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CURRENT USE OF BUILDING INFORMATION MODELLING WITHIN AUSTRALIAN AEC INDUSTRY

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ABSTRACT

It has been widely acknowledged that Building Information Modelling (BIM) is an emerging technological and procedural shift within the Architecture, Engineering and Construction (AEC) industry. BIM represents a methodology to manage the building design and project data in digital format throughout a buildings lifecycle. It is based on the Industry Foundation Classes (IFC), which is an open standard to enable interoperability between project supply chain phases as well as between proprietary BIM solutions. In Australia, the need for BIM stemmed from several issues identified by Engineers Australia, most notably the lack of integration along the supply chain linking parties, and between the project phases. The aim of the research presented in this paper was to provide an updated view on the current practices on the use of BIM within the Australian construction industry. This is necessary to understand the level of readiness of BIM adoption among Australian construction organisations given the push for the adoption of "full BIM" by the Australian Government as mentioned above. The research was conducted through a series of interviews with 25 AEC companies from two major cities in the state of Queensland. The findings highlighted the current issues related to the application of BIM technology such as: intellectual property, responsibility issues, data ownership issues, and security issues. The findings also indicated the number of current adoption barriers being faced by firms/organizations operating in the Australian AEC industry such as interoperability, resistance to change and lack of BIM understanding.

Keywords: Australia, Architect, Engineering, Construction, BIM.

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1. INTRODUCTION

The Architecture, Engineering and Construction (AEC) industry is constantly in pursuit of techniques to improve quality, increase productivity, decrease cost of construction projects. One of the most notable examples is the development of Building Information Modelling (BIM). BIM represents a methodology to manage the building design and project data in digital format throughout a building lifecycle (Succar 2009). It is perceived to have the potential to significantly change and improve performance and documentation in the AEC industry by reducing inefficiencies, enhancing productivity, and increasing collaboration and communication (Campbell 2007; Goedert and Meadati 2008). Despite the far-reaching benefits of BIM, the rate of adoption appears to be lower than expected.

In Australia, the need for BIM stemmed from several issues identified by Engineers Australia, most notably the lack of integration along the supply chain linking parties, and between the project phases. A “National BIM Initiative Blueprint” has been developed by BuildingSMART Australasia to promote the education and uptake of BIM among Australian AEC industry. It aims to facilitate the Australian Government’s adoption of full collaborative BIM for all of its building procurements from 2016. However, recent research by Gu and London (2010) revealed that the lack of experience in BIM due to their limited understanding of industry needs and technical requirements represented a major factor delaying the advancement and adoption of BIM related technologies within the Australian construction industry. The aim of the herein presented research was thus to provide additional insights into the current issues surrounding the use of BIM within the Australian AEC industry.

2. BENEFITS AND ADOPTION OF BIM

There are many reasons why the use of BIM in the AEC industry is becoming of vital importance. From and organizational and economical perspective, BIM is said to be a catalyst for change as it has the capability to: (1) reduce industry's fragmentation; (2) improve its efficiency; and (3) lower the high costs of inadequate exchange and use of information (Succar 2009). A number of other benefits have also been identified when utilising BIM during the conception phase of a project, including: (1) rapid visualisation; (2) rapid and accurate updating of changes; (3) increased communication across the entire project development team; (4) clear improvement in engineering design quality in terms of error free drawings; and (5) a steady improvement in labour productivity (Linderoth 2010). Linderoth (2010) further maintains that the end result of using BIM is improved project coordination, minimised errors, as well as reduced delays and conflicts, which could lead to a potential saving in construction cost alone ranging from 15% to 40% (given the full integration of entire design and construction team at all stages of project development in place). Azhar et al. (2008) indicate the importance of BIM through the following benefits: (1) removal of unbudgeted change up to 40%; (2) accuracy in cost estimation within 3%; (3) decrease in time taken to produce a cost estimate up to 80%; and (4) decrease in project time up to 7%.

Although, the benefits of BIM have been recognised within the AEC industry and the technology supporting BIM has grown matured, BIM adoption has been slower than anticipated (Bernstein and Pittman 2004). Succar (2009) argues that BIM adoption is slow because of concerns about the reluctance of the industry to adopt or deploy the new technologies. Bernstein and Pittman (2004) identify fragmentation and set processes as the inhibitors to the widespread adoption of BIM suggesting that the application alone is not the only issue.

In a study by Yan and Damian (2008), "only 26% of companies in the USA, 14% in the UK, and 5 % of companies elsewhere report that they are using BIM to design, construct and operate their projects" (p. 3). Very few respondents in their survey reported they knew a fair amount about BIM and no one in total was found to be an expert. Whereas most studies focus on the benefits and business drivers of BIM, Holzer (2007) has opposed popular opinions suggesting BIM is the solution that could overtake the industry's age-old challenges. Olatunji et al. (2010) suggested that the way forward is to explore ways to compare the benefits and disadvantages arising from BIM adoption.

In Australia, the number of study focusing on the adoption and utilisation of BIM within the industry is still limited. Nonetheless, it can be anticipated that Australian AEC industry may be currently facing similar adoption issues identified by past research studies conducted elsewhere, as cited above. One of the issues is the lack of experience and understanding of BIM, as identified by Gu and London (2010).

3. RESEARCH METHOD

3.1. Research design

This research employed a two-stage semi-structured phone interview with selected AEC firms within Australia. The first stage of the interview was carried out in order to determine whether the firms employ BIM and to understand the reason behind their adoption decisions. If the firm reported that they use BIM, further interview was conducted as the second stage to enquire about:

- How long the firms have been using BIM;
- The BIM-based tools being used;
- The primary reasons for using BIM;
- The main tasks for which BIM is used;
- The criteria of project to implement BIM;
- Proportion of firms outsourcing BIM;
- The perceived benefits and risks associated with BIM; and
- The main barriers associated with the adoption of BIM.

3.2. Sample and analysis

The target population for this research was business organisations (firms) operating within the Australian AEC industry. The sampling frame included well established firms located in the two major cities in Queensland: Brisbane and Gold Coast areas. Research participants were selected using convenience sampling techniques due to the location of the researchers. In total, 30 firms were invited to participate in the study. For the purpose of confidentiality, the names of these firms are withheld to maintain their anonymity. In this research, a qualitative data analysis was conducted. The data was collected, interpreted and manually organised into various themes, in order to observe the interview responses and look for similarities and differences in responses and allocating them to the appropriate themes. Following the data analysis, conclusion and recommendation were drawn.

4. RESULTS AND DISCUSSION

For the purpose of this study, 30 firms were recruited for the research in the middle of 2012. Of these 30 firms, 25 agreed to participate in the research. For each firm, a senior professional was referred to as the firm's representative for the interview. The results from the analysis are presented in two sections following the adopted two-stage interview approach described earlier. The first section presents the results of the 25 firms that responded to the initial questions regarding the awareness of BIM and their adoption decisions. In the second section, the results of the firms proceeding to the second stage of the interview, which targeted the issues of how BIM was used, were presented and discussed.

4.1. BIM awareness and adoption decision

The majority of the 25 firms participated in the research were architectural (44%) and design consultancy firms (30%). Most of these firms also had the number of employees ranging from 20 to 80 (75%). With respect to the awareness of BIM, 16% of these firms reported that they were unaware of the technology. However, 52% of the firms who reported that they were aware of BIM indicated that they did not use it. That leaves only 32% of the firms that were aware and actually used BIM as part of their work. The 52% non-adoption rate is consistent with the finding from an industry-wide survey conducted by McGraw-Hill (2009) indicating that 51% of the firms within the US AEC industry did not use BIM. The 32% adoption rate is consistent with that found in a recent BIM survey in Europe by McGraw-Hill (2010).

Further analysis revealed various reasons as to why the non-adopter firms did not decide to adopt BIM. The top three most cited reasons are: (1) the existing CAD system can already fulfil the need (37.5 %); (2) BIM is expensive to operate and maintain (32.2%); and (3) the projects they undertook did not require the use of BIM (23.8%).

4.2. Current usage of BIM

Further interview (i.e. second stage) was conducted with the 25% of the participating firms (i.e. 8 firms) that adopted BIM. With regards to the first interview question, half of these firms reported they had implemented BIM for around 3-5 years, while only one firm reported that they had used BIM for more than 5 years. Regarding the types of BIM supported tools being used, Autodesk Revit was most utilised by the firms (48%), followed by Graphisoft ArchiCAD (38%). This coincides with the findings from the studies by Arayici et al. (2009) and Becerik-Gerber and Rice (2010) that Autodesk Revit is the most widely used BIM authoring tool in the UK and USA.

Five firms reported that the primary reason for adopting BIM was to help improve design quality to reduce errors. Client request was cited by two firms as another reason of adopting BIM while only one firm reported that they decided to use BIM because it helped reduce cost. These firms further reported that they mainly utilised BIM for: visualisation; clash detection; project review, and building design. Given BIM has the main capability to improve collaboration through streamlined electronic information exchange, this result demonstrates that BIM was rather under-utilised by most of the firms as information management and project collaboration were not mentioned as one of the main tasks for using BIM.

If not requested by the clients, firms further reported that they will consider implementing BIM depending on project types and complexities. Projects with higher values will also be given higher priority for using BIM. For example, one firm mentioned that they only consider using BIM for a project with value greater than $50 million. Furthermore, because the implementation BIM to the large extent requires specialised systems and human resources, all of the interviewed firms, except one, reported that they outsourced this task to BIM specialists.

4.3. Benefits and issues

In terms of profitability, almost all of the firms reported that they did not see, or were unaware of, any improved or declined profitability due to the implementation of BIM. Perhaps, this is because calculating the return on investment of BIM requires long-term records of associated investment and returns to ascertain this benefit. Given most of the interviewed firms had only used BIM for only short period of time, determining the return-on-investment of BIM can be a challenge. Nonetheless, these firms observed and acknowledged certain benefits of BIM in their operations. With respect to using BIM for visualisation, they reported that they gain benefits in terms of:

- Cost and time savings in creating redundant building models;
- Improved project presentations to clients and for approval process;
- Facilitation of the examination and verification of architectural design concepts;
- Reduced production time; and
- Increased quality of the outputs.

In relation to the benefits of using BIM for clash detections, they commented that BIM provides benefits in reducing costly errors by integrating models to analyse and resolve clashes early. Another benefit included time savings during construction as a result of reduced clashes between building components. Furthermore, they reported that by using BIM for project review, it can facilitate the better examination of plans, sections and elevations which enables early detection of project issues and helps improved collaboration. In fact, the above benefits are consistent with past research. For example, Linderoth (2010) lists the benefits associated with the use of BIM at an early stage of projects including: rapid visualization, increased communication across the total project development team, and clear improvement in the design quality in terms of error free drawings.

In addition to perceived benefits, the interview also revealed several adoption issues currently faced by the firms. These issues include: data ownership and intellectual property, the lack of clarity as to which party is responsible for which part of BIM and to what extent; and choosing the appropriate BIM software. Previous literature also identified similar issues when implementing and using BIM. According to Azhar et al. (2008), there are concerns from the designers of BIM models revolving around the ownership of the BIM data and how it can or should be protected through the use of copyright. The firms interviewed in this research also highlighted ownership issues and security issues as risks being faced. For instance, in the case of the owner paying for the design, the owner may feel entitled to own it, but if team members are providing privately-owned information for use on the project, such information needs to be protected as well. Thus, there is no simple answer to the question of data ownership. Howell and Batcheler (2005) also identified key issues associated with the use of BIM technology as: the liability among project stakeholders and the lack of clarity on individual roles and responsibilities.

4.4. Adoption barriers

A number of barriers to BIM adoption and implementation were also identified from the interview. These are: the persistent lack of interoperability; upfront cost of system setup; resistance to change; lack of BIM understanding; industry culture not suitable for BIM adoption and lack of visions; and inadequate training and education. In fact, the acceptance of technology, especially IT, within the Australian AEC industry was found to lag behind most of their counterparts (Stewart et al. 2004). At the industry level, the barriers that tend to inhibit the adoption of IT related technologies (including BIM) are typically related to the competitive nature of the industry and the distribution of expertise. The interviewed firms highlighted the fragmented and adversarial culture of the industry as well as cost driven as the main barriers to the deployment of new technologies. The fragmented nature still appears to be the main factor that inhibits the industry to come up with practical strategies for the interoperable exchange of information (Bernstein and Pittman 2004) despite the existence of an industry standard such as IFC. In addition, due to the fact that most of the participants of this research are medium sized firms, limited resources available for IT expenditure was cited as another main barrier.

Gu and London (2010) highlight the lack of awareness and training as well as that the AEC industry is either reluctant or resisting to change are the barriers associated with BIM adoption. Moreover, a survey conducted in the US with industry participants by Auburn University (Azhar et al. 2008) found that approximately 75% of survey participants consider candidates with BIM skills to have an employment advantage over candidates who lack BIM knowledge. Properly structured BIM courses would provide industry-required knowledge to prepare students for successful careers in the AEC industry. The lack of in-house BIM knowledge and expertise among the interviewed may also explain the reason why most of the BIM tasks were outsourced.

5. CONCLUSION

The aim of this research was to shed additional light on the current usage and adoption of BIM from the perspective of Australian AEC industry. The findings from this research revealed that the adoption of BIM among the 25 sampled firms from two major cities in Queensland: Brisbane and Gold Coast, was still not widespread, i.e. only 32% (8 firms). Firms that did not adopt BIM stated that they did not require BIM due to: the existing CAD system can already fulfil the tasks required; the projects they undertook did not required the use of BIM; and BIM is expensive to operate and maintain. For those firms adopting BIM, they cited that they did so to help improve design quality to reduce errors and to meet client requirements for BIM. Although these firms perceived the benefits of BIM in saving cost and time, reducing errors and improving collaborations, they reported a number of issues associated with the adoption and implementation of BIM; these include: data ownership and intellectual property; unclear responsibilities; and choosing the appropriate BIM software. They also reported a number of barriers that need to be addressed, mainly at the industry level, including: the lack of interoperability; upfront cost of system setup; resistance to change; lack of BIM understanding; fragmented industry and adversarial culture; lack of visions; and inadequate training and education. Consistent with other researchers, these represent the barriers being faced by the AEC industry worldwide that needs addressing in order to increase the diffusion of BIM within the industry. It is thus recommended that if the government decided to enforce the use of full BIM in the delivery of public projects, they should address the above issues to ensure that the industry has adequate level of preparedness to ensure successful adoption of BIM.

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