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BARRIERS TO ADOPTING BUILDING INFORMATION MODELLING (BIM) WITHIN SOUTH AUSTRALIAN SMALL AND MEDIUM SIZED ENTERPRISES

Nafiseh Hamidi Monozam, Department of Interior Architecture & Industrial Design, Swinburne University of Technology, Australia, nafiseh_hamidi@hotmail.com6;
Hamidreza Hamidi Monazam, Faculty of Art and Architecture, Tarbiat Modares University, Iran, darashokouh_1980@yahoo.com;
M. Reza Hosseini, School of Architecture and Built Environment, Deakin University, Australia, Reza.Hosseini@deakin.edu.au;
Fahimeh Zaeri, School of Engineering, Auckland University of Technology, New Zealand, fahimeh.zaeri@aut.ac.nz

Abstract

A review of literature on BIM reveals a bias towards focusing on large companies and overlooking SMEs in South Australia. This paper explores the main barriers hampering the widespread adoption of BIM among SMEs within the South Australian construction industry building upon the theories of innovation diffusion. To achieve this questionnaire survey was administered and 41 responses were received from construction SMEs. Afterwards, semi-structured interviews with seven experts were conducted to compensate for the small sample size and to cross-validate the survey data. The findings brought to light that current knowledge of BIM in SMEs is negatively biased with an inclination towards underlining challenges and overseeing the advantages. The most influential barriers to BIM turned out to be associated with a lack of demand from clients and perception of unviability of setup costs of BIM for small sized projects. The study contributes to the field by providing an illuminating insight into the main barriers to adoption of BIM in SMEs in South Australia. Policy makers in other states and countries can also benefit from the findings in order to overcome the barriers and promote BIM adoption in SMEs.

Keywords: *Building Information Modelling (BIM), Barriers, SMEs, South Australia*
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Introduction

Level of BIM implementation is still approximately 20% lower in Australia against that of the Northern America (Stanley and Thurnell, 2014). When it comes to South Australia, the findings by Newton and Chileshe (2012) showed that around 83% of South Australian construction companies have not been engaged with BIM in any form. As a result, the objective of promoting BIM adoption on projects and attempts to encourage non-users has been high on the agenda in South Australia. Against this backdrop, the major part of the construction industry in Australia is comprised of SMEs that control 98% of all businesses in the sector (ABS, 2013). It was estimated by Mills *et al.* (2012) that around 94% of construction companies in Australia have fewer than four personnel with merely 0.5% employing more than 13 people. This brings to light the profound positive impacts envisaged for promoting BIM within SMEs in the South Australian construction industry.

[6] Corresponding author – e-mail adress: nafiseh_hamidi@hotmail.com

BIM methodology is an unconventional procedure, which is still deemed an innovation for construction practitioners (Murphy, 2014). The way companies treat, adopt and accept BIM is strongly affected by the size of the company (McGraw-Hill, 2012). This was acknowledged by McGraw-Hill (2014, p. 8) in regards to BIM stating that smaller companies have a much lower rate of BIM engagement in Australia. Nevertheless, review of literature reveals a lack of research on BIM adoption in construction SMEs in South Australia. To address such a gap, the present study is aimed at providing a picture of the current state of BIM in SMEs in the South Australian construction context. Of particular interest is to reveal the main barriers to adoption of BIM in SMEs in South Australia. This is deemed necessary for promoting BIM in South Australia. That is, the findings would facilitate identifying the main sources of reluctance to BIM adoption and assist policy makers in directing available resources towards suppressing the true sources of the current sluggish uptake.

Background

BIM has become renowned throughout the construction industry in view of the wide range of advantages envisaged for its use on projects. These include resource savings, productivity enhancements and improvement of quality (Azhar, 2011). In spite of such advantages, review of literature shows that the extent to which BIM benefits has been embraced in different countries varies notably. It seems Australian construction firms have been slower in adopting BIM in comparison to their counterparts in the UK and North America (Stanley and Thurnell, 2014). Things get worse in South Australian small companies (McGraw-Hill, 2014). As evidence, Newton and Chileshe (2012, p. 8) argued that "…none of the firms with an annual turnover of less than $10 Million were currently using BIM…". Yet, a number of investigators such as Olatunji (2011) contended that Australian SMEs have the potential to benefit from BIM more than large-sized firms. That is, more opportunities to introduce BIM and make the necessary changes are available in organisations of smaller size as pointed out by Engineers Australia (2014). On the other hand, according to Stanley and Thurnell (2014) discovering the barriers and accordingly suppressing and moderating the effects of barriers is a precursor for success in achieving the advantages of BIM in the construction industry. Hence, discovering the barriers to adoption of BIM in SMEs has become an active field of research in different countries. For example, Olatunji (2011) stated that SMEs with different organisational structures require dissimilar training and hardware tools to adopt BIM. Besides, the cost of BIM implementation for SMEs was found to be higher compared against large-sized firms as a barrier specific to SMEs. Likewise, Stanley and Thurnell (2014) asserted that software and hardware upgrades and training requirements are significant barriers to BIM implementation for SMEs in New Zealand whereas large-sized companies are capable of fulfilling such requirements. In the same vein, observations by McGraw-Hill (2012) in North America showed that lack of resources and experience with technology detrimentally affects SMEs capacity to adopt BIM on their projects. Similarly, the findings by Mellon and Kouider (2014) in the UK showed that initial cost and increase in the overall cost of project delivery is a major barriers for SMEs. According to Mellon and Kouider (2014, p. 240) "SMEs in general will require substantial support in order to become BIM compliant…". These acknowledge the observation by McGraw-Hill (2012, p. 10) indicating "the size of an organisation has the biggest influence on the likelihood that it has adopted BIM.". The South Australian construction industry's role in Australia's Gross Domestic

Product (GDP) amounts to about 7%, and thus plays a crucial role in contributing to public and private economy at the national and state level (Newton and Chileshe, 2012). Therefore, increasing the interest in BIM in South Australia has been a target pursued by the federal and state government alongside professional bodies. However, such attempts are almost entirely focused on large-sized companies. For instance, Department of Planning, Transport and Infrastructure (DPTI) in South Australia has plans to promote BIM on projects over $10 million. Basically, review of literature brings to light that previous inquiries on BIM in Australia have had a bias towards large-sized construction firms. Furthermore, previous studies within South Australia have been very few and have paid scant attention to SMEs. Consequently, there is a clear lack of research on BIM in SMEs within the South Australian construction context.

Research methods

A mixed-methods sequential explanatory design was the leading method deployed in the present study. This consisted of two distinct phases i.e. a quantitative phase followed by a qualitative phase. The reason for considering a mixed method was because; (1) combining diverse methods of data collection and analysis yields richer and deeper insights and facilitates overcoming the weaknesses of using a single method for doing research (Venkatesh et al., 2013, p. 26). (2) as asserted by Venkatesh et al. (2013, p. 26) qualitative analysis in mixed methods serves in the capacity of compensating "…the small sample size in the quantitative study.", which was another reason for conducting a qualitative study subsequent to the quantitative phase. The sample of companies for the quantitative phase was considered as a combination of the authors' own private contacts in the industry alongside Yellow Pages listing of the South Australia's telephone directory. This sampling method was regarded as justifiable inasmuch as the same method was used for sampling SMEs by Mills et al. (2012) in Australia. A total of 326 invitations to complete the online survey were sent to SMEs in South Australia, which resulted in receiving 41 duly-completed responses, thus giving a response rate of 13%. This sample size was relatively small, thus as suggested by Venkatesh et al. (2013) a qualitative analysis was considered in order to compensate for the small sample size of the survey questionnaire. In total, 7 semi-structured interviews were conducted with experts in the field. Interviewees A, B, C and D were working in SMEs with at least 6 years of experience whereas Interviewee E was the BIM manager of a large-sized company in which a wide range of SMEs as subcontractors were using BIM. Interviewee F was involved in training and education of BIM while interviewee G was the manager of the government body directly working with South Austrian companies in promoting BIM.

Research results and discussion

Respondents' profile

As defined by ABS (2013) the size of construction businesses based on the number of employees could be classified as 'small' with up to 19 employees, 'medium' with 20 to 199 employees and 'large' employing more than 200 employees. Therefore, collected data was reflective of the perceptions of different sizes of SMEs as illustrated in Table 1 with similar share for each category. Besides, only 5 companies were SMEs with 6-10 years of service. As a result, the findings were deemed reflective of the perception of SMEs with adequate experience.

Table 1

Years of service and the number of employees of the companies

Employees (number)	Service in the construction industry (number of years)			Total
	6-10	11-20	Over 21	
24 ≥	4	6	5	15
25-114	1	2	10	13
115-200	0	1	11	12
Total	5	9	26	40

Source: Authors' construction

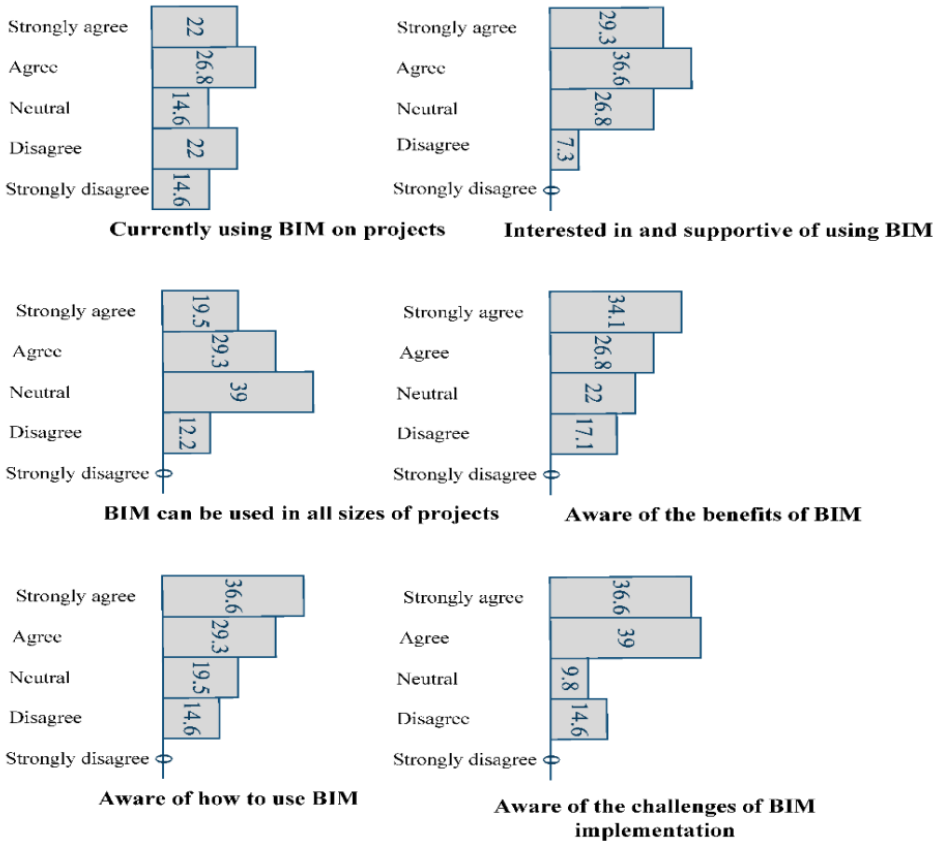

Figure. 1. **The status quo of BIM in South Australian SMEs**

Figure 1 illustrates a summary of different aspects of BIM status quo in SMEs in South Australia. The percentages for each option on the survey regarding implementation and awareness of BIM among the respondents are noted. As illustrated in Figure 1, at least 48% of SMEs indicated that they have implemented BIM to some extent on their projects. This was consistent with the observation by McGraw-Hill (2014) that the level of BIM implementation in

SMEs (48%) is lower compared to the general implementation rate (64%) in Australian companies. Nevertheless, 48% is higher than the estimation by Newton and Chileshe (2012) in 2012 which might be due to the time factor. Yet, it points to of the large number of companies, which have joined BIM adopters in two recent years.

There was no consensus regarding the appropriateness of BIM for all sizes of projects (48% in favour of the idea, 40% with no idea and 12% were against it). This observation implies that South Australian SMEs are not sufficiently informed of the business values of BIM on small projects. In the same vein, interviewee E and interviewee G stated that SMEs have an incomplete level of knowledge of potential profits of BIM on projects as pointed out by Newton and Chileshe (2012). This reveals a barrier to BIM implementation in SEMs because companies that fail to comprehend the business value of BIM, will have no motivation to go to the process of change in order to adopt BIM as enunciated by Kassem et al. (2012), Another reason for such lack of awareness of the values of BIM was attributed by the interviewees to the small size of the typical projects of SMEs, which are doable without innovative methods. In addition, interviewees contended that business values of BIM for SMEs is only achievable through using BIM in a large number of projects due to the unjustifiable initial cost and investment needs of BIM for only a few projects. Even so, as many as 67% of companies expressed interest in BIM and implied that they are supportive of BIM use on their projects in the future. Likewise, McGraw-Hill (2014, p. 4) stated "all users predict a strong increase in implementation (the percentage of their projects that involve BIM).". While only 61% of companies are aware of BIM benefits, 76% claimed to possess knowledge of the challenges of BIM (see Figure 1). This reveals another barrier to widespread use of BIM on projects being the partial and one-sided knowledge of BIM among SMEs. Such one-sided knowledge in South Australian SMEs is justified in view of the nature of SMEs' knowledge management. That is, as observed by Scozzi et al. (2005) SMEs commonly overlook available knowledge about innovative methods. Likewise, the interviewees pointed out that SMEs merely accept advantages of innovations only through having first-hand experience or through their peers.

Major barriers to BIM

The test of reliability using Cronbach's Alpha for the ten drivers included in the questionnaire resulted in a value of 0.94, which was well above the accepted cut-off point of 0.7. For ranking the relative importance of the ten barriers the mean value of each barrier was considered as the criteria for identifying the relative importance of the item as an acceptable method recommended by D. Holt (2013) for identifying the relative importance of items using Likert-scale survey. As illustrated in Table 2, the most important barrier to implementation of BIM in SMEs turned out to be the lack of demand from clients and other members of the construction supply chain. This acknowledged the observations by Kassem et al. (2012) and was in line with the findings of the descriptive statistics and the statements of interviewees who frequently highlighted the crucial role of clients' demand on pushing companies towards BIM. Yet, clients' demand is strongly dependent on awareness of clients' of the business value and advantages achievable out of investing in BIM. As a result, the most important measure to take for promoting BIM in SMEs would be to increase the level of awareness of clients of the business value of BIM and how they can take advantage of BIM.

Table 2

Major barriers to BIM implementation in South Australian SMEs

Barriers	N	Mean	Std. Deviation	Relative Importance
Clients and other builders are not demanding BIM	41	3.17	1.202	1
Setup costs	41	3.15	1.131	2
Smaller projects do not warrant using BIM	41	3.02	1.151	3
Lack of protocols and standards for adopting BIM	41	2.83	1.070	4
Cultural resistance in the company	41	2.78	.936	5
Software compatibility issues	41	2.71	.929	6
Our current software is adequate	41	2.68	1.128	7
Lack of collaboration decreases BIM effectiveness	41	2.66	.911	8
Potential for increased risk exposure (e.g. legal issues)	41	2.63	.888	9
Incompatibility with common industry standards	41	2.61	.862	10

Source: Authors' construction

Setup costs as the second most important barrier also highlights the crucial role of comprehending the wide range of gains from investing in BIM. This is because construction practitioners make a business-oriented comparison between the gains and requirements of a technological innovative. This is a key stage of the lifecycle of diffusion of an innovation in a construction company termed by Murphy (2014) as the 'evaluation' process. That is, based on the outcome of the evaluation stage, a decision will be made. Thus, the innovation will be adopted as long as the business gains outweigh the investments and resource requirements. The 3rd and the 7th most important barrier turned out to be rooted in the adequacy of current practices for small-sized projects. This is also understandable considering the evaluation stage. According to Peansupap and Walker (2006) construction practitioners valuate all the alternatives for an innovation and select the option that fulfils their requirements with the best value for money. Thus, due to lack of awareness of the values achievable in using BIM, they keep on using traditional methods for small projects. The 4th, the 5th, the 8th, the 9th and the 10th barriers refer to the perceived issues and potential risks with adopting BIM including the lack of protocols and standards, software complications and incompatibility with the current

standards. This could be explained by the concept of 'difficulty of adoption' as pointed out by Au and Enderwick (2000) implying the level of perceived difficulty in using an innovative method makes companies shy away from deploying the innovation. This findings coincides with the results of descriptive statistics that showed perceptions of construction practitioners regarding BIM in South Australian SMEs is one-sided and mostly points to difficulties of BIM. Cultural resistance to BIM adoption that is embedded in the typical resistance to change within construction organisations was found to be a problem in South Australian SMEs as a common barrier to BIM. Such resistance is so strong in the construction industry that according to Arayici et al. (2012, p. 77) "…BIM stakeholders are required to go through a comprehensive change management process which may require external assistance.". In common with the observations above, interviewees were all in agreement that barriers to BIM in South Australian SMEs mostly stemmed from a lack of awareness of stakeholders and particularly clients regarding the advantages and difficulties of using BIM on their projects. These findings reinforced the crucial role of clients and their perceptions regarding the advantages of BIM for their projects as the source of major barriers to widespread use of BIM within South Australian SMEs. Such an insight is supported by the statement by Na Lim (2014) maintaining that the main barrier to using an innovation is lack of demand and interest from influential stakeholders mainly clients in construction projects.

Conclusion

Lack of demand by clients and other members in the supply chain of construction is the main barrier to BIM adoption for SMEs. This largely stems from the lack of awareness among clients and construction practitioners of the benefits achievable for their businesses from using BIM on small projects, against the initial costs. As a result, the main focus of policy makers and major resources should be allocated to increasing the level of awareness of clients and influential stakeholders of the possible gains from using BIM on projects of all sizes. The study sheds some light into the nature of the barriers preventing widespread use of BIM in SMEs, yet the findings should be considered in light of the limitations of the study. Main limitations include the relatively small sample of the study alongside using experts merely based in South Australia with its specific socio-economic characteristic. Thus, further research is warranted to validate the findings in other locations using a wider range of experts as the respondents.

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