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FACTORS AFFECTING THE FULL IMPLEMENTATION OF BUILDING INFORMATION MODELING AS A CONSTRUCTION MANAGEMENT TOOL

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There has been growing concern about the efficiency of the Australian construction industry. It has been identified that inefficiencies due to industry fragmentation has significant impacts on the way construction projects are delivered. It is largely believed that Building Information Modeling (BIM) has the potential to significantly improve the efficiency of a project throughout its entire lifecycle. The main focus of BIM research has, up until now, been principally focused on its ever increasing use in the design phase of a project. The construction phase of a project has been largely overlooked, particularly the implementation of BIM during this phase of a project.. A mixed method approach has been utilised in this study comprising of quantitative and qualitative techniques. The quantitative method was conducted through the distribution of a statistically analysed questionnaire survey to a sample population of construction professionals within Australia. Concurrently, the qualitative method of analysis is conducted through case studies of selected construction projects with some involvement of BIM. Through the research, it was proven that Australian construction projects are far from the full utilisation of BIM as a construction management tool. The factors affecting BIM's utilisation were also discovered in this research and validated through statistical analysis of the population data found by the questionnaire survey.

Keywords: BIM, Productivity Construction industry, Australia.

1 INTRODUCTION AND BACKGROUND

The Australian Bureau of Statistics (2012) has identified the Australian construction industry as being the fourth largest contributor to Gross Domestic Product (GDP) and is vital to Australia's economic development (Yan and Chunlu 2010). In June 2012, the industry employed 950,000 people and supported 209,783 businesses. The industry generated a total of $305.5b comprising construction services, building construction and heavy and civil engineering construction. However, the industry has been suffering from a decline in productivity due to significant inefficiencies (buildingSMART Australasia 2012). As shown in figure 1, the construction industry in Australia has been growing, however, the growth is at a slower rate than the cumulative productivity in Australia (The Allen Consulting Group 2010).

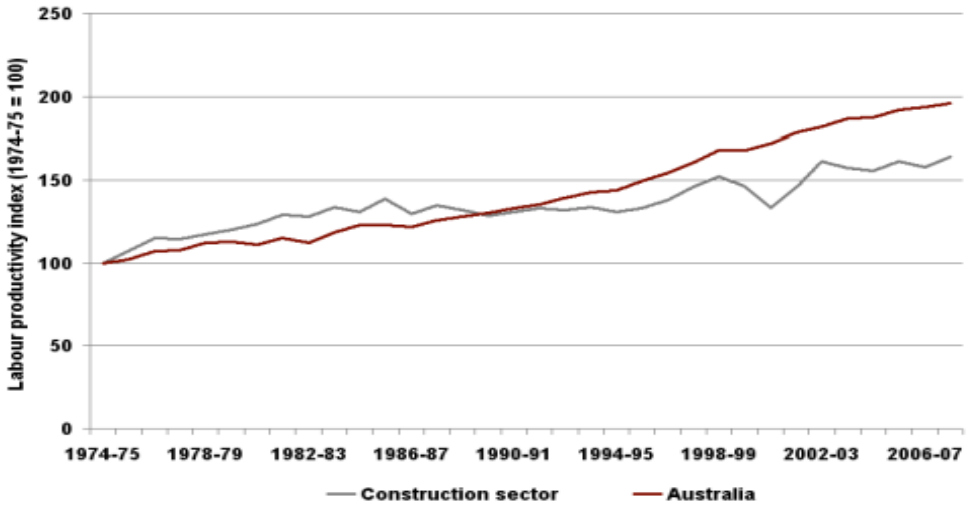

Figure 1. Construction sector labor productivity (The Allen Consulting Group 2010).

The slowing of the industry's growth in comparison to the Australian benchmark raises concerns. Given the size of the construction industry, more effective processes would lead to greater efficiencies.

The large percentage of small businesses has led to specialization of the construction industry and has therefore become more fragmented (Wu 2009). This results in linear, uncoordinated and highly variable project processes (Kagioglou *et al.* 2000). Zraika (2003) agrees and adds that the fragmentation results in construction project delays and reduced quality. Fragmentation arises from two areas within the construction process, the separation between design and construction and the construction structure itself (Mohd Nawi *et al.* 2014). As stated, a long standing problem has been the lack of coordination of the different specialist activities. Team integration or Integrated Project Delivery (IPD) is a single tri party contract between a minimum of the architect, building owner and general contractor that moves towards addressing this issue (Mohd Nawi *et al.* 2014). Other consultants or trades can join the contract but the three main parties are unchanged. IPD creates a system that integrates people, operational process, business practices and organizational systems into a collaborative framework (Furst 2010). Building Information Modelling (BIM) offers a collaborative platform to employ IPD. BIM improves productivity, efficiency and quality and ensures the whole process will become less fragmented, more streamlined and positively address communication throughout the project lifecycle (Chew and Riley 2013, The Allen Consulting Group 2010). BIM technology generates greater construction efficiency and effectiveness through increased collaboration of project participants, thus reducing the industry's fragmentation (Migilinskas *et al.* 2013).

BIM is a process that encompasses all aspects, disciplines and systems of a facility within a single, virtual model. BIM is not a simple three dimensional model, but a process to improve the performance through the whole life cycle of buildings (Lu *et al.* 2013). The model is a database providing digital information about the design, construction, project management, operations, logistics, materials and energy consumption of a building (The Allen Consulting Group 2010). BIM allows for a managed environment so that people, tools and tasks can effectively share this information throughout the building lifecycle (Migilinskas *et al.* 2013). The virtualized world of BIM allows control, information and familiarity before a

shovel is put in the ground. The BIM process generates stores, manages exchanges and shares building information through a computer generated model. The model is used to simulate the project lifecycle, including planning, design, construction, operations and demolition as seen in Figure 2.

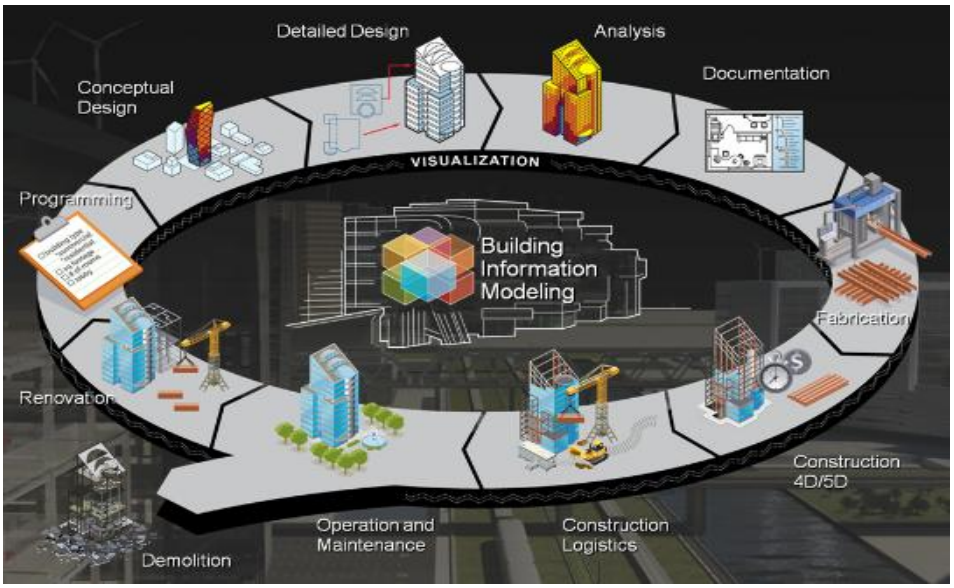

Figure 2. BIM project lifecycle (Miner 2012).

There have been numerous studies that have identified BIM as a tool that increases productivity, efficiency and quality values (Chew and Riley 2013). Therefore, why has it been identified that Australia has such a slow uptake? To help understand the lack of BIM utilization within the Australian construction industry, the research seeks to identify the barriers common to BIM implementation. Through a review of literature, it was identified that interoperability, cost, industry culture and client demand are the major contributors to the lack of implementation (Azhar 2011, Migilinskas *et al.* 2013).

2 RESEARCH METHODOLOGY

The case studies were conducted on five medium and large sized construction companies within Australia, forming a multiple-case design of research, therefore increasing validity through triangulation (Yin 2013). Additionally, the data allowed the comparison between medium and large companies. The selected construction companies, chosen by their characteristics, were contacted by email and follow up telephone call. The email allowed the researcher to describe the purpose of the research, the required areas of interest and asked for the willingness to participate in a case study interview. The collection of data used to gain background information on the specific companies and their current use of BIM was derived from electronic information available on the internet and printed information from construction journals. Observations were conducted during the interview process. This provided an insight into the current use of BIM and identified some common barriers of implementation. Observations were also made when the researcher was able to attend the construction site. Researcher observations proved invaluable due to the first-hand experience that was not filtered by what others may have self-reported. The

interview was conducted in a semi-structured format. The purpose of the interview was to identify the factors restricting BIM being utilized as a construction management tool. To assist finding these factors, it was required to identify the level of BIM capability and current BIM utilization for the particular project being assessed. The mixed methodology is used to compare the two research paradigms to determine the BIM capability, utilization of BIM in construction and the factors affecting the implementation of BIM within the Australian construction industry context.

3 FINDINGS

Figure 3 presented below summarize the extent in which BIM was used as a construction management tool for both medium and large sized companies. It is clear that large companies engage BIM for construction management tasks more so than medium companies. It can also be said that large companies meet the criteria of utilizing BIM for all construction management categories. In comparison, medium companies only utilize BIM for visualization and 3D coordination tasks. This information can prove useful for medium sized construction companies to address the shortfall of BIM utilization for scheduling and planning and costing in a bid to fully utilize BIM.

The results of each factor that affects the implementation of BIM in Australian construction projects are shown overleaf. The Figure 4 clearly shows that education was the biggest factor limiting the implementation of BIM as a construction management tool. A mean score of 4.06 is described as being a major impact on implementation. Client demand was found to have the least impact with a mean of 2.7 translating into a minimal to moderate impact. However, it should be noted that all five factors present some sort of impact to the implementation of BIM for construction management purposes.

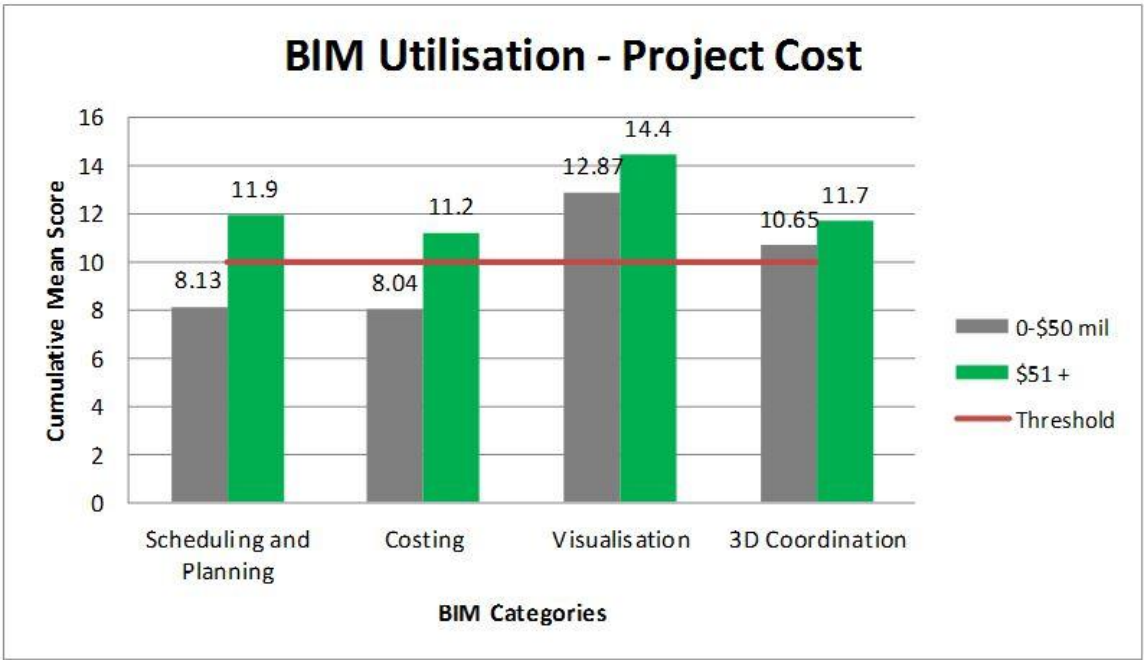

Figure 3. Project Cost 0-$50mil vs $51mil + - BIM utilisation in construction.

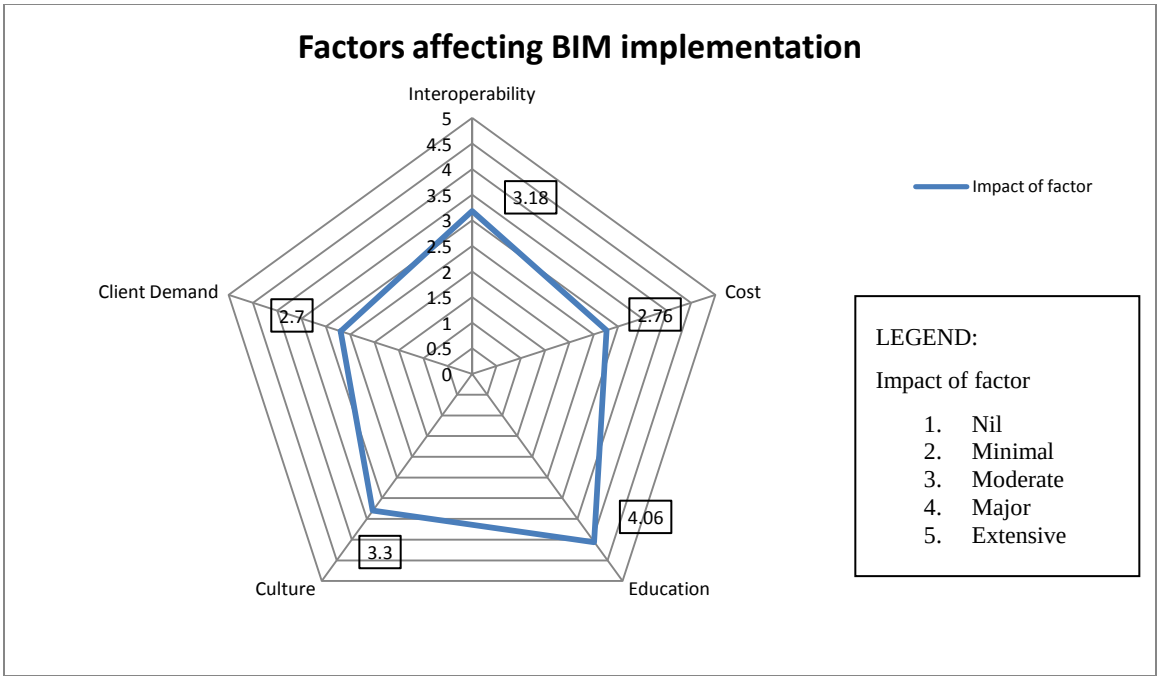

Figure 4. Factors affecting BIM implementation.

4 CONCLUSION

The results demonstrate that the Australian construction industry is capable of utilizing BIM for construction management. The results proved that generally BIM is utilized in visualization and 3D coordination only for construction management purposes. Scheduling and planning together with costing were not adopted by BIM as tools for construction management. However, sub-groups within this data showed a more detailed perspective. Medium sized construction companies were found to only utilize visualization as a BIM construction management tool. Conversely, large companies fully utilized all categories of BIM as construction management tools. Further analysis of sub-groups found that construction projects exceeding $51 million utilized all categories for BIM as a construction management tool. This was in direct contrast with projects under $50 million, as their primary utilization of BIM as a construction management tool was for visualization. The results showed that education presented the most significant factor to the implementation of BIM as a construction management tool for Australian construction companies. However, further analysis of sub groups found that medium sized companies were mostly affected by cost, education and industry culture.

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