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BIM Adoption in Managing Construction Risks Amongst Malaysian Quantity Surveyors: Current Practice and Challenges

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Abstract: Building Information Modelling (BIM) is a technology that has received an impetus within the construction industry worldwide. It has also triggered a new approach of working in quantity surveying practice, replacing the conventional methods. In term of managing risks, BIM potentially detects conflicts during visualization process at the design phase, subsequently reduces possible costs risk at the pre-construction phase. However, there are few issues to be dealt with by the construction players in integrating BIM to manage risks in construction projects such as lack of experience and skilled individuals in an organization, lack of awareness amongst project stakeholders and the fragmented nature of the construction industry. These issues somewhat hinder the technology to be implemented effectively and contribute towards the slow development of BIM in the construction industry in Malaysia. Therefore, this study aims to explore the adoption of BIM technology in managing construction risks amongst Malaysian Quantity Surveyors by investigating the current practice and identifying its challenges. Data were collected using a questionnaire survey and the survey results were analyzed adopting descriptive analysis and Average Index by using SPSS. It was found that the current adoption of BIM technology in managing construction risks amongst Malaysian Quantity Surveyors is still at the low level of implementation, despite having high level of awareness on BIM usage in the construction industry. The findings confirmed that the challenges to adopt BIM are related to the upgrade of hardware to match with new technology, lack of clear and specific BIM guidelines, provision of BIM training for employees and high cost for new technology. The results should direct to the Malaysian Quantity Surveyors to be BIM-ready in improving the number of Quantity Surveyors of becoming experts in BIM technology to manage risks in construction projects.

Keywords: Building Information Modelling, challenges, construction risks, quantity surveyors, Malaysian construction industry

1. Introduction

In every construction project, risks are inevitable as every stage of construction from the beginning to the end, has its own risk that must be faced by the construction players. According to Jannadi (2007), risk does not necessarily involve only bad results and consequences, it can also refer to the chances of positive events. Risk creates both problems and opportunities for individuals, business or in other industries like construction. Thus, risk management is important to

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organize and control the source of risks systematically that may occur in each stage especially in the construction process. In the construction industry, the Quantity surveyors (QSs) play significant role in providing services for cost management from the feasibility phase until completion of the building. QSs are very synonymous with tasks related to building measurement where it is very time-consuming and is always exposed to human errors. Mitchell (2012) mentioned that 90 % of time are devoted by QSs in calculating building quantities.

With the adoption of Building Information Modelling (BIM) technology, these repetitive and time-consuming activities performed by QSs can be eradicated by automating the process as this technology may solve the above problems and allow the QSs to commit their time to other services (Nagalingam et al., 2013). It reduces many tedious Quantity Surveying tasks such as measurement, take-off and production of Bills of Quantities (BOQ). Based on Zainon et al. (2016), wrong assumptions and misunderstandings are normally occurred in projects when using traditional 2D drawing. Then, the use of BIM technology is capable to provide a more intensive and detailed drawing. The more comprehensive construction information and more precise BOQ can diminish the gap among the project team members. BIM technology also can improve and boost the quality in terms of documentation and constructability (Wang et al., 2013). Apart from quality, any program, cost and project are several main success metrics to be considered in construction. With the advent of parametric modelling, QSs play an important role in contributing these fundamental parameters from the outset to the modelling process and adding the most value from the initial stage. In general, QSs are involved in providing services related to cost and contract management from the initial phase until building completion. Therefore, QSs are exposed to many risks in various forms in completing their tasks in a construction project.

By adopting BIM technology, QSs can manage and reduce construction risks occurred in many ways since BIM has the ability to revolutionize the Quantity Surveying activities by eliminating repetitive activities and thus improving job efficiency among QSs. Quek (2012) stated that the Malaysian Quantity Surveying field should take the necessary action to undertake an evaluation of BIM's impact on its operation. Researching to what extent BIM integration might have spread into the Quantity Surveying field is worth exploring because there are few studies on the use of BIM technology amongst QSs compared to Architects and Engineers. Malaysia is a developing country that wants to advance its status towards a developed country. Since 2007, the Department of Public Works (PWD) already started the introduction of Building Information Modelling (BIM) in Malaysia. PWD has received numerous responses from different stakeholders regarding this new initiative. Furthermore, the Malaysian construction industry aims to reach the second level of BIM capability model by 2019. However, most of the developing countries have a low implementation of BIM technology, including Malaysia (Ismail et al., 2016). It will be difficult and risky to acquire BIM without identifying the potential benefits for organizations. In Malaysia, the architectural firms' BIM adoption rate was 20% (Mohd-Nor & Grant., 2014), and only 10% of Quantity Surveying firms involved in BIM adoption since BIM was introduced 10 years ago (Ali et al., 2013). As architectural, engineering, and surveying practices are the main players in BIM working environment, this can be a significant indicator of slow uptake of BIM in Malaysian construction industry as a whole. Therefore, this study aims to explore the adoption of BIM technology in managing construction risks amongst Malaysian Quantity Surveyors through investigating current practice and identifying its challenges.

2. Challenges of Adopting Building Information Modelling (BIM) Technology in Managing Construction Risk

There are four aspects considered in this study in determining the challenges contributing to BIM adoption in managing construction risks namely process, people, technology, and legal issues. According to Zainon et al. (2016), the process aspect involved as of current ways of collaboration between the project team through the adoption of BIM have been offered, some issues may occur. For instance, some problems may arise when it comes to things associated with the method for sharing model information among the team members. The Architect usually uses traditional drawings on paper triggering a third party to construct a model to be employed especially for planning and estimating the construction project. If BIM software needs compatibility with other hardware, and team members use a wide variety of modelling tools, then the project may require some other tools to transfer or combine the models between different environments (Zainon et al., 2018). Consequently, it might add complications or cause errors to the project. Meanwhile, the adoption of BIM requires the users to upgrade the hardware to match with new technology. The firm requires to periodically upgrade their hardware to run the processing software and this had become a significant barrier particularly for small medium size enterprises (SMEs) (McGraw-Hill Construction, 2012). The upgrade of hardware ensures the processing software runs smoothly and can deliver the work without any difficulties. Besides, some circumstances may occur on the firm financially especially for the purpose to fix technical issues regarding BIM adoption. The huge investment must be made financially by the firm to adopt BIM technology. Only large organization business can afford the cost of this technology (Zainon et al., 2018). As described by Autodesk (2013), the cost for Building Design Suite Premium, an entry-level software for BIM is US$6,825. The current exchange rate is US$ 1.0: RM4.21, which makes Malaysia's price RM28,749.00. The calculation of cost previously only involves the purchase of the most basic BIM software. Hence, BIM technology can cause vital and fundamental changes to the operational procedures of an organization. There will be

essential and basic changes that must be made in terms of its operational processes if the organization wants to fully adopt BIM technology (Liang et al, 2016).

In term of people aspect, it is essential to provide the correct BIM technology training for employees in companies. The firms require to allocate time and money in order to search the best experts to assist them in adopting BIM technology (Zainon et al., 2018). Moreover, people working in the organization can also be another challenge to face. When the important people in the firm are reluctant to accept the new tools and technology, it makes it harder for them to change their behaviour into liking and accepting it (Zainon et al., 2018). Thus, it is hard to make the transition in their behaviour into accepting new technology such as BIM technology. Consequently, there are obvious reasons as to why BIM adoption in Malaysia has not really been as much as anticipated (Zainon et al., 2016). It is hard to adopt new information technology (IT) in the industry due to technical reasons as compared to social issues. According to Latiffi et al. (2015), the low number of skilled technical experts is one of the challenges to adopt BIM technology. In addition, the unwillingness to adopt BIM technology in a company becomes one of the challenges faced among staff. The reasons why the staff are not interested in new technology is because they will need to learn and explore something new or try new software and technology. Other than that, the adoption of new technology creates the undesirable feelings such as feel threatened or anxious amongst staff in a company. They might think that their roles will be taken over by the software and hardware that BIM needs in order to function (Zainon et al., 2018). Also, the fear to take the risk of changing their business process by adopting BIM due to the large cost incurred, making some organizations unwilling to take the risk in transforming their business processes (Pittard & Sell, 2016). They have thoughts about the huge uncertainty that may or may not affect their organizations as well as the large cost that they have to bear (Zainon et al., 2018).

In term of technology, construction firms must prepare financially to adopt BIM technology since they need to consider costs to train their employees and even hire BIM expertise (Zainon et al., 2016). In Malaysia, only a large company can afford the costly technology such as GAMUDA Berhad, IJM Corporation Berhad, and other blue-chip companies since adopting BIM technology requires the firm to make a huge investment financially. Then, the difficulty to convert a company to embrace the new technology. A lot of time will be invested in order to convert a company into being accepting a new technology like BIM and this is seen as a challenge as construction projects are extremely impacted by time. Applying BIM software require the QSs to spend a lot of time to get used to it due to the complexity and difficulty in understanding its operation (Latiffi et. al., 2015). It becomes even more difficult when the users are amongst the senior QSs. Additionally, there is an obligation for excellent practical strategies to be developed in order for vital information to be communicated and integrated successfully amongst the components (Zainon et al., 2018). It leads to another technical reason as to why BIM has not been adopted for some firms. The issue of interoperability cannot be fixed as it requires detailed and precise models. This is the reason why BIM technology may have been accepted at a low rate (Zainon et al., 2018).

For legal issues, Zainon et al. (2016) mentioned that BIM technology implementation has its challenges to be confronted due to the question of responsibility and ownership related to the numerous designs, datasets, and analysis amongst the project team members. There are various difficulties when it comes to determine who will be responsible and in charge of its accuracy and precision. These difficulties are being questioned by the BIM expertise since this technology is adopted in their project. A building model will require the building owners to improve the renovations, maintenance, and operations once they educate themselves about the advantages and benefits provided through BIM adoption. Furthermore, the absence of BIM contract documents that highlight the working methods, legal aspects and procurement have limited the application of BIM (Tatt et. al., 2016). There must be some specific and clear guidelines to be followed and requirements in standardizing the steps to implement BIM technology by firms (Zainon et al., 2018).

Following the reviewed literature, a conceptual framework as shown in Figure 1 is developed for this study, deducing that BIM could possibly assist the Quantity Surveyors in managing construction projects risks, however it requires the issues and challenges in current practice to be addressed accordingly.

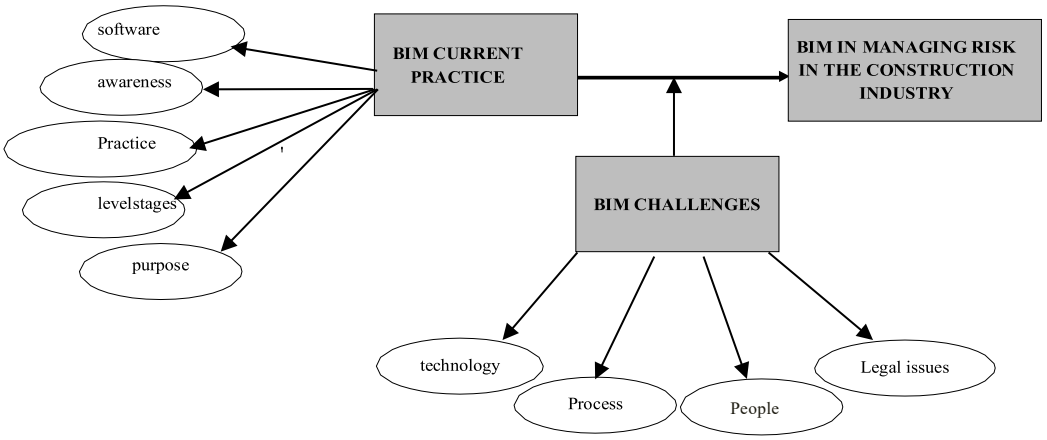

Fig. 1 - Conceptual framework

3. Methodology

This study explored the adoption of BIM technology in managing construction risks amongst Malaysian Quantity Surveyors by identifying its current practice and challenges. A quantitative research method was employed which involved soliciting the responses of Quantity Surveyors in the Malaysian construction industry via a structured questionnaire. The questionnaire as the main research instrument used for this study has established three main sections of Sections A, B, C and D related to achieving the study objectives. The demographic background in Section A in the questionnaire includes working experience in the construction industry, type of project involved, current organisation business and the number of projects the respondents have been involved with. To examine the current practice of BIM adoption, the next Section B in the questionnaire provides five questions to be answered by the respondents in conjunction with the level of the awareness of BIM technology in the construction industry, the practice of BIM technology in managing construction risks, BIM software that normally used in construction project, the phases that usually apply BIM, and the purposes of using BIM in construction projects.

In identifying the BIM adoption challenges in managing construction risks in Section C, Likert-scale form of questions were asked requiring the respondents to rate their agreement towards the statements given in the questionnaire using a rating scale ranging from 1 to 5 of Strongly Disagree to Strongly Agree. The total of eighteen items questions in this section are divided into four categories of challenges in terms of people (5 questions), technology (5 questions), legal issues (3 questions), and process (5 questions). Final part of the questionnaire provides one section (Section D) of open-ended question on recommendations to allow the respondents to give any suggestions related to the study, other than mentioned in the questionnaire.

The sample of respondents adopting Krejcie & Morgan (1970) formula, was determined so that the questionnaire would be distributed to the reliable Quantity Surveyors meeting the study requirements of the study. The population in getting the samples was derived from the list of Quantity Surveyors registered with the Royal Institution of Surveyors Malaysia (RISM), who work whether with consultant firms, contractor companies, developers, academic institutions, and others. To get diversified perspectives, the QSs whether they are BIM users or non-BIM users were targeted as respondents for the study. The sampling technique used in this study was random sampling where each sample is fairly likely to be chosen from the total population. A randomly selected sample is intended to represent the total population in an unbiased manner. The survey was conducted online, in which the link created via Google form was sent to the selected respondents through emails, WhatsApp, LinkedIn, and other appropriate online platforms.

The results obtained from the survey were then analysed using SPSS software. Demographic background and current practice (Sections A and B in the questionnaire) were analysed descriptively using frequency analysis to get frequency and percentage of respondents responded to the related questions in both sections. Meanwhile, Average Index indicator for mean values (as shown in Figure 2) was used to analyse results for Section C in the questionnaire and rank the challenges based on the process, legal issues, people, and technology aspects accordingly.

$$Average\ Index = \frac{\sum (\mu \times n)}{N}$$

μ = Weighting given to each factor by respondents (1 to 5).
n = Frequency of the respondents.
N = Total number of respondents.

Whereby the weighting would be:

μ1 = 1, frequency of "Strong Disagree" response.
μ2 = 2, frequency of "Disagree" response.
μ3 = 3, frequency of "Moderately Agree" response.
μ4 = 4, frequency of "Agree" response.
μ5 = 5, frequency of "Strongly Agree: response.

With the Likert scale as below:

1	= Strongly Disagree	(1.00 > Average Index < 1.50)
2	= Disagree	(1.50 > Average Index < 2.50)
3	= Moderately Agree	(2.50 > Average Index < 3.50)
4	= Agree	(3.50 > Average Index < 4.50)
5	= Strongly Agree	(4.50 > Average Index < 5.00)

Fig. 2 - Average index indicator for mean values

4. Results and Discussion

4.1 Respondents' Background

In overall, 150 respondents responded to the questionnaire survey conducted for this study. 50% of the respondents completed the survey were aged between 25 years old and below, 36.7% were between 26-35 years old, 8.0% of between 46 years old and above and the rest 5.30% with age between 36-45 years old. It was observed that the majority of the respondents are the QSs who have working experience between 1-5 years in the construction industry (64%), followed by the QSs that have working experience between 6-10 years (18.7%), more than 20 years (8.7%), between 11-15 years (6.0%), and between 16-20 years (2.7%). Majority of respondents who answered this survey are those QSs who involve in private projects (44.0%), involved in both government and private projects (42.0%) and only 14.0% of the respondents involved in government projects. Most of the respondents' organization business are from Contractor's Firm (42.7%), followed by Quantity Surveying Firm (30.7%), Authority/Government Agency (7.3%), Client/Developer (6.7%), Academic Institution (3.3%), and other organization businesses such as Claims and Contract Consultant (0.7%), Multi-Disciplinary Practice (0.7%), Digital Solution for Construction (0.7%), Engineering Consultant Firms (2.0%), Logistic (0.7%), Oil and Gas Supply (1.3%), Project Management Consultant (2.7%) and Supplier (0.7%). Majority of the respondents are QSs who performed the number of projects less than 10 projects (64.7%), while 18.7% of them have handled 10-20 projects, 14.0% have experience in handling more than 30 projects, and only 2.7% had handled 21-30 projects in their involvement in this industry. By demonstrating significant background required for this study, it can be concluded that the surveyed respondents could give reliable responses towards questions asked in the questionnaire remaining sections. Table 1 summarizes the surveyed results for the respondents' background.

Table 1 - The background of respondents

Year of experience in the construction industry	Frequency (No.)	Percentage (%)
1-5 years	96	64.0
11-15 years	9	6.0
16-20 years	4	2.7
6-10 years	28	18.7
More than 20 years	13	8.7
Total	150	100
Type of project involved	Frequency (No.)	Percentage (%)
Both (Government and Private)	63	42.0
Government	21	14.0

Private		66	44.0
	Total	150	100
Current organization business		Frequency (No.)	Percentage (%)
Academic Institution		5	3.3
Authority/Government Agency		11	7.3
Client/Developer		10	6.7
Contractor's Firm		64	42.7
Quantity Surveying Firm		46	30.7
Others		14	9.5
	Total	150	100
Number of projects involved		Frequency (No.)	Percentage (%)
Less than 10 projects		97	64.7
10-20 projects		28	18.7
21-30 projects		4	2.7
More than 30 projects		21	14.0
	Total	150	100

4.2 Current Practice of BIM Adoption in Managing Construction Risks Amongst Quantity Surveyors in Malaysia

Table 2 describes the current BIM adoption practiced by the surveyed respondents to manage risks in their construction projects. This Section B in the questionnaire contains five questions asking on the awareness level of BIM technology usage in the construction industry, the practice of BIM technology in managing construction risks, BIM software that normally used in construction projects, the phases that usually apply BIM technology, and the purposes of using BIM technology in construction projects.

Table 2 - Current practice of BIM adoption in managing risks

Awareness on BIM usage in the construction industry		Frequency (No.)	Percentage (%)
Aware and use BIM technology frequently.		17	11.3
Aware and use BIM technology rarely.		40	26.7
Aware of BIM technology but does not use it.		86	57.3
Not aware of BIM technology and never use it.		7	4.7
	Total	150	100
Practice of BIM technology to manage risks		Frequency (No.)	Percentage (%)
Never practice any BIM technology.		55	36.7
Not Sure.		23	15.3
Use BIM but not for managing construction risks.		46	30.7
Yes, use BIM to manage construction risks.		26	17.3
	Total	150	100
BIM software used in construction projects		Frequency (No.)	Percentage (%)
Revit		43	21.1
Navisworks		8	3.9
Cubit		23	11.3
Cost X		33	16.2
ArchiCAD		8	3.9
Others		22	10.9
Never used any BIM software		67	32.8
	Total	204 (by cases)	100.0
Stages in construction projects using BIM		Frequency (No.)	Percentage (%)
Planning		55	22.0
Design		54	21.6
Construction		59	23.6
Maintenance		11	4.4
Demolition		4	1.6

Others	3	1.6
Never used BIM at any phases	63	25.2
Total	250 (by cases)	100.0
Purposes of using BIM in construction projects	Frequency (No.)	Percentage (%)
Quantity take-off	75	28.4
Cost Estimates	65	24.6
Bidding Process	17	6.4
Collaboration and Communication	21	8.0
Database Management	26	9.8
Others	3	0.12
Never used BIM technology to complete the works	57	21.6
Total	264 (by cases)	100.0

From Table 2, it shows that majority of respondents are *"aware of BIM technology but does not use it"* (57.3%). Meanwhile, 26.7% of respondents are those who are *"aware and use BIM technology rarely"*, *"use BIM technology frequently"* (11.3%) and *"not aware of BIM technology and never use it"* (4.7%). For the level of practice of BIM technology in managing construction risks, it is indicated that mostly respondents never practice any BIM technology to manage their projects (36.7%). This is followed by the respondents that use BIM but not for managing construction risks (30.7%), use BIM technology to manage construction risks in their projects (17.3 %) and 15.3% of respondents, however, feel uncertain about the use of BIM technology to manage risks in their projects. The next three questions are in a form of multiple choice allowing the respondents to choose more than one answer by cases. In term of BIM software application, Revit is the most used software in most of respondents' construction projects (21.1%), followed by Cost X (16.2%), Archicad and Navisworks (3.9%) and others (10.9%) respectively. Other software listed by the respondent are Glodon (3.9%), Sketch Up (0.5%), Cubicost (1.5%), Autodesk Infrastructure Design Suite (0.5%), BIM Sight (0.5%), Brava Reader (0.5%), Binalink (0.5%), Infraworks (0.5%), Dimension X (0.5%), Aconex (0.5%), Autocad (0.5%), Civil3D (0.5%) and Builsoft (0.5%). In term of BIM usage by stages, it shows that there are three top stages namely planning, design and construction rated by the respondents where they normally apply BIM, with the percentage of 22.0%, 21.6% and 23.6% accordingly. Meanwhile, 4.4% and 1.6% are the percentages for BIM usage in maintenance and demolition stages. The other stages (1.6%) in construction projects using BIM technology are stated as preparation of Bill of Quantities, Costing and Re-measurement. However, 25.2% of respondents never used BIM technology at any phases of construction projects. For the purposes of using BIM technology in construction projects, most of the respondents rated BIM adoption to perform quantity take-off tasks (28.4%). This is followed by "Cost Estimates" (24.6%) and "Never used any BIM technology to complete the works" (21.6%), other purposes (0.12%) including Design Coordination, Educational Purposes and Interfacing, and the least BIM was used are for "Database Management" (9.8%) and "Collaboration and Communication" (8.0%) purposes.

Based on the responses reflecting current practice of BIM adoption in managing risks in the respondents' construction projects, it can be postulated that there is high percentage showing the awareness level towards BIM technology, however, does not align with the low adoption level demonstrated in the survey. The findings are in line with Ismail et al. (2019) study, showing most likely unchanged similar results regarding awareness and BIM usage amongst the Quantity Surveyors in Malaysia. The reasons behind are maybe due to the challenges exist throughout the process of the technology implementation, in which will be discussed further in the next section. It can also be observed from the survey results that the usage of BIM for constructions projects to manage risks is varied depending on the phases in the respondents' construction projects, therefore portrayed the type of BIM software used as well. It is shown that BIM mostly adopted for quantity take-off tasks in Bill of Quantities preparation, aligned as one of the most significant duties of Quantity Surveyors, the targeted respondents for this study.

4.3 BIM Adoption Challenges in Managing Construction Risks amongst Quantity Surveyors in Malaysia

This section used a five-point Likert scale to identify the challenges consisting of 18 items divided into four categories by ranking, which are process, legal issues, people, and technology. The values on the scale are as follows: 1 as "Strongly Disagree", 2 as "Disagree", 3 as "Moderate", 4 as "Agree" and 5 as "Strongly Agree". Table 3 shows the findings with regards to the challenges of BIM technology in managing construction risks amongst Malaysian Quantity Surveyors.

Table 3 - Challenges of BIM technology in managing construction risk

Rank	Description	Mean Value	Standard Deviation
a) BIM challenges in term of process			
1	BIM technology requires to upgrade the hardware to match with new technology.	4.13	0.833
2	Difficulty for the firm financially to fix technical issues regarding BIM adoption.	4.11	0.796
3	BIM software needs compatibility with other hardware.	4.05	0.767
4	BIM Technology can cause any vital and fundamental changes to its operational procedures to the organization.	3.97	0.802
5	Difficulty in sharing model information among the team members.	3.50	0.865
b) BIM challenges in term of legal issues			
1	The lack of clear and specific BIM guidelines to be followed and the steps to implement.	3.85	0.789
2	The lack of BIM contract documents that highlight the legal aspects, and procurement.	3.85	0.822
3	Difficulty in responsibility and ownership related to the numerous designs, analysis, and datasets.	3.77	0.770
c) BIM challenges in term of people			
1	It is essential for providing the correct BIM technology training for employees in companies.	4.15	0.806
2	The low number of skilled technical experts	4.03	0.835
3	Fear to take the risk of changing their business process by adopting BIM due to the large cost that they have to bear.	3.83	0.878
4	The unwillingness to adopt BIM Technology among staff in a company.	3.70	0.954
5	The important people in a company are not willing to use newtools and technology such as BIM technology.	3.66	0.904
d) BIM challenges in term of technology			
1	High cost for new technology and its training programs.	4.29	0.805
2	A requirement for excellent practical strategies to be developed	4.05	0.712
3	The complexity to understand the new software.	4.05	0.797
4	A requirement for detailed and precise models to fix the issue of interoperability.	4.03	0.723
5	Difficulty to transform a company into accepting newtechnology.	3.98	0.863

BIM challenges in term of process highlighted that the highest mean value is 4.13 stating that BIM technology requires to upgrade the hardware to match with new technology. The project may need some other tools to move the models between different environments or to combine them together (Zainon et al., 2018), and this circumstance occurs if the team members use a wide variety of tools for modelling. The next ranks of other challenges are consequently on the difficulty for the firm financially to fix technical issues regarding BIM adoption (mean value = 4.11), BIM software needs compatibility with other hardware (mean value = 4.05), BIM technology can cause any vital and fundamental changes to its operational procedures to the organization (mean value = 3.97), and the lowest value of mean is 3.50 stating the difficulty in sharing model information amongst the team members.

In terms of legal issues, the highest mean value rated for challenges under this category are on the lack of BIM contract documents that highlight the legal aspects, and procurement and the lack of clear and specific BIM guidelines to be followed and the steps to be implemented (mean value = 3.85). There must be some specific and clear guidelines to be followed and the standardized steps to implement BIM technology in projects (Zainon et al., 2018), otherwise it will lead to constraints in applying BIM technology and become a dilemma amongst QSs if the implementation of BIM is essentially required in construction projects. The least rated challenges are on the difficulty in responsibility and ownership related to the numerous designs, analysis, and datasets (mean value = 3.77).

Concurrently, the highest rated challenge in term of people aspect is when it is essential for providing the correct BIM technology training for employees in companies (mean value = 4.15). The firms require to allocate money and time in order to find the best experts to assist them in implementing BIM technology (Zainon et al., 2018). It is

followed by other challenges on low number of skilled technical experts (mean value = 4.03), fear to take the risk of changing their business process by adopting BIM due to the large cost that they have to bear (mean value = 3.83), unwillingness to adopt BIM technology among staff in a company (mean value = 3.70) and the lowest ranking with the mean value of 3.66 is on the important people in a company are not willing to use new tools and technology such as BIM technology.

For the technology aspect, the highest rated challenge by the respondents is on the high cost for new technology and its training programmes with the mean value of 4.29. This might be in line with the fact that BIM technology is mainly used in large companies or known as blue chip companies such as Sime Darby, IJM and others due to their capabilities in many aspects, especially in the financial aspect. Most of the smaller firms are still loyal to the conventional methods because they are not financially able to adopt BIM technology as there are several involvements of supplementary costs to adopt the new innovation of BIM. The organization needs to pay extra costs to train its staff and even recruit new workers who are equipped with the BIM experience and skills as they begin to internalize a new working atmosphere in their business (Zainon et al., 2018). The ranks are accordingly followed by the challenges in terms of the complexity to understand the new software (mean value = 4.05), a requirement for excellent practical strategies to be developed (mean value = 4.05), a requirement for detailed and precise models to fix the issue of interoperability (mean value = 4.03), and the difficulty to transform a company into accepting new technology (mean value = 3.98).

Notably, the highest-ranked challenges encapsulating all aspects of process, legal issues, people, and technology, are related to each other. BIM technology to be adopted in the construction projects incurs high cost, especially to bear the cost for training programs. Then, whenever BIM trainings are required for the construction teams, appropriate BIM programs need to be done intensively so that the investment on the programs will be somewhat beneficial and valuable for the staff to practice BIM correctly. Subsequently, the challenges are associated with the next process of adopting the technology dealing with upgrading the hardware parts when accepting BIM software to be used as new technology, to ensure compatibility between both hardware and software. Ultimately, proper BIM guidelines are necessary to be legalised amongst the users, to signify clear and specific steps to be implemented when using BIM in the construction projects.

In overall, this study is significant in contributing towards adding knowledge in the existing literature regarding BIM current adoption and its challenges in managing risks in the construction industry, specifically in the field of quantity surveying practice. For the practical contribution towards the industry, this study findings benefit the Malaysian Quantity Surveyors to have better understanding on BIM, especially on the effects BIM could give when implemented, eventually help in decision-making process of using BIM to manage risks in construction projects.

5. Conclusion

BIM technology has been widely used by developed countries, but not to developing countries such as Malaysia where the level of adoption of BIM technology remains low despite of its introduction a long time ago. Nonetheless, many challenges exist in adopting BIM technology to manage construction risks amongst Malaysian Quantity Surveyors, in terms of process, legal issues, people and technology. To adopt BIM technology in term of process, the challenges faced by QS are mostly on BIM technology that requires upgrading hardware to match with new technology compatibilities. Legally, lack of clear and specific BIM guidelines to be followed by the users are one of the most challenging parts to implement BIM in an organization. While in term of people, the necessities in providing the correct BIM technology training for employees is the most significant challenge amongst the industry players. It can be seen that the adoption of BIM innovation involves the highest cost on its technology and training programmes. These difficulties have led to the reasons why the adoption of BIM technology in managing construction risks amongst Malaysian Quantity Surveyors is still at the low level of implementation. Thus, the government needs to create several initiatives in facilitating many companies by giving certain incentives to maximize BIM adoption in Malaysia. Additionally, it was found through the study findings that despite having high level of awareness on BIM usage in the construction industry, the current BIM technology usage amongst Malaysian Quantity Surveyors is still at the low level of its adoption. This study outcomes convey interesting issues in which future studies could consider to further examine and prove the relationships might exist between these two facets of awareness and adoption levels.

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References

Ali, K.N., Al-Jamalullail, S.N.N.S.I, & Boon, T.C (2013), Building Information Modeling Awareness and Readiness among Quantity Surveyors and Quantity Surveying Firms, Universiti Teknologi Malaysia-Royal Institution of Surveyors Malaysia, Technical Paper.

Autodesk. (2013). Autodesk Building Design Suite. Retrieved from http://usa.autodesk.com/autodeskbuilding-design-suite/compare/.

Ismail, N.A.A, Drogemuller, R. Beazley, S. and Owen, R. (2016). A review of BIM capabilities for quantity surveying practice. 4th International Building Control Conference 2016 (IBCC 2016), MATEC Web of Conferences, Kuala Lumpur, pp.1-7.

Ismail N.A.A, Adnan H. and Bakhary N.A. (2019). Building Information Modelling (BIM) Adoption by Quantity Surveyors : A Preliminary Survey from Malaysia. IOP Conf. Ser. Earth Environ. Sci. 267, 052041.
Jannadi, O.A. (2007). Risks associated with trenching works in Saudi Arabia. Building and Environment, 43(5): 776-781.

Krejcie, R. V, & Morgan, D. W. (1970). Determining sample size for research activities. Educational and Psychological Measurement, 30, 607-610.

Liang, C., Lu, W., Rowlinson, S., & Zhang, X. (2016). Development of a Multifunctional BIM Maturity Model. Journal of Construction Engineering and Management, 06016003.

Latiffi, A.A., S. Mohd and J. Brahim (2015). Application of Building Information Modeling (BIM) in the Malaysian Construction Industry: A Story of the First Government Project.

Mitchell, D. (2012), "5D BIM: creating cost certainty and better buildings", Proceedings of RICS COBRA 2012, The Annual RICS International Research Conference, Las Vegas, NV, pp. 1-9.

McGraw Hill (2012), the Business Value of BIM for Infrastructure, McGraw Hill Construction, Bedford MA, United States.

Mohd-Nor, M. F. I., & Grant, M. P. (2014). Building information modelling (BIM) in the Malaysian architecture industry. WSEAS Transactions on Environment and Development, 10, 264-273.

Nagalingam, G., Jayasena, H. S., & Ranadewa, K. A. T. O. (2013). Building information modelling and future quantity surveyor's practice in Sri Lankan construction industry. In Second World Construction Symposium (pp. 81-92).

Quek, J.K. (2012) "Strategies and Frameworks for Adopting Building Information Modelling (BIM) for Quantity Surveyors," Appl. Mech. Mater., vol. 174-177, pp. 3404-3419.

Tatt, S. L., & Abidin, H. H. N. Z. (2016). Quantity Surveying Firm Change Model in Managing the Constraints of BIMImplementation. Research Journal of Fisheries and Hydrobiology, 11(3), 105110.

Wang, X., Love, P.E.D., Kim, M.J., Park, C.-S., Sing, C.-P. and Hou, L. (2013), "A conceptual framework for integrating building information modeling with augmented reality", Automation in Construction, Vol. 34, pp. 37-44.

Zainon, N., Mohd-Rahim, F. A., & Salleh, H. (2016). The Rise of BIM in Malaysia and Its Impact Towards Quantity Surveying Practices. MATEC Web of Conferences, 66, 4-11. https://doi.org/10.1051/matecconf/20166600060.

Zainon, N., Mohd-Rahim, F.A, Aziz, N.M., Kamaruzzaman, S.N. and Puidin, S. (2018) Catching Up with Building Information Modeling: Challenges And Opportunities For Quantity Surveyors. Journal of Surveying, Construction and Property (JSCP), Volume 9, Issue 1.