Sustainable Solutions in Structural Engineering and Construction
Edited by Chantawarangul, K., Suanpaga, W., Yazdani, S., Vimonsatit, V., and Singh, A.

ISBN: 978-0-9960437-0-0

ICT BARRIERS TO IMPLEMENTING BIM IN THE AUSTRALIAN CONSTRUCTION INDUSTRY

SWAPAN SAHA and CRAIG KING

University of Western Sydney, Sydney, Australia

Advances in Information Communication Technology (ICT) have led to the development of more advanced computer management systems in the Australian construction industry, including Building Information Modelling (BIM). BIM is an ICT-enabled approach involving digital representations of building elements and information related to different phases of the building lifecycle, and is used to provide shared information and to form a reliable basis for decision making. Pilot projects and research papers have verified many claims about BIM, and prove a viable economic case, yet uptake of the technology still remains low. A literature review revealed three key productivity gains experienced by BIM use on a construction project: accuracy, communication and time/performance. Four ICT barriers to its implementation were identified as interoperability, funding and resource cost, cultural barriers and perceived risk, and security and protection. Findings on research done on these barriers in Australia reveal that many companies see the benefits for BIM, but believe other disciplines and the client should implement the model. Construction professionals usually work within their field of expertise, with limited interaction with other disciplines, even though many issues on work sites require collaboration from multiple disciplines. A common medium of communication, provided by BIM systems, will achieve this integrated building approach. This paper finds that ICT barriers prevent the Australian construction industry from taking full advantage of potential productivity gains proven in BIM.

Keywords: Building Information Modeling, ICT Barriers, Interoperability, Australia.

1 INTRODUCTION

The first binary digital computers developed in 1939 went from being massive machines capable of basic tasks to tiny handheld devices capable of complex calculations, communication, storage, word processing etc. Since then they have been used in the construction industry as a calculation and storage tool, but modern handheld computers now allow managers and traders to track materials, track quantities, punch list, access drawings, access MSDS, request information, etc. out in the field or on site. The foundation of any business process is information and Information Communication Technology (ICT) has changed the way we conduct business.

ICT was defined by Stevenson (1997) to not only include the "the study, design, development, application, implementation, support or management of computer-based information systems", as defined by the information technology association of America (Proctor 2011), but to also encompass communication areas, such as telephony, broadcast media, and all types of audio and video processing and transmission.

Advances in ICT have led to more advanced computer management systems in the Australian construction industry, including Building Information Modelling (BIM). BIM is an ICT-enabled approach that involves digital representations of building elements and information related to different phases of the building lifecycle, and is used to share information and form a reliable basis for decision-making. Pilot projects and research papers have verified many claims made about BIM as a viable economic tool, yet uptake of the technology still remains low.

As ICT barriers to BIM implementation in the construction industry contend with a greater understanding through case studies and other research, this paper explores the remaining hurdles to BIM and why. We conclude that leadership and a greater understanding of BIM in the Australian construction industry will overcome many of the barriers. These are our research questions:

1. Why are BIM techniques the next step for the Australian construction industry and what do they offer?
2. What are the barriers facing BIM implementation in the Australian construction industry and how are they evaluated?
3. What action has been taken to address the barriers facing implementation?
4. What action can be taken to further dissipate common barriers

2 ICT BARRIERS IN IMPLEMENTING BIM

"Correct use" is a phrase often used and misunderstood when evaluating potential gains in productivity when using BIM as an ICT tool. Its importance is underplayed and overlooked, causing neglect of the issue. Without "correct use", many of the potential productivity gains highlighted by this work will not be realized. Correct use of BIM as an ICT tool involves collaboration, trained use, and integration. Barriers involve interoperability, funding and resource costs, cultural barriers, and security concerns. The focus of this review is to convey the effectiveness of BIM as an ICT tool and to address the associated limitations concerning ICT.

2.1 Interoperability

Due to the complexity of construction projects today, multiple stakeholders and professional disciplines from around the world are involved in the building process, with diverse software applications. To accurately transfer information from one software application to another, a common, interpretable, form needs to be established. We define "interoperability" as per Gallaher et al. (2004) as the "ability to manage and communicate electronic product and project data between collaborating firms, and within individual companies, design, construction, maintenance, and business process systems". This issue is common to 3D and 4D CAD, and has long been regarded as an issue in the Australian AEC industry. The fragmented nature of the construction industry has worsened the issue of interoperability, creating an unnecessary cost. The United States National Institute of Standards and Technology estimated that $15.8 billion was lost annually due to interoperability in the capital facilities industry.

Resolving interoperability requires leadership to foster an accurate exchange of data amongst multiple systems and platforms, with a set of principles and rules to classify information requirements into data exchange specifications. Young et al. (2007) found that over 60% of the AEC industry identifies incompatibility as a primary concern when adopting new processes, making it one of the biggest barriers to BIM. Action has already been taken by software vendors such as BuildSMART, formally known as AIA, which has produced no-cost open BIM standards so that software developers can create a common exchange reference to allow for accurate data transfer.

These standards are known as the Industry Foundation Classes (IFC), registered by International Standards, which became official under ISO 16739:2013. A neutral environment is created through comprehensive specifications on the project's lifecycle, across different disciplines, and software systems. IFC's contain information on who (Actors), what (Groups), when (Processes), where (Products), why (Controls), how (Resources), relationships, and many more properties needed to represent the data using the EXPRESS language in the Schema. The use of IFC Schemas has helped resolve the issue of interoperability (Smith and Tardif 2009), as industry professionals feel less pressure to "pick a winner" (as they are less connected to a specific vendor and the success or failure of that vendor). However, lingering resistance can be associated with a lack of industry education on the matter, as users must know to consider interoperability when selecting their BIM software systems in order to avoid interoperability issues (Azhar et al. 2012).

2.2 Funding and Resource Cost

Whether perceived as a cost or an investment, the set-up and implementation of BIM systems within a company requires funding and resources. The Australian Bureau of Statistics (2010) identified that this barrier poses more of an issue for smaller companies (0-4 employees) than it does for larger companies (200+). However, at 33.8% and 14.7%, respectively, this issue stood as the most common barrier to implementing this innovative system for the period of 2009-10. Funding and resource costs are explored below as hardware expenses, software expenses, and funding for skilled workers and training.

2.2.1 *Hardware*

Every firm considering the use of BIM already uses hardware. Therefore, the question is not whether hardware is needed but whether more advanced hardware is needed to run BIM systems at the desired level. Individual companies must decide whether hardware costs outweigh perceived benefits, and decide what level of hardware their company requires based on project sizes. Systems requirements can be requested from software developers, but the firms must consider system recommendations (and exceed them) rather than stopping at mere system requirements when aiming for hardware efficiency. Two popular BIM software products within Australia are Graphisoft and Revit, which require extra consideration in terms of hardware requirements. For example, when it comes to RAM, bigger is usually better; for example, the ArchiCAD 17 system requires 4GB RAM, but 8GB is recommended. Similarly, 10GB of storage

space is recommended per project. However, these figures based on estimated average company and project sizes, and must be tailored to individual firm self-assessments.

2.2.2 *Software*

The cost of software can be broken down into the cost of software licences and software maintenance fees. Most software vendors will offer various types of commercial licenses for use on their BIM systems, but for the purposes of this paper a stand-alone licence was used as an example of cost. Autodesk Product Design Suite Premium 2014 can be purchased off their website for US$9,995 (AutoDesk 2013) and Graphisoft's ArchiCAD 16 for US$4,250 (ArchVista 2013). Earlier versions cost less but their relevance will continue to fall short of future requirements, so it is important to select the product that best suits the company. Cost of software applications can be easily obtained and related to company use, but it is important to consider maintenance costs and training expenses.

2.2.3 *Skilled workers and training*

The second-most common barrier to BIM implementation identified by ABS (2010) is a "lack of skilled persons", which remained relatively consistent across all company sizes. A full 26.5% of small businesses identified it as a barrier, while a similar 24.4% of large companies identified a lack of skilled persons. The shortage of skilled ICT workers continues to increase, as shown by KPMG Economics group in its Clarius Skills Index for the June Quarter 2012. The report takes employment data from the ABS and compares it to job vacancies in the DEEWR database to produce a calculation based on labour demand/labour supply in Australia. Of the 9 occupations facing a skills shortage, ICT professionals ranked third, with an "extreme" shortage reading of 8,258 employees. This is credited to the fact that demand increased more than supply, with employment continuing on an upward trend since September 2011.

Due to the nature of the industry, ICT workers are more likely to be hired on a contracted basis in Australia rather than be employed full-time, which creates a lack of job security when students choose to study the profession. Recently concerns have been raised about the decline in ICT enrolments in university, with a fall of 50% in the last decade. The Australian Computer Society believes that more should be done to attract students to the ICT industry, or skills gaps will continue to rise, damaging Australia's $100 billion digital economy, an important driver for productivity and growth in the construction industry.

The Australian construction industry has seen growth in a number of specific areas within ICT, including cloud computing, information management, mobile development, and business intelligence, increasing overall demand in the industry. However, there remains a shortage of ICT workers throughout Australia's construction industry, including areas of 3D and 4D CAD. However, as a new technology, BIM suffers the greatest hit, with very few people trained in the software and very few training programs for interested professionals.

2.3 Cultural Barriers and Perceived Risk

As BIM brings together multiple disciplines to form a collaborative approach to the construction of a building, it creates relationships between all stakeholders, altering the way the Australian AEC industry communicates on a project. This brings about uncertainty, and with uncertainty comes the inevitable perception of risk. This perception of risk soon manifests itself as a reluctance to accept change, and a slowed adoption of potential BIM benefits.

2.4 Security and Protection

Apprehensions still exist in relation to data security on model servers. These concerns include Intellectual Property (IP) rights and the protection of copyrights. Network security concerns can be limited through technical processes, and are common to 3D and 4D CAD applications. Design protection and copyright issues, on the other hand, can be addressed through a greater awareness of legal action and measures. Any IP issue is a legal issue; BIM falls into the same category as 3D and 4D CAD in this regard. However, the nature of BIM brings up a number of new complications to IP and liability issues.

3 CONCLUSION

This research investigated the ICT barriers facing the implementation of BIM processes in the Australian construction industry. The development of ICT software tools show a trend towards more collaborative approaches to construction. BIM systems have been used as a supportive tool, communicative tool, and analysis tool to help improve building processes. Their benefits are seen worldwide and action has been taken internationally with governmental and industrial initiatives underway to assist the adoption of BIM in the construction industry. However, these benefits are challenged by ICT barriers, such as interoperability issues, which affect all company sizes as software vendors struggle to collaborate. Also, initial start-up costs, such as hardware, software, training, and skilled-workers' expenses are a deterrent, especially for the average construction company (1-20 employees).

Cultural barriers also foster a reluctance to fully implement BIM processes within businesses and the industry. The collaborative nature of BIM requires the involvement of all stakeholders and contributors, difficult in a notoriously fragmented industry. Security issues prove to act as a final barrier to BIM in Australia, with IP rights, liability, and contractual complications further deterring prospective industry professionals.

Professionals in the construction industry usually work within their field of expertise, usually working within their area of expertise, with limited interaction with other disciplines. However, many of the issues arising on work sites require the collaborative input of multiple disciplines, and a common medium of communication, provided by BIM systems, will achieve this integrated building approach.

SMEs generally follow the leadership of larger companies and the successes of companies willing to pave the way. Therefore we find that implementation of BIM in the Australian construction industry is inevitable, but an unplanned approach is likely to slow its adoption. We also believe that all ICT barriers identified in this report could be

overcome with coordinated industry and government incentives and initiatives for leadership and education.

References

Australian Bureau of Statistics, *Business use of information technology 2009-10*, cat. no. 8166.0, August, AusStats Database, 2010.

Azhar, S., Khalfan, M., Maqsood, M., Building information modelling: Now and beyond, *Australasian Journal of Construction Economics and Building* 12(4): 15-28, 2012 .

Smith, D. K., and Tardif, M., *Building Information Modeling: A Strategic Implementation Guide for Architects, Engineers, Constructors, and Real Estate Asset Managers*, NJ: John Wiley & Sons, 2009.

Young, N, Jones, S. A., and Bernstein H.M., *Interoperability in the Construction Industry*, *SmartMarket Report*, McGraw Hill Construction, New York, 2007.