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Readiness of Malaysian Small and Medium Enterprises (SMEs) Construction Companies for Building Information Modelling (BIM) Implementation

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Abstract: Building Information Modelling (BIM) has shown its efficiency in helping the construction industry players. The BIM has thus helped to achieve better integration of project information and to enhance collaboration between stakeholders and the industry players from the early phase of projects. Small and medium-sized companies (SMEs) have been under-represented in studies on BIM adoption. Despite the fact that the technology to implement BIM is readily available and rapidly maturing, the adoption of BIM is still slow. Many governments support adoption of BIM-oriented Integrated Design (ID) approaches on their national markets, however the implementation of BIM software support system among Small and Medium Enterprises (SMEs) in Malaysia is considered inadequate. In terms of the implementation of information technology, the construction sector in Malaysia still lags behind other sectors. In order to have a better knowledge of BIM in SMEs, it is important to first identify the major barriers to BIM adoption in SMEs and then examine potential solutions. Hence, the main motivation of this study is to investigate the readiness of Malaysian SMEs construction companies for BIM implementation, determine the challenges to implement BIM and develop strategy to overcome the challenges. An online questionnaire survey was planned to accomplish these aims and Statistical Package for the Social Science (SPSS) data analysis are carried out. Quantitative approach was used which the data obtained from a set of questionnaires encoded in the form of numbers and put in as a statistical analysis. This study uses a descriptive research method which uses structured questionnaires by revising research questionnaires from previous study. The findings of this research have expected to bring a result that determine contemporary barriers and challenges and have provided an adequate strategy to help organisations to fully implement BIM that will lead to the total readiness of BIM implementation.

Keywords: Building Information Modelling, Small and Medium Enterprise

1. Introduction

The existence of modern technologies in this era is seen to be essential for the growthof construction industries sectors in Malaysia. Building Information Modelling (BIM)has shown its efficiency in helping the industry players to analyse and develop projectsdesign. The BIM has thus helped to achieve better integration of project information and to enhance collaboration between stakeholders and the industry players from the early phase of projects. Despite the fact that the technology to implement BIM is readily available and rapidly maturing, the adoption of BIM is still slow [1]. The ideas of Building Information Modelling (BIM) had been introduced in theArchitecture, Engineering and Construction (AEC) industry to overcome problems inconstruction projects. Each construction player uses BIM for different purposes [2].

The implementation of building information modelling (BIM) in construction projects includes the digital representation of the physical and functional characteristics of the components that represent a construction project. In the construction industry, BIM has been able to solve several key problems. The BIM concept has embedded information and communication technology (ICT) into the construction process. Until ventures start, BIM incorporates knowledge from the outset of the building phase. Therefore, by creating a digital model prior to the completion of the project, BIM incorporates multiple construction processes involved in handling building construction. BIM itself is not a technology, it is an information-rich, model-centric business process with the potential to transform project execution and add value over the entire life cycle of the infrastructure assets – plan, design, build and manage BIM is a system of knowledge about how to build things. Technology is what enables the transformative potential of BIM for the construction industry. Technology allows intelligent 3D models to be developed and used and links both project parties and stakeholders.

2. Building Information Modelling Definition and Concept

Building Information Modelling (BIM) is a tool that converts the process of construction from conventional fragmentary processes to an integrated digital process[3]. It is assisted by numerous instruments, technology and contractsfor collecting, producing, evaluating and managing the digital representation of the project model generated. BIM is well-known as an efficient connectivity and coordination n-D modelling platform and its use has expanded from the 3D geometricmodel to include planning, costing and facilities management [3]. Throughout the project life cycle, BIM implementation has brought important benefitsto the construction industry. BIM has demonstrated its ability to increase productivityand performance in the design stage. BIM will integrate auto scheduling and cost analysis in the construction phase and facilitate better project delivery management and efficiency. Compared with the traditional working model, using BIM methods will help us achieve coordination, cooperation, and integration while enhancing the flow and processing of information.

Recognizing the above benefits, most AEC companies have begun to use BIM in their projects and have again tried not to introduce conventional approaches, as BIM improves their efficiency and dramatically reduces the requests for information and rework, and also applies to the handling of demolition waste. Although the possible advantages of the technologies can appear obvious, BIM's industry acceptance and adoption rate varies [4]. Kouide et al. found that although the new software solutions are readily accessible, major hidden technology restrictions in Malaysian construction industry prevents their widespread acceptance. In other words, the BIM adoption in Malaysian construction industry is at an infant level.

3. Materials and Methods

This study aims to explore and discuss the suitable methods for the current study as well as research design and process flows. The importance of any research method, methodology, or design lies in its ability to help the researcher accomplish the researchpurpose and goals in the most efficient and convenient way possible. The significanceof this chapter lies in the ability to establish methodological

approaches and process flows, as it explains the steps and all aspects necessary to be taken as data and outcomes are gathered, evaluated and addressed. A literature review-based questionnaire survey was planned to accomplish these aims. A semi-structured interview to evaluate the hypotheses was then performed. The Internet was the source for a literature review to analyse the implementation of BIM technologies in the wider perspective.

In this research, materials such as books, journals, international conferences and scientific papers were used. In order to evaluate BIM implementation in the global sense, McGraw Hill Construction 2014 reports on BIM were introduced and used to define variables for assessing BIM level based on the understanding and implementation of BIM technology, the usage of BIM, and the extent of use of BIM. The questionnaire is therefore structured to examine the participants' knowledge and awareness of BIM in this work, the current level of readiness for BIM adoption in Malaysian construction industry SMEs, the challenges to implementing BIM and the strategy to overcome the challenge. The questionnaire results will be validated by conducting an online survey questions through Google Form to construction industry players. In order to accomplish particular aims in a thesis which is evaluating the current level of readiness for BIM adoption in Malaysian construction industry SMEs, there are many different methods of investigating and a variety of methods to consider. In this research, the method selected as the most fitting for this study is quantitative method which is by sending structured questionnaires to construction industry professionals within SMEs as targeted respondents. This research is called as targeted sampling. It is a purposeful, systematic method by which controlled list of specified populations within geographical districts are developed and detailed plans are designed to recruit adequate numbers of cases with each of the targets. Statistical Package for the Social Science (SPSS) will be used in this study. After collecting data and information via online questionnaires, the analysis process begins. The frequency distribution, reliability analysis, and descriptive analysis provided by SPSS software enable researchers in understanding the results better. Quantitative data intake will be carried out using online questionnaire. The fundamental concepts of these techniques will be presented in research methodology, as well as the selected methods of study and interpretation of the data obtained.

4. Results and Discussion

The data obtained by the methods specified in previous chapter are analysed and discussed. Objectives of the study has been achieved by systematic analysis the collected data. Hence, this research has collected data through online questionnaire surveys within Malaysian SMEs construction companies and have been analysed and discussed. All obtained results, are recorded for in-depth analysis purpose. The data is presented in tables.

The questionnaire was developed based on awareness of respondent to BIM adoption level, BIM usage, and frequency of using BIM. The questionnaire was distributed to the construction workers through online who live in Malaysia for the purpose of achieving the objectives of this study. Answer rate of 115 sets of questionnaires obtained from construction industry workers in Johor. Scaling method is also used to analyse each response from the respondent's choices. In this section, the questionnaire results are analysed based on the research objectives using the findings from SPSS Analysis. The result of the readiness of BIM adoption and the level of awareness in Malaysian construction industry SMEs have been obtained and compared with the other country.

4.1 Findings from SPSS Analysis

4.2.1 Frequency Distribution Analysis

Frequency distribution was conducted to know in depth about the findings of the demographic data among respondents that have been collected. It is used to analyse data form section A from the questionnaire which contained the demographic profile of the respondents. In this section, there were 4 questions to identify the background of the respondents participated in the survey and 9 questions to indicate the readiness of BIM adoption in Malaysian construction company in Johor. Demographic insights are used to validate more specific information to have a deeper understanding of the attributes of the respondent. Validation of respondent is the first few questions that was asked in the online

questionnaire to validate the respondent background and their involvement in Small to Medium Enterprise (SME) construction company. Respondents have to choose two (2) choices of answer "yes or no". At the same time, they were asked to select their profession, type of organisation they work for and other question that indicates the readiness of BIM adoption in SMEs construction company. This study manages to collect 115 valid views of the respondents. The analysis begins with a description of the demographic profile of the respondents as indicated in Table 4.1 below. For frequencies analysis, all 115 respondents are included in the said analysis to know in-depth about the respondents participate in the survey.

Table 4.1: Frequency and Percentage of Respondents' Profile

No.	Description	Frequency	Percentage (%)
1	**SME Company**		
	Yes	115	100
2	**Johor Construction Company**		
	Yes	115	100
3	**Profession**		
	Civil engineer	49	42.6
	Building surveyor	42	36.5
	Architect	24	20.9
4	**Experience in construction industry**		
	1-4 years	45	39.1
	5-9 years	45	39.1
	10-14 years	25	21.7

Table 4.1 above shows the frequency and percentage of the demographic profiles of the respondents. A total of 115 respondents, 100% are from Small to Medium Enterprise (SME) construction company at the same time based in Johor. It showcased that all the respondents are working in Johor SMEs construction company.

The second demographic characteristics is the respondent profession. The highest group who answered the questionnaire are civil engineer (42.6%), followed by building surveyor (36.5) and the least are those who works as architect (24%). These results indicated among all the respondents involve in this survey, the highest age group are mixed of various construction industry players. Their willingness to participate in this survey mainly because of their involvement in BIM area. On the year of service of the respondents in construction company, only 25 respondents have experience working in the company for between 10 to 14 years which is 21.7%. The highest services year is 39.1% or 45 employees already been working in construction company that is between 1 to 4 years and 5 to 9 years respectively.

Table 4.2: Frequency and Percentage of BIM adoption readiness in Malaysian construction industry SMEs

No.	Description	Frequency	Percentage (%)
1	**BIM awareness**		
	Yes	115	100

2	**BIM experience**		
	Yes	11	9.6
	No	104	90.4
3	**BIM software tools usage**		
	Revit (Autodeks)	17	14.8
	None	98	85.2
4	**BIM tools proficiency level**		
	Beginner	102	88.7
	No experience	13	11.3
5	**BIM adoption level**		
	Poor adoption	93	80.9
	No adoption at all	22	19.1
6	**Years of implementing BIM**		
	Less than 2 years	95	82.6
	2 to 5 years	20	17.4
7	**Attended BIM workshop**		
	Yes	11	9.6
	No	104	90.4
8	**Numbers of BIM project**		
	1 project	11	9.6
	2-5 projects	104	90.4
9	**BIM exposure**		
	Industry Led training	7	6.1
	None/ Self-taught	108	93.9

The next demographic characteristics from the Table 4.2 above is the awareness of BIM and experience of using BIM in construction project. Based on the table in 4.2, 115 respondents indicating 100% are aware of the BIM. Next, only 11 respondents indicating 9.6% have experience using BIM, meanwhile 104 respondents or 90.4% have not experienced it. Nevertheless, this shows that although the awareness of the BIM is widely promoted but the level of adoption and implementation are still low to be compared to the other country.

On the usage of BIM software tools, only 17 respondents or 14.8 % used Revit (Autodesk) whereas 98 respondents or 85.2% have not used any of the BIM software. This indicates that Malaysian construction company needs to be updated on the latest version of software of BIM and works on reaching the full adoption of BIM. Next, there are 88.7% of respondents have rate as beginner in proficiency level in applying BIM tools and 11.3% have no experience. This indicates the level of proficiency in applying BIM tools are still relatively low to be compared with other country who has advanced.

Next, from the study has shown that the majority of the respondents which is 80.9% has chosen poor adoption as to describe their adoption level of BIM in the organisation. Meanwhile, only 22% has no adoption at all. However, this indicate that the state of BIM adoption among Malaysian SMEs construction company are still at the low level. Those rates give a drawback indicator of the BIM adoption in Malaysian construction industry. Next, on the year of experience in implementing BIM for

construction project, only 17.4% or 20 employees are being implementing it for 2 to 5 years. The majority which is 82.6% or 95 of the employees has less than 2 years of experience. This shows that not many of the industry players have much experience in implementing BIM in construction project.

Furthermore, the survey has also shown that only 9.6% has attended BIM workshops or talks and 90.4% has not. In order to overcome this challenge, practical application of the technology must be implemented. Therefore, it is recommended that construction businesses begin implementing BIM and urge their teams to practice it. This will make it easier for businesses to incorporate BIM into their operations. The practical BIM application's adaptation and familiarity will have a major influence on professionals' understanding of BIM implementation. This clearly indicates that BIM has not been fully adopted by the Malaysian SMEs construction company.

In addition, the result has shown that 90.4% of the respondents have carried out 2 to 5 projects on BIM, meanwhile only 9.6% have worked on only 1 project of BIM. This still shows that the adoption of BIM is still low in construction project to be compared to the other country who have used BIM for more than 10 projects. Lastly, the result from the survey has shown that majority of the respondent which is 93.9% are exposed or learned about BIM by self-taught or none and only 6.1% are by industry Led training. This data is important to make an assumption later based on the descriptive and regression analysis on the readiness of BIM adoption in Malaysian SMEs construction company.

4.2.2 Descriptive Analysis

Descriptive analysis allow researcher to summarize analysis of data in more meaningful way. Descriptive analysis for this study was run on 115 respondents who are working in Malaysian SME construction company in Johor.

Table 4.3: Mean Score Range

Range	Level
1.00 – 2.33	Low
2.34 – 3.67	Medium
3.68 – 5.00	High

Table 4.4: Response for Challenges in BIM implementation

Number	Description (Qs)	Mean	Standard Deviation
CH4	High initial cost of software	4.12	1.240
CH6	Reluctance to adopt BIM from the management level	4.12	0.880
CH9	Lack of BIM standard, guideline and protocols	3.97	0.968
CH3	High cost of implementation process	3.84	0.790
CH5	Lack of demands from clients	3.84	0.790
CH1	Lack of information sharing in BIM	3.51	0.852
CH7	Lack of enforcement for implementing BIM by the government in construction projects	3.51	0.852
CH10	No legal or contractual agreement on BIM	3.07	0.856
CH2	Lack of professionals	2.97	0.837
CH8	Lack of best practice and guidance within industry	2.97	0.837
	Total Mean	3.59	

From the table 4.4 above, it shows that the mean for CH4 and CH6 is 4.12 which are the highest and these indicate that most of the respondent cannot afford the cost of the BIM software and the reluctancy from management level to adopt BIM is one of the top challenges. The table also shows the second highest mean is CH9 which is 3.97 as this indicates most respondents are also lacking BIM standard, guideline and protocols. They need clear guidelines and protocol in order for them to achieve total BIM adoption. Next, it followed by CH3 and CH5 which have the same value of mean 3.84. This proves that the high cost of implementation process of BIM and lack of demands from clients are as well listed as the top 5 challenges. Next, most respondents also agreed that they are lacking of information sharing in BIM and enforcement for implementing BIM in construction projects by the government which shows the mean of 3.51. In addition, some of the respondents also agreed that they have no legal or contractual agreement on BIM as the mean is 3.07. Lastly, the lowest mean in this variable with 2.97 indicates that respondents are lacking professionals and best practice and guidance within industry.

Table 4.5: Implementation strategy to overcome the challenges

Number	Description (Qs)	Mean	Standard Deviation
IM1	Provide information of BIM from the start for the top management in an organization	4.18	0.874
IM5	Promotion and awareness by industry's contributors	4.18	0.874
IM3	Provide BIM education and certifications	4.12	0.880
IM10	Development of BIM standard legal or contractual agreement	4.12	0.880
IM4	A strategic approach model is required to assist construction players to implement BIM in construction projects.	4.08	0.785
IM6	Encouragement from top managerial in organization to implement BIM	3.93	1.041
IM2	Employing BIM specialists	3.84	0.790
IM9	Government should provide BIM guideline	3.84	0.790
IM7	Enforcement for implementing BIM by the government in construction projects	3.83	0.973
IM8	Establish BIM organizational structure	3.11	0.915
	Total Mean	3.92	

Table 4.5 above shows the mean for IM1 and IM5 is 4.18 which indicates majority of respondent agreed that by providing information of BIM from the start for the top management in an organization and promoting awareness by industry's contributors are the best strategy to overcome the challenges of BIM implementation. From the above table also shows the second highest mean are IM3 and IM10 with the same value 4.12 which indicates that the respondents need to be provided BIM education and certifications to overcome these top three challenges. The table also shows that some of respondents completely agreed that a strategic approach model is required to assist construction players to implement BIM in construction projects as the mean for IM4 is 4.08. Next, most of the respondents are also agreed that they need encouragement from top managerial in organization to implement BIM as the result shows the mean of 3.93 and followed by IM2 and IM9 with the value of mean 3.84 respectively. Lastly, the lowest mean is from IM8 with mean value of 3.11. This also show that BIM organizational structure need to be established in order to overcome the challenge.

5. Conclusion

The recent state of BIM adoption and readiness in Malaysian construction industry SMEs has been determined, the challenges to implementing BIM in Malaysian construction industry SMEs has

been identified and the strategy to overcome the challenges has been recognised. The construction sector collaborates with CIDB to promote BIM adoption in Malaysia, raising awareness among professionals and organizations and encouraging them to adopt and implement the process at their workplace. Questionnaire survey was distributed through online platform to all the construction industry players. The adoption and use of the BIM technology concept within the company has a major influence on professionals and management abilities, according to the findings of this study. If a company implement BIM in its everyday operations, the degree of BIM implementation and team awareness rises, and training and promotion seminars become ineffective if it is not applied. Willingness and dedication always lead to successful adaption participation and teamwork to improve BIM implementation awareness. The perspectives of experts on BIM adoption and advantages were explored in this study, and suggestions were made appropriately.

The most significant finding of this study is that BIM adoption in Malaysia is still relatively low in Malaysian construction industry sectors. As a result, the adoption of BIM is delayed. The construction industry is struggling to comprehend how BIM may be implemented across parties. According to the research, BIM was implemented in a fragmented environment to create models, but BIM implementation in a full BIM project management is inefficient. As a result, intensive workshops to promote BIM should show the process of BIM implementation rather than only advocating the advantages and benefits of implementation, according to this study. To generate actual confidence for adoption, a case study demonstrating the entire system process and its effectiveness in improving the work environment is required.

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