BIM and its impact upon project success outcomes from a Facilities Management perspective

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Abstract

The uptake of Building Information Modelling (BIM) has been increasing, but some of its promoted potential benefits have been slow to materialise. In particular, claims that BIM will revolutionise facilities management (FM) creating efficiencies in the whole-life of building operations have yet to be achieved on a wide scale, certainly in comparison to tangible progress made for the prior design and construction phases. To attempt to unravel the factors at play in the adoption of BIM during the operational phase, and in particular, understand if adoption by facilities managers (FMs) is lagging behind other disciplines, this study aims to understand if current BIM processes can ease the challenges in this area faced by facilities management project stakeholders. To do this, success from a facilities management viewpoint is considered and barriers to facilities management success are explored, with focused BIM use proposed as a solution to these barriers. Qualitative research was undertaken, using semi structured interviews to collect data from a non-probability sample of 7 project- and facilities- management practitioners. Key results from this study show that the main barrier to BIM adoption by facilities managers is software interoperability, with reports that facilities management systems are unable to easily import BIM data produced during the design and construction stages. Additionally, facilities managers were not treated as salient stakeholders by Project Managers, further negatively affecting facilities management project success outcomes. A 'resistance to change' was identified as another barrier, as facilities managers were sceptical of the ability of current BIM-enabled systems promoted as being FM compatible to be able to replicate their existing Computer Aided Facility Management (CAFM) legacy software and its user required capabilities. The results of this study highlight that more work is needed to ensure that BIM benefits the end user, as there was no reported use of BIM data for dedicated facilities management purposes. Further investigation into the challenges of interoperability could add significant value to this developing research area.

Keywords: BIM, CAFM, Facilities Management (FM)/Facilities Managers (FMs), Interoperability, Project Success, Stakeholders.

1. Introduction

Although Building Information Modelling (BIM) has been touted by industry bodies, government reports and academic research as a potential solution to many of the ailments afflicting the Architecture, Engineering and Construction (AEC) industry, some of the potential benefits have been slow to materialize. In particular, despite claims in research that BIM will revolutionise Facilities Management (FM) (Sabol, 2008; Arayici *et al*., 2012; Korpela *et al*., 2015) and significantly save money in building operations (Gallaher *et al*., 2004; Wijekoon *et al*., 2016), these aspirations have yet to be achieved on a wide scale, when compared to the progress made in recent years for the design and construction phases (Eadie *et al*., 2013; NBS; 2017; Ashworth & Tucker, 2017). The UK Government, in a first of two related Government Construction Strategies (2011), set a mandate for all centrally funded construction or infrastructure projects to use fully collaborative 3D BIM (or 'BIM level 2') by April 2016 (HM Government, 2011). This was followed in the GCS 2016-2020 by a commitment to "*embed and increase the use of digital technology, including Building Information Modelling (BIM) Level 2*". This approach has seemingly resulted in a strong uptake during the design stage, much slower uptake in the construction stage, and little use in the operational phase of a building (NBS, 2018). More recently, findings from the British Institute of Facilities Managements' (BIFM) survey have reinforced the claims that the FM industry are lagging behind other members of the construction industry (Ashworth & Tucker, 2017). Such surveys also reiterate the importance of ensuring that there is an earlier inclusion of FMs and clients as project stakeholders in the BIM process to ensure project success (Ashworth, Tucker & Druhman, 2019). The present paper addresses current BIM processes and the challenges faced by facilities management as project stakeholders in that process. To achieve this, success from a facilities management viewpoint is considered and barriers to facilities management success in BIM are explored.

1.1 Perspectives of Success

Success in construction project management is often judged by the 'Iron Triangle' of Time, Cost and Quality and has been used to measure the success of the PM process for decades (Atkinson, 1999). However, the 'Iron Triangle' does not consider the subsequent operational success of the project, merely management of the project delivery process (Ika, 2009). This distinction is expanded by Baccarini (1999) who splits success into two components, 'project management success' and 'end-product' success, which are independent of each other. De Wit (1988) upheld that projects can be over budget and behind time, but if the product met the quality requirements and achieved the operational requirements stipulated by the client, it could be considered a successful product, even if the management of the project had not been successful in meeting budget or time targets.

1.2 Facilities Managers as Project Stakeholders

Cooke-Davies (2002) attributes a projects long-term benefits to those involved in managing the operational phase of a building, namely the Facility Managers (FMs). FMs play a crucial role in delivering value and cost savings to the operational phase of the whole life cycle (WLC). It is estimated that 60% of operational costs of a building are attributed to the overall cost of an asset, and that 80% of these costs are influenced during the first 20% of the design process (ISO, 2017). Therefore, early inclusion of FMs expertise in construction is crucial to realising long-term cost saving and benefits of the built asset (Ackamete et al., 2010; Ashworth et al., 2016). However, there have been a number of inherent barriers associated with the integration of FMs as key stakeholders in the design and construction phase. These have included the aforementioned differences in what constitutes success, as well as poor engagement with FMs. In addition to these, there are other well documented issues such as: industry fragmentation and pervading silo mentalities (Miettinen & Paavola, 2014); inefficient collaboration; lack of communication between stakeholders (Azhar, 2011); adversarial contractual relationships; inefficient use of technology, and; poor understanding of operational requirements from other project members.

1.3 Challenges of the construction process for FMs

These barriers underpin one of the biggest challenges experienced at the operational and decommissioning stages of an asset, the flow of information. The construction process: "is highly reliant on the management, flow and usage of information… Much communication between the disciplines is normally necessary in such a process" (Tizani, 2007, p. 15). Several researchers discuss the problems in the current practice around loss of knowledge and information as a project progresses, from concept, through design, to construction, operation and finally decommissioning (Demian & Walters, 2013; Parsanezhad & Dimyadi, 2013; Yalcinkaya & Singh, 2014). Furthermore, the outputs that are delivered to FMs are usually delivered in hardcopy or e-paper as Operations and Maintenance Manuals (OMM), resulting in the information being voluminous to store, laborious to catalogue, difficult to search and slow to access (Patacas et al., 2015). This results in poor facility performance, much wasted time trying to capture, transfer and catalogue data from design and construction phases (Patacas et al., 2015, Kasprzak & Dubler, 2012). Another difficulty faced by project teams are the silo mentalities frequently experienced in practice (Miettinen & Paavola, 2014), where each part of the team works in relative isolation. This leads to individual work package optimisation rather than whole project optimization. Such difficulties are further compounded by inefficient communication (Azhar, 2011).

1.4 The Progress of BIM

Although BIM is no longer cutting-edge, it is still "seen by many as being a disruptive innovation, which is bringing about the reconfiguration of practices in the AEC industry" (Poirier et al., 2015, p. 46). BIM is more than technology change; it is a collaborative approach with the potential to be a paradigm shift in the AEC industry (Gerrard et al., 2010). The BIM process helps to manage the flow and usage of information by allowing the reuse of data, reducing the need for re-inputting of data by different specialists and reducing the chance for human error (Azhar, 2011). BIM also has potential for improving handover, as data can be exported from the model in a suitable format for FM purposes (Wu & Issa, 2012). Implicit in BIM is greater sharing of information, which enables a more collaborative working environment. In practical terms, this means using a common data environment (CDE), as a reliable single source of information (Volk et al., 2014). There is also potential for cost savings via the digital information generated during the construction process for FM purposes, with an estimate that two thirds of potential savings from BIM use would be by FMs and owners (Gallaher et al., 2004). FMs have a lot to gain from using BIM, but it is not being widely achieved. The FM Awareness of BIM (2017) report found that only 39.8% had some experience of being involved in a BIM project but only 20.5% (combined) have direct experience of writing or implementing an Asset Management Strategy in line with ISO 55000 or other system." (Ashworth & Tucker, 2017). The annual NBS BIM Surveys report increasing potential for BIM use in FM, with the number of projects producing COBie data increasing year by year, from 15% in 2012, to 23% in 2013, 27% in 2016 (NBS, 2016) and 41% in 2018 (NBS, 2018). However, in an alternative 2017 report, of 254 respondents, many noted that they were neutral with regards to the use of COBie for transfer into CAFM/other systems. It was indicated that the reason for this may be that FMs see COBie as just part of the process (Ashworth & Tucker, 2017) Many researchers have discussed this apparent lack of progress with BIM for FM, noting difficulties in defining which information is valuable for FMs and the lack of early engagement with FMs (Alwan & Gledson, 2015; Wijekoon et al., 2016).

1.5 BIM in the Operational Phase

BIM for FM is relatively new compared to the other phases of construction and, as such, there appears to be a lack of client demand. In order to get the relevant information into the model, FMs need to specify in their Asset Information Requirements (AIRs) what they want, however, "very few owners have defined these informational needs or developed an integration strategy into existing maintenance management systems" (Kasprzak & Dubler, 2012). It seems that the potential benefits of BIM to the operational phase of the building are being hampered by lack of knowledge by building owners and

operators. Giel & Issa (2014, p.552) state that, "many owners are unsure of what BIM deliverables to require and lack the technical knowledge and resources required to operationalize the models they receive from designers and contractors". The same researchers (ibid) advise, "there is a need to truly understand the information needs of FM professionals before requirements documentation are refined", which is supported by Kasprzak & Dubler (2012, p. 68) in that, "very few owners have defined these informational needs or developed an integration strategy into existing maintenance management systems." Other researchers point out that there are difficulties defining data requirements for FM (Yalcinkaya and Singh, 2014), and additionally prioritising which information is needed at what time during the project delivery (Kassem et al., 2015).

1.6 Conceptual Model

The concepts which have emerged from a review of the literature have been synthesized to construct a framework diagrammatically presenting the key issue and its possible causes by way of a Fishbone model (as popularized by Kaoru Ishikawa) shown in Figure 1. The 'problem' or key issue, is success in the operational phase of the project lifecycle, and the concepts identified in the literature are all possible causes that have an impact on operational success1.

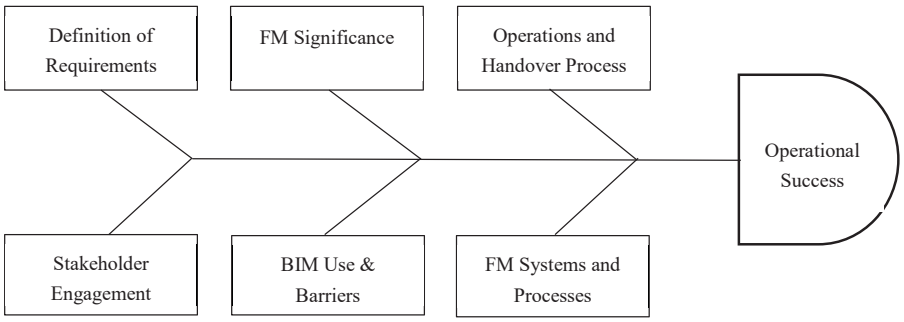

Figure 1: Theoretical model of the themes identified in the literature

2. Methodology

Qualitative research, informed by an interpretivist epistemology and an inductive approach was undertaken, using semi-structured interviews to collect data from a non-probability sample. The population of interest were project professionals from the project-, and facility-, management domains. Use of a convenience, purposive, sampling strategy afforded 7 interviews to be undertaken. These were with 4 FMs and 3 PMs, all of whom were currently engaged in construction projects and whose experience in the industry ranged from 6 – 40 years. They were drawn across five separate organisations based in the North of England, UK (see Table 1 for details of research particpants). The interview guide was distributed two weeks before each interview took place, along with a reminder letter, to enable the participants to prepare and as such generate more considered data. Use of semi-structured interviews also allowed for some question development to occur, whereby some unexpected themes that arose from the initial, early interviews could be incorporated into the research instrument. The interviews were recorded using a digital voice recorder and then transcribed. Anonymous participant numbering was also allocated to research participants. To aid thematic analysis of qualitative data, Nvivo was also used.

[1] As the research has been undertaken from a qualitative only perspective, the researchers have refrained from using terminology of independent and dependent variables here, despite how well Ishikawa models also lend themselves to quantitative analysis of cause and effect.

Table 1: Characteristics of Research Participants (RP).

RP	Role	Experience	Sector.	Organisation.
1	FM, Head of Maintenance.	40 years.	Higher Education.	1: Newcastle.
2	PM, Senior Programme Manager.	19 years.	Local Government.	2: Cumbria.
3	Project Manager.	7 years.	Higher Education.	1: Newcastle.
4	FM, Estates Planning & Development Manager.	23 years.	Higher Education	3: Sunderland.
5	FM, Senior Maintenance Supervisor.	14 years.	Higher Education.	4: Lancaster.
6	Project Manager.	6 years	Higher Education.	3: Sunderland.
7	Property and Facilities Manager.	5 years.	Heritage.	5. Durham.

3. Results and Analysis

a. Success

Prior research identifies that the 'Iron Triangle' is a commonly used method to analyse project success (Atkinson, 1999). Other researchers (Baccarini, 1999; Ika, 2009) report that PMs look at project success, while FMs are more concerned with end product success. Literature tends to identify that tight profit margins leads to adversarial approaches being taken, which along with a tendency to work in silos with poor communication can impact on success (Miettinen & Paavola, 2014). Because of these concerns, participants were asked: ***How do you judge if a project was successful?*** This question generated various responses focusing on issues such as success measurability, client and end-user satisfaction, and quality of collaborator relationships. Although not mentioned by name, many participants talked about the iron triangle, including Participant 6 (PM) who said: "*There are three key elements, time quality and cost, two are easy… quality is a lot harder.*" Operational success was mentioned by some respondents, such as Participant 1 (FM): "*Is it easy to maintain,* [and] *does it work is the fundamental one… if it doesn't work properly, it's hopeless.*" Customer satisfaction was raised as a measure of success by Participant 3 (PM): "*On time, on budget, but the main thing is if the client is satisfied.*" While Participant 7 (FM) said "*My customers are the people who work here, so as long as they get what they need… then that is the success of it.*" Several participants reported that adversarial relations were indeed common and impacted negatively on success, Participant 1 (FM) said, "*in value engineering the contractors will go to their preferred supplier and say this is what you are after, but it isn't, in reality, so we do spend a lot of time arguing with them about that.*" Silos were also mentioned as a barrier to success, even with in house PM / FM teams, Participant 6 (PM) said, "*because we maintain our own estate…we have a serious incentive to involve our FM guys. Unfortunately, that is not always very forthcoming.*"

b. Stakeholders

FMs were mentioned as important stakeholders due to the lifecycle costs of a building outweighing construction costs (Ashworth et al., 2016, Patacas et al., 2015). Participants were separately asked: (PMs) Where would you place FMs on a scale of stakeholder importance and why? / (FMs) At which points were you involved in the project delivery? PMs reported FMs as high importance, just below the end user. FMs felt that they were sufficiently engaged, but not sufficiently listened to. Participant 2 (PM) said: "I would put them up there with the likes of the project sponsor, because the FMs are going to be the ones who are operating the building and maintaining it." Lifecycle costs were important to PMs, with Participant 4 (PM) saying: "we get the money from capital for projects, but long term our revenue budgets aren't huge, so we need to make sure that we are specifying good long-term value for money." All FMs reported that they were engaged throughout the project, from early on in developing the brief, through to signing off changes due to value engineering, however their concerns were not

always acted upon. Participant 1 (FM) said "once it gets through outline design and it goes to the contractors for detailed design, we are involved then and that is when the arguments start, because they want to give you something you don't want, cos its cheap as chips for them."

c. BIM for FM, use and barriers

Surveys of AEC professionals (Eadie et al., 2013, NBS, 2016-2018) report that BIM for FM is lagging behind BIM adoption for other purposes. Wu and Issa (2012) suggest that BIM has significant potential for FM, but it is not being realised. Participants were asked a series of questions on BIM: Do you currently use BIM, if so what for? What benefits can you see in using BIM for FM? What is stopping you from using BIM for FM? Interestingly, no participants reported currently using BIM for FM, with no one using a 3D model or asset information from a model for FM purposes, in contrast with widespread use of BIM in design, stakeholder engagement and construction. A key difficulty mentioned by several participants was that current FM software couldn't readily import models or COBie data, despite software manufacturer claims. Participant 2 (PM) reported, "BIM is being used for design, coordination, clash detection, we are using a common data environment for the sharing documents, but not yet for FM." Several respondents were unconvinced about the ability of BIM to meet their needs, or offer a significant improvement over their current systems. Participant 1 (FM) noted that, "I'm sceptical, because I haven't found a software system yet that does anything near what people tell you it can do." This was echoed by Participant 3 (PM) who said: "We have just purchased an add-on for our CAFM system to import BIM data, but it is not really able to import models and COBie data right now without a lot of fiddling and re-mapping of fields." Lack of awareness of BIM was mentioned by several respondents, Participant 6 (PM) said "there was a significant amount of education we had to do with the FM team, even to bring them up to a basic awareness of what could be done with BIM… People are busy doing their day job, keeping up on new software advances is pretty far outside their usual role." Several respondents pointed out that even if there was software available which could deliver, there is an element of resistance, with Participant 3 (PM) commenting "We need to make people aware within the FM crowd, because they are resistant to change, they are very traditional in the way they work." This was echoed by Participant 7 (FM) who remarked "I think people are reluctant to change away from a system that works, even if it is not very efficient." Other barriers such as the cost of implementing a new process and a lack of skilled staff were also reported by Participant 4 (FM), "the other thing is resource, you need someone to coordinate the process, we are struggling to deliver the projects as they are at the moment...the start-up costs are prohibitive." This was supported by Participant 6 (PM) who said: "The complexity of changing CAFM systems and the amount of data we have makes adopting a new system quite laborious, very expensive really. Despite the potential savings it is really the upfront costs and finding the time, getting people with the right knowledge who can actually deliver the potential for us."

d. Defining Requirements

Kasprzak & Dubler (2012) report that few owners have defined their FM requirements. This is supported by Giel & Issa (2014) who note that many owners are unsure what they require and that FMs need to be engaged to define these requirements. All Participants were asked a series of related questions: How are FM requirements for a building defined? At what point were FMs requirements discussed / mapped out? Have you developed Asset Information Requirements? Only two respondents (Participants 2 and 6) reported having comprehensive Asset Information Requirements (AIRs). Several others reported that they were developing AIRs, however everyone who had or was developing AIRs had brought in consultants to help develop their requirements, as they did not have the expertise in-house. However, some organisations had much less in the way of formal requirements and relied on looser specifications. Participant 2 (PM) reported: "we appointed a consultant to take us through that process and they drew up the Asset Information Requirements document." Participant 6 (PM) described the process they went through to map out FM requirements, "we sat with the FM team and went through the COBie sheet, to see what information they needed, what they didn't need, what they wanted embedded in the model, what could be linked to the model as a PDF, so we developed a full set of Asset

Information Requirements." Participant 4 (FM) commented: "We don't have a standard briefing document at the moment, that is probably what we need, but at the moment it is just using team members knowledge of historical successes and issues." Participant 7 (FM) described their process: "As part of going out to tender we write up our expectations, our requirements for O&M information and testing schedules." Participant 3 (PM) reported use of an internal design guide, which stated what type or brand of equipment to use or not use, but not what information was required to maintain it. "The briefing document is owned and updated by the FM team, it is their design bible for projects." Participant 4 (FM) noted that some asset information was requested however, "I don't think we go into that level of detail for the different assets."

e. Loss of information at handover

Many researchers note that loss of information at handover is a big problem for FM, which BIM could help to resolve (Demian & Walters, 2013, Patacas et al., 2015, Parsanezhad & Dimyadi, 2013). Participants were thus asked: Can you give me an overview of your processes for handover / receiving maintainable asset information? Do you use, or have you considered using BIM to assist with handover? Both PMs and FMs reported struggles with traditional handover practice, no participants reported using BIM data at handover. Participant 1 (FM) said "you get a pile of O&Ms with some brochures in." Some respondents reported having adopted soft landings procedures to assist with handover, such as Participant 3 (PM) who noted, "we have been operating BSRIA soft landings over the last few years." And Participant 6 (PM) who said, "we follow the FMAP42 process, which walks through all the different parts of handover." Participant 3 (PM) was keen to explore the possibilities of BIM at handover, but noted "I have not actually worked on a project using BIM which has got to that stage yet."

f. Operational Information

Studies by Gallaher et al., (2004) and Patacas et al., (2015) report challenges with O&Ms that BIM should help to solve. Participants were asked: How do you access O&Ms currently? Do you use / have you considered using BIM to assist with building operations and asset management? Participants were united in their agreement that current practices were inefficient, with either not enough information or not specific enough information being delivered. Reliance on paper and scanned documents was still widespread. None of the respondents had any success with importing COBie data into their CAFM system. Participant 5 (FM) noted: "The main problem we have is that most of the O&Ms we get are the full product catalogue, it can be difficult to get the exact information that we need out of that." Participant 1 (FM) remarked: "I could take you to a storage unit which is full of O&Ms." No-one reported successful use of a standard classification system. Participant 6 (PM) said "Our O&Ms are scanned in, we get them as hard copy or pdfs, they are put into our central database. We don't really have a standard format or naming system, which can cause issues for the maintenance guys trying to find the right information." Participant 3 (PM) reported "In terms of O&M format we have guidance notes that go out to the design team and contractors that defines exactly what needs to be where, the previous version was a bit woolly and we didn't get what we wanted." Several respondents reported struggling to import BIM data from the design and construction phase into their CAFM systems. Participant 1 (FM) noted that "the FM software providers all said, oh yeah we can do that, in reality none of them can."

4. Discussion

The data from this study broadly followed the split identified in the literature (Baccarini, 1999), with PMs more concerned about project management success and FMs giving more weight to end-product success. However, both groups reported that the best measure of success was a satisfied client or end user. The disconnect between project management success and long-term project success (Munns and Bjeirmi 1996) was raised by several respondents. Results also highlighted a disconnect between PMs assessment of stakeholder importance and how FMs felt they were treated. PMs regarded FMs with high importance as identified in the literature (Ashworth et al., 2016). However, FMs stated that

their concerns were sometimes excluded due to the type of contract used, or cost implications. FMs reported being over-ridden by other demands such as meeting the project budget. Despite most of the respondents working for large public-sector organisations, there was a clear lack of BIM for FM use. A key finding, here, not widely reported in the literature, is that most FM software is still unable to readily import COBie data and 3D models in any format. However, there are now some interoperable CAFM solutions with upstream BIM workflows, meaning those identifying this as a barrier, could be demonstrating a lack of current knowledge. Despite this, and the fairly widespread uptake of BIM for design and construction, information is still nonetheless being lost at handover, or at least not being utilized by the building operators. Reluctance to change FM software was a major barrier, as is was perceived as a paradigm shift (Gerrard et. al, 2010) and a disruptive innovation (Gledson, 2016). Further reported barriers included; the cost associated with changing CAFM systems, the lack of knowledge within the FM sector of BIM capabilities and the additional cost to the project of requesting asset data in the BIM model. It was apparent from the results that there were some early adopters of BIM processes. However, there were some who were significantly further behind, reporting no standardised requirements document or no CAFM system, just a collection of spreadsheets. Most FMs reported being engaged to define requirements, but at varying levels of detail. This matches well with thoughts that most clients struggle to generate detailed requirements. The data shows that the defining of FM requirements for BIM is no longer an insurmountable barrier, but is still a significant challenge for FMs. The data collected shows no reported use of BIM for operational FM purposes, despite several respondents having completed projects which utilised BIM for design and construction and produced 3D as-built models and COBie data. This suggests that despite widespread BIM use at other project stages, information is still being lost at handover, as described by Patacas et al., (2015). Difficulty accessing operational information due to independent FM databases (Patacas et al., 2015) and, in some cases, continuing use of paper files and a lack of a standard classification or filing system was also reported. Overall FM's in this sample, were yet to be convinced about the ability of current FM software to utilise BIM data such as COBie sheets and 3D models for operational purposes and still provide the same capabilities as they have in existing FM software.

5. Conclusions, Limitations and Further Research

The aim of this study has been to understand what challenges FMs face in achieving successful outcomes using current construction project management practices and to ascertain if FMs do see BIM as a useful tool to help overcome these challenges. In the first instance there is a disconnect between the perception of success with FMs claiming that that the long-term product success of the built asset was overshadowed by the more traditional, short term project management success criteria of time, cost and quality. Despite the early engagement of FMs in the project process and the belief that FMs were seen as important stakeholders in the process by PMs, they felt that their concerns for the long-term success of the project were over ridden by demands such as meeting the project budget. Barriers to operational success identified that current FM processes were inefficient, particularly around handover with the loss of information at stage transition. In additions to this respondents also noted that adversarial relationships, silo working, working to poorly defined requirements and resistance to change were also barriers. The literature reported that BIM would enable huge efficiency savings and could revolutionise FM processes, however, A significant finding from the results found that BIM data, both 3D models and asset information was not readily compatible even with support from BIM consultants and specialist plugins for the latest FM software, they were still unable to import 3D models or COBie data into their CAFM systems. A comprehensive search of the literature brought up only one recent study highlighting that the primary barrier to adopting BIM for FM, suggesting that more research around the problem of software interoperability is needed. Whilst the findings are interesting, it must be stressed that the results from this study cannot be generalised due to the small sample size and the convenience sampling method used. However, the study has enabled the identification of several potential areas for future research: First, a quantitative survey using a probability sampling approach would help to ascertain if the findings of this study are representative of the wider FM population. Additionally, research into what barriers FMs face when developing Asset Information Requirements, as this was major chal-

lenge for many FMs and projects. Finally, a deeper technical study to gauge difficulties of interoperability between FM software and BIM outputs would benefit, as this was the primary barrier preventing FMs from utilising BIM data for operational purposes.

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