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Review of Building Information Modeling (BIM) Adoption Amongst SMEs in the Malaysian Construction Industry

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Abstract

BIM is a modeling technology consisting of digital tools that can be used in project planning, design, monitoring, and control among construction professionals to deliver the construction project efficiently, ensuring the whole project's success. The Malaysian government is aware of the potential benefits of implementing BIM. Therefore, the Malaysian government has launched several programs to encourage BIM in the hopes that the country's building industry will use it extensively. However, there are a few obstacles and difficulties that are delaying

the adoption of BIM in Malaysia. The challenges of implementing BIM are usually encountered by smaller companies. Even with all of BIM's advantages, SMEs are still hesitant to use it when performing their task. The importance of this review is to understand the BIM Adoption amongst SMEs in the Malaysian construction industry. For methodology, a critical review was conducted to find out the present level of BIM adoption, the difficulties in implementing BIM technology, and the most effective strategies for promoting improved BIM adoption among SME contractors in the Malaysian construction industry. The review's major findings indicate that the adoption of BIM by SME contractors is still lagging because of several obstacles that need to be overcome before it can be put into practice. One of the biggest obstacles to SME contractors adopting BIM is cost. The government agencies' role in effectively promoting and encouraging BIM adoption in the Malaysian construction industry is the best way to improve BIM adoption among SME contractors. The importance of this study is in gathering feedback on the degree of BIM adoption among the construction industry participants, with a particular focus on small and medium-sized contractors. This information could serve as a benchmark and point of reference for the development of BIM in the Malaysian construction sector. Further research proposed including to identify the challenges of adopting BIM in future projects, investigating the way to enhance the construction professionals' knowledge of BIM technology, conducting similar research towards the reason and perception of different level managements on BIM, and developing a more appropriate approach for a good integration on BIM implementation in the context of the local construction industry.
Keywords: Building Information Modeling (BIM), Small and Medium Enterprise (SMEs), Malaysian Construction Industry, Construction Technology.

Introduction

A substantial portion of Malaysia's economy is composed of the construction sector. The GDP growth of the construction industry in Malaysia is heavily influenced by the country's GDP (Gross Domestic Product). According to the Department of Statistics Malaysia (2019), the GDP from construction in Malaysia grew to RM 16950 million in the third quarter of 2019 from RM 16064 million in the second. Through the provision of fundamental infrastructure, the building industry in Malaysia contributes significantly to economic growth and fosters social development (building Industry Development Board (CIDB), 2007).

With such potential, the Malaysian government has launched numerous projects to raise the standard of the country's building sector both now and in the future. Information and communication technology (ICT) can be used to improve the construction business more effectively because it offers management solutions. According to Hamid and Kamar (2010), focusing on information technology tools and programs is the best practice program model for the Malaysian construction industry.

BIM can be described and characterized in a variety of ways. A digital representation of the building is created to facilitate the exchange and interoperability of information in digital format and building information modeling (BIM) is one of the emerging technologies to be deployed in design, construction, and facility management, according to the Construction Industry Development Board (2014Different people define BIM differently, and it also depends on the user's background and level of comprehension. BIM provides a variety of tools, each of which applies to a certain subset of construction professionals. Thus, depending

on the viewpoints of the users, the definition of BIM may change. The architectural, engineering, construction, and facilities management (AEC-FM) sector has made extensive use of BIM to manage the life cycle of construction projects (Levy, 2010). Many nations, including Australia, the UK, the USA, Singapore, Europe, France, Germany, Denmark, Netherlands, Spain, Norway, Italy, China, Japan, etc., have adopted BIM worldwide (Paul, 2018). Since 2009, the private sector has mostly been driving the implementation of BIM in Malaysia. In 2007, the Public Work Department's (PWD) Director proposed implementing the BIM approach.

The Malaysian government is aware of the possible advantages of using BIM, including lowering the risk of project delays, preventing construction cost overruns, and preventing design-related issues at an early stage (PWD, 2013; Ahmad Latiffi et al., 2013; Zakaria et al., 2013). Therefore, the Malaysian government has made several initiatives to promote BIM with the hope that it will be used widely by construction professionals in Malaysia. However, the implementation of BIM in Malaysia is distracted by some barriers and challenges. Several constraints and challenges may be impeding the use of BIM. In most developed countries, the benefit of applying BIM costs, but in Malaysia, cost is one of the major impediments. (Linblad,2013; Gardezi et al.,2014). However, for large organisations, money is not a key concern when using BIM. The hurdles and problems of implementing BIM differ depending on the size of the firm.

Literature Review

To elaborate on the Adoption of building information modeling (BIM) amongst Small and Medium Enterprises (SMEs), especially in the Malaysian Construction Industry. The discussion generally on the definition and concept of a BIM, and the status of BIM adoption in Malaysia specifically amongst the SMEs in the Malaysian Construction Industry.

Overview of SMEs in Malaysia

The construction sector is a significant aspect of Malaysia's economy. Malaysia's national GDP (Gross Domestic Product) growth has a substantial impact on its construction GDP growth. The GDP from Construction in Malaysia increased to RM 16950 million in the third quarter of 2019 from RM 16064 million in the second quarter of 2019 (Department of Statistics Malaysia, 2019). The Malaysian building sector contributes to social development by providing basic infrastructure (Construction Industry Development Board (CIDB), 2007). SMEs contribute significantly to Malaysia's economic growth. SME's contributions to national GDP are crucial since they can be the cornerstone of the economy of any emerging or advanced nation (Tehsen, 2014). For this reason, the Malaysian government has worked hard to improve the productivity of the construction industry, particularly by supporting the use of BIM by construction professionals and fostering an environment that is more favorable to SME contractors.

Even though the construction industry growth rate is at a moderate rate expected to be 4.9% this year (Leng, 2018), it will be improved marginally through a new plan in the upcoming years and it will still contribute a great impact to the Malaysian GDP since it provides job opportunities and crates a multiplier effect to the other industries in Malaysia (Danny Myers, 2013). SME Association of Malaysia: The SME Masterplan (2012-2020) will be the breakthrough that will speed up the growth of SMEs and make Malaysia an economically

prosperous country by 2020. All SMEs in Malaysia will be covered by the master plan, regardless of industry, gender, location, or ethnic heritage. By 2020, SMEs will contribute more to the economy because of the Master Plan's successful execution.

Definition of Small and Medium Enterprises (SMEs)

There is no universally accepted definition of a small and medium-sized business (Hooi, 2006; Omar et al., 2009). The definition of SMEs will vary throughout nations. From a larger and more comprehensive viewpoint, the term "small and medium enterprise" refers to an enterprising company that aims to generate wealth for the nation through new economic activity carried out by gathering distinctive resource packages that will be utilized to take advantage of market opportunities (Arbaugh et al., 2008). Looking into the perspective of international business, the definition of SMEs according to the researchers and practitioners is the socio-economic development of each country (Chelliah, Sulaiman and Yusof, 2010). A company with fewer than 500 employees is considered a small and medium-sized enterprise (SME) in the United States (Cavusgil, Knight & Riesenberger, 2008). According to Lin & Chaney's (2007), research, SMEs in Taiwan are defined as businesses having 650 employees or fewer. Conversely, in Malaysia, the number of full-time employees and the yearly sales turnover are the primary factors used to define SMEs (Hashim and Abdullah, 2000, SMECorp, 2008). The definition of an SME was approved at the 14th National Skill Development Corporation (NSDC) conference in July 2013, according to SMECorp Malaysia. All industries are included in the term, including manufacturing, services, construction, agriculture, and mining and quarrying. The number of full-time employees and sales turnover are the two factors that go into defining SMEs. SMEs in the manufacturing industry are defined as companies with fewer than 200 full-time employees OR a sales turnover of no more than RM50 million. SMEs are defined as businesses with sales turnover of no more than RM20 million OR 75 full-time employees or less in the services and other industries. To ensure uniformity and comparability of data across sectors, the National SME Development Council (2005) states that a specific definition of SMEs for the construction industry has been devised. In the construction industry, a small and medium-sized firm (SME) is commonly described as an organization with 50 or fewer full-time employees or an annual sales turnover of no more than RM5 million.

The Development of Building Information Modeling (BIM) Definition.

Professor Charles Eastman was a person who originally introduced the Building Information Modelling concept in the late 1970s (Reddy, 2011; Dobelis, 2013; Ghaffarianhoseini et al., 2016; Li et al., 2017). The issue with regards to inadequate use of documents has resulted in the limitation for the construction professionals to have a view on the projects before their completion. This has urged the concept of BIM to be introduced. Furthermore, the issues with duplication and false project information were caused by the used drawing that is not being updated. Thus, these issues, several organizations from the USA and Finland have used ICT to mitigate the problems. Before the introduction of BIM terminology, some terms in the ICT already applied the concept of BIM but with different purposes. The establishment of the BIM term in 1996 has developed and improvised from time to time in the construction industry. However, there is no actual definition of BIM and thus it is crucial to study and understand more about the development of a BIM definition to provide us with a great conceptualize of BIM and its uses in the construction industry.

Since there is no specification on BIM definition, BIM can be defined and described in several different ways. Enegbuma et al. (2014) defined BIM as a building data management process during the building life cycle. Meanwhile, Sawhney (2014) stated that BIM is not just a software tool or technology that can be implemented for construction projects. It is a model that involves a collaboration between technology and people working together to mitigate problems in the industry. This has made the construction industry transition towards efficiency in the way how built environment is being performed. According to the Construction Industry Development Board, CIDB which conducted a seminar titled "Issues and Challenges in Implementing Building Information Modelling for Small and Medium Enterprises (SMEs)" in 2014, one of the newest technologies to be used in the design, construction, and facility management phases is building information modeling, which creates a digital model of the building to enable the interchange and interoperability of digital information. To improve information delivery across the project life cycle, the Public Works Department, PWD (2014), defined BIM as a modeling technology that entails the creation and application of a 3D parametric model that comprises project information.

According to Thurairajah et al (2013), Building information modeling is a digital model representation that is used from the design stages of a facility's existence to the operation stages. Latiffi et al. (2013) stated BIM is a set of digital tools that can assist in managing the construction project to be more efficient. Zahrizan et al. (2014) stated that BIM is a combination of technology and advanced processes that can act as a medium that allows collaboration between various parties in construction projects with the adoption of IT. Meanwhile, Arayici et al. (2012) stated BIM is the utilization of a database infrastructure to encapsulate built facilities with specific viewpoints of stakeholders. Thus, it can be perceived that Building Information Modelling can be defined and described in various ways.

BIM Tools

Given the complexity and difficulty of obtaining pertinent information when working on a building project using BIM, some companies have developed software specifically designed to function well within a BIM framework. Autodesk Revit, a program intended for use by construction professionals like architects, structural and MEP engineers, designers, and contractors, is among the best examples of building information modeling software. Users can create a building's structure and individual parts in three dimensions. The user can also access the building model's database to mark the model in a 2D drafting element and obtain building information. The Revit is constructed using 4D drafting parts and includes capabilities for tracking and organizing each stage of a building's life cycle, from conception to deconstruction, according to the research report by Latiffi et al. (2013). The article of research further addressed the benefits of utilizing Revit, including the ability to collaborate across disciplines during the building design process. The use of BIM by various construction participants regarding varying BIM tool specifications is applicable in the Malaysian construction industry.

The Uses of BIM in the Construction Industry

Understanding how BIM could be implemented is essential, in addition to being aware of the tools and software used in the process. Before BIM is used in a construction project, construction professionals must investigate and comprehend its applications. This is because BIM has a degree of maturity in present practices and operates differently in

different project life cycles. BIM has several applications and functions differently at every step of a building project, from design and construction to operation and planning. Brahim (2018) stated that firstly, the construction project's objectives must be determined. The BIM usage can be chosen later when the project goals have been established. However, not every BIM application needs to be implemented in building projects because this depends on the experts' degree of awareness and the maturity of the nation's current practices (Shou et al., 2015). Five (5) BIM uses are found in the study, according to Shou et al. (2015), and are commonly employed in building projects.

According to the survey, with a frequency of 60%, 3D coordination came in first, followed by existing condition modeling, design reviews, design authoring, and construction system design. These five (5) best BIM applications demonstrate how frequently BIM is used during the planning and design phases of building projects. This supported by a study conducted by Eadie et al. (2013) shows the UK industry typically applies BIM uses for feasibility study and design. Jung and Lee (2015) state that 3D coordination, design writing, structural analysis, and cost estimation for existing site modeling are the main tasks associated with using BIM for design purposes. In contrast, organizations in Australia used BIMs mostly for project reviews, visualization, conflict analysis, and building design. This demonstrates that the primary motivations for implementing BIM in construction projects were to increase design quality and decrease design errors (Alaghbandrad et al., 2015; Gerges et al., 2017).

Nevertheless, there isn't much research on the application of BIM, and the technology is still relatively new in Malaysia's construction industry. However, Malaysia has adopted BIM mostly for 3D visualization, cost prediction, clash analysis, design review, and building operation and maintenance (Ahmad Latiffi et al., 2016). Thus, it can be said that Malaysia mostly used BIM during the pre-construction phase and very little of it during the post-construction phase. Construction professionals must investigate and comprehend the applications of BIM. One research study that may be used as a reference to help ensure the success of building projects is the one on the regularity of BIM use (Kreider et al., 2010). Determining the project's objectives is also essential for choosing which BIM to employ in building projects (Computer Integrated Construction Research Programme, 2010). This is so because BIM objectives are linked to the intended project performance, which includes reducing project duration, reducing project cost, and improving project quality. Thus, construction professionals must comprehend the adoption of Building Information Modelling (BIM) in projects, as proper implementation can yield the benefits of BIM.

Advantages of BIM in the Construction Industry

By implementing BIM, it provides cost and time reduction which will enhance the efficiency of the overall work (Azhar et al., 2008; Barlish et al., 2012; Sawney, 2014; Chougule et al., 2015). Therefore, it is undeniable that BIM serves benefits in reducing the cost spending and time consumption which is the reason it is gaining attention across the globe, especially in the construction industry. BIM has started to be embraced by the government in most developed countries with the benefits it serves.

Reduction of Capital Cost and Carbon Burden

BIM strategy has been prepared by the UK government to assist the UK Government Construction Client Group. From the strategy, the results show that twenty percent (20%) of capital cost and carbon burden have been reduced (Azhar et al., 2008; Mc Auley, 2012; Sawney, 2014; Dodia, 2015; Kathi, 2015).

Improve Project Coordination and Communication

One of the benefits of adopting BIM is that it improves the coordination of projects. Besides that, communication among construction professionals also improved as BIM allows everyone to understand the project flows and goals where everyone is working together as a teamwork. (Autodesk, 2007; Gerber et al., 2010; Dodia, 2015). Plus, communication also being improved since different construction disciplines are networking together and the progress of work is accordingly being updated (Elhag et al., 2014).

Preventing Project Delay, Design Clash, and Cost Overrun

BIM implementation has become one of the Malaysian government's concerns and the encouragement to adopt BIM by construction professionals has been initiated with several initiatives. It is undeniable that BIM implementation will preventing project delay, clashing in design from different construction professionals as well as overcoming cost overruns. (Becerik-Gerber et al., 2010; Latiffi et al., 2013; Elhag et al., 2014; Kathi et al., 2015).

The Adoption of BIM in The Malaysian Construction Industry

The adoption of BIM in the Malaysian Construction Industry was primarily started in 2007 by the private sector. The idea to implement BIM was highlighted by the Director of the Public Works Department (PWD) in 2009 urging the construction companies to adopt BIM as it could enhance productivity and efficiency (Ahmad Latiffi et al., 2013; Haron et al., 2017; Musa et al.,2018). A seminar and workshop entitled 'Issues and challenges in implementing Building Information Modelling for small and medium enterprises (SMEs) in the construction industry' organized by CIDB has mentioned about one project in Malaysia that has implemented BIM is the National Cancer Institute (NCI). Table 2.11 shows the pilot projects that will be constructed in Malaysia in the future. According to Latiffi et al. (2013), these pilot projects were initiated and intended by the Malaysian Government to expose BIM among government officers. The Malaysian government has made a lot of initiatives to promote BIM adoption among construction professionals. These initiatives were driven due to the fact that the Malaysian construction industry is classified as inefficient, and it requires reformation in terms of its structure and culture (Haron, 2013). According to Haron (2013) and CIDB (2016), the diversification of disciplines in construction professionals has made it complex has led to project delays and overspending in costs. To find a mitigation plan for this, some government-related agencies in Malaysia have come up with initiatives to promote and encourage BIM implementation among construction professionals. Table 1.1 shows a list of government-related bodies with their respective initiatives in promoting BIM.

Table 1.1
BIM Initiatives by Malaysian Government-Related Body

NO	GOVERNMENT-RELATED BODY	INITIATIVE	YEAR
1	Public Works Department (PWD)	- BIM Committee	2007
		- Training on BIM	2008
		- BIM Unit Projects	2010
		- Pilot Project-National Cancer Institute (NCI)	2011
		- Pilot Projects-SPRM Shah Alam, Selangor and Health Centre, Maran Pahang.	2012
		- BIM Roadmap - BIM Studio - Pilot Project-Mara College, Banting Selangor	2013
		- BIM Standard Manual and Guidelines - BIM Project- Majlis Perbandaran Kuala Terengganu (MBKT)	2014
		- JKR BIM Day - BIM Manual Work Process - Memorandum of Understanding (MoU) between PWD and Universiti Malaysia Pahang (UMP) - BIM Project-Putrajaya Hospital	2015
		- PWD Guideline for BIM Template - BIM Project-Parit Buntar Hospital	2016
2	PRIMA Corporation Malaysia (PRIMA)	- 1Malaysia People's Housing - BIM guide for PR1MA	2015
3	Construction Industry Development Board (CIDB)	- BIM Portal - BIM Steering Committee - Seminar and Workshop	2013
		- National BIM Day	2014
		- Construction Industry Transformation Programme (CITP)	2015
		- CIDB BIM Guideline	2016
		- MyBIM Centre	2017
4	Multimedia Super Corridor (MSC)	- Training on BIM	2013
5	Construction Research Institute of Malaysia (CREAM)	- Seminar and Workshop - Training on BIM	2014

The Barriers and Challenges of BIM Adoption

Even with all of the advantages and benefits that come with using BIM, its acceptance is still lacking, particularly in Malaysia's construction industry. The majority of the obstacles to BIM implementation are found in poorer nations. The deployment of BIM can be impeded by a lack of familiarity among construction professionals, as demonstrated by studies conducted in Pakistan by Masood et al (2014), and Iran by (Hosseine et al., 2011). It will be challenging to embrace BIM if the government believes it is ineffective. Though at a rather slow pace, the Malaysian government has taken many steps to encourage the use of BIM by those involved in the construction industry. On the other hand, cost is one of the benefits of adopting BIM in poor nations (Lindblad, 2013; Gardezi et al., 2014), although cost is also a barrier in Malaysia. This is consistent with studies by Liu et al (2015), and Franco et al (2015), which demonstrated that the biggest obstacle to deploying BIM was cost. This resulted from a lack of national guidelines for BIM implementation and insufficiently trained staff. The majority of researchers came to the same conclusions, demonstrating that the biggest obstacle to the adoption of BIM was cost. The high cost is a result of the initial outlay for new equipment and the subsequent time required for staff training on BIM usage.

Barriers and Challenges of BIM Adoption Among SME Contractors

The interrelated key variables that participants in a 2014 CIDB seminar and workshop titled "Issues and challenges in implementing Building Information Modelling for small and medium enterprises (SMEs) in the construction industry" stated as impeding BIM implementation in the Malaysian construction industry have been ranked down. The four categories of barriers to BIM implementation—cost, system requirements, change readiness, and lack of knowledge—are used by CIDB to classify the variables. The results indicate that the factor with the highest percentage, cost (26.2%), was placed top, followed by IT (hardware, software, and computers) (23%), time (16.4%), and readiness (14.8%). The percentages for knowledge and technology were the same (8.2%), while the lowest obstacle to applying BIM was information (3.3%) (Eadie, 2013; CREAM, 2014; Salleh, 2014; Chougule et al., 2015; Hedayati, 2015).

Cost

Most of the participants who attended the seminar agreed that the most critical barrier to implementing BIM for SMEs was the cost. To apply for BIM, the SMEs are required to invest. The investments are BIM software and hardware provision, engagement training for the staff, appointing personnel who are capable in BIM, certifications and licenses requirements, and additional overhead costs. All of this investment just for BIM application would not promise or guarantee to secure the job of the SMEs. The initial capital expenses to adopt BIM are too expensive and might disturb the cash flow of the project and also uncertainties in recovering the ROI (Return on Investment).

System Required (IT)

The majority of SME contractors claimed that they cannot adopt BIM provided that the implementation of BIM involves the use of a technology comprising of some hardware and different software. Implementing BIM in construction projects conducted by small businesses such as SMEs is doubtful since these businesses have a limitation in their resources especially investing them in high-tech equipment. The participant also had issues about how compatible the equipment and software to the contractors, sub-contractors, and other related parties that are involved. They also questioned if communication and inter-operability can be improved through BIM implementation as there is lacking expertise to adopt BIM. However, they believed that the government plays an important role in promoting, encouraging, and enforcing BIM adoption for construction professionals especially the SMEs through several initiatives and efforts.

Lack of Knowledge

BIM is an emerging approach that is still relatively new, particularly in the building business in Malaysia. Many tools are developed by BIM, and before implementing it, it is crucial to comprehend the idea and the tools that BIM employs. The majority of SME contractors claimed that they have no basic or general knowledge of what BIM is. Some of them claimed that they had experience in managing work processes and information but lacking in IT skills, particularly BIM. Implementation of BIM in their organization will provide them with two options which are training the existing staff or employing new expertise. Providing training to the existing staff may take some time as the learning process is not easy for them and it involves obtaining certification and a license. Plus, it may be the the behavior of the staff that is reluctant to change by transitioning from the traditional approach to the new approach of

BIM technology that caused to barrier in BIM adoption. Meanwhile, employing new expertise is expensive and may incur an additional overhead for the SMEs.

Readiness to Change

Changing from traditional to BIM may require a high cost of investment. The resistance to change from both managerial and operational levels is slow because there is lacking a BIM standardization process and no BIM implementation guidelines to be referred by the SMEs. Meanwhile, the acceptance of BIM among the contractors was influenced by the software's usability and complexity. The arguable issue among the industry stakeholders is questioning who will be in charge of developing and operating the BIM. They are also questioning how the distribution of developmental and operational costs.

Despite the advantages that deploying BIM offered in terms of increased productivity and cost-effectiveness, the organization's team was not prepared for training. The Malaysian construction industry currently employs a relatively modest number of skilled building information modelers. Therefore, the participants thought that government-related organizations like CIDB and PWD could make a significant effort to help SMEs implement BIM. They suggested that seminars, workshops, or hands-on training focusing on BIM implementation need to be held and organized regularly until the industry especially the SMEs proficient with BIM.

Therefore, for BIM to be implemented successfully, the participation and involvement of all construction professionals are needed. By embracing this change of implementing BIM in the organization, success can be achieved. Construction professionals need to explore and understand the concept and uses of BIM. According to Linblad (2013), the implementation of BIM can not be achieved if a single player is not contributing. Thus, all construction professionals need to be completely involved to achieve success in BIM adoption.

Solution for Adopting BIM in Malaysia

Roles of Government

Roles of Government The government-related bodies and agencies are required to play a major role in encouraging and forcing BIM implementation in the construction industry and making sure that it is implemented successfully (CREAM, 2014; Rogers et al., 2015). The governments can strategically organize frequent seminars, workshops, or hands-on training for all levels of construction industry players which not only raises awareness among them but also motivates and encourages them in BIM adoption.

Roles of Higher Educational Institutions

According to Haron et al (2017), stated that higher educational institutions also play a major part in mitigating the barriers to BIM adoption. Malaysian educational institutions are urged to include courses related to BIM in the lesson or syllabus to provide graduate students with a better understanding of BIM technology as an initial step of preparation for their careers in the industry. The provision of structured BIM courses needs to be prepared for different grades of contractors and practitioners allowing them to study the BIM adoption. In addition, the provision of standard code and practices and guidelines of BIM needs to be accommodated to have a standardization of BIM adoption among stakeholders which will ensure better communication and integration.

Roles and Support from the Construction Professional

The approach to promoting BIM adoption can be achieved through national leadership and better coordination between the government and the industry players. It is undeniable that government entities are the most influential entities in driving the construction industry toward the success of BIM implementation. However without support and collaboration from the industry players such as clients, contractors, and industry professionals associations, these goals can hardly be achieved (Smith, 2014; Rogers et al., 2015).

Awareness and Motivation Programme

Introducing new technology such as BIM to the AEC industry required the cooperation, readiness, and cooperation of construction professionals. Therefore, the government needs to strategically organize a series of programs such as seminars and workshops that could raise awareness and motivation among construction professionals. In organizing those programs, it would be a good notion to have a collaboration from various professional bodies.

Training Programme

According to the participants, they were suggesting training programs to be divided into two levels. The two training programs will be held concurrently before the BIM application. The first level training program can be done during tertiary education and practitioner's levels. It is suggested that all Institutions of Higher Education across Malaysia integrate BIM courses in the content of the syllabus which will allow them to have a great introduction of understanding about BIM technology. This is to ensure that they will be well-prepared for their future careers. Afterward, the provision of a second level of training program to the AEC industry practitioners especially to the SMEs. Well-structured courses of BIM consisting a industry industry-related knowledge are provided to the various grades of contractors and practitioners before the implementation of BIM. The respective bodies such as CIDB and PWD need to provide subsidies for BIM training to the industry players or the practitioners to ease their burden and motivate them.

BIM Standard / Guideline

To have efficient communication and integration among stakeholders, the government must prepare a standard code practice of BIM guidelines. Instead of inventing a new one, the government is suggested to stick to the existing international standard of BIM but in a way that it is modified and improvised to match the requirements of local practitioners. Plus, the government also needs to set a standard for a particular project that prerequisite to adopting BIM.

Certification and Accreditation / License

The government or private sector needs to provide a certification and accreditation system to the contractors who have undertaken BIM training. By doing so, the contractor will be motivated to implement BIM technology in their projects, and along the way, they will develop and grow as a contractor that is competent in BIM.

Setting up BIM Technology Centre

The Malaysian government is suggested to collaborate with the respective bodies such as CIDB and JKR in setting up a 'BIM Technology Centre' for SMEs. The aim is to facilitate and assist the contractor that is new in BIM technology in conducting their project Services like

this will assure them to be confident in implementing BIM for their project. The SMEs need to be provided with easy access to the use of BIM in their project. Therefore, the participants have suggested that the concept of pay-per-use or periodical license needs to be introduced to ease BIM adoption. Plus, free consultation by the BIM experts in terms of software and system use can be added as one of the services provided in the BIM technology center.

CIDB Portal

The CIDB portal can be a great platform for SME contractors seeking BIM information. The CIDB needs to provide full information with regards to BIM to those who are seeking clarity in BIM technology. This move will allow for the sharing of information among SME contractors and decision-making can be made easily with the sufficient information of BIM.

The Incentives to be Deployed for BIM Adoption

A lot of SME firms have limitations in their resources. Thus, they are expecting the government to assist them in terms of finances by providing few incentives. The participants suggested the government financially aid the SME contractors by reducing the tax charged by the CIDB for BIM adoption. Apart from providing incentives, the government can make a recognition to the SME firms successful in their BIM implementation in their project. It can be yearly rewards or special rewards. This move can surely motivate them to be more committed to BIM adoption. Recognition from the government and other professional bodies through their excellence may secure them in upcoming projects in the future.

Conclusion

In summary, the various obstacles impeding the application of BIM are the reason why SME contractors are still lagging behind in terms of adoption. One of the biggest obstacles to SME contractors adopting BIM is cost. It is clear that the government agencies' role in effectively promoting and encouraging BIM adoption in the Malaysian construction industry as a whole is the best way to improve BIM adoption among SME contractors.

Recommendation

A few suggestions can be made to strengthen and promote the use of Building Information Modelling (BIM) by SME contractors in the Malaysian construction sector. BIM is made as an optional or compulsory subject/course in the higher institution across Malaysia especially for the construction-based student as this will help with an earlier exposure for their career later in the real life of the construction industry. Small and Medium Enterprise (SME) companies may have limited and small capital and resources to adopt BIM. Thus, the Government should provide special funding to the SME's contractors for their initial BIM adoption in their companies. The benefits of BIM to the construction industry should be explored and spread to the construction professionals through conferences or forums. Building Information Modelling (BIM) is a new technology emerging in the construction industry and it is continuously under study the following recommendations for future research that may also be beneficial to the industry are to identify the challenges of adopting BIM in the future projects, to investigate the way to enhance the construction professionals knowledge on BIM technology, to conduct a similar research towards the reason and perception of different level managements on BIM, and to develop a more appropriate approach for a good integration on BIM implementation in the context of the local construction industry.

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