How Facility Management can use Building Information Modelling (BIM) to improve the decision making process

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Abstract

Building Information Modelling (BIM) is changing the way the construction industry works and whilst designers and constructors are already rapidly implementing BIM in their practices, its potential use for facilities management is still not clearly identified and existing case studies show only a marginal use. The research presented in this paper aims to identify the opportunities and barriers related to the integration of BIM and Facility Management (FM) knowledge. It investigates how FM and BIM can add value to and improve the transition process from construction to operation by capturing and making better use of relevant FM information. A focus group workshop approach was used with a group of subject matter experts (SME) from across the building whole life process. The workshop was the first step of a three-year project aimed at understanding how BIM can support sustainable FM decisions.

BIM offers FM an opportunity as a process tool to enable a more informed decision-making process. The paper summarizes the theoretical applications of BIM to FM and presents the outcomes of the workshop. FM can use BIM as a unique source of data that needs to be transformed into usable information for day-by-day activities. The creation of BIM standards is necessary to enable data exchange with other software. Cultural and behavioural aspects, as well as soft services, should be integrated within the BIM model.

Keywords: Facilities Management, BIM, decision making, Building Operation

1. INTRODUCTION

The gross value added (GVA) from the construction industry to the UK economy in 2012 was £83 billion, 6% of the total economy of the country, with over 2.12 million workers employed in Q4 2013 (Rhodes, 2014). Although the industry suffered from two contractions during the recession it is estimated that the construction sector will grow globally by over 70% by 2025 (Global Construction Perspectives and Oxford Economics, 2013).

The UK Government has created, together with the UK construction industry, an industrial strategy aimed at helping the growth of British businesses and at putting "Britain at the forefront of global construction over the coming years" (HM Government, 2013). The Government goal is to lower initial and whole life costs by 33%, achieve a 50% time reduction from inception to completion, lower emissions by 50% and reduce by 50% the gap between total exports and total imports of products and material for construction. As part of the strategy the UK Government (HM Government, 2012) is promoting a smarter and more digital industry to achieve innovation and as part of this, Level 2 BIM implementation will be mandatory for all centrally procured Government contracts from 2016. This means that collaborative 3D BIM will be necessary, with all project and asset information, documentation and data being electronic and available in a COBie UK 2012 format. To achieve this, the UK BIM Task Group has been formed with the purpose of supporting and helping deliver the government objectives.

Although the term "BIM" was created around 2003 (Saxon, 2013) only recently the construction industry has started implementing it, driven mainly by Government, major private owners and institutional clients. The NBS National BIM report (2014) shows that 54% of the over 1000 UK construction professionals who took part of the survey had used BIM at least once during 2013, with an increase of over 40% compared with 2010 results whilst the percentage of participants unaware of BIM has reduced from 43% in 2010 to 5% in 2013. Among the respondents aware of BIM, 93% of them stated that they would use BIM in the next three years, which indicate that the Government's BIM mandate has driven the whole industry. With an increasing number of companies using BIM for their projects, numerous case studies are now available to suggest the benefits of using BIM during design and construction, showing higher potential in exploring opportunities and finding solutions to problems, when compared to standard stand-alone 2D and 3D drawings (British Standards Institution, 2010; Salman, 2011; Bryde et al. 2013).

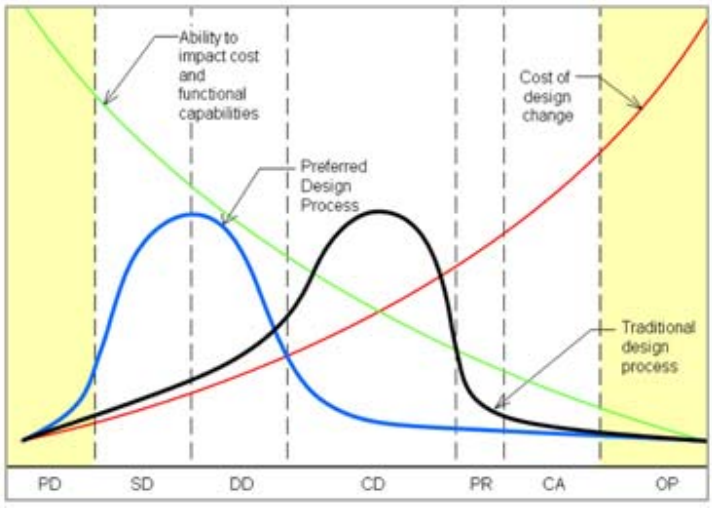
However, once a building is complete and in use, the potential use of BIM for facilities management is still not clearly identified. Beyond maintenance schedules and equipment information and location, there is no mention of the potential use of BIM for a decision making process (Eadie et al., 2013). BIM seems to be a tool aimed to simplify FMs job (Morton, 2011, IFMA, 2013) and ease the initial process of entering FM information after a building is handed over (Eastman et al. 2011) and there are few case studies currently available like the Sydney Opera House (CRC, 2007) and the Atlantic College (Gillard et at. 2008).

This paper presents preliminary findings of an ongoing three years study on how BIM could be used to manage buildings in a more sustainable way. It presents a review of the literature on how BIM is changing the construction phases and what the possible implications of BIM for FM might be. The main focus of this paper is on the findings derived from a stakeholders workshop held in London that highlighted the barriers, opportunities and added value of BIM for facilities management.

2. BIM AND THE BUILDING LIFE-CYCLE

There is a multitude of different definitions of BIM (HM Government 2012, McGraw Hill Construction 2008, Woo et al. 2010) but for the purpose of this paper the buildingSMARTalliance (2007) BIM definition will be adopted "a digital representation of physical and functional characteristics of a facility. As such it serves as a shared knowledge resource for information about a facility forming a reliable basis for decisions during its life-cycle from inception onward. A basic premise of BIM is collaboration by different stakeholders at different phases of the lifecycle of a facility to insert, extract, update, or modify information in the BIM to support and reflect the roles of that stakeholder. The BIM is a shared digital representation founded on open standards for interoperability".

The opportunity to integrate physical and functional characteristics of a facility in a unique intelligent model shared between stakeholders makes BIM a powerful tool that enables a decision making process at earlier stages, with greater effectiveness and lower cost. In 2005 Patrick MacLeamy presented at the AIA National Convention the graph presented in figure 1, now known as "MacLeamy curve" (Anderson, 2010).



PD: Pre-design
SD: Schematic design
DD: Design development
CD: Construction detailing
PR: Procurement
CA: Construction Administration
OP: Operation

Figure 2: MacLeamy curve

The curve represents how the cost of changes (red line) and the effectives of those changes (green line) vary during the timeline of a project, from pre-design to operation. In the traditional design process (black curve) changes are made when the effectiveness is lower and the cost of changes higher, while in a preferred design process (blue curve) the decision process is complete before the construction documentation phase, when the effectiveness of the decisions is higher and cost is lower. To achieve the blue curve a "shift of effort", as MacLeamy called it (Light, 2011), is needed. But in order to have all the information available during the first stages of the project, constructors, installers, fabricators, suppliers and facilities managers need to work together with designers (The American Institute of Architects, 2007) using BIM as a tool to model and simulate the project and thus identify synergies, opportunities and arrive to optimum solutions.

An integrated and collaborating team working on a single building information model can facilitate the design-construction process, reducing cost, schedule and request for information (Luth et al., 2014). Breaking down the contractual silos that characterised the construction industry will benefit the facility throughout all of its life cycle. Therefore, a detailed BIM model accompanied with relevant performance analysis of the building before it is build can potentially lower operational costs, enabling savings during the building life span.

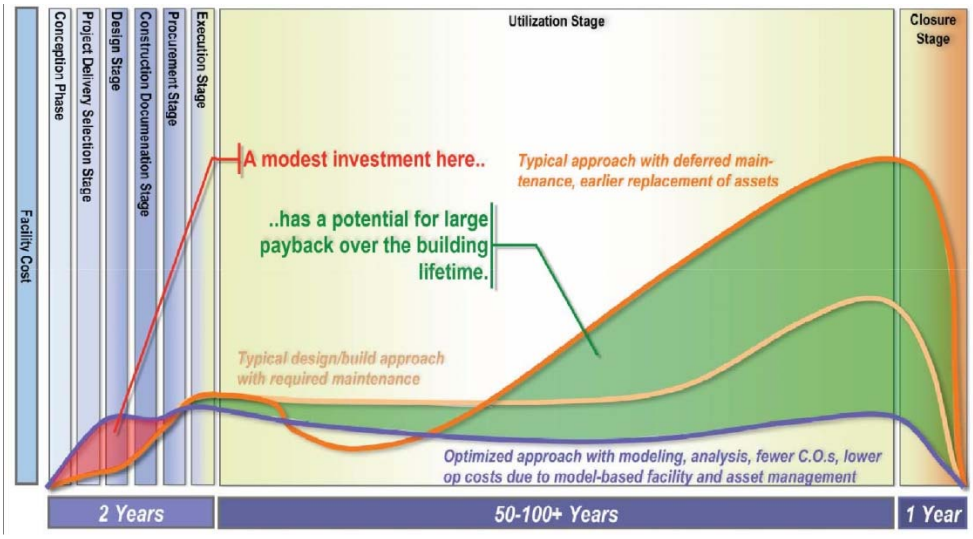


Figure 3: Notional Chart of Life-Cycle Facility Costs (Anderson, 2010)

The most important part of the BIM definition is that "…it serves as a shared knowledge resource for information about a facility forming a reliable basis for decisions during its life-cycle from inception onward…". BIM also serves as a graphical representation of a building but above all is a tool for decision making and analysis, based on data, which can be used during all stages of a building. From the inception of a building as an idea and a sketch, where preliminary data can be inputted to track progress and various performance aspects and share

the information with the design team, all the way to a completed building that is operating where data is shared between facilities managers, maintenance engineers, occupants and owners among others.

More specifically, from a facilities management perspective, the main benefits achieved when integrating BIM and FM as suggested by IFMA (2013) are that it:

- Reduces costs: accurate and complete data ready for use when building completed, lowers data capture and O&M costs
- Improves performance: more complete and accessible FM data allows faster analysis and correction of problems and fewer breakdowns. Supports happier and more productive users
- Integrates systems: data from BIM integrates with CMMS/CAFM/BAS, updated over the life of a building.

Although some of these benefits are still not easily achievable, like the integration of BIM and CAFM systems that is in its infant stage (Gnanaredman, M. and Jayasena, H. S. 2013) with only few pilot projects available like BAM's "Project Robin" (BAM, n.d.), the list suggests that once a building is complete and handed over the BIM model will mainly be used as an intelligent database, potentially losing its function of decision support and as a tool for analysis. Therefore, a question can be raised as to whether facilities managers need to look at BIM as an opportunity to understand the building, its behaviour and its future opportunities. If BIM cannot bring these benefits, then it will not be a major improvement for the FM industry but simply an add-on of the current building management software.

3. BIM FM WORKSHOP

A one day workshop sought to explore practical problems associated with integrating BIM into FM and to identify knowledge gaps that the industry identify as keen to be filled was held in January 2014 in London at the University of Greenwich. The aim of the workshop was to begin to explore some of the issues related to the implementation of FM and BIM, as identified through the literature review and analysis of similar events, answering the following questions:

Question 1: "How can BIM help Facility Managers to manage their facilities?"

- How can FM be brought into the early design stages to review operational practicality and cost issues of design?
- How can software tools be adapted to help deliver the best operational management

systems during the transition from construction to operation?

- How can FM and BIM help improve whole life and operational costs?
- What is the best way to improve the provision of O&M information in electronic searchable formats?
- How can BIM help FM manage their operations and add value to their business?

Question 2: “Intelligent BIM; How can BIM help Facility Managers to manage buildings in a more sustainable way?”

- How can soft services be included in BIM?
- What aspects of the sustainable agenda can be integrated with BIM?
- What other aspects or functionality should be included in BIM to support FM operational needs?

Question 3: “What kind of data does FM need in order to use BIM?”

- How should data be organised in BIM to allow WLC and LCC analysis during the planning and on- going operational phases?
- How can energy management data (measuring and monitoring) be included in BIM to allow accurate measurement of long term energy use?
- How can data that is important for operation be separated from data that is for archive purposes?
- What FM operational information is required for the BIM process and when?
- COBie and data management issues?

Question 4: “Research, education and policy”. What are the key areas of research that would benefit from the integration of FM and BIM and the value it can bring?

- How can BIM be used to help Facility Managers in existing buildings?
- What are the advantages of including BIM in NBS and other forms of contract?
- What education and possible opportunities exist to develop BIFM training and qualification?
- How can we build up a database of case studies to show the operational benefit of BIM to facility managers?

The workshop was by invitation only and the 22 attendees were pre-selected to represent a variety of stakeholder groups involved over the whole life process (FM service providers,

clients, academia, UK Government, professional bodies and FM contractors). The workshop started with three presentations, setting the background outlining the potential application of BIM to FM. The first one emphasised the many questions that are still unanswered regarding the management of buildings via BIM, for example what should be modelled from the facilities management perspective and how can a FM-BIM be integrated into strategic built asset management. The second presentation highlighted how the UK Government wants to change the construction industry by 2025 and how BIM and Soft Landings are milestones in order to achieve a 33% reduction in costs, 50% faster delivery and 50% lower emissions. The last presentation provided a brief description of how BIM is currently used by the construction industry, what benefits have been reported from companies that have used BIM, what changed once a building was completed and handed over and what are some of the potential uses of BIM for FM researched so far.

After the presentations, participants were divided into three groups. The groups were organised so as to have two representatives of the academic world in each group, adding other participants to each group based on their knowledge and expertise in the topic areas covered during the workshop. Groups remained unchanged during the first part of the workshop (question 1 and 2) and were subsequently modified for the third and fourth question following the same organizational logic. For each session each of the groups had a total of 15 minutes to discuss the topic and gather ideas on flipcharts followed by a 5 minute presentation of the results to other groups.

4. RESULTS AND DISCUSSION

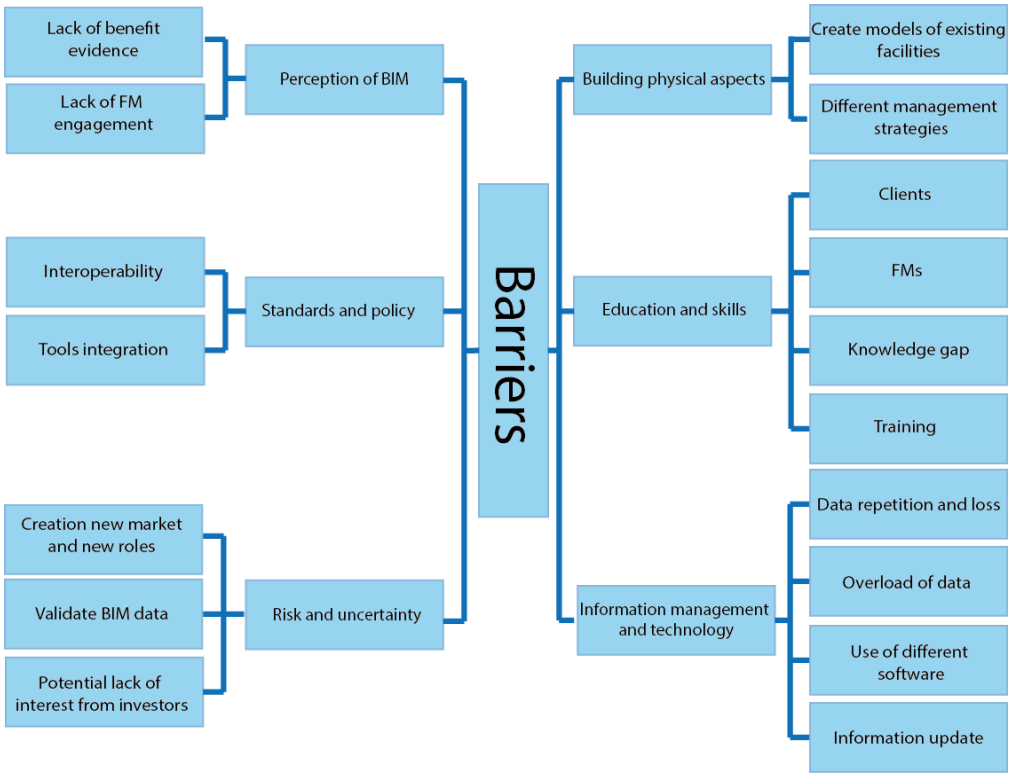
The presentations were recorded and subsequently analysed together with the flipcharts used during the group discussions using a qualitative analysis approach in four stages, as proposed by Lacey & Luff (2007):

1. Transcription of all presentations and comments recorded
2. Organising the data into four different questions
3. Preliminary coding of interesting concepts
4. Identification of themes

A thorough analysis of the transcriptions and flipcharts was then conducted, taking into account all the concepts that immerged during the workshop. Subsequently a further one day workshop was held at the Zurich University of Applied Sciences (ZHAW) in Switzerland to supplement the analysis with additional findings which then led to the organisation of the

findings into three themes: barriers, opportunities and added value of implementing BIM for FM.

BARRIERS



Perception of BIM

Even though facilities managers consider BIM a facilitator rather than an inhibitor to their work (Carbonari, 2014) BIM is still a new topic and its potential is still not fully understood. The industry is aware of the possible use of BIM for enhanced building maintenance (McGraw Hill Construction, 2014) but still there is not enough evidence to convince facilities managers to fully embrace this new technology. The current lack of interest is slowing the process of implementing BIM for FM in contrast of what is happening in the rest of the construction industry.

Building physical aspects

It is estimated that approximately 75% of the current UK Commercial Buildings will still exist in 2050 (Ravetz, 2008); therefore, implementing BIM for existing buildings, seems to be a great concern for both the construction industry and facilities managers. There is the need to understand to which extent the model has to be created, what are the necessary data to make a

BIM model helpful for FMs and who will be in charge of implementing it and its on-going management.

Furthermore, companies can have different attitudes towards facilities management and this can change the potential use of BIM. Different management strategies imply different breadth and depth of information to be stored and recorded during the building life and need to be taken into consideration while implementing the model.

Standards and policy

In order to assist the industry adoption of BIM, there is a need to create a unique BIM standard preferably at an international level. This will put pressure on software developers to create globally applicable tools that will make information and data exchange between other tools a straightforward process. The UK Government is currently demanding COBIe files as output from a BIM model for public projects, but as long as there is not a unique standard interoperability between software and integration, this will be hard to achieve.

Education and skills

BIM is a fairly new topic and the construction industry is in the middle of the learning curve. If the stakeholders are not aware of the potential of BIM, there is the risk they won't be interested in investing money, time and effort to implement it, therefore losing future opportunities. Training will help stakeholders to understand what can be achieved using a BIM model and how it can be helpful to accomplish the company's goals.

Risk and uncertainty

The workshop participants agreed that the new BIM market might create new BIM job roles and specific courses: this would lead to a fragmentation instead of the ideal of integration and shared information that should underpin a BIM model. All the stakeholders should understand how the model works, what its purpose is and how to use it as part of their work. Until the stakeholders mind won't change, investors won't probably be interested in including FM at the design stage or creating BIM model of buildings that will be sold once the building is completed.

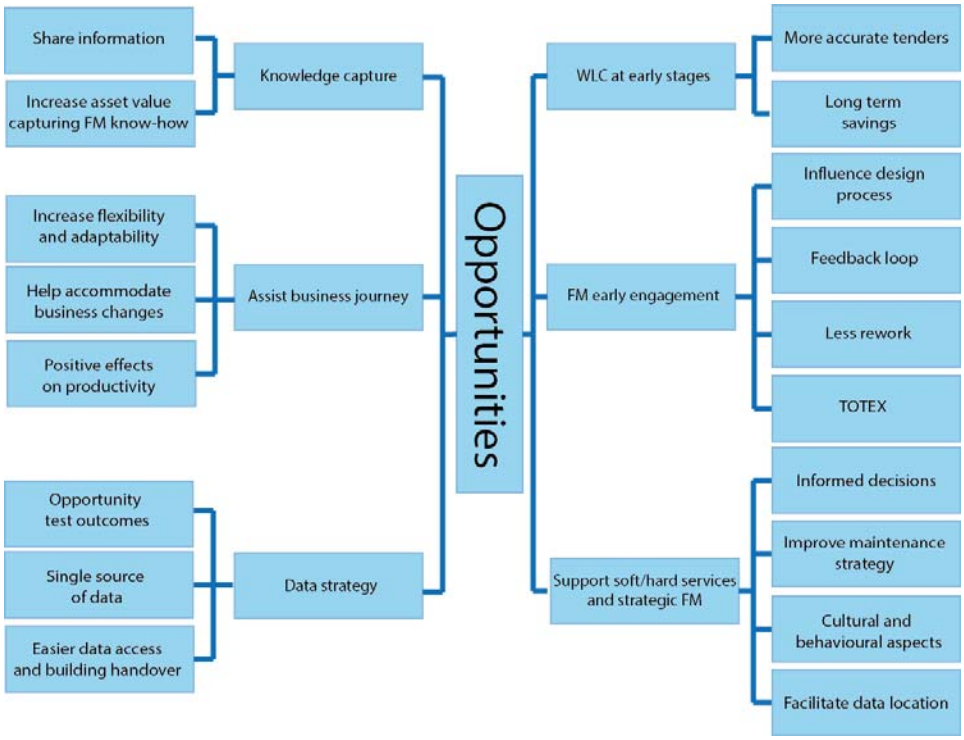
Information management and technology

Once the BIM model is handed over to FM not all the information within the model will be useful for managing the facility during its operational phase so the model may be overloaded with unnecessary information. The information will then be exchanged with various other software such as computerized maintenance management systems, building automation

systems, energy management systems and electronic document management systems, and the data might be duplicated or lost during the process.

During the life cycle of the building, the information about changes needs to be recorded in a unique format, but it is still not clear who will be in charge of this task. Also, it is necessary to decide whether a kind of information should be included in the BIM model or rather in different software.

OPPORTUNITIES



Knowledge capture

Sharing a common model between all the stakeholders allows the sharing of information in a more rapid and effective way: once a change is made the model will automatically show if it could cause any issue or if other changes are needed, unlike what happens with 2D/3D stand-alone drawings.

If facilities managers are involved in the design process, giving feedback on the decisions made by designers and architect using the visualisation and walkthrough opportunities provided by BIM, the asset will have an increased value and the management process will be easier during the building life. BIM will enable designer, engineers, builders,

suppliers, clients and facilities manager collaboration and information sharing, allowing the industry to break down the silos in which the different teams have worked in the past.

WLC at early stages

The inclusion of FM in the design stage and the consequent collaboration on a single model facilitate the capture of detailed information on the building before it is built. The information can be used during the tender process and to model the building behaviour over time, identifying potential alternatives, and make informed decision that will have a greater impact on the whole life cost of the building.

Assist business journey

During the life of the building, BIM can be used to accommodate the business changes, modelling different solutions and helping the decision-making process: BIM can be used as a tool to increase flexibility and adaptability of a building, improving the quality of the work environment and therefore having positive effects on productivity.

FM early engagement

BIM allows facilities managers to be involved in the design stage, giving FM the opportunity to visualise the building and influence the design process. This will create a feedback loop and a continuous improvement of buildings, and consequentially less need to rework during the construction phase. FM can also use the model to calculate, once the design is complete and before the construction begins, the operational expenditure (OPEX) that together with the capital expenditure (CAPEX) gives the total expenditure (TOTEX) of the building during its whole life.

Data strategy

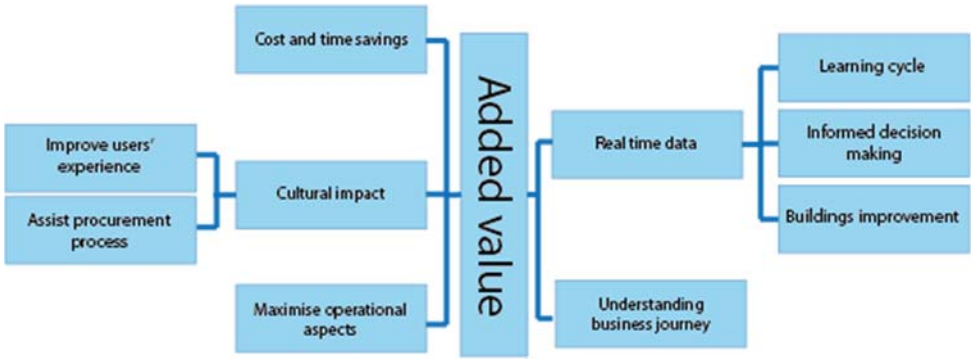
Identifying the data needed by facilities managers for managing the building during the pre-design stage helps in collecting this data into the BIM model before handover, providing a single source of data fit for purpose. This will allow facilities managers and clients to set the targets at the beginning of the process and test the outcomes while the building is in use. BIM can also facilitate the building handover and provides an easier access to data, as it contains all the information needed to operate the building in a single database.

Support soft/hard services and strategic FM

The data within the model and collected during the life of the building can be used to make informed decisions together with the opportunity to improve the maintenance strategy. Data can be located in an easier and faster way, for example by using mobile devices directly on site. The workshop participants agreed that the model should include cultural and behavioural

aspects in order to enable more informed decision making processes, tailored on the building and users. Unfortunately, presently available software on the market does not present these features as of yet, to the authors' knowledge.

ADDED VALUE



Cost and time savings

Various case studies show that BIM has a positive impact in cost and time savings (Bryde et al., 2013; Barlish and Sullivan, 2012) reducing errors, omissions and rework. Companies fully committed with BIM report a return of investment over 25% (McGraw Hill Construction, 2014)

Real time data

BIM, as an intelligent model automatically updates the model once a change is made: this can help facilities managers to make decision based on real time data about the building behaviour and use. The information stored within the model can create a learning cycle, a deeper understanding of the building dynamics and a constant improvement throughout the facility life cycle.

Cultural impact

BIM can have a positive impact also on the building users: improved buildings can enhance the users' experience and a deeper understanding and analysis of the building can lead to a building tailored on the users and companies' needs. A deep understand of the building in use, from pre-design to the building end of life leads to reduce costs and waste, especially of the energy use.

The "shift of effort" (MacLeamy, 2004) has as a consequence that all the design decisions are made before the design detailing; at the procurement stage all the information is available and can be used for more accurate tenders.

Maximise operational aspects

Facilities managers can use BIM not only for location and visualisation purposes but also as a tool to maximise operations and maintenance: the data stored within the model can be used for analysis of the building during its life, revealing information useful for future strategies.

Understanding business journey

A building has to accommodate the business' needs and facilities managers can use BIM to review what has changed in the past in order to create hypotheses and scenarios of what might happen in the future.

5. CONCLUSION AND RECOMMENDATION

The Government strategy to have all government buildings built with a BIM model by 2016 has mobilised the construction industry into change and the adoption of BIM as a process. The RIBA 2013 plan of works introduces BIM in Stage 0 – Strategic Definition. At this early point in a project a matrix is required to define the roles and responsibilities and the client should "consider the merits and protocols of using a BIM model to help deliver sustainability aims". Feedback from the workshop suggests clients and facility managers' perception of BIM is unclear and the lack of knowledge and education around BIM means many clients are unaware of their responsibilities in the RIBA process and as a result facility managers are often left out of these critical early discussions.

It is critical that facility management is involved in the early stages as they understand the culture of the client and will help the client make informed decisions, meet their requirements to provide relevant information and develop a well thought out information and data strategy and to help plan for Stage 6 – Handover and Closeout where the Soft Landings and BIM End of Construction Model Data so that the right information is captured and prepared for handover to the facility management team and the project performance reviewed. Stage 7 – In Use, addresses the need to manage and update the BIM model on-going.

In order to maximise operational time and cost savings and deliver the potential cultural benefits facility managers and others keys stakeholders need to bring the benefit of their knowledge into the process to deliver maximum added value. This will allow facility management to use BIM to improve the decision making process when considering both new and existing buildings. Most of the workshop delegates all recognised they are on a BIM journey and in order to ensure the success of BIM it is important for all stakeholders to educate themselves and engage fully with the process.

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