Barriers to Implement Building Information Modeling (BIM) in Construction Industry: A Critical Review

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Abstract. Construction is a complex industry. A system like Building Information Modeling (BIM) has benefited many construction players in order to expedite their works effectively and efficiently in terms of design, implementation, and management of a project. As the construction industry involves many players such as clients, designers, contractors, and manufacturers, the existence of BIM can speed up planning time, minimizing resources, and even saving project costs. However, in some countries, the acceptance of BIM technology in the construction industry is still very low. This paper aims to explore and review the barriers associating with adopting BIM as a digital information tool in the construction industry. A systematic review was conducted of 26 journal articles and conference papers published between 2013 to 2019. The identified barriers were then classified and analyzed. The results of the study revealed that from the 26 selected articles, 15 categories of barriers have been successfully extracted and discussed. 15 categories of barriers are cost, law, experts, interoperability, awareness, culture, processes, management, demand, project scale, technology, skills, training, contract, and standard. The study offers significant insights for future research to overcome the barriers to the implementation of BIM.

Keywords: Building Information Modeling*, barriers, review, construction*

1. Introduction

This technology cannot be separated from human lives. It developed rapidly since humans always seek to advance and develop current knowledge, especially in constructional technology [1]. Technological advances in construction caused some shifts in working

methods; one of them is called Building Information Modelling. The implementation of BIM in construction can facilitate and increase data accuracy for architects and engineers in performing their jobs [2]. Building Information Modeling (BIM) is an intelligent 3D model-based process that gives architecture, engineering, and construction (AEC) professionals the insight and tools to more efficiently plan, design, construct and manage buildings and infrastructure [3]. In terms of effectiveness such as time and cost details and productivity, Building Information Modeling yields advantages for scheduling, designing, implementing, and managing facility. From a stakeholder and construction consultant perspective, BIM helps owners, designers, contractors, and management teams to collaborate in making their work better [4][5]. Building Information Modeling offers benefits on quantity and quality. The quantity aspect influenced by BIM includes costs, schedule, and materials supply which is caused by fast decision making. Meanwhile, the quality aspect encompasses data analysis related to a specific structure and environment [6]. Other benefits of BIM can be classified below.

a. ability to purchase new hardware and hardware for BIM,
b. ability to train company staff on BIM software,
c. encourage to implement BIM by government,
d. free courses for people using BIM techniques,
e. minimize project costs,
f. minimizing the time needed to complete the project,
g. minimizing the time needed to complete the project,
h. proven successful in research projects,
i. understanding and awareness of BIM techniques,
j. support from professional bodies,
k. reducing security risks in the design phase,
l. predict project time,
m. improve visualization,
n. improve collaboration,
o. improve communication,
p. clash detection, maximize productivity,
q. reduce data loss,
r. better document management and integration [7].

One advantage of using BIM in construction planning is the implementation of BIM on time, human resources, and project planning costs in planning the construction of a 20-story building in Indonesia compared to the performance efficiency of conventional methods. This research concluded that the implementation of BIM concepts can accelerate project planning time by around ±50%, decrease the need for human resources by 26,66 %, and save personnel costs by 52,25% compared to those of conventional methods [8]. Several benefits and the large percentage of resources that can be saved when using BIM in construction planning are the reasons for the Ministry of Public Works and Public Housing (PUPR), which is responsible for infrastructure development in Indonesia, to develop BIM. There are many challenges and obstacles to develop BIM. General obstacles in developing BIM in

several countries have been identified and are believed to occur in Indonesia, therefore PUPR can find solutions to obstacles to the development of BIM in Indonesia [9].

2. Methodology of study

This study aims to determine the general obstacles in the implementation of Building Information Modeling throughout the world. The methodology employed in this study can be seen in Figure 1.

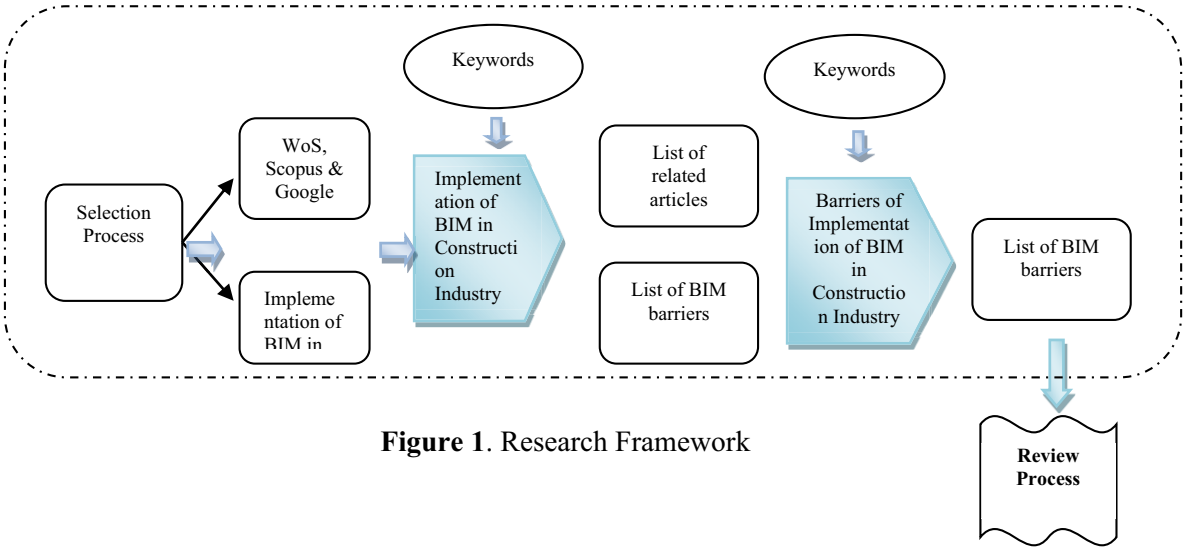

Figure 1. Research Framework

In the initial stage, the study started by identifying relevant articles through Web of Science (WoS), Scopus, and Google Scholar databases. The keyword used to search for relevant academic publications in the databases between 2013 until 2019 were include “Implementation of Building Information Modeling”, “Adoption of BIM in Construction Industry” resulted with was too many articles related to BIM were turned out. Due to the large numbers of articles discussing BIM, the search was refined on the specific issues on the implementation barriers of BIM by using keywords like "barriers”, “issues”, “obstacles” and “constraint” which have been associating with the keywords like “Implementation of BIM in construction. Approximately 1,760 journal articles were found in Science Direct, meanwhile approximately 17,800 journal articles were found in Google Scholars. The next step the searching was conducted in more detail as all the downloaded papers were screened and checked for quality, relevancy and adequacy to determine whether they address all the problems of BIM implementation in the construction industry. This was due to a large number of journals found with the keyword "Barriers to Implement BIM in the construction industry" that did not focus on explaining the barriers to implementing BIM in the construction industry. Therefore, 26 journal articles located on five continents were selected. Many countries in Asia like India, Malaysia, and various countries from the Middle East were chosen because of their location, demography and cultures that can be adjusted to suit the research on BIM implementation issues in Indonesia. There was only one article from

South Africa that was found discussing the obstacles of BIM implementation. On the other hand, four journal articles were found specifically discussed the obstacles of implementing BIM. Meanwhile, only one article was identified in America and Australia discussing the issues in BIM implementation respectively.

3. Finding and Discussion

The study found a relatively strong focus on several variables from the 26 selected journals that discussed the barriers to BIM implementation from five continents. The BIM implementation survey in the 26 journals was found conducted at several levels that include industry, organizations, and individual companies. The 26 related articles are as shown in Table 1. In total, 217 barriers related to the implementation of BIM were found from the 26 selected articles.

Table 1. Barriers to Implement BIM

No.	Origin	Authors	Category														
			Cost	Culture	Law	Interoperability	Process	Management	Awareness	Expert	Demand	Project Scale	Technology	Skills	Training	Contract	Standard
1	Thailand	Ruthankoon (2015)	1				1								1		
2	South Africa	Kekana, Aigbavboa, & Thwala (2014)	1			1								1			1
3	Malaysia	Yaakob et. al (2018)	1	1		1					1				1		
4	Malaysia	Abd Hamid et. al. (2018)	1						1				1				
5	UK	A. Kiviniemi and R. Codinhoto (2014)			1												
6	Malaysia	Latiffi, Mohd, and Rakiman (2016)		1													
7	Malaysia	Kiani et. al. (2013)	1	1			1				1			1			
8	Hongkong	Chan, (2014)	1		1	1	1	1		1	1		1		1	1	
9	Malaysia	AL-Btoush and Haron, (2017)	1	1	1		1	1	1		1			1			
10	Malaysia	Ahmad Jamal et. al. (2019)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
11	India	Ahmed and Hoque (2018)	1		1	1	1	1	1	1	1	1	1	1	1	1	1
12	Middle East	Gerges et al., (2017)	1				1			1	1		1				
13	Iraq	Hatem, Abd, & Abbas (2018)	1		1	1			1	1	1			1		1	1
14	Mesir	Elyamany, (2016)	1					1									
15	Jordan	Matarneh & Hamed (2017)	1						1	1	1				1		1
16	India	Sreelakshmi et. al. (2017)	1	1	1		1	1	1	1							1
17	UK	Eadie et. al. (2014)	1	1			1	1									
18	Iran	Reza et. al. (2015)		1	1	1			1		1			1	1		1
19	Poland	Walasek & Barszcz (2017)			1	1	1				1						
20	Pakistan	Siddiqui et.al. (2019)	1		1	1				1						1	
21	Iraq	Hamada et. al. (2016)	1	1	1		1	1	1	1	1						
22	Australia	Liu et. al. (2015)	1		1			1		1							1
23	Malaysia	Ramilo, Embi, & Datta (2017)	1	1	1								1				
24	Iran	Sardroud et. al (2018)	1	1	1			1									
25	Sweden	Ghavamimoghaddam & Hemmati (2017)						1	1			1	1				
26	UK & Malaysia	Zahrizan et. al. (2014)	1	1	1		1				1			1	1		1
Frequency			21	12	15	9	12	11	10	10	13	3	7	8	8	5	9

The results of the review show that the related barriers to the implementation of BIM had been widely discussed by many researchers from various countries throughout the world.

Barriers to BIM implementation were classified into fifteen categories, namely *costs, experts, law, interoperability, awareness, culture, processes, management, demand, project scale, technology, skills, training, contract, and standard BIM* based on two benchmark studies conducted by Siddiqui et. al (2019) and Ahmad Jamal et al (2019).

The cost of the BIM was found to be the main constraint in implementing BIM with the highest frequency of 21. The implementation BIM system in any organization requires costs such as purchasing the BIM software as well as the cost of training for the staff to use the software. The amount of up-front investment that must be spent on updating the software, replacing equipment, and training staffs were among the main contribution to the major cost barriers of BIM implementation. The benefits of implementing BIM did not exceed the implementation cost, therefore, BIM was considered as an additional cost. BIM also did not offer certain financial benefits to guarantee its use. The high cost of BIM experts becomes an obstacle in terms of BIM implementation costs. *Law* was also found as the next biggest obstacle in implementing BIM. There were no laws requiring the use of BIM at a specific project scale, making BIM rarely used. There was no legal certainty in the work contract, making the use of BIM something unimportant. Law dealt with all aspects including determining BIM standards and project contracts. Countries that had no regulations for BIM usage were also found to have no national BIM standard implemented. *Deman*d became the next barrier in implementing BIM. The construction market was not ready to use BIM. The uncertainty on the immediate benefits of BIM especially in the planning stage, made the demand for using BIM still inadequate. The perspective of BIM that did not be able to reduce the time used on drafting compared to the current drawing approach was also the reason for the lack of demand for BIM usage.

Cultural nature that did not want to step outside the comfort zone led to the refusal to change. Reluctance to start new workflows or train staff was a fundamental obstacle for construction actors. The social environment which had the same culture made it difficult for organizations to apply the new atmosphere because it would experience social resistance. This was also caused by the workers' attitudes towards new technology which were considered complex and difficult to be available in the field. Convenience with traditional processes made constructors refusing changes. They felt that the benefits of BIM were not real and cannot be felt directly. Changing attitudes towards the use of BIM require massive cultural change. Apart from that, interoperability made this barrier even more complicated. The other categories of the barrier that have the least frequency than the above-mentioned barriers such as *process, management, awareness, expert, project scale, technology, skills, training, contract, and standard* were also considered significant to be highlighted as part of the important barriers of implementation of BIM.

Based on the barriers in implementing BIM, which can be grouped into 15 categories, BIM implementation in Indonesia could be done to find better solutions to these obstacles. One of them is by making regulations that become a reference for consultants and contractors at work. This is based on the fact that Indonesia is a developing country where most of the development projects are owned by the government. The government regulations will help to overcome other obstacles from time to time. The government needs to have a high commitment to implement BIM and become the sector leader. The development of training

programs, education, BIM certification, BIM national standards, and guidance on the adoption and implementation of BIM for the construction industry, organizations, and stakeholders will make it easier to implement BIM in Indonesia. Problems such as the lack of skills and reluctance to start something new will change. The desire to learn new technologies will emerge so that the exchange of information will be even better; therefore the waste of time and money on revisions can be controlled.

4. Conclusion

Barriers to BIM implementation in one country are different from other countries. This is because each country sees the obstacles from various perspectives based on the country's own background. This article links the practice of BIM in various countries throughout the world and across the continents. There are 15 submissions collected from 26 journal articles discussed in this paper. Lack of regulations in countries contributes to the unfamiliarity of BIM implementation. Support and direction from the government, as well as the mandatory use of BIM in projects, will improve the implementation of BIM. In general, further studies are needed to cover the responsibilities in this paper.

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