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AN INVESTIGATION OF FACTORS AFFECTING BIM ADOPTION IN FACILITY MANAGEMENT: AN INSTITUTIONAL CASE IN AUSTRALIA

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ABSTRACT

The primary objective of Building Information Modelling (BIM) is to support the whole-of-life project life-cycle. However, the adoption of this promising technology appears so far to have been limited to the design and construction phases, with little emphasis on facility management (FM). While some countries have or are developing policies on the adoption of BIM in FM, others, such as Australia, are in stasis in terms of BIM policy. The aims of this project are to investigate the current level of BIM adoption, to evaluate awareness of and willingness to adopt BIM, to identify the motivators and challenges, and to explore the strategies and potential issues of BIM adoption in FM through an institutional case study. A qualitative method was adopted, including in-depth interviews and open-ended questions to capture rich information to enable better understanding of the research question. The data were thematically analysed, revealing that the adoption of BIM by the case study institution is in its infancy. The organisation is still in the value realisation phase of the BIM-enabled FM implementation process. The external and internal motivators are outweighed by the major challenges faced by the organisation, which explains the current level of adoption.

Keywords: Building Information Modelling (BIM), Facility Management (FM), Institutional Buildings, Australia.

INTRODUCTION

Building Information Modelling (BIM) has enabled a paradigm shift in the architectural, engineering and construction (AEC) industry during the past decade. While there are many definitions of BIM, Succar et al. (2007) define it as “a set of interacting policies, processes and technologies producing a methodology to manage the essential building design and project data in digital format throughout the building’s life-cycle” (emphasis added). Similarly, the definition given by the American Institute of Architects (AIA, 2015) places an emphasis on facility management: “BIM utilizes cutting-edge digital technology to establish a computable representation of all the physical and functional characteristics of a facility and its related project/life-cycle information, and is intended to be a repository of information...
for the facility owner/operator to use and maintain throughout the life-cycle of a facility”.

The ongoing maintenance and operational costs of a building throughout its life-cycle far outweigh the original capital cost of construction (BIM Task Group, 2012). Less than 15% of the life-cycle cost is taken up by design and construction, while the remainder (more than 85%) is taken up by FM (Teicholz, 2004). Lee et al. (2012) estimate that the life-cycle costs of a building could be as much as 5-7 times higher than the initial investment costs. While the primary objective for BIM is that it be adopted throughout the life-cycle, the FM cost is significant compared to construction costs, and in general BIM adoption and exploration in FM remain immature.

BIM-enabled FM is becoming mandatory in some countries, and a significant increase in interest in BIM-based FM can be expected in the industry in response to such policies (Edirisinghe & London, 2015). In the UK, for example, the Digital Built Britain Level 3 Building Information Modeling Strategic Plan (HM Government, 2015) states that “Level 3 will enable the interconnected digital design … and will extend BIM into the operation of assets over their lifetime...”. In October 2015, the Building Construction Authority (BCA) of Singapore announced the second BIM roadmap (2015-2020), which promotes BIM for FM. It is fascinating, in contrast, to see the degree of adoption of BIM in FM in countries where there is little or no BIM policy, be it in the form of regulation or reward schemes, to influence the adoption of the practice in any phase of the life-cycle. Australia is a good example. BIM guidelines in Australia include the National Guideline for Digital Modeling (2009) by CRC for Construction Innovation, and the NATSPEC National BIM Guide (2011) which emphasise FM. While there is no strong, federal-level policy mandating the use of BIM in Australia some state-level initiatives have recently appeared. For example, New South Wales’ Health Infrastructure has mandated BIM deliverables on all projects over $30 M since 2013 (NSW Government, 2013).

A pilot project was established with the aim to explore the factors affecting BIM adoption in FM through an international comparison of institutional cases. Initial phase of the project covered Singapore and Australia. This paper focuses on the findings of the Australian case study. Findings of the Singapore case studies (Shen et al., 2016) and comparative analysis are beyond the scope of this paper.

BACKGROUND
The ability to support FM is considered an important value-adding feature of the BIM approach (Gu and London, 2010). Value propositions for BIM-enabled FM have been identified in building operations in life-cycle phases from commissioning to maintenance. Among these propositions are efficient building commissioning (Eastman et al. 2011) and information handover for facility management (Kassem et al., 2015), rapid population of FM databases (Eastman et al. (2011) with accurate FM data (Kassem et al., 2015), efficient data entry through automation (Becerik-Gerber et al., 2012) compared to manual data entry (Kassem et al., 2015) and information transfer from the early stages (Yalcinkaya and Singh, 2015). Also, applying BIM as a tool (Eastman et al., 2011) in a number of maintenance areas (Becerik-Gerber et al., 2012) has been found to be beneficial for facility operation (Eastman et al., 2011). Becerik-Gerber et al. (2012) identified these areas as: locating building components; space management and controlling; and energy monitoring or life-cycle sustainability.
Practitioners perceived additional benefits of BIM to be: facilitating real-time data access; visualisation and marketing; creating and updating digital assets; and personnel training and development (Becerik-Gerber et al., 2012).

One reason for BIM not having been fully adopted within FM may be that its potential value has not yet been perceived by, or conveyed to, building owners – who should take the lead role in enabling BIM in FM. Without a full understanding of BIM and its benefits, organisations are not strategically well-placed to execute a BIM implementation plan. The findings of many national and international surveys (Australian Construction Industry Forum & Australasian Procurement Construction Council, 2014; Becerik-Gerber & Rice, 2010; Ku & Taiebat, 2011; McGraw Hill Construction, 2014a, 2014b) have contributed to increasing the perceived value of BIM and this may have had a significant impact on companies’ attitudes to BIM adoption. However, these findings mostly address design and construction issues and not asset or facility management, despite the fact that BIM can be used to improve the process of an asset's design, construction, operation and maintenance (Love et al., 2013).

Value propositions and challenges for BIM-enabled FM have been suggested by a number of studies (Eastman et al., 2011; Becerik-Gerber et al., 2012; Yalcinkaya and Singh, 2014; Kassem et al., 2015), but evidence-based knowledge from case studies is lacking. Value realisation or return on investment is a significant initial step in the BIM-enabled FM life-cycle. However, the benefits of BIM in the post-construction stage are difficult to measure using quantitative means. Love et al. (2013) argue that evaluation should focus not only on the operational improvements enabled by BIM, but also on managerial, organizational, infrastructural and strategic benefits. For the successful implementation of BIM in FM to be followed by value realisation, planning and guidelines, internal leadership and knowledge, procurement and BIM-based facility management functionalities should be implemented, in that order.

**METHODOLOGY**

The project aimed to:

- Identify barriers and drivers of institutional clients towards digital engineering for whole-of-life delivery
- Explore the adoption process used in each phase for whole-of-life delivery and evaluate the lessons learnt from the adoption experience
- Showcase the exemplar case studies
- Derive recommendations for good practice.

The project case studies were from Australia and Singapore. The study aimed to capture the perspectives of key decision makers in BIM implementation for FM. Hence, this exploratory study used the qualitative method of open-ended interviews.

A global tertiary education institution was selected for the Australian case study. Its total property portfolio asset value across all campuses is currently AUD1.7 billion. The case study organization (CSO) is at an early stage of BIM adoption, and it is currently between value realizations for strategic planning. The organization still uses a ‘traditional’ FM framework, and its workflows are based on 2D drawings and in
excess of 30 different software applications that serve various purposes in procurement and FM. Four professionals representing FM clients in the CSO were interviewed for this study. The interviews, each of which lasted for approximately 45 minutes, were audio-recorded with the participant’s consent and later professionally transcribed. The participants were recruited by contacting a senior manager responsible for strategic planning for BIM adoption in the CSO. The participants included: three senior managers, of asset planning, of space improvement and post-occupancy evaluation, and of a major retrofit project respectively; and an internal Associate Professor who serves on a BIM advisory board. Only one participant had previous hands-on BIM experience. Collectively, these interviewees represented various aspects of FM to provide a reasonable sample for the study.

Interview questions covered the interviewee’s background and awareness of how BIM related to his/her work, the interviewee’s willingness to adopt BIM in his/her workflow, the challenges of, or barriers to, BIM adoption in FM, the motivators/drivers and (potential) benefits of BIM adoption in FM, and the strategies to be implemented in the adoption of BIM for FM.

DATA ANALYSIS AND RESULTS

The interview data, together with content analysis of important relevant documents, were coded in NVivo (version 11) for qualitative analysis. The top-level coding structure distinguished between the following attributes: barriers or challenges, potential benefits, and motivators. Integrating the participants’ responses with theoretical findings led to more components (sub-attributes) being added to the main attributes given above. The data analysis and the recommendations derived from it were based on the framework by Love et al. (2014), guidelines for implementing BIM in FM (Eastman et al., 2011) and Love et al. (2013), in which the authors describe organizations at early stages of value realization in BIM adoption.

Status of BIM Adoption in FM in the CSO

The CSO has committed a significant amount of capital over the next four years to delivering its infrastructure plan. A BIM initiative has been proposed (funded partly from the capital budget and partly from the operational budget) and is in the approval stage. As one participant put it, when asked about the status of the organization’s adoption of BIM: “so far we’ve only got an aspirational brief”. That “aspirational brief” is intended to help develop a roadmap and implementation plan in 2016/17. Another participant referred to the current stage as the “exploratory stage”, in which the future strategy will go through a consultation process with key stakeholders. “Stage 2,” the participant said, “is the BIM implementation plan”. On this basis, the CSO can be classified as being in the agenda setting phase of the initiation stage, which as stage 1, of the five stages in the organizational innovation process (Rogers,1995 p. 392).

Perceived Benefits of BIM adoption in FM in the CSO

A potential benefit of adopting BIM in FM is having a centralized system with the ability to integrate with other software or systems. A participant commented that “ideally, for BIM to be effective, all of these need to then come under the umbrella of BIM; BIM’s the single source of truth...”.

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Another perceived potential benefit was **competitive business advantage**. One participant commented “to win our business, you’ve got to impress our socks off. It’s a little bit the same with BIM…”.

Consistent with the research literature, three participants (Love et al., 2013) perceived that **effective asset delivery and performance** could be achieved with BIM-enabled FM. One participant commented: “because then you can keep track of the latest documents around you... it could be your contractors' credentials. It could be your building certificates”. Another participant, stated “3D modelling... 4D modelling scheduling...5D modelling, which is costing, or 6D modelling. It’s facilities management... life-cycle. It’s end-to-end”. Another participant commented: “within those buildings, you can then determine the suitability for the building to be upgraded or retrofitted to a future or a different purpose. ... [it gives you] access to a better understanding of your infrastructure ... the restrictions to you. How you can maintain it. And if you wanted to upgrade or configure or reconfigure or repurpose the building it’s much easier to do that if you know the building, how the building’s built”. The **ability to perform upkeep while in use** was also perceived as valuable. One participant commented: “effective guesstimation in terms of pricing and business cases, capturing things like hazardous material in the walls... through to the design, the delivery and then the ongoing life-cycle, maintenance and upkeep of the building”.

One participant commented that potential **cost-savings** are another benefit: “we estimate that there’s a potential cost-saving in delivery, build and on-going maintenance of somewhere between 5 and 10% overall”.

One participant saw an additional advantage of integrating BIM-based FM in **learning and teaching** and collaboration within the CSO: “Collaboration is going to be improved both internally, externally. Student experience, learning and teaching will be improved because they can tap into it”.

**Challenges for BIM adoption for FM in the CSO**

Since asset owners generally do not engage in the design and engineering of a new project, the operations and management of the facility are not considered in the formative stages (Love et al. 2014). A similar concern was raised by participants that BIM is mainly targeted to design and construction but is not targeted for **future asset management**. For example, one participant commented: “it’s not going to be good enough for construction. Or you create a BIM for construction; it’s not going to help you for operation”. The same participant added the need that **level of detail** and appropriate information be included: “BIM for FM, it really is the last frontier and BIM for FM is more about data than geometry”.

Another perceived challenge was **compatibility between BIM and existing asset management systems**. For example, one participant discussed the difficulty of integrating the 36 different software packages used in facilities and operations management at the implementation planning stage: “How much can we streamline all of our 30-odd software programs that we use if we implement BIM?” From a technical point of view (for warranty and maintenance) one participant highlighted the effort required in **entering the data** (on existing buildings) in to the system: “so if you know defects, so you can track your defects, you can track your warranties...but again, someone has to manage all of that. And also, if you, for future asset planning, you
need to collect information”. Two other participants also had similar perceptions of the challenges posed by the time-consuming and costly data collection and set-up process for existing buildings.

One of the participants highlighted the integration of work-flows as a challenge and explained: “we're the end-user, we're the maintainer. So we rely on the people out the front at the beginning of the process to provide the right details, the right information in the right format that the system can accept that we can use to maintain the building”. This participant also expressed the need to integrate the process into procurement and contractual obligations: “If it’s not part of the contractual obligation, the sub-contractor will not provide the information [the CSO] wants in the format that we can use”.

Love et al. (2014) argue that BIM is a costly technology (in both direct and indirect costs). Three participants also perceived cost to be a major barrier compared to resources. One considered cost to be a barrier due to the complexity of prioritising the institutional portfolio and technical and societal requirements of stakeholders: “[the] impact on costs and all that sort of thing through to the design, the delivery and then the on-going life-cycle, maintenance and upkeep of the building”. One participant said “they’re very expensive systems to set up”, another that: “There’s lots of benefits, but it comes at a cost”. One participant also mentioned the associated direct costs: “[The] cost of the software is about $xxx [commercially confident information and removed] and consultants’ fees is quite high”. Other fine-grained elements such as human organisational costs (Love et al., 2013) did not emerge in the interview data, possibly because the CSO is only in the very early stages of strategic planning.

A perceived cultural barrier was a lack of industry push. One participant expressed a belief that: “The market’s still very green on BIM. There’s a lot of people out there trying to get into it that aren’t really sure about it”. One participant also mentioned that peer pressure, learning from others and seeing other similar organisations benefit from BIM was a motivator, but that the low priority placed on BIM in property portfolio plans is a challenge that can outweigh these motivators. The participant commented: “I was supposed to meet with them … in a week’s time, but I’ve had to push it out about three weeks because of other priorities.”

Unawareness of correct requirements was another challenge, as one participant expressed: “Of course it’s more about not knowing what you want. So a client, how are they going to brief their consultants on what do they need? … How detailed and how good is that BIM model?” Another participant said “I don’t, to be honest I think a lot of people think that’s wonderful and they go and buy these systems and then they, can’t capture the data that’s required to go into it”. This participant also added: “you’ve got to work out what you want the system to do. And then who, you’ve really got to determine what is your asset strategy?”

DISCUSSION AND RECOMMENDATIONS

In the CSO, the adoption of BIM for its projects is in its infancy. In the absence of any external motivation (such as regulation or rewards schemes), an internal motivation appears necessary if BIM is to be adopted for the FM needs of new buildings. An ability to gain a competitive advantage, potential cost savings, effective asset management through a centralized system, better performance and ability to perform
upkeep during use were perceived as benefits. However, the barriers currently appear to outweigh the motivators and perceived benefits. Technical barriers include the following: that BIM is not inherently intended for future asset management; there are compatibility challenges between BIM and the large number of existing asset management systems, and hence data entry is impeded; and that the integration of currently unlinked workflows will be time-consuming and complex. There are also social and cultural barriers: a lack of industry push; uncertainty about requirements; and the complexity of managing organisation and other stakeholder priorities. The only economic barriers were costs, direct and indirect, and the resource requirements. This analysis of the CSO is summarised in Figure 1, below. On the basis of the literature review, the guidelines for successful BIM implementation in organisations, and the interview data, the following recommendations can be made to the CSO.

**Recommendation 1:** Love et al. (2013) argue that BIM offers an opportunity to add value throughout an asset’s life and recommend the use of financial evaluation methodologies or measures to better achieve these benefits. One of the participants believed that benefit realization and BIM engagement is important at this early stage. Their comment was that “…as a business, how far are we going to engage with this and how much benefit is [it] going to … bring to us?” While the CSO has conducted a high-level evaluation, a more rigorous financial evaluation with tangible and intangible cost-benefit analysis is highly recommended for the next phase.

![Figure 1: CSO BIM adoption for FM – current status](image-url)

**Recommendation 2:** Eastman et al. (2011) argue that strong internal leadership is critical during implementation planning. One of the participants commented “[a leadership poison] has empowered xxxx [name removed] to lead the BIM process at [the CSO]”. Due to the absence of an organisation-level policy, it is recommended that strong leadership be provided by the CSO that can overcome the current barriers,
particularly the challenge of setting priorities, which is critical to the success of implementing BIM, particularly in the early stages. Leadership is one of the key drivers in initial implementation, as well as in the take-up of BIM by broader stakeholder groups.

**Recommendation 3:** For any organisation in the strategic planning stage of the adoption of BIM in FM, such as the CSO, establishing *internal knowledge* is just as important as strong leadership (Eastman et al., 2011). One of the participants, in support of this, said that “for BIM to be successful there would need to be a dedicated internal BIM manager... That would be absolutely essential”. It is strongly recommended to the CSO that a BIM plan should be implemented, and that this be followed by a brief to establish a strong internal knowledge base.

**Recommendation 4:** While robust experimental data on the influence of *policy and regulations* on adoption are as yet unavailable, some researchers argue that national and state-level policies (Edirisinghe & London, 2015), rewards (Gu et al, 2015) and subsidies (Singapore Government, 2015) can influence technology adoption.

One of the participants believed that governments’ influence on raising the rate of industry adoption varies according to the culture: “*Australian culture, especially with the construction industry, they’re really conservative and reactive ...*”. This participant added, regarding the need to provide a support structure, including up-skilling and training if adoption were to be mandated by regulation, that: “*If you enforce it? Well you just need to make sure you get the skills to do it*. The same participant thought there might be negative consequences of having strong policies, such as a *decline in innovation:* “*I don’t think innovation happens when you have such a [high] level of prescription*. Participants’ responses on the question of how much government should be involved in promoting BIM ranged from wanting user guides and training material to be provided, to wanting BIM to be a must-have. This latter participant further commented: “*BIM at the moment for us is a nice-to-have, although it really should be a must-have... Because the sooner we get it in, the better off we’ll be. That’s how I see it*. In the absence of external pressure, such as regulation, to promote BIM adoption in the CSO, it is strongly recommended that the CSO actively participate at strategic and technical levels in external events to determine if a BIM strategy is the best way to proceed. In particular, the CSO should participate in events that promote broad industry-level adoption, such as free state-level BIM workshops, conferences and forums that bring industry stakeholders together to discuss the issues.

**CONCLUSIONS**

The aim of this research project was to investigate the awareness, willingness, motivators, challenges, and strategies of building owners and facility managers regarding BIM-based FM in an institutional case study of an Australian organization. A qualitative method using unstructured interviews with open-ended questions was used to collect data from interviewees recruited from a large institutional organization in Australia. Interview data revealed that the selected organisation was at a very early stage of implementing BIM for FM. While there is a high degree of awareness and willingness to adopt BIM for FM, there are significant barriers to overcome; the complexity of the large portfolio and of stakeholder priorities and other processes, the importance of a thorough infrastructure plan, and the lack of an industry push for the
CSO to learn from others. This paper has made strategic recommendations on several political, technological, economic and social themes. The results generated from this study will give some insights into the challenges and motivators of the adoption of BIM for FM, particularly in an institutional organisation where adoption is currently in its infancy. However, due to the limitation of the small sample size, more extensive study may be needed to make the findings generalizable.

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