across the hierarchical, divisional, time and geographical boundaries (Bouchlaghem & Shelbourn, 2012)

4.6. Updated information and clash detection

In a single respiratory, BIM able become a possible medium to and store changes happening to as-is conditions and track of a facility (A. Golabchi, M. Akula, 2013; Akcamete et al., 2010). BIM software able to do checking or clash detection which identify the locations of two elements are in conflict others (Levy, 2012; Weygant, 2011). In FM, BIM can ensure that facility remain in use for one purpose or another for as long, by allowing facility managers and building owner to conduct detailed analyses (Smith & Tardif, 2009)

5. Conclusion

Our finding reveal that the benefit gained for the benefit of QOL are 1) Operational cost; 2) Shorter time for decision making; 3) Resource for decision making; 4) Better documentation system; 5) Collaboration and work flexibility; 6) Updated information and clash detection. To achieve QOL in FM for a sustainable workplace integrated with 3P and 1T in built environment, BIM is recommended. This study provide a clear of direction to promote BIM in the organization to design the appreciate plan toward successful teamwork to achieve minor failure in operational building. The practical practice of conceptual framework among stakeholder may increase the organization reputation and enhance value of asset as outgoing smooth data management may conduct working environment much systematic. Thus, more extensive use of BIM repository by user enabling better QOL in term of working environment. Due to revealed benefit in adopting BIM in FM, the study of adoption of BIM in FM is recommended to for future study.

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