Building Information Modelling (BIM) Education in South Australia: Industry Needs

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Abstract

Building Information Modeling (BIM) is at the early stages of adoption in the South Australian construction industry. At present some South Australian firms have embraced BIM and consider that to boost their competitive advantage. In order for a wider adoption of BIM, the industry should have enough human capital with BIM knowhow. Nonetheless, literature review shows a very grim picture with regard to the availability of human resources with BIM knowhow in many countries. As a remedy, universities are expected to produce graduates who are capable of dealing with this new technology. In order to address such a need, this study focuses on identifying the perceptions of BIM experts on skill gaps prevalent in the South Australian construction industry that prevents large-scale adoption of BIM. The findings substantiated previous studies conducted within the Australian context highlighting that the main issue is to design and execute a systematic collaborative working procedure alongside maintaining high quality communication among the team members. Interviews highlighted the need for skills such as collaboration, communication, leadership and facilitating change management alongside technical skills related to BIM. The clear message is that the enhancement of technical skills alone would not be sufficient for an effective BIM adoption in South Australia.

Keywords: Building information modelling, collaboration, competency, skills, South Australia, training.

Introduction

There is consensus on the potential benefits of BIM for the Australian construction industry for added economic value and enhanced efficiency in project delivery (Shih & Sher, 2014). This has been supported in a recent report by Allen Consulting Group (2010) denoting that BIM adoption should be regarded as a unique practical measure to achieve higher levels of productivity in the Australian construction industry.

Against this backdrop, adoption of BIM in the construction industry of Australia has been slow and below full potential (Tsai et al., 2014). Evidence has shown that BIM implementation is around 20% lower in Australia compared to North America (Stanley & Thurnell, 2014). This situation is worse in South Australia according to Newton and Chileshe (2012) who claim 83% of South Australian construction companies implied that they have not adopted any form of BIM in their businesses.

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Such low level of uptake could be attributed to the fact that BIM adoption is fraught with challenges. One such challenge is the lack of skills and understanding of BIM within the Australian workforce (Gu & London, 2010). Given that BIM is increasingly becoming a common practice for the construction industry, training and education of BIM should be pursued through a systematic approach. As opined by Sacks and Pikas (2013) "without structured careers, professional education, and ongoing training, neither continuous improvement nor the knowledge management necessary for holistic BIM can be achieved". Though the current level of BIM adoption relies on professionals with a reasonable level of skills and knowledge in BIM, long term sustenance need a massive investment in training and education (Pikas et al., 2013). Designing such training and education programs should be in response to the requirements of the industry. Thus, a systematic investigation of the current skills and competency gaps would immensely benefit education providers in devising effective programs for producing industry-ready professionals.

As BIM is still a very young field, such investigations are very limited. This knowledge gap is particularly apparent in the building discipline where training is provided for careers in construction management, quantity surveying, building surveying and allied fields. To fill this knowledge gap, the present study aims to identify skills needed by future building professionals to effectively function in a fully BIM-enabled work environment.

Literature Review

The Construction industry is a competitive industry with profit margins generally becoming smaller and the expectations of clients and business owners becoming higher. There will be a greater demand for efficiency and productivity enhancement within the construction industry (Wu & Issa, 2013). This demand for efficiency will then lean on employees to have improved level of education and more specifically a higher level of knowledge for tertiary graduates entering into the construction industry. As BIM's popularity increases and is used on more projects, so too will the demand for employees who have an understanding of the fundamental skills of BIM. Sacks and Barak (2010, p.30) also backed this up through their study in the US arguing that "lack of BIM skills is a significant constraint retarding use of the technology in the construction industry". Gilligan and Kunz (2007) reinforced this through their research identifying that it was not because of technology malfunctions rather it was due to the lack of training and availability of qualified staff issues arose with some models. This suggests that the technology is well advanced, however there is a challenge to educate staff to be competent with the technology.

Clevenger et al. (2010) identified the effective addition of BIM into the construction education curriculum will be critical in the preparation of future employees for the industry and goes on to say that educational institutions currently lack strategies and capabilities to effectively introduce and leverage BIM into existing or future coursework. This statement outlines that sufficient training of BIM or lack of is an issue affecting BIM adoption in the construction industry. As BIM is still young and making its way into the industry there is a very tiny group of educators who could help expand this knowledge (Becerik-Gerber et al., 2011). Sabongi (2009) from Minnesota State University in the USA conducted a study and found that from 54 Universities in the United State, only 9% currently address BIM in their course work and less than 1% teach BIM as a stand-alone class. Some of the implementation challenges were; no room in the current curriculum for additional classes (82%); the impossibility of adding additional required or elective classes and still graduating in eight semesters (66.7%); problems with the faculty having the time or resources to develop a new curriculum (86.7%) and the availability of BIM specific materials and text books for use by the students (53.3%). Hietanen and Drogemuller (2008) identifies how young BIM is in the industry and how it is going to pose a challenge to educators because of the versatility and profound effects of the new technology. They then argued that at a University level there should be a standard that everyone should adhere to, thus justified and presented ideas for BIM education at a University level.

Mills et al. (2013) in their report on education on BIM maintained that to enhance the relevant abilities of graduates of architecture and construction disciplines, BIM technical skills as well as collaboration requirements should be included within courses of such disciplines. Their findings revealed that few Australian universities (e.g. Newcastle and UNSW) have embarked on teaching courses associated with BIM. Likewise, Ken et al. (2014) stressed the growing requirement for universities to prepare their graduates to have a satisfactory level of knowledge of BIM.

As there is continuing evidence of the positives stemming from BIM, it will only be a matter of time before BIM is widely used throughout Australia. This technology will continue to spread throughout the construction industry due to the benefits that comes with it, including the cost and time savings, improved sharing of information and better design. In saying that, there will also be greater demand for personnel who have been educated with specific skills as the adoption of BIM continues. Thus, as opined by Mills et al. (2013, p.10) “this move can be further advanced by the development and implementation of educational innovations” as discussed in following sections.

Methods

Taking into account the exploratory nature of this study, following du Toit and Mouton (2012) a qualitative approach was used in this investigation. Discovering the skills and competency needs of future building professionals entails a rigorous exploration of the real life context. In such situations interviews were found to be very useful (du Toit & Mouton, 2012). Additionally, this study calls for mapping the subjective opinions of BIM experts on an unexplored territory which makes interviews “the best avenue for inquiry” as opined by Seidman (2005, p.11). In order for the interviewees to respond to questions freely and discuss the various issues concerning BIM adoption, the study adopted a semi-structured interview approach as suggested by Mitra and Tan (2012). Each interview lasted approximately one hour, and all the interviewees were selected based on their willingness to participate in the study. To identify eligible respondents, a preliminary list of 42 potential experts was considered through companies’ websites and professional networks and groups such as LinkedIn and BuildingSMART (http://buildingsmart.org.au). Invitation emails were sent and eventually nine experts agreed. According to Simms and Rogers (2006), such a selective sample would enhance the quality of collected data as a result of the true intention of respondents to add value to this research study. Table 1 provides an overview of interviewees participated in this study. Though the sample could be deemed small, the methodology could be justifiable in the grounds that the saturation could occur after six interviews based on the richness of data (Bazeley, 2013). Nvivo 10 was deployed to analyze the interview transcripts in order to provide a deeper insight into expert comments in conjunction with the benefits of great speed and flexibility of using such a computer package (Lewins & Silver, 2007).

As suggested by Bazeley and Jackson (2013), visualizing the emerged ideas adds value to qualitative studies by highlighting the relationships and patterns emerging from the data. That is, creating models based on analysis of interviews will show who the source of any idea was and how such an idea is associated with other ideas and broader themes. Hence, ability of Nvivo 10 in creating models out of coding the interview transcripts was deployed for compiling Figure 1 and Figure 2. As defined by Bazeley and Jackson (2013), Nvivo models provide an overview of the main ideas and concerns raised by respondents of qualitative research studies as well as the relationships among the ideas and interpretation of ideas as fundamental explanatory concepts. This facilitates understanding how ideas developed and emerged from the data and how researchers came to presented conclusions of a research study.

Table 1. Respondents profile and attributes

No.	ID	Occupation	Experience with BIM
1	A	3D Designer	5 years
2	B	BIM manager	More than 10 years
3	C	Project manager	4 years
4	D	3D Drafter	7 years
5	E	BIM Researcher	8 years
6	F	3D Drafter	6 years
7	G	Government	5 years
8	H	3D Drafter	3 years
9	I	3D Designer	6 years

Status of BIM competency in South Australia

In regards to competency and skills requirements, results of the interviews unfolded some fundamental patterns manifesting the status of BIM competency in South Australia as captured in Figure 1. This reaffirmed the findings of McGraw-Hill (2014) indicating that in spite of high awareness of BIM in Australia, the level of competency and experience with BIM are still relatively low. Furthermore, as far as investment in BIM (including training and education) is concerned, the Australian construction industry could be described as "similar to the North American market in 2009"(McGraw-Hill, 2014, p.7). The major factors associated with the current status and the main lessons drawn from analysis of interviews are as follows.

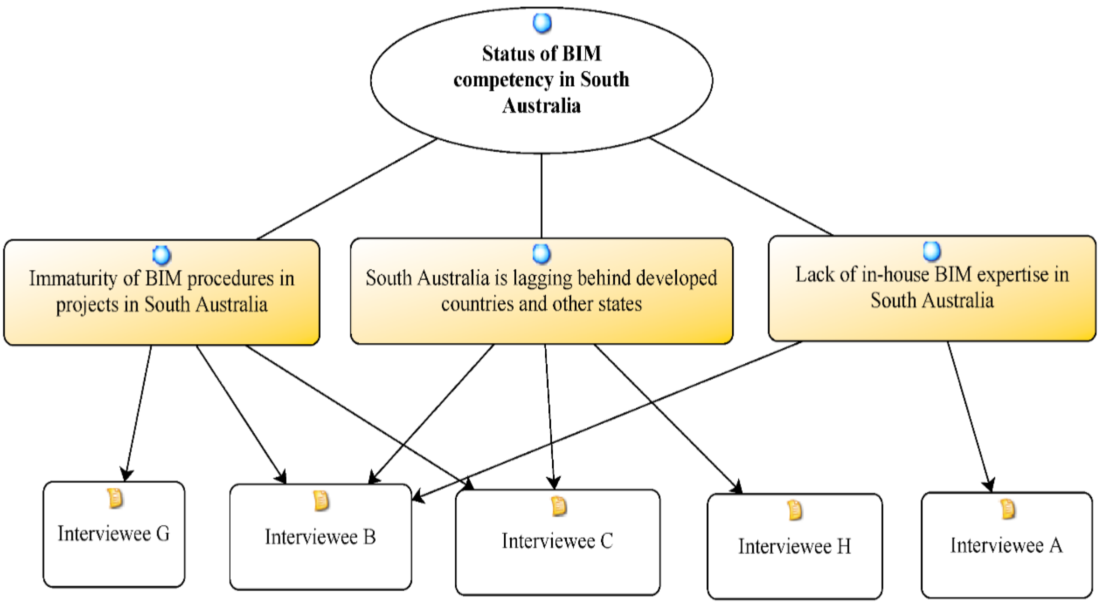

Figure 1.Factors associated with the current status of BIM competency in South Australia

Lesson one: Effective BIM adoption in South Australia relies upon facilitating establishing integrated seamless BIM procedures in existing projects and widespread dissemination of acquired experiences. Interviewees were of the general opinion that BIM procedures implemented in projects are not mature enough to provide an impetus for others to learn. As an example, **Interviewee B** said "I am still looking for a system for BIM in which people issue the data that could be fed into a structured process so we make sure that it comes out approved in the other end". Likewise, **Interviewee D** went on to say that "we are still in early stages of getting right services together and allow that happen in an intelligent way". **Interviewee E** argued that "it is not about technology any more it is about putting the right people and the technology in the right place". Such insights substantiated the claims about lack of competency in Australia when it comes to treating BIM as an integrated process opposed to a tool as argued by Gu and London (2010) and Panuwatwanich et al. (2013). Thus, successful cases of implementing integrated BIM in South Australia should be identified and immersion of young professionals to such cases to gain experience should be supported.

Lesson Two: South Australia is in dire need of addressing the issues associated with lack of in-house BIM expertise for harnessing the benefits of BIM in construction projects. Lack of in-house BIM expertise in South Australia could explain the reason why BIM tasks in many high profile projects need to be outsourced to other states or even overseas as outlined by the interviewees. This reiterates the arguments by Alabdulqader et al. (2013) on the lack of in-house expertise for BIM as a barrier impeding BIM use in Australia. **Interviewee A** and **B** observed that BIM experts need to be hired from Melbourne and Sydney to join their teams. **Interviewee B** added that in case of one high profile project "The reason for using overseas BIM experts from […] was that we knew that we cannot get that number of people with skills necessary in SA". The same issues was raised by **Interviewee F** regarding the necessity of recruiting overseas experts only due to lack of such competency in South Australia. On top of that, it came to light that **Interviewee A**, **B**, **D**, and **H** had moved to South Australia only after obtaining a job in BIM. One remedial solution to this could be easing up the process of employing skilled overseas BIM experts as well as providing particular incentives for interstate experts to move to South Australia.

Lesson three: More resources should be allocated to enhance the widespread level of BIM awareness in construction companies in South Australia. According to the recent report by McGraw-Hill (2014), competency of BIM in Australia in all levels has remained lower than that of the North America. Some interviewees are working in high profile projects in South Australia that are regarded among the most advanced BIM projects in the Australian context. Nonetheless, there was consensus among respondents that South Australian projects are late adopters of BIM against the national level as well as other developed countries. To underpin that, **Interviewee B** claimed that "I have been in SA for a while and I know that what we are doing in this project has been done in South Eastern states for a bit longer. This is not something new". **Interviewee C** went on to say that "even the work we do in […] is behind what happens in USA while this is an iconic project of the country at the moment. So how do we get better?".

Skill Requirements

Different skill requirements emerged in interviews with regard to implementing BIM in the South Australian construction industry as shown in Figure 2. There are important lessons to be learned in view of such needs as discussed in following.

Lesson four: skills essential for enhancing team working and collaboration are required in South Australia as a prerequisite to adopting BIM effectively. Interviewees identified the ability to collaborate as the most striking skill gap in South Australia. According to their description of projects, collaboration procedures for BIM are designed based on a "trial and error" basis. Highlighting this as an issue, **Interviewee A** said "the underlying problem is that our teams still work in complete isolation". He added "there is no control for the entire collaboration process". **Interviewee B** stated that "our collaborative systems need to be improved". Similarly, **Interviewee D** claimed that "everyone in our BIM teams is a mercenary fighting for their own little rights and this is not good for team working". Thus, effective implementation of BIM in South Australia needs collaborative practices among team members and this should start at the education and training level. Likewise, according to Stanley and Thurnell (2014), incompetency and lack of protocols to design collaborative working in BIM projects was regarded as the major barrier in implementing BIM in New Zealand.

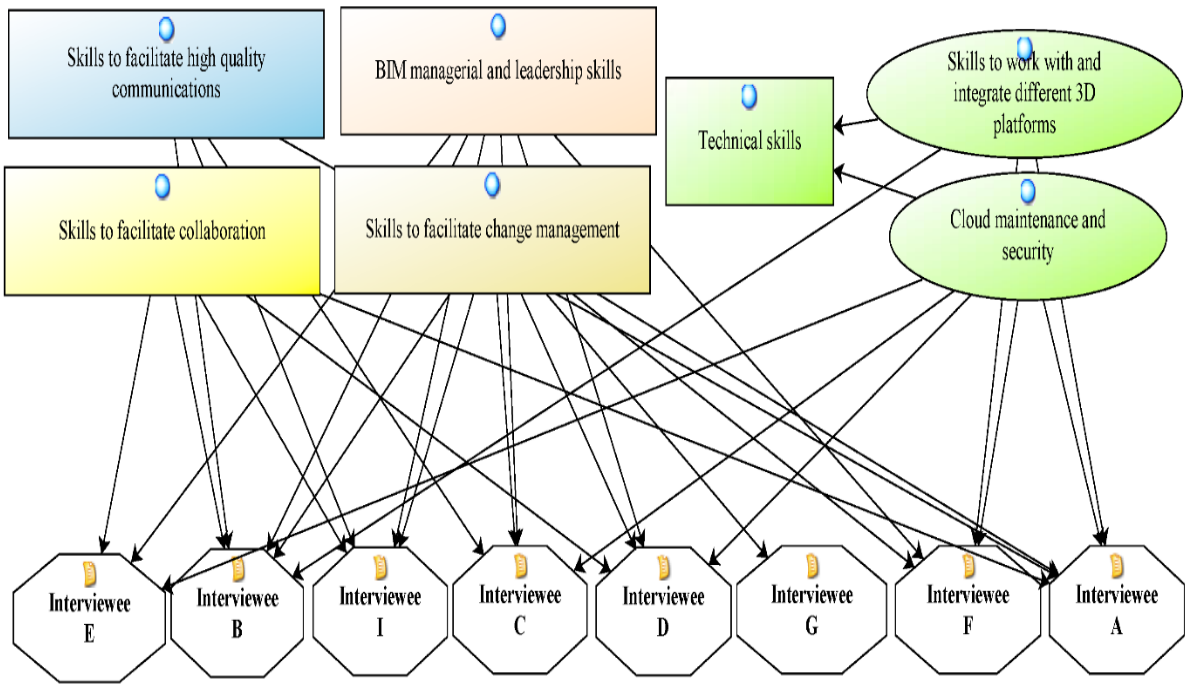

Figure 2. Skills required for BIM in SA based on interviews

Lesson Five: There is a dearth of technical skills associated with BIM in South Australia. There was unanimous agreement among interviewees that technical skills cannot be compromised in a BIM-enabled work environment. Industry professionals should have the same level of technical skills as highlighted by **Interviewee I** "a difference in the levels of technical competency is a major issue. It affects the quality of communication and collaboration that finally leads to conflicts". Most of the interviewees highlighted that BIM is witnessing a proliferation of software packages that support 3D modeling in different disciplines, which demands integration of these outputs into a single model. This observation is supported by Ahn et al. (2013) and Quigley (2013) indicating that there are too many software packages in the market supporting BIM practice. In this context, **Interviewee D** mentioned that "we still have a big issue for making different programs talk to one another. Someone working in Revit and the other in Tekla so that we have to use IFC to get the Tekla into Revit. We should get that IFC file into Revit and Navisworks. So we had to award a contract to a company to do such diversions but still it is not effective". **Interviewee F** reaffirmed such an insight by saying "access to different technology is a problem because there are many different programs and they are not compatible and they do not communicate with each other, so you should use communicators such as IFC and it does not work very well". He went on to say that currently in South Australia "companies employ people based on the software they're capable of using". In a similar observation by Ahn et al. (2013, p.293) in the USA stated that " the construction graduates should be able to use BIM software such as Navisworks, Revit Architecture and MEP and Google Sketchup". **Interviewees A, C, E** and **D** stressed the importance of cloud technology for managing a seamless collaborative BIM. Cloud technology and the skills associated with maintaining its security should be enhanced within the construction industry of South Australia. According to **Interviewee E**, "The days of having one model is over. Now it's all about giving access to the piece of information they need; and if all could be sorted in the cloud; issues of non-compatible technology won't arise". Investing in "Cloud BIM" technology and allied skills as proposed by Redmond et al. (2012) and recently acknowledged by McGraw-Hill (2014) would help South Australian practitioners in future proofing their careers.

Lesson Six: South Australia is in need of people with skills necessary for managing and leading effective integrated BIM processes. While every profession demand managerial/leadership skills, interviewees referred to certain specific leadership skill requirements based on their experiences with previous projects. **Interviewee B** and **I** observed that managers of BIM should be able to develop trust among team members. **Interviewee B** went on to say that "based on my experience, there is an element of distrust between members in BIM projects". **Interviewee C** mentioned that managing BIM takes detailed, continuous and close supervision of work by stating "if I want to do it again I will focus in being specific as much as possible and put in management attempt as much as possible and will control every aspect of work rather than allowing them to slip from my attention for a while until someone finds a fault". The above observation gives an impression that BIM managers should resort to micro-managing the project for it to be a success. This substantiated the claims by Quigley (2013) that BIM practitioners in managerial levels should have both technical knowledge and competency to handle software packages. There was also consensus on the leadership abilities of BIM managers to make people share information and communicate effectively. According to Quigley (2013) BIM managers usually come from technical and engineering backgrounds which turned out to be true for South Australia based on interviewees' statements. This explains why interviewees prioritized the leadership skill over technical for managerial roles in projects. According to Shelbourn et al. (2007) the main barrier in effective implementation of BIM have roots in managing human interactions and leading people than on technical aspect of a project. According to Quigley (2013) management of BIM process takes specific managerial skills and one should only take such responsibility if he/she is confident of having necessary skills and abilities.

Lessons seven: attempting to enhance level of communication skills among South Australian construction practitioners is perceived indispensable to effective adoption of BIM. Interviewees were unanimous that effective communication is an absolute necessity for a BIM environment. **Interviewee B** stated that "the main issue with BIM and collaborative virtual working is communication". He added that "electronic distribution needs a robust management of data as it should substitute the seal on the paper based system". **Interviewee C** conceded saying "we tried many tricks and recently managed to find some packages by which you could share screens and that was the best method of communication we had so far". **Interviewee B** added "we need training for effective communication. It doesn't come automatically". BIM environment does not need face-to-face meetings but other means of communication is vital. As explained by **Interviewee I**, "sometimes it is difficult for people who work together in a team but seldom know each other very well and the only means of communication is emails". This idea was highlighted by Quigley (2013) as BIM workflows have to accommodate novel systems for information and data exchange, communications and documentation. As such, quality communication should be a part of the BIM execution plan (Quigley, 2013).

Lesson eight: skills associated with change management are required in South Australia to facilitate a seamless shift from current practices to integrated BIM. Interviewees highlighted an important but rarely discussed skill that requires in the short to medium run to be successful in a BIM-enabled environment. The requirement will slowly fade away once the industry is fully integrated with BIM technology. The skill to facilitate change management is a soft skill that interviewees were eager to discuss, for example **Interviewee D** said "the issues with change management and resistance against BIM is resolved by builders telling people that if you want to work in this job you should use BIM. Otherwise, you will not work on the job". **Interviewee I** explained such strong resistance by postulating "we have a pervasive culture in the construction industry that does not support trust and sharing of information in BIM". **Interviewee D** added that "I think BIM and virtual working still face some big challenges from pre-existing work flows". Such an insight is understandable because an important prerequisite for diffusion of any innovation (including BIM) is systematic management of change (Hosseini et al., 2014). Resistance to change due to lack of understanding of BIM was identified as one of the major barriers in BIM adoption by Australian companies (Alabdulqader et al., 2013). As such, change management practices should be accompanied by enhanced training and education on benefits of BIM for construction industry practitioners.

Conclusions

Findings of the interview survey substantiated the claim that South Australia is in its early stage of BIM adoption due to lack of in-house expertise and immaturity of its applications in projects. Though one might expect technical skills to be the most lacking, interviewees highlighted soft skills such as collaboration, communication, leadership and facilitating change management in the South Australian construction industry. Consequently, authors are of the view that resources for training and education on BIM should be allocated not only to improve technical skills but also to promote collaboration, communication and change management in work settings. While the study unearths major aspects of education and training requirements for BIM in South Australia, some limitations should be noted. These [limitations] relate to the restrictions of the respondents' to only South Australian construction practitioners with competency in BIM. Hence, reported viewpoints predominantly reflect the observations of South Australian BIM experts. The small sample size (n=9) for the interviewees is another limitation of the current inquiry. As a corollary, caution should be exercised in the interpretation and generalization of the results for contexts other than the South Australian construction industry. Such restrictions open the door for future enquiries in the field. As such, future investigations should target detecting the training requirements and mapping the status quo of BIM education in other contexts and countries. For South Australia, future inquiries should focus on developing training programs and courses to provide university students as well as practitioners in the industry with the essential skills as detected by the findings of the present study.

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