UK Building Information Modelling (BIM) Road Map for FM: where are the potholes?

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Abstract

This research contributes towards further understanding of implementing Building Information Modelling (BIM) in the UK with a focus on the operational life cycle of buildings and assets. The research identifies the gaps in the current UK Government approach in implementation of BIM, based on an extensive literature review and focus group interview methodology. The findings suggest that, for BIM to deliver its promised benefits of integration and collaboration, the flow of FM data requires advanced and user-friendly FM interfaces that integrate and are compatible with other current FM software. Furthermore, buildings and projects should be seen as strategic assets rather than operational machines requiring a culture shift. The culture shift is considerable for FM companies which sometimes operate on the belief that 'profit depends on hiding data'. Problems of data sharing, ownership and accuracy also need to be addressed. The findings also suggest that there is a need for the UK Government to prepare a mandate for BIM in FM.

Keywords: BIM, FM, building life cycle, data requirements

1. Introduction: the promise of BIM in FM

In the UK, the Government is incorporating Building Information Modeling (BIM) by making so called BIM level 2 compulsory for public projects from 2016. The hope is that it will deliver improved environmental efficiency, enhancing quality of construction through collaboration, overcome the gap between predictive and actual operational costs, thereby cutting carbon footprint and provide other tangible financial benefits. The UK approach differentiates different BIM maturity levels:

- Level 0: shift from drawing boards to computer aided design (CAD).
- Level 1: file based collaboration through the use of 2D and 3D models.
- Level 2: file based collaboration and library management through use of different 2D/3D models and objects, such as separate design model, construction model, Mechanical Engineering model etc.

- Level 3 or iBIM: integrated model, through inter-operable data where web services and BIM hub are connected to deliver life-cycle management.

As part of the UK Government efforts to meet carbon reduction targets and cost reduction together with improving quality and efficiency within the construction industry (BIS, 2013), Building Information Modelling (BIM) is identified as a crucial strategy and tool in achieving these targets (Cabinet Office, 2012). BIM is the process through which the data for planning, design, construction, operation and maintenance can be integrated through a unified model using graphic and non-graphic, machine readable attributes for each facility/building component, new or old, which contains all appropriate information created or gathered throughout the building life cycle. In principle BIM is to facilitate collaboration between various parties and stakeholders involved in a project throughout the project life cycle from design to construction, handover, operation, decommissioning and demolition or major refurbishment. This will help to reverse the trend by achieving financial savings which are currently almost nil in the operational phase according to Government's BIM Task Group report (BIM Task Group, 2011). The same report indicates that whilst previous legislative efforts did deliver some savings in the design and commissioning phase, they essentially had no effect in the operational phase. This indicates the gap that exists in the area that is directly related to facility management, whose primary work starts when construction finishes and the building is ready for occupation and in need of ongoing management.

As the primary function of facility management is to support organisations whilst managing assets and human resources, facility management is crucial for the delivery and success of decarbonisation, and quality and efficiency improvement strategies within the built environment. FM duties are critically reliant on data and that information must be the core of BIM. BIM for FM is considered the most innovative and useful aspect of BIM by building designers (RIBA, 2012). It is thus essential that building information modelling further develops not as an end but as a means for ensuring better building operability. To deliver a building which is "fit for purpose" and which maximizes operational performance with minimal disruption to the "end user", FM needs to act as a proactive interface between building design and operation (Baldwin, 2003 & Jensen, 2009). While traditionally there has been little long-term relationship between operations and the majority of the contributors in the design and construction phase, that is not true for the facility managers as they are responsible for building operation (including maintenance, space planning, energy, water and waste management). The long-term commercial interests of FM providers are inextricably

linked to the performance of the assets they manage (Brown et al, 2001). Additionally the rise of whole life procurement through PFI/PPP requires a consideration of FM as a core part of any bid. Facility managers can supply in-depth knowledge on what constitutes optimally operable, fit for purpose buildings. In the past, the issue of operability has not been a major concern for designers (Nutt, 2000), but nowadays flexibility and adaptability in relation to change in (business) needs over time are one of the most important design brief elements (Jensen, 2009). Codification in knowledge from building operation has been suggested as a way of ensuring that building operability is considered in the design process (Kelsey et al, 2014). Building information modelling is seen as the tool for bringing FM into the design phase (Wang et al, 2013).

There is widespread agreement in the research community that, if valuable data is communicated through BIM to the operational life cycle, it can reduce the costs of data acquisition, management and maintenance significantly as well as reducing energy consumption (Devetakovic et al, 2007 & Redmond et al, 2012). Version management has been identified in previous research (Gu et al, 2010) as a key capability of BIM, which allows different disciplines to maintain and modify their data and keep records of changes applied. Facilitating collaboration is the purpose of BIM in the Architecture, Engineering and Construction (AEC) industries. There is evidence to support the notion that interoperability can add value in a project using BIM which can help revolutionize project information management (Grilo et al, 2010). Inter-operability is considered as the crucial dimension for the success of BIM in adding value (Becerik et al, 2011 & Foster, 2012 & Grilo, 2010 & Sabol, 2008). In particular, the BIM platform's ability to support facility management is seen in its capability to provide as-built models with updated databases throughout the life cycle, which at the point of handover in particular can be crucially useful for FMs (Gu et al, 2010). An effective BIM-based facility information strategy requires first accurate specification of data relevant for operational use, and second integration and inter-operability of BIM-based data with the Computer Aided Facility Management (CAFM) systems (Teicholz, 2013). CAFM is at present a combination of CAD and/or relational database software addressing specific FM operational needs. BIM cannot replace CAFM, but instead it should be used to enhance it (Sabol, 2008).

The 'I' in BIM should not only be about automating information but also about creating processes to synchronize information between applications to achieve a purpose-driven content shared across different disciplines and throughout the project life cycle (Redmond et

al, 2012). Yet the reality is that information from earlier life-cycle phases that is turned over to facility managers is often incomplete, incoherent and in multiple, incompatible systems (Lucas et al, 2013). The inadequacy of the data being communicated exists both ways. While it is alleged that 40% of energy savings can be achieved in commercial buildings if accurate, relevant data are produced and communicated (Carbon Buzz), instead some crucial information that could be instrumental in understanding a building's performance throughout its life cycle gets unnoticed or lost (Ahmed et al, 2010). The information loss during facility handover may dramatically increase the costs of operations and maintenance of the buildings (Foster, 2012). This information loss keeps increasing the further the building is from the planning and design stage leading to potentially significant additional costs of reproducing missing information once the building enters its operational stage. Gathering essential FM information at the end of the a build or refurbishment project can take up to 3 years after the financial close of a project, (East, 2013), costing billions (NIST, 2004). There is often an organisational problem in the division between FM and project delivery departments within client organisations which exhibit different and sometimes conflicting objectives and cultures – a problem already evident in the field of Health and Safety (Kelsey et al, 2014).

For effective and efficient management of built facilities, information management should not be driven purely from the perspective of the asset life cycle but also from the perspective of the value-creating business activities taking place within them (Lucas et al, 2013). Very little is known on how process and product driven information flows interact and affect each other in general and/or how operational decision are prioritized by facility managers. For example, the decision making process for the control, maintenance and refurbishment of a building's lighting system should depend not only on product information but also upon the nature of the business taking place in the building. In other words, knowledge based on the economic value created within the facility, as well as the particular viewpoint of its operation and maintenance, should inform asset design. Some authors therefore propose that, by extending BIM to include knowledge-based techniques such as case-based reasoning, it would be possible to better plan and organize building design and operation so as to avoid inefficiencies (Lucas et al, 2013 & Motawa et al, 2013).

2. Methodology – focus group interview

This study used a focus group interview as the central method informed by the literature review. The focus group interview was planned to meet three objectives:

- to provide clarity and better understanding of FM data requirements in BIM,

- to follow data created during design and construction phases to the point of delivery and handover
- to identify the data available to extract through COBie (Construction Operations Building Information Exchange).

The aim is to pull data for operational and FM uses from the BIM model, rather than data created for design and construction being pushed. This research method was also designed to create a specification for detailed data requirements, to help one software developer company – the study partner – to facilitate a better reporting tool (one of which could be COBie data extract) for its BIM software solutions.

Planning the focus group started with clearly defining its objectives, continued by establishing a timeline and followed by inviting participants from various stakeholders. The focus group interview was conducted with 15 participants in March 2014 at UCL in a relaxed, academic environment encouraging unattributable open discussion. In order to cover the wide spectrum of the building life-cycle the participants were selected to represent various stakeholders including facility managers, BIM and FM software developers, project construction managers, property owners and developers, architects, civil engineering and M&E contractors. The headline topics were given to the participants in advance in order to maintain the focus. The discussions centered on five main themes discussed below, each including several discussion questions.

BIM and Integrated Project Delivery (IPD):

- In knowledge transfer and project data sharing, BIM is perceived both as a culture and process for collaboration. It provides a collaborative framework which uses software platforms to enable the exchange of information and data and to facilitate better and effective communication. It develops a platform for synchronized work and share of knowledge. However, data sharing is not new. Historically, large projects often had dedicated (web) space to store and share information. The question is how does this transition – from project websites and shared files to BIM models – really work or has worked in participants' view, and whether they have examples they could share from their representative organization. When do they think information sharing becomes knowledge sharing? What does inter-operability mean for them? How far do they see this transition from exchange to interoperability, within their profession?

- It seems that BIM tools are more concentrated around design and construction stages compared to FM and operational cycle. Why is this the case, in their opinion?
- One of the main advantages in using BIM is its ability to deliver an as-built model and cut the need of having to create one when the building is hand over to the user/FM team. Based on their experience, is that really true? Not only is the preparation of as-built models costly, but so is their maintenance. Who should pay for it? Who controls the dataset and related drawings? What are the systems in place for doing that? Can as-built models be part of the contract deliverable? How?
- There seems to be knowledge gap of awareness of how much you could save. Do you think we in the FM industry are trapped in wanting only not to be worse than "average"?

Minimum FM data requirements in BIM platforms which should include statutory and maintenance issues:

- Scope of FM data requirements in BIM platform: Although the desired level of details for a FM friendly building model can be different in each project and for each owner, what are the absolute minimum or basic requirements for a model? i.e. what are the definition of FM data requirements in BIM model?
- In your opinion what are the main Push and Pull factors when it comes to data collection and production? Are they product or process driven?
- FM/BIM Data prioritization: What are in your opinion essential FM data entry for BIM? Should BIM include statutory compliance? How important tender specifications are in delivering a BIM platform that can successfully support FM operations?
- The information loss during facility handover may dramatically increase the costs of operations and maintenance of the buildings. What do you think causes this information loss? BIM is supposed to if not eliminate then decrease this information loss. Do you see that happening and if yes what do you see in BIM process that will insure that? Who should be responsible for insuring that this does not happen?
- Planned Preventative Maintenance: How the record of maintenance will be logged for Planned Preventative Maintenance (PPM)? It would be good to do lots of automatic audits and checks. Would a facility manager for example get a red flag if maintenance hasn't been done?
- Reactive Maintenance: How the record of maintenance will be logged for Reactive Maintenance over Helpdesks. Noting the importance of Helpdesk function in CAFM

systems due to the level of un-predictability this types of maintenance and their expenses in balance sheets.

- Smart BIM: How do you know somebody has actually carried out the maintenance? Can BIM be smart enough to detect that?
- Cost effectiveness can only be maximized by turning lessons learnt from completed projects and applying them to new projects. BIM model change analysis.

BIM/CAFM relation; Compatibility and integration of various platforms and BIM; COBie data content and format:

- BIM/CAFM integration (COBie) and compatibility: How can BIM integrate the current software platforms used in FM (CAFM systems)? Noting that CAFM Systems are expensive and companies are not willing to switch immediately.
- Does size or function of the facility matters in the deciding whether or not to invest in BIM/CAFM integration? If yes, what are the sizes and activities?
- Openness and dialog between: 1) data 2) applications 3) people. Interoperability in real term rather than data exchange [how far we are from it?] Dialog between data (format)/applications (standards, common identifiers, classification)/people(professional)
- Standards/classifications…

Asset and space management:

- Predictive Modelling: Can BIM be used in predictive modelling? Something like "What if" scenarios, of for example what would be the effect if flow of people increased, or vary during the life-cycle. Do you think it would be useful to run such scenarios using BIM tools to simulate those situations and see their effects on wear and tear and maintenance schedules?
- How BIM can help seeing how well space is occupied, locate vacancies and so secondary lease which would reduce the running cost and generate some revenues.
- Should BIM provide a feedback on asset performance and how?
- Visuals: How important BIM visuals are for FM?

BIM in retrospect:

- How costly is for BIM to be introduced retrospectively on older builds, how long for payback to the client / customer?

- What are the main barriers which you think should be resolved as soon as possible and do you also see some longer term barriers?
- Have you tried raw data collection for an existing facility? How did that work?
- Feedback on behaviors of collaboration. How does that really work?
- Do you think BIM application could potentially result in new business models?
- Is FM industry really ready for BIM?
- Which FM delivery model you think works best within BIM?

3. Results and discussion

The interview data were analyzed by the use of a thematic approach. They were coded to shorter phrases to summarize the focal points and then into overarching themes. The significant finding of this study was that the representatives of different facets of the built environment industry seemed to have aligned their insights to the questions discussed. The extracted themes of the analysis are explained below:

Interoperability

Participants indicated that interoperability is yet to be achieved across various platforms of design, construction and operation. While there are attempts starting to explore this area, in practice, this remains a far reaching goal. Another participant believed that interoperability does not work due to the sheer volume of data systems. The practicality and/or usefulness of having one data system for everything was questioned especially as that can led to over-engineering and over-complexity. Currently, in practice, a bespoke, integrated solution is created based on the outputs from different software platforms. It was thus also suggested that software designers and professionals need to know how people will use the data. Another point in this regard was a discussion about the fact that architects are starting to get interested in FM, which is viewed as a positive move. All of the interviewees agreed that there needs to be a clear contractual agreement in regards to as-built models and liability issues around them. Issues to be resolved with as built-models were clarity as to who pays for it, how it gets maintained and how does an as-built BIM model vary from reality?

Data specification for FM in BIM, COBie

This theme involved much debate and contention during the interview. The participants agreed that currently there is no extended standard data specification for FM in BIM and that data are not useful without prioritizing the required dataset and level of detail. They also agreed that specifying the data for FMs would be a major challenge which confirmed the

finding of Williams et al (2013). The lack of defined performance measures for FM was also discussed and the need for research to identify metrics and measures for FM performance. One of the participants noted that the focus on COBie seems to be a question rather than an answer as it is not working for FM in its current status as it covers only around 60% of the data required with the remaining 40% of data needing to be especially created. It was also mentioned that the profit of some FM companies lies in obtaining data by surveying, which also addresses the liability issue. Another view proposed was that the data identification process should be client based rather than supply driven. However not all clients have the same level of understanding or in other words not all are so called 'intelligent' clients. The importance of ensuring that clients do have sufficient knowledge was identified as something that should possibly be very high at the agenda of policy makers but as a topic goes beyond the scope of this focus group.

Asset Management:

In relation to this theme, an asset register was the focal point of discussions while transparency of data also caused debate. It was suggested to start turning the current situation around with the idea that all data can be transparent and then see which cannot be. The interviewees noted that FM companies usually operate on low margins and high turnover and hence data sharing seems less feasible. That is why each FM company usually creates its own asset register system. The move from this point to having an asset information model, which is linked to the asset register and is digital, seems a far way to go. It was suggested that asset management needs to come to the fore, and that data stewardship for FM needs clarification. Examples were brought as how a lack of provision in this regard is not best practice. It was also discussed that many organizations do not know what assets they have. Another issue that was discussed in this relation was outsourcing CAFM data along with FM services which could allow TFM providers to integrate data, but when FM is outsourced then access to data could be very restricted if possible at all.

Protocols and standards:

In summing up the discussions it was noted that FM needs to adopt CIC (Construction Industry Council) protocol, a classification that is usable by FM and ultimately a Plan of Work devised by FMs. It was also clearly noted that FMs have currently not been sufficiently involved in decision making processes and establishment of standards. Another suggestion was that procurement contracts need to be changed to accommodate new ways of doing things

that have become possible through the advancements of technology. It was also argued that running a project is very different from running a building/facility and that standards and plans of work need to appreciate this. It was also argued that within each FM company several categories of information are in fact defined differently, such as PAS1192:3 (BSI, 2014) and budget codes since the corporate focus defines them.

It was noted that a contradiction exists between government tendering for construction in comparison with operation. The current government programme is driven by CAPEX reduction and there is a lack of clarity in BIM maturity levels in relation to FM. It was argued that it is not yet clear what BIM Level 2 really means for FM, including PAS 1192:2 (BSI, 2013) and the forthcoming Digital Plan of Works. In particular criticism was made that the UK Government framework request for FM tenders (April 2014), does not mention BIM. This is happening at a time when FM companies need to prove that BIM works for their operations. Another criticism was that the target efficiency savings seem to be ephemeral.

It was also discussed that attributes, objects and performance need to be defined by the Government Soft Landings framework (Cabinet Office, 2013). At present some standards exist, but the market does not yet deliver against a framework of standards. Diagnostics and analysis can be done by Building SMART UK (http://www.buildingsmart.org.uk/) in order to provide best practice case studies.

An example of a pilot project that commenced in November 2013 for a large secondary school, the UCL Academy, was discussed. By using xml interface, Uniclass2 data mapping and a BIM platform, an efficiency benefit of 15 to 20% in FM has been achieved. In that pilot project, on site engineers use tablets to record task times, and also note their personal reflections on whether or not the central data repository helped them. Currently engineer data is feeding into the improvements that are needed, by using various systems to link software such as an asset information model for energy use.

4. Summary: Where are the potholes?

Data management is an expensive process, both financially and in terms of expertise. Preparing and maintaining accurate, as-built models and maintaining them are perceived as costly and without clear tangible benefits to property owners, developers and ultimately facility managers. Therefore, an important question is how to quantify the returns on investment in data management for owners and developers. Looking into the whole process of BIM, it seems that there are various drivers for its implementation.

There are challenges, barriers as well as opportunities that BIM adoption poses to the FM industry. A longer term view on BIM is needed, in relation to already existing building stock. The UK carbon agenda, demographic and financial changes mean that in future we need to do more work on existing assets and infrastructure than the new. In relation to retrofit and BIM for existing buildings, initial benefits analysis shows that 15% saving in engineering savings in relation to response time are possible. One company has developed a survey with both quantitative and qualitative measures. We need to move from projects to assets, if BIM process is to work in operational phase. Three key generic issues were identified as: business purpose, performance and assets.

It was concluded that open case studies should be created to demonstrate the benefits and challenges and serve as blueprints for the industry. It was also recommended that more research and development is needed in order to overcome the issues raised and move forward in this area.

In the discussions of barriers and ways to overcome them, it was argued that there needs to be a collective acknowledgement that FM is about 'systems of systems' and that the speed and cost of change is improving. It was also noted that we need to be specific about data and its level of detail towards a lean strategy as lots of data can be wasted if they are not fit for purpose. It was also noted that we need to promote the vision of design/build/operate (as opposed to hand over). The clarification of who needs to do what and when as a plan of work and a Government Mandate for FM in Level 2 is essential. The focus group participants were hopeful of having a similar mandate for FM in 2016. It was suggested that institutions like CIBSE and BIFM need to support suggested decision making processes.

This study is limited by being based only on an extensive literature review and a single focus group. Nevertheless it is considered that, because of the participants' deep knowledge and experience in the FM industry, BIM and other data platforms, their observations and recommendations should be heeded. Further research in the area of BIM and FM is recommended.

References

Ahmed A, Ploennigs J, Menzel K, Cahill, B. (2010): Multi-dimensional building performance data management for continuous commissioning, Advanced Engineering Informatics 24, pp. 466-475.

Baldwin, E. (2003): 'The private Finance Initiative – What opportunities for facilities management?, Journal of Facilities Management, pp. 54-67.

Becerik-Gerber, B. Jazizadeh, F., Li, N. and Calis, G. (2011): Application areas and data requirements for BIM-Enabled Facilities Management, Journal of construction engineering and management, 138(3), pp. 431-442.

BIM Task Group (2011): A report for the government construction client group: Building Information Modelling (BIM) Working Party Strategy Paper, [Online], Available: http://www.bimtaskgroup.org/wp-content/uploads/2012/03/BIS-BIM-strategy-Report.pdf, [Accessed: Sep 2013].

BIS (2013): Construction 2025,'Industrial Strategy: Government and Industry in Partnership.

BSI (2013): PAS 1192-2 Specification for information management for the capital/delivery phase of construction projects using building information modelling.

BSI (2014): PAS 1192-3 Specification for information management for the operational phase of assets using building information modelling (BIM).

Brown, A., Hinks, J., Sneddon, J. (2001): 'The facilities management role in new building procurement', Facilities, 19(3/4), pp. 119-130.

Cabinet Office (2012): Government Construction Strategy, [Online] Available: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/61152/Government-Construction-Strategy_0.pdf, [Accessed: March 2014].

Cabinet Office (2013): Government Soft Landings framework, [online] Available: http://www.bimtaskgroup.org/wp-content/uploads/2013/05/Government-Soft-Landings-Section-1-Introduction.pdf, [Accessed: June 2014).

CarbonBuzz [Online] Available: http://www.carbonbuzz.org/index.jsp [Accessed: Dec 2013).

Devetakovic, M.R., Radojevic, M. (2007): Facility Management: a paradigm for expanding the scope of architectural practice, International journal of Architectural Research, 1(3), pp. 127-139.

East, B. (2013): Using COBie, in Teicholz, P. ed. BIM for Facility Managers, 1st Edition, New Jersey: John Wiley & Sons, pp. 107-143.

Foster, B. (2012): Using real-time CMMS asset data capture during construction to improve Facilities Management, Journal of Building Information Modeling, Fall 2012, pp. 16-17.

Grilo, A., Jardim-Gonclaves, R. (2010): Value proposition on interoperability of BIM and collaborative working environments, Automation in Construction 19, pp. 522-530.

Gu, N., London, K. (2010): Understanding and facilitating BIM adoption in the AEC industry, Automation in Construction 19, pp. 88-999.

Jensen, P.A. (2009): 'Design Integration of Facilities Management: A Challenge of Knowledge Transfer', Architectural Engineering and Design Management, 5, pp. 124-135.

Kelsey, J. M., Roberts, A. H., Smyth, H. J. (2014): Health and safety maturity in project business cultures. International Journal of Managing Projects in Business, 5 (4), pp. 776-803.

Lucas, J., Bulbul, T., Thabet, W. (2013): An object-oriented model to support healthcare facility information management, Automation in Construction, 31, pp. 281–291.

Motawa, I., Almarshad, A. (2013): A knowledge-based BIM system for building maintenance, Automation in Construction, 29, pp. 173–182.

NIST (2004): Cosy analysis of inadequate interoperability in the U.S capital and facilities industry, [Online], Available: http://fire.nist.gov/bfrlpubs/build04/art022.html [Accessed: 20th Sep 2013].

Nutt, B. (2000): 'Four competing futures for facility management', Facilities, 18(3/4), pp. 124-132.

Redmond, A., Hore, A., Alshawi, M., West, R. (2012): Exploring how information exchanges can be enhanced through cloud BIM, Automation in Construction 24, pp. 175-183.

RIBA (2012): BIM Overlay to the RIBA Outline Plan of Work, [Online], Available: http://www.ribabookshops.com/uploads/b1e09aa7-c021-e684-a548-b3091db16d03.pdf, [Accessed: April 2014].

Sabol, L. (2008):Building Information Modeling and Facility Management, Design and Construction Strategies, [Online], Available: http://dcstrategies.net/files/2_sabol_bim_facility.pdf, [Accessed: May 2014].

Teicholz, P. (2013): BIM for Facility Managers, 1st Edition, New Jersey: John Wiley & Sons

Wang, Y., Wang, X., Wang, J., Yung, P., Jun, G. (2013): Engagement of Facilities Management in Design stage through BIM: Framework and a case study, Advances in Civil Engineering, 13, pp. 1-8.

Williams, R., Shayesteh, H., Marjanovic-Halburd, L. (2014, under review): Utilising Building Information Modelling for Facilities Management, International Journal of Facility Management.