Building Information Modelling: Scope for Innovation in the AEC Industry

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Abstract: *Building Information Modelling (BIM) has a key focus on collaborative working practices and technological innovations, which support the consistent and coordinated flow of accurate information across the lifecycle of a building project. Visualisation of BIM through 3D and Virtual Reality representation is vital to drive maximum value of BIM at every stage of the construction processes. The use of 3D/Visualisation parametric modelling tools is the foundation of the BIM framework, whereby building elements are represented in an intelligent digital environment as they are assigned with graphical and data driven attributes. Information from this primary phase can then be interrogated using environmental analysis, clash avoidance (visual/systematic), construction visualisation through 5D modelling, costing and facilities management systems. The interoperability of information across such systems has supported acknowledgement within industry that they are fundamental constituents of a truly integrated BIM approach. Furthermore the link between BIM and sustainability is becoming a growing trend; however there have been limited initiatives in this area which explore the methodologies for effectively implementing a viable system framework. This study will provide an overview of the UK industry status in respect to the adoption of BIM, whilst exploring the scope to exploit BIM workstreams and support innovation in the AEC industry. The paper also identifies current government and professional bodies in the UK.*

1. Introduction

Building Information Modelling (BIM) is growing at a phenomenal rate as organisations in the AEC industry understand the evident benefits in respect to enhancing efficiency throughout the lifecycle, Building Smart Alliance (2009)

The various BIM definitions amongst practitioners include descriptions relating to knowledge databases (Sah and Cory, 2009), 3D modelling technologies and multidisciplinary collaboration (Gerber and Rice, 2010). The key emphasis of BIM has been on interoperability and visualisation, whereby consistent and accurate information can be communicated across the lifecycle process,. Eastman, C. et al. (2008). Industry Foundations Classes (IFC), a file format developed by the International Alliance for Interoperability (IAI), remains a popular concept in supporting the exchange and use of data across technological platforms. Although shortfalls have been highlighted by various individuals and organisations in respect to implications of IFC use on information technology systems (Pazlar and Turk, 2007), the IAI continues to improve the IFC framework. Therefore the possibilities associated with the application and use of a single file format across a global scale, is a goal in proximity of realisation.

Autodesk Revit, Graphicsoft ArchiCAD and Bentley Microstation are amongst the top BIM solutions currently being utilised by industry professionals. The functionalities and attributes associated with these technologies range from 3D modelling, scheduling, reporting and the creation of construction drawings. Furthermore parametric design and intelligent processing are the core constituents of these technologies which differentiate them from competitors. It is important to emphasise that the capabilities of the three technologies are highly geared towards supporting the design process, rather then the full lifecycle approach. However the design process is the pivotal point whereby the structuring of data and information has a direct impact on downstream activities.

A study undertaken (Jurewicz, 2008) provides a detailed overview of the three main modelling technologies and their associated capabilities. The analysis conducted illustrates the similarities which exist between technological platforms, emphasising that the key focus is on supporting the creation,

management and communication of data and information. Technologies have varying degrees of sophistication and selection decisions in respect to adoption are usually based on organisational preferences. The purpose of this study is not to provide recommendations on which technologies or systems are best suited in supporting organisational needs. However it is important to highlight the need for firms to benchmark solutions and explore how solutions can be integrated to enhance operational practices.

Furthermore beyond the initial stages of purchasing technology, training users and company wide adoption, there is a period when momentum declines in respect to the learning of new skills. For example results from a survey (Fig. 1) conducted in a design firm employing 80 technical staff, which have been using BIM technologies for a period of four years, illustrates the current divide in skill levels:

Fig. 2 illustrates that in order to sustain an increased growth in skill levels, it is imperative that organisations have a long term strategy in place to support continuous development. The successful adoption of technologies and exploitation of capabilities can only be fully realised when the supporting processes and strategies are aligned accordingly

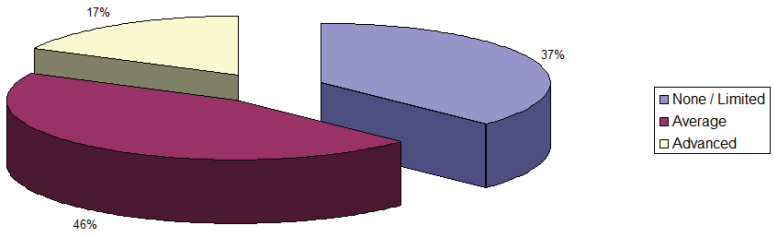

Fig. 1: Survey Results - Revit Expertise Levels

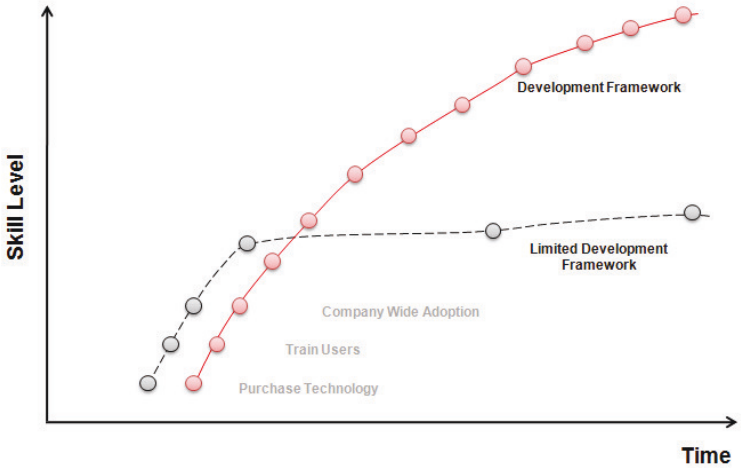

Fig. 2: Technological Adoption Strategy

2. Industry Trends

Rapid developments are occurring in other areas such as environmental analysis, construction planning and facilities management solutions. Whereby organisations in the AEC industry are continuing to explore how technologies and processes can be aligned to provide complete lifecycle solutions for clients. The evident benefits of BIM, namely; enhanced productivity, reduced construction errors, cost savings and increased collaboration between stakeholders (Aranda et al, 2008) continue to be realised in the AEC industry. Furthermore there is increased understanding that the adoption methodology is not a simple process, hence it cannot be successfully incorporated over a relatively short period of time, Smith D. and Tardif, M. (2009)

BIM adoption is gaining increased support from industry bodies and regulators within the US, such as the American Institute of Architects (AIA) and General Services Administration (GSA). In the United Kingdom the British Standards Institution (BSI) has recently released BS 1192 which provides guidelines to support collaboration and BIM implementation. Furthermore architects and engineers continue to drive awareness amongst clients and industry partners in order to share knowledge and understanding of the collective benefits associated with the BIM approach.

The integration of technology, processes and people is integral for organisations in order to successfully adopt BIM. Furthermore practitioners are moving beyond barriers associated with cost implications and infrastructure changes (Becerik and Pollalis, 2006). McGraw Hills Construction report (Young, 2009) confirmed early adopters are experiencing benefits across the operational infrastructure i.e. enhanced productivity, reduction in rework and improved communication.

Technological innovation continues to influence organisations in their adoption of BIM. Advancements in Laser Scanning and Point Cloud domains are set to have an explosive impact on industry, as the time required to capture data in the form of building geometry is reduced substantially. Developments are pushing towards creating techniques which will enable clouds to be fully manipulated and assigned attributes; hence they could be directly used by BIM systems.

Government workgroups in the United Kingdom, such as Construction Excellence are now beginning to support the establishment of a framework for the adoption of BIM. However the link to sustainability initiatives such as the Climate Change Act 2008, which is a legally binding framework introduced by the UK to tackle climate change needs to be integrated into the BIM lifecycle approach. The use of technology aligned with operational practices to support sustainable development requires greater integration and coordination.

Interviews with AEC organisations highlight that the adoption of BIM is favourable due to the competitive advantage offered and its role in enhancing operational practices and collaborative working. In respect to implementation strategies considerations need to cover business benefits, investment requirements, training initiatives and cultural resistance. Organisations fall short of effectively implementing BIM due to a variety of reasons, which includes the lack of willingness or drive within the organisation to support successful implementation. Clients also need to be aware that they have the authority to request the obligatory use of BIM on live projects. Such an approach means project stakeholders are inclined to support integrated practices, knowledge sharing and collaboration. Hence a project can be delivered on time and budget whilst adhering to sustainable practices and industry regulations.

3. BIM Process Review

The Royal Institute of British Architects (RIBA) has a distinct process for organising and managing building design projects through a number of key work stages i.e. A – L (Fig. 3). The process most commonly known as the ‘Outline Plan of Work’ is an integral part of the framework for design and construction projects within the UK. Furthermore it is important to emphasise that although the RIBA Outline Plan is commonly illustrated as a start to end process, in reality it is of an iterative nature, whereby information at various stages is reviewed and modified depending on project requirements. The study undertaken has demonstrated (Fig. 4) the link which exists between the RIBA process, BIM

workstreams, technologies and the interoperability of information across technological platforms. Architectural practices have an opportunity within industry to lead in the adoption of BIM to support integrated project delivery. The BIM approach provides architects with the opportunity to regain lost ground in respect to their traditional status as leaders (Hiley and Khaidzir, 1999), as it enables enhanced control, coordination and management of building projects.

The practical implementation of BIM must have the full support of all project stakeholders, whereby individuals and organisations understand the various BIM workstreams in the context of the lifecycle (Fig. 5). Furthermore at the initial stages of project initiation it is compulsory that a BIM champion is selected to brief stakeholders of the approach and to manage its implementation until project completion.

In addition various bodies including Pennsylvania State University have highlighted the need for a 'BIM Execution Plan' (Building Smart Alliance, 2009) at the early stages of a project, which relates to BIM goals, uses, processes and information exchange. Industry recognises the need for the deployment of such a plan, however greater simplification is required in order to support its feasible implementation in a time constrained operational environment.

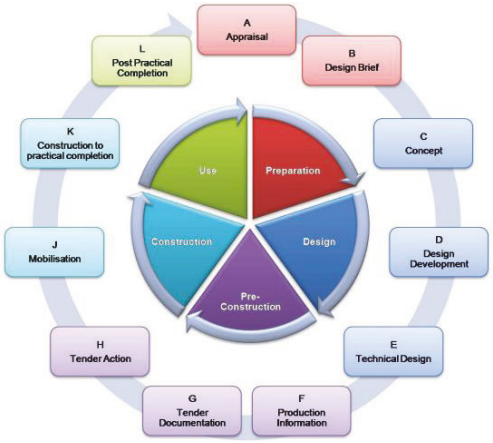

Fig. 3: RIBA Outline Plan of Work Process

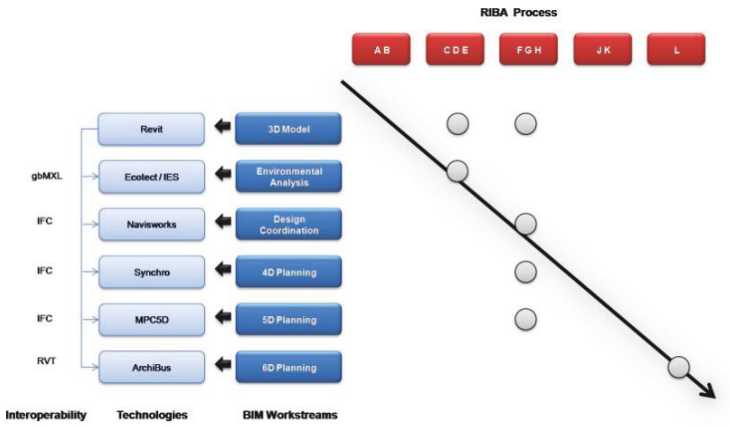

Fig. 4: BIM Process Framework

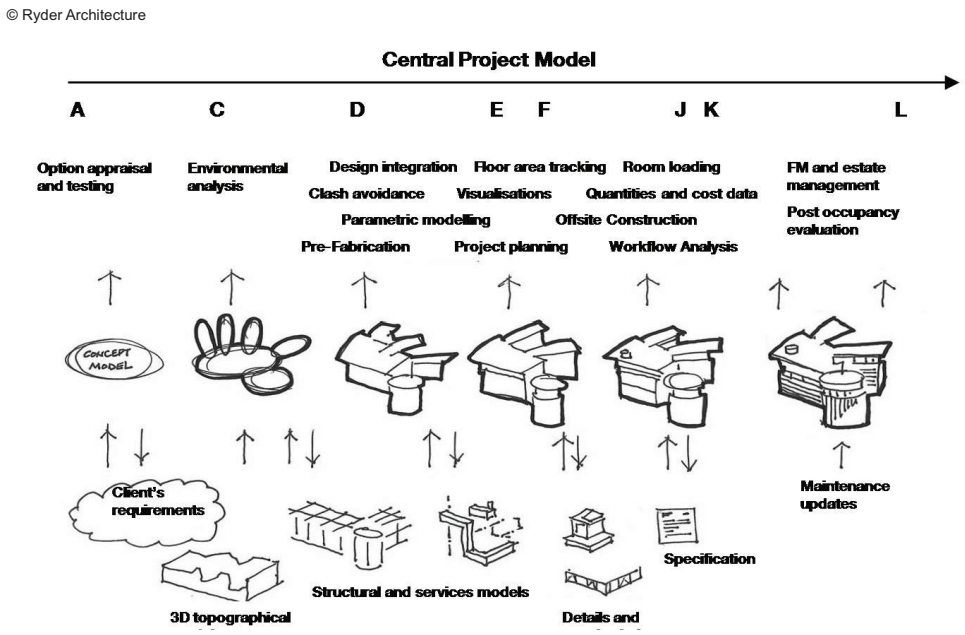

Fig. 5: BIM Lifecycle Process

4. UK Government and BSI views of BIM

UK Government-department for business innovation & Skill has stated that 'Government as a client can derive significant improvements in cost, value and carbon performance through open asset management system'. According to BS1192:2007, 'Collaboration between the participants in construction projects is pivotal to the efficient delivery of facilities. Organizations are increasingly working in new collaborative environments in order to achieve higher standards of quality and greater re-use of existing knowledge and experience, BSI 2010. A major constituent of these collaborative environments is the ability to communicate, re-use and share data efficiently without loss, contradiction or misinterpretation'. This implies that there are emphasis of new ways of working to drive a better value of construction processes and improve practices. According to BSI report on Constructing the Business Case for BIM: 'BIM continues to develop. Clearly, not all businesses will adopt systems and technologies at the same rate. However, just like organisations in the retail sector before them, BIM adopters will need to go though a managed process of change which encompasses not only their internal organisation but also the way they interface with their external supply-base and clients. The majority of the UK market is still working with Level 1 processes, and the best in class are experiencing significant benefits by moving to Level 2. It is clear that organisations adopting BIM now will be those most likely to capitalise on this advantage as the market improves'. Fig. 6 shows the different levels that BSI has introduced to bench mark applications of BIM in the Market.

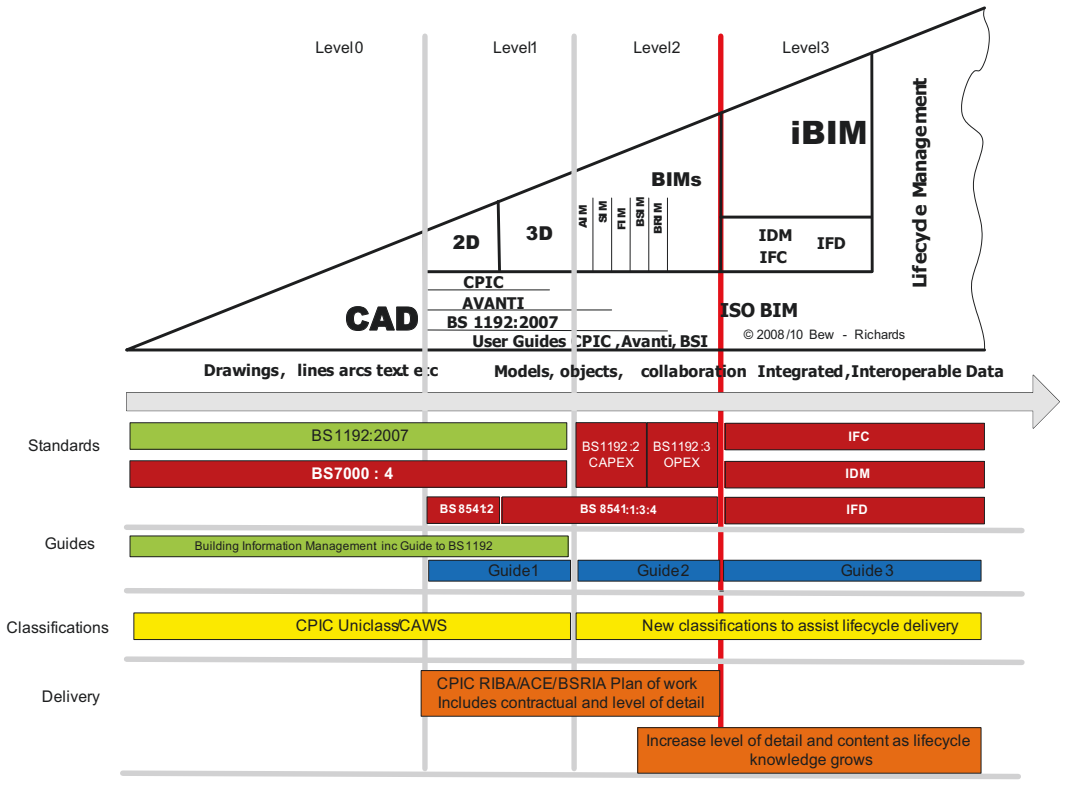

Fig. 6: Levels of information management, data sharing and collaborative working, source: BSI

5. Conclusions

The aim of this paper was to present BIM technologies and processes in the UK construction industry. The paper outlined current tools capabilities and briefly reviewed BIM processes in the context of RIBA plan of work. A process framework has been presented and mapped current commercial tools against RIBA processes.

Current Building Smart initiative has highlighted the level of penetration of BIM in the industry. Four Levels of information management, data sharing and collaborative working have been identified by BSI roadmap. Industry can identify their BIM capacities through mapping their current practices on this road map. It was concluded that the

majority of the UK market is still working with Level 1 processes, and the best in class are experiencing significant benefits by moving to Level 2.

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