THE STATE OF BIM-TO-FM IN VICTORIA

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Part 1: BACKGROUND RESEARCH AND LITERATURE REVIEW

Specialist Trade contractors are mainly responsible for the appropriation of construction information to be taken further into the operational stage of an asset. Yet their interface with those who ultimately operate and maintain the asset is typically low. Technology in support of a structured and standardised way to transfer information from construction to operation is mostly absent and a clear gap can be identified in the industry when it comes to skills and capabilities in doing so. The literature review conducted as part of the Virtual Building Quality System explores key themes associated to the BIM to FM transition. The topic has increasingly gained relevance over the past 5 years as more and more industry and government representatives show interest in how to leverage off the potential of BIM and introduce value-add during the operation and maintenance (O&M) of built assets.

Previous studies conducted on BIM for facility management (FM) can be summarized into papers discussing the opportunities and challenges of using BIM for facility management; the definition of FM requirements, the development of framework/model for BIM and FM; evaluation of BIM standards and specifications, as well as the legal implications of using BIM for FM and the uptake of BIM for facility management.

A. Opportunities and Challenges of Using BIM for Facility Management

With increasing awareness of the benefits of linking construction information through to the operational phase of built assets, more and more researchers address the benefits as well as the obstacles of connecting these two (traditionally separated) activities. A major part of the study about the state of BIM to FM efforts in the Victorian Construction and Facility Management sectors therefore consists of an extensive literature review to understand existing efforts undertaken in this field by others both within Australia, as well as overseas. The review highlights the broad spectrum of researchers\(^1\) who have been investigating the benefits and the challenges experienced by Construction and FM professionals when adopting BIM. Based on this extensive review, benefits associated with linking BIM to FM can be summarised as follows:

- increased utility and speed for data retrieval from a centralised BIM model;
- improved handover of BIM to FM data
- enhanced collaboration through BIM processes and modelling;
- improved embedded building data in a centralised model;
- better access to FM data that can be found within models;
- 3D visualisation/location of assets;
- increment of the efficiency of work-orders execution;
- longer equipment asset life; and
- more effective space planning.

Some of the challenges include (among others):

- the shortage of BIM skills in the FM industry
- the amelioration of data integration or interoperability;
- the need for augmented knowledge management and enhanced performance measurement.

\(^1\) Pärn et al. address this in their 2017 study titled: The building information modelling trajectory in facilities management: A review as well as Gheisari and Irizarry (2016) in Investigating human and technological requirements for successful implementation of a BIM-based mobile augmented reality environment in facility management practices.
• the requirements of enriched training and competence development for Facilities Managers to better deal with the amorphous range of services covered by FM

Next to the abovementioned points, researchers\(^2\) assess that main challenges include the lack of methodologies that demonstrate the tangible benefits of BIM in FM, as well as limited knowledge of implementation requirements, particularly those for facilitating data transfer from BIM (models) to FM systems.

### B. Defining FM Information Requirements

Drawing on existing literature, it becomes apparent that identifying what information is most relevant to those operating and maintaining built assets is one key hurdle to overcome when linking BIM to FM. As a recent study\(^3\) illustrates, client representatives often do not consider the use of BIM in adding value to the existing maintenance information systems. Therefore, they often do not make an effort to express their Asset Information Requirements (and the associated data) to the construction teams in a concise way. A flexible solution is therefore required that allows those involved in construction, installation and commissioning of equipment to set up their data within models in a way that can later be adjusted and queried as per the specific requirements of owner/operators and their Facility Managers.

Several recent studies\(^4\) report on efforts for formulating information requirements by large owner organisations (such as educational institutions, health facilities, and other agencies responsible for delivering and maintaining public infrastructure). These studies reveal the need for broad stakeholder engagement as well as the inclusion of spatial data (adjacencies, proximity, orientation and accessibility by user type) in the establishment of information and requirements to be handed from BIM to FM. The studies also touch on data transfer mechanism to facilitate the data input into the computerised maintenance management system (CMMS) and automatically populates the relevant information for the assets of the building.

The transition of data from BIM to FM for Mechanical, Electrical and Plumbing (MEP) equipment is highly significant as it is cost-intensive and supports safe maintenance and repair practices during the operational phase. So far, several research teams\(^5\) investigated the use of BIM in heating, ventilation, and air conditioning (HVAC) tasks and identified a generic set of information requirements for troubleshooting the HVAC-related problems. In some instances, researchers propose developing a BIM-based automated approach to provide the required information for HVAC mechanics during the facility operation phase. In other instances, researchers suggest continuous accumulation and sharing of knowledge for BIM-FM throughout a project’s life cycle. One study\(^6\) tested a BIM plug-in tool which uses a fault detection and diagnostics (FDD) algorithm to automate the process of detecting the malfunctioning of the heating, ventilation and air conditioning (HVAC) equipment.

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2 Kassem et. al (2015): *BIM in facilities management applications: A case study of a large university complex*
3 In Finland Korpela et al. (2015) researched: *The challenges and potentials of utilizing building information modelling in facility management: the case of the Center for Properties and Facilities of the University of Helsinki*
4 Examples include Cavka (2017) with: *Developing owner information requirements for BIM-enabled project delivery and asset management*, as well as Thabet and Lucas (2017) who studied: *Asset Data Handover for a Large Educational Institution: Case-Study Approach*
5 In 2017 Yang and Ergan (2017) investigated: *Leveraging BIM to Provide Automated Support for Efficient Troubleshooting of HVAC-Related Problems*. Liu and Issa (2016) surveyed *Common knowledge in BIM for facility maintenance* with a distinct focus on MEP systems. Mayo and Issa (2016) studied information requirements for linking BIM to the maintenance of HVAC systems in *Non-geometric Building Information Needs Assessment for Facilities Management*. Golabchi et al. (2016) explore opportunities for *Automated building information modeling for fault detection and diagnostics in commercial HVAC systems*. 6 As part of their study, Golabchi et al. (2016) use an algorithm that connects to a complaint ticket database and automates BIM to determine the potentially damaged HVAC system components. It further develops a plan of action for the facility inspectors.
Efforts for identifying BIM deliverables as mentioned above are complemented by research focussing on assisting owner/operators to assess their BIM competency and to provide owners with guidance on how to establish a baseline of where their organisation stands and indicate possible areas for improvement.

C. Development of Framework/Model for BIM-FM data transfer

In the past, researchers have dealt with the question of how to develop an approach for structured BIM to FM transition. Researchers from around the globe are currently trying to establish frameworks to help owners and Facility Managers in defining the requirements for asset management tasks in a structured way and to validate project and asset data against these requirements. Patacas et al. suggest a combined use of an Information Delivery Manual (IDM), Industry Foundation Classes (IFC), Construction Operations Building Information Exchange (COBie), and Content Management Interoperability Services (CMIS). In combination, these components are consolidated to assist in the development of Asset Information Models (AIM) to fulfil the owner’s asset information requirements throughout the lifecycle of a building.

The necessity of drawing data from various sources and in different formats highlights both the difficulty in deriving structured construction data that can feed into FM, as well as the shortcoming of current tools and associated data-models to deal with this transition.

Yang and Ergan suggest an automated approach in 2015 to identify the potential causes and retrieve the required information for a given work order to streamline the process of troubleshooting MEP-related problems. The retrieval was facilitated via algorithms that identify applicable causes and match them to facility-specific instances. Similarly Love et al. (2015) developed a systems information model which can be used by asset managers and staff to make more informed and quicker decisions about maintenance of electrical, control, and instrumentation assets.

In summary, existing efforts in developing BIM to FM frameworks predominantly address data transition and decision-support processes. As much as these approaches are relevant, they do not change the fact that the data stemming from the design and construction processes is rarely adequately formatted to feed into FM. This view is seconded by a recent study concluding that the vehicle to project success in BIM-FM is reciprocity, shared trust and efficient integration of project team’s efforts across multiple lifecycle stages. The study explored the implications of disclaimers to losses that may occur when contract clauses are not efficient and when virtual models fail to deliver as promised in the Australian context. The study assesses that BIM is critically consequential to FM processes when system integration becomes smooth and modellers or designers can include the facilities managers’ requirements starting from the very early stages of a project life.

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7 Giel and Issa developed BIMCAT (BIM Competency Assessment Tool) as part of their research on a Framework for Evaluating the BIM Competencies of Facility Owners
8 Patacas et al. (2016) test how BIM data can be fed into an Asset registry in: BIM for facilities management: Evaluating BIM standards in asset register creation and service life planning
9 In 2015 Wetzel and Thabet investigated safe maintenance and repair practices as part of their study titled: The use of a BIM-based framework to support safe facility management processes
10 Hu et al. (2016) analysed multi-scale solution to address the insufficiencies of current applications in the construction and Facility Management of MEP projects in: Construction and facility management of large MEP projects using a multi-Scale building information model
11 See: Leveraging BIM to Provide Automated Support for Efficient Troubleshooting of HVAC-Related Problems
12 The purpose of their study: A systems information model for managing electrical, control, and instrumentation assets is to present a systems information model (SIM) that is akin to a building information model (BIM) and can be used by asset managers and staff to make more informed and quicker decisions about maintenance.
13 Olatunji and Akanmu (2015): BIM-FM and consequential loss: How consequential can design models be?
Background research for the Virtual Building Quality System revealed one approach from Finland\textsuperscript{14} that is closest aligned with the consortium’s efforts. In that case, researchers worked on an application programming interface (API) plug-in which integrates building information modelling (BIM) and facilities management (FM) via the novel development and application of totems. The study indicates that the totems could visualise rich semantic FM data in a 3D object and extend the application of Construction Operations Building Information Exchange (COBie).

D. Evaluation of Standards, Legal Implications, and Alternative Uses of BIM-FM

Findings from the literature review point towards a direct correlation between uptake of BIM for Facilities Management among owner/operators and Government/policy incentives or directive. The strongest evidence could be found in a study\textsuperscript{15} that reveals discrepancies between the perceived value of BIM among UK owner/operators (where the provision of BIM to FM is required on all government projects) and their counterparts in the US (where BIM to FM is only required for a limited set of data transfer for space management). The study found that UK owners exceed American owners in their enthusiasm for the greater use of BIM for facilities management. All UK owners report some degree of value and over three quarters (78\%) said BIM for FM has a high value; meanwhile, only 5\% of US owners regard it as having a high value. Outcomes from the study highlight that nearly all UK owners (98\%) predicted that they will perceive a high value in five years. However, 27\% of the US owners predicted that they will perceive a high value in five years.

In some instances,\textsuperscript{16} studies tried to establish if open data standards such as the Industry Foundation Classes (IFC) and specifications including the Construction Operations Building information exchange (COBie) are sufficient to translate asset data from construction into information required by facility managers. Findings to this point reveal that IFC and COBie do not satisfy all information requirements for specific facility management tasks such as ‘asset register’ and ‘service life planning.’

The background check of existing literature uncovered the tendency of underestimating BIM’s impact on the Facility Management profession due to its limit on newly built assets (in contrast to including BIM strategies for existing building stock) as well as the apparent exclusion of construction in larger (linear) infrastructure. On study in particular\textsuperscript{17} offered insights into the development of software architecture for the effective integration of building information modelling (BIM) into a geographic information system (GIS)-based facilities management (FM) system.

\textsuperscript{14} Pärn and Edwards (2017): Conceptualising the FinDD API plug-in: A study of BIM-FM integration
\textsuperscript{15} Bruce et al. wrote a ‘Smart Market Report’ for McGraw Hill in 2014 comparing the uptake of BIM among owners on a global scale in: The business value of BIM for owners.
\textsuperscript{16} Research on Evaluating BIM standards in asset register creation and service life planning by Patacas et al. (2015) showed that while IFC and COBie do not satisfy all information requirements of asset register and service life planning by default, they allow users to add some of the unsupported information in the form of property sets using Revit shared parameters. However, not all IFC Entity Types can be supported using shared parameters.
\textsuperscript{17} Kang and Hong (2015): A study on software architecture for effective BIM/GIS-based facility management data integration
PART 2: THE STATUS QUO OF BIM UPTAKE AMONG VICTORIAN SPECIALIST TRADE CONTRACTORS AND FACILITY MANAGEMENT PROFESSIONALS.

A. LEVEL OF ADOPTION

In Victoria, adoption levels of BIM vary greatly between Specialist Trade Contractors and representatives of the FM professions. Whereas nearly 70% of Trade Contractors regularly use BIM, this can only be said of about 24% of Facility Managers. Yet, they are quite aware of BIM as 39% of FM professionals claim to have come across it on some projects. At the same time 37% of Facility Managers either don’t know about BIM, or have not had any experience using it. That number is much lower with only 14% of Trade contractors not using BIM.

These numbers make sense given that FM professionals typically neither produce any BIM models, nor use them for coordination of information. The sole benefit of BIM for FM is accessing information relevant for the operation and maintenance (O&M) of assets, plus life-cycle costing. FM professional are normally not trained in the use of BIM and that they are highly dependent on the quality of information they receive from the supply-chain. Most notably the Trade Contractors. *Quote: As a sub-contractor we are often driven by our clients to use CAD only*

B. HOW PROFESSIONALS RATE THEIR EXPERIENCE WITH BIM

Following from their dependency on others, it is not surprising that the experience with BIM by FM professionals is a mixed bag: 24% claim it does not give them any advantage for their work, 20% start to see the benefits, 24% start to get value from the BIM they receive from the supply chain, and only 16% perceive it to be high-value. 16% argue they can’t yet comment about potential benefits.
Responses from Trade Contractors are far more positive: 44% already boost their productivity via BIM, 26% claim to get real value, 21% start to see the benefits, and only 8% still face many issues with BIM. Quote: *We see BIM as a construction tool, not an FM tool!*

### C. PRESSURE ON THE SUPPLY CHAIN

Demand for BIM is growing, and the growth is more and more driven by the Client. Both the Trade Contractors as well as the Facility Managers agree that the demand for BIM by the (construction) client is increasing. Nearly 80% of Trade Contractors express this sentiment, and about 70% of FM professionals agree. Only 8% of both Trades and FM representatives don’t see an increase in demand. 5% of Trade Contractors and 9% of Facility Managers don’t feel in the position to comment on the level of demand by the Client.

Despite being clear about the increase in demand, respondents from both professions attest that ‘what’ is being requested is less clear. Chances are, clients ask for BIM very late in the construction phase of projects when asking for it represents a major effort for the supply chain. In addition, respondents lament the lack of purpose behind Client’s request for BIM with one comment stating: *Clients have heard about this new toy (BIM) and want it, but don’t quite know why!*

Even if Clients are often not clear about their desired output from BIM, Trade Contractors feel the pressure that owner-operator Clients want BIM to support their ongoing Facility Management. 55% of Trade Contractors report increased pressure to take BIM from Construction and Commissioning further into FM; only 26% argue this isn’t the case. Trade Contractors express their frustration about this issue as they feel pushed to produce extra work for Clients who ultimately neither understand how BIM can benefit them, nor clearly articulate how they want to use the data derived from BIM. Facility Managers respond differently when asked if the pressure to take BIM further
into FM is rising. The sentiment is mixed with 41 perceiving the pressure to rise, whereas an equal number see little or no change to existing practices.

**Do you feel overall there is an increased pressure from the client to take your BIM efforts further into FM?**

![Bar chart showing responses to the question about increased pressure from clients to take BIM efforts further into FM.](image)

**D. FOCUS ON OUTPUT: DATA & MORE**

Specialist Trade Contractor and FM professionals agree that one major obstacle in transitioning information from BIM to FM is a lack of well-defined handover specifications. 64% of Trade Contractors claim that information requirements form the Client side are ill-defined. Only 3% argue the contrary. Facility Managers second this sentiment with 74% arguing that it is not well defined what information they can get out of BIM, while only 16% think it is. It appears either side does not engage sufficiently with the processes of the other (due to a variety of reasons) and ‘second guessing’ what may be required often works to the detriment of BIM. There is no magic ‘red button’ that will allow for structured and purposeful data transfer out of construction into operation.

Opinions are divided among both Trade Contractors as well as FM professionals when it comes to the suitability of data within BIM for integration with Facility and Asset Management software. In both camps around 27% of respondents argue that the data is likely going to be unsuitable with equal numbers saying it is; most answers attest the data is only suitable ‘to a degree’. The question about data suitability has attracted the highest number of ‘do not know’ replies with 15% of trades and 11% of FM professionals. It appears more testing needs to occur and many professionals simply haven’t yet come across this issue in their dealings with BIM.

**E. NOBODY LIKES COBie**

COBie stands for Construction Operation Building information exchange and it functions as a schemer to identify any data to be transferred from BIM to FM. In principle, it should facilitate exactly what the industry is asking for, namely a structured and standardised way of linking data from BIM into FM. Yet despite its intended use and its
availability as a reference for several years, practitioners do not warm up to it. Responses from the industry point towards an overall rejection of the COBie approach with only 5% of Trade Contractors and 9% of Facility Managers using it.

We have used it on a number of projects. We have received minimal (or no) feedback to gauge whether our produced COBie outputs have been 'successful'.

Responses to the survey explain why: COBie appears to be - in its basic form - a top-down, all-encompassing framework that is overly complicated. As one respondent puts explains: We believe the majority of COBie data if completed fully would not be used and only serves to increase project cost and complexity for team members.

Are you aware of the Construction Information Building Exchange (COBie) schemer?

COBie schemers were always meant to be a resource to tap into to then work out what applies on a specific project context. Yet this approach requires both discipline as well as in-depth knowledge. The industry wants more-hands on and easy approaches that apply directly to the kind of information beneficial to a specific project. COBie is certainly useful for practices who are very organised and who manage to work with their collaborators (typically on larger projects) in a highly structured way.

F. SHORTCOMINGS OF BIM TO FM SOFTWARE

Is the data within BIM models suitable for integration with Facility and Asset Management software?

Quote: With standards, such data should be no harder to create, but it’d have huge downstream benefits; begin with the end in mind!

Representatives from both professions lament the lack of standards and guidelines that would introduce more structure and consistency to the data that is handed from the design/construction process to operation via BIM. At this point, substantial and time-intensive data-manipulation is often still required in order to ‘make the data from
BIM useable’. Respondents call for tools that makes it easier to pre-format data inherent to construction information in a way that ties straight into the Asset Registry database as well as the Building Automation System (BMS) software used by the Facility and Asset Managers.

When asked if there exist software interoperability gaps between BIM and FM tools, stakeholders from both industry groups (Trades & FM) clearly say: Yes! Only 3% of Specialist Trade Contractors argue that Software interoperability is not an issue. 10% aren’t sure and the rest perceive this to be a hindering factor.

Facility Managers are even more convinced about software issues with over 63% clearly seeing a gap, 18% arguing it exists ‘to a degree’ and only 5% reporting it does ‘not really’ seem to be a problem.

**Are there any software interoperability gaps when transitioning BIM data to Facilities and Asset Management?**

One commentator adds:

* Bim to FM software is clunky to say the least. There is a push to have everything automated when the reality is that every development has different requirements. As with physical architecture, virtual architecture needs massively customisable solutions.