A Review of Facilities Information Requirements towards Enhancing Building Information Modelling (BIM) for Facilities Management (FM)

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Abstract. Building Information Modelling (BIM) for facilities management (FM) benefits the owner the most by increasing the value of information in their possession and the amount of Return on Investment (ROI). Research and application of BIM in FM are lagging behind similar efforts in design and construction. Information management is a major threat facing FM practice where the multidisciplinary activities demand extensive information requirements. Lack of accurate transmission of building information from the earlier stages of a building project to FM professionals leads to a significant loss in the quality of building information for operational needs, significant costs and rework, impedes the promotion of an automated FM practice integrated and a life-cycle oriented construction. This paper reviews current literature to gain an overview of the significant challenges to the demand and supply of critical data for FM in a BIM model. It also sought to understand efforts addressing these challenges to provide direction for facility information management at the project and organisational level.

1. Introduction

There are compelling reasons for leveraging BIM for facility operations, but the utilization of BIM in FM is lagging behind the BIM implementation in design and construction phases [1][2][3] Similarly, BIM research at the FM stage while growing, is still at a very early stage and there has been even less implementation in this area [4–6].

A large volume of data is generated during the design and construction phases of a project but unfortunately, there are discontinuities in the transmission of building data that occur throughout the typical building process. [7] reports that the lack of accurate transmission of building data impedes the promotion of an automated facility management practice and an integrated and life-cycle oriented construction. Additionally, Facility Managers are continually faced with the challenge of improving and standardizing the quality of the information they have at their disposal, both to meet day-to-day operational needs as well as to provide organisational management and planning [4].

The key challenges facing the FM practice revolve around accurate information collection, retrieval and sharing [8,9]. The challenges get more acute when they are experienced during design and construction and consequently multiplied across the lifecycle of a facility. It also places more burden on the lifecycle cost accounting for about (75-85%) of the total lifecycle costs [10]. The study by

Becerik-gerber, et al (2012) posits that Facilities management (FM) incorporates and demands multidisciplinary activities with a consequent extensive information requirement. While some of these needs are addressed by several existing FM information systems, building information modelling (BIM), which is becoming widely adopted by the construction industry, holds undeveloped possibilities for providing and supporting FM practices with its functionalities of visualization, analysis, control, and so on.

A clear definition and identification of FM information for specific FM tasks in BIM models are therefore essential for realizing the full potential of BIM in FM. This study is a structured literature review of the issues that underscore efforts in managing FM information that contributes to organisations strategic thinking on BIM-FM implementation. This is with a view to developing a framework for implementing BIM-enabled FM in a university FMorganisation using UniversitiTeknologi Malaysia (UTM) as a case study. This study is part of an ongoing doctoral research work in the Department of Quantity Surveying, UTM Johor. Peer reviewed journal articles were sourced from the core collection of the Web of Science using queries relevant to the study.

The remainder of the paper is structured as follows: Section 2 gives an overview of BIM for facility management. Section 3 discusses some of the current major issues confronting FM information requirements in BIM. Section 4 discusses information quality for FM in BIM models. Section 5 discusses data open standards. Finally, Section 6 provides the conclusion of the study.

2. BIM for facility management

The emerging field of BIM research keys into the identification of collaborative environments in the construction industry. The whole purpose of BIM for FM is to leverage facility data through the facility lifecycle to provide a safe, healthy, efficient and effective work environment [12]. While its potential to support FM is recognized, its application is still limited [13,14]. As reported by [5] BIM was the main digital technology covered in FM articles between 2004 and 2017 (from technical papers, publications, and statements from industry). Similarly, BIM adoption and standardization, and BIM programming feature as the areas with the most significant growth in the industry [13]. While its potential to support FM is recognized, its application is still limited [13,14].

Significant challenges facing BIM for FM integration include greater consideration of long-term strategic aspirations, resolving data interoperability issues, converting building information into tangible business knowledge for FM, the need for customized data standards appropriate for each owners' needs, and accommodating inputs from facility managers during BIM development at the earlier stages. [14–19]. Perhaps a more worrying development in these challenges as reported by [9], is the apparent lack of consensus among industry practitioners and academics about the successful and practical information exchange process between BIM and FM systems.

3. Information requirements for BIM in FM

A common view is that BIM is a catalyst for process change across the lifecycle of construction projects where it is demonstrated in identifying more precise and accurate information throughout the design and construction process [15,20]. This process change can resolve information exchange during handover and information management during operations and maintenance [21]. Real-life cases of BIM implementation in FM are scarce and where present the facilities information typically does not contain the necessary information for FM tasks [22]. [11] also reported that FM practice with its multidisciplinary activities demands extensive information requirements. The required information is for operational purposes, both geometric and non-geometric, typically generated as part of deliverables in the course of project execution contractually identified in time and content. Additionally, the information or content is usually contained in text files, spreadsheets, presentation files, image files, graphic files, audio-visual files, simulation files and database files.

The study by [23] argues that previous studies on FM information requirement mainly focused on providing guidelines for generic information on FM activities without consideration of specific FM tasks. This compels FM teams to make decisions with insufficient information for specific tasks

especially building systems. Similarly, [17] reports that previous studies also primarily focused on geometric data leaving out non-geometric data. However, the importance of non-geometric data for the operation phase increases as the project moves from the earlier phases to the operation phase. The study of [17] supports that of [7] about the lack of accurate transmission of building data for automated FM. [24] drew attention to the widely held view that the design and construction phases are the main focus of information flow in construction. Their study argues that this phenomenon presents challenges in complying with clients' requirements for the operation phase. Also, their study proposed a decision support system for prioritizing and assigning values to information requirements on projects for better management of clients' requirements at the operation phase.

Another dimension to this is the demand for customised data standards that fit owners' needs [25]. Furthermore, the NBS National BIM Report posits that the surfeit of information for BIM demonstrates the technical capability while lacking the ability to specify only the required amount of information for successful BIM implementation [26].

Concerning accommodating clients' requirements in BIM for FM, [18] maintains that asset information, in general, must align with organisational objectives for increased operational performance. Asset information requirements traditionally generated bottom-up by maintenance and operational personnel contradicts this position. This is because technical operational requirements do not capture an organisation's strategic thinking. Their finding is consistent with that of [27] on the strategic importance of information management.

Figure 1 shows the interrelationship of information management (IM), information systems (IS) and information technology (IT) with their respective key alignments.It concisely captures the different dimensions of information across the whole lifecycle and also clarifies the erroneous prioritization of IT and IS over IM in BIM implementation. While IM is important in the earlier phases, facility managers are more conscious of its impact on operational performance. Overall, these studies highlight the need for a practical process for collecting BIM data for FM that supports the provision of precise information for specific FM tasks, customized data that address owner requirements, and alignment with organisational objectives.
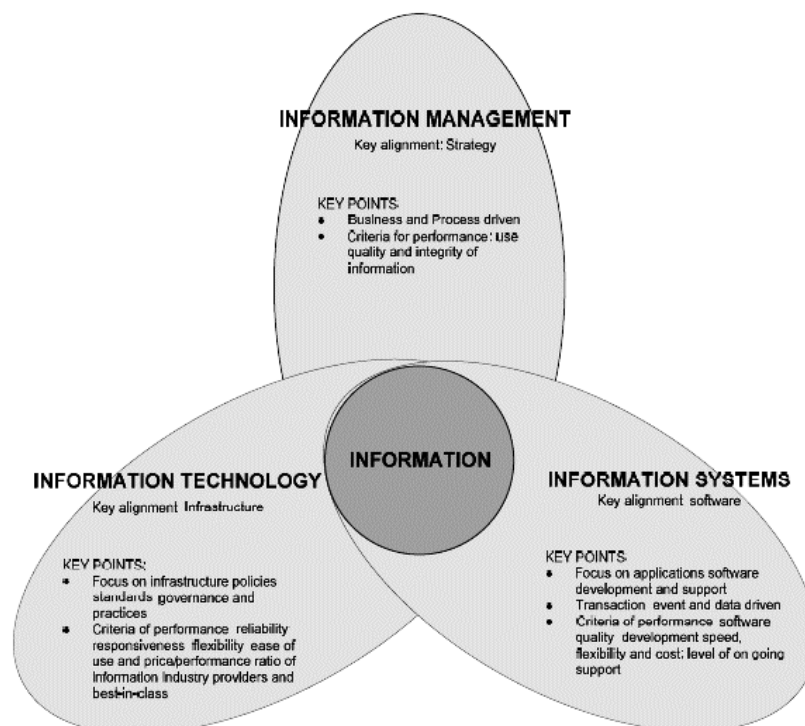

Figure 1. IM,IS,and IT alignment (adapted from Sheriff A 2011)

4. Information quality

Improving and standardizing the quality of information remains a constant challenge facing facility managers to meet day-to-day operational needs as well as to provide organisational management and planning [4]. BIM standards and protocols developed in countries with a drive for BIM adoption define expectations for information exchange in a facility's lifecycle (BS 1192-4:2014). As projects are increasingly being delivered using BIM it is crucial to obtain quality models from the earlier phases for downstream information consumers. Ensuring the quality of information from the earlier phases for FM purposes will address cases of significant costs and rework [28].

Yet, there is a synergistic relationship between BIM quality and BIM standards. Quality information in BIM models informs the development of enabling BIM standards that, in turn, guide the development of quality metrics. A 2012 RICS report challenges the lack of strategic thinking in FM that has led to unsustainable and inefficient buildings and facilities. Consequently, this affects the quality of information at the disposal of FM professionals for daily operational needs and strategic organisational demands. A framework for information quality assessment (IQA) of BIMs for FM use is one such solution proffered to solve the inconsistencies in 'demand' and 'supply' of critical data for FM tasks [28]. The quality and integrity of information at the disposal of FM professionals are often unique and tailored to different FM tasks and to different organisations suggests that handover information in BIM models must also be tailored FM teams' requirements.

5. Data open standards

Poor interoperability is one of the main barriers to BIM adoption across countries. Others include time, level of expertise, high cost of hardware and software, and lack of client demand [11,29–31]. Fragmentation in the construction industry has exacerbated the problem of interoperability which, impact sharing of information as reported by [32].

Industry Foundation Classes (IFC) and Construction Operations Building information exchange (COBie) are open standards developed to deliver structured asset information held in a BIM for FM data requirements from the early stages of project development [33]. In contrast, however, asset owners are not likely to leverage the benefits of emerging handover standards including IFC and COBie because they do not specify the ways to populate these standards over a project lifecycle as reported by [34]. Furthermore, IFC and COBie still exhibit shortcoming in handling specific FM cases [33].

There is also a dearth in studies on benchmarking COBie outputs against the information requirement of the construction industry. Efforts are currently underway to develop standardisation for BIM application to cater to unique contractual relationships to strengthen the ability of IFC and COBie to deliver asset data and information required by facility managers within a whole life cycle perspective [33].

The study by [25] proposes the development of a model-based approach for capturing and handing over facility data. A six-step process strategy for digital facility data handover was proposed describing how facility data can be defined, captured and stored into the BIM and further exported and automatically linked to the FM system. This strategy eliminates the necessity of third party software since a direct link in the form of a plug-in allows for tracking data between the BIM model and the FM system.

6. Conclusion

While BIM is poised to provide a common and formidable platform for identifying, collecting and analyzing construction-related information for virtually all project stakeholders, it becomes imperative that seamless interoperability between the different domains of a building project and their respective practitioners exists. The FM practice is quite diverse and the consequent information demands are as varied as well. Also, the quality of information must be precise to handle the specific FM task.

The situation where superfluous information is being transmitted to FM is not tenable for effective BIM-FM integration. Likewise, FM professionals collecting as much information as they could from the earlier phases because of *just-in-case* situations is also not justifiable. In general, therefore, it seems that owners must be thorough in defining their information requirements for all FM tasks in the operation phase. This is to accommodate these requirements in the earlier phase as much as it is allowable since there are currently no contractual arrangements to support this. It is anticipated that further developments in standards for BIM adoption will assist IFC and COBie proprietary standards for improved interoperability.

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