eISSN: 2600-7920
INTI JOURNAL
Vol.2, 2018 (1)

BUILDING INFORMATION MODELLING (BIM) IN SMALL AND MEDIUM ENTERPRISES (SMES) WITHIN MALAYSIAN CONSTRUCTION SECTOR: IMPLEMENTATION, BARRIERS, AND SOLUTIONS

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Abstract: Building Information Modelling (BIM) is an evolutionary technology that is emerging rapidly in the construction industry around the world where the need to implement it has become increasingly dire. However, BIM implementation progress in Malaysia has not been satisfactory. There are researches which were aimed at Malaysian construction sector in general to figure out ways and strategies to solve this issue but the needs and problems faced by the small and medium enterprises (SMEs) have been left unheard and set aside. SMEs are the backbone of a nation's economy and the issues that are affecting them in regards to BIM implementation should be specifically studied since their capabilities and needs are distinct and diverse compared to large enterprises. This paper aims to discover the extent of BIM implementation level and barriers of BIM implementation to promote BIM implementation among the SMEs within Malaysian construction sector. Questionnaire survey based on stratified random sampling method were distributed to 300 SMEs in Malaysian construction sector and 96 of them have been collected back. Relative Importance Indices (RII), Variance and Standard Deviation (SD) were used to analyse the results. The findings reveal that BIM implementation level among the SMEs in Malaysian construction sector is only at an early stage, between Level 0 and Level 1, where paper-based formats and 2D CAD formats are the most common. The barriers hindering BIM implementation are related to cost, attitude, government involvement, awareness, expertise, nature of industry, IT, personnel, contentment, and education. In conclusion, should the most challenging barriers be revealed and controlled, the SMEs within Malaysian construction sector has a huge potential for BIM growth in the future.

Keywords: BIM, SMEs, construction, implementation, barriers.

INTRODUCTION

Building Information Modelling (BIM) is an evolutionary Information Communication Technology (ICT) that helps all the stakeholders to generate and manage the digital representation of physical, functional, financial and other aspects throughout the entire lifecycle of the Architectural, Engineering and Construction (AEC) projects which, back in the day, was only limited to 2D representation but nowadays, because of BIM, the information from all the involving parties can now be merged simultaneously on a well-structured platform from 3 dimensional all the way to 8 dimensional approach with endless algorithmic possibilities that will transform the traditional approaches to become more interactive and collaborative.

The need to realize that BIM is the next big phenomenon in the global AEC industry has become increasingly urgent. Patrick MacLeamy, Chief Executive Officer of HOK, has acknowledged the imminent future of BIM influence in the construction industry by calling BIM a "game changer" that is "here to stay" (Digital Built Britain, 2014). Similarly in China, realizing that BIM will be the next IT solution, Chinese government is strongly supporting BIM, according to Tsinghua

INTI JOURNAL

eISSN: 2600-7920
INTI JOURNAL
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University, Beijing. Malaysia's very own Construction Industry Development Board (CIDB) Information Technology (IT) Division head Mohd Harris Ismail also highlighted the important features and benefits of BIM that can make the construction industry "more efficient, effective, flexible and innovative" while enhancing the national productivity upon deployment (Star, 2015).

Such enthusiastic interest towards BIM implementation, shown by prominent researchers, academicians, technology experts and authorities around the world, can be pressuring on the shoulders of local industry players, especially for the Small and Medium Enterprises (SMEs) who have more diverse and distinctive limitations compared to the larger companies. Therefore, this pressure ignites a great spark for the need to "see" the current BIM deployment level among the SMEs; "hear" the calls of help from them when it comes to BIM adoption; and "think" of the practical ways to promulgate BIM implementation among them in the local construction sector.

First and foremost in this study, a thorough investigation on the extent of current BIM usage among SMEs within Malaysian construction sector will be conducted. Next, the significant barriers that are in the way of SMEs within Malaysian construction sector fully adopting BIM will be identified. Last but not least, any feasible solutions most called for by SMEs within Malaysia construction sector which will help them with their BIM transformation from current traditional approaches will be explored. This paper is tacitly aimed to bring the Malaysian construction sector one step closer to achieving nation-wide maximum BIM maturity.

STATEMENT OF PROBLEM

Nowadays, BIM is increasingly implemented by the most advanced and developed countries globally. The British Government has described BIM as "the first truly global digital construction technology and will soon be deployed in every country in the world" (Digital Built Britain, 2014). In order to embrace this advancement trend in Information Communication Technology (ICT), the need to implement BIM in Malaysian construction industry has become more and more dire.

However, BIM implementation in Malaysia has not been satisfactory. Be it due to the absence of national BIM standard guideline to follow or the insufficiency of government involvement, the construction industry players lack knowledge on where, when and how to properly utilize BIM to its full potential (Zahrizan et al., 2013) and therefore, to assuage the criticality of this problem, several reports, workshops and research papers are found to be conducted by several scholars, academicians, and industry professionals. Nevertheless, most of such researches are directed more towards preliminary and exploratory approach whereby the research scope is broader. The construction sector, consisting of micro, small, medium and large enterprises, is either generalized as a whole or is studied in the mixture together with other sectors such as education, oil and gas, government sector and such.

Furthermore, the findings of the aforementioned literature ushers the fact that different sizes of enterprises, in their respective sectors, are facing different issues regarding the implementation of BIM which cause these enterprises to become the way they are- resistant and reluctant to venture. It is important to realize that the views on barriers in implementing BIM differ between the companies of different specializations and of different sizes (Teo, 2012). While large construction companies and consultants seem to gradually discern the importance of deploying BIM, involvement among SMEs still faces the problems and requires attention (CREAM, 2014). Malaysian Public Works Department director-general Datuk Seri Prof Judin Abdul Karim said that big companies can afford ICT investment while most of the small companies find its adoption unaffordable (Star, 2009). Therefore, the issues that are challenging different sizes of enterprises

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eISSN: 2600-7920
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from different sectors need to be separately addressed and discussed rather than in combination approach.

Nevertheless, despite the empirical importance of SMEs' involvement towards BIM adoption in Malaysian construction sector, there are no studies purely focused in this perspective so far, to best of researcher's knowledge. This drives the need for conducting research and studies to unearth the issues provoking the Malaysian construction sector, specifically the SMEs, when it comes to implementation of BIM such as the barriers that are hindering them and their most-demanded solutions.

OBJECTIVE OF RESEARCH

1. To ascertain the extent of BIM implementation in SMEs within Malaysian construction sector.
2. To identify the barriers of BIM implementation in SMEs within Malaysian construction sector.
3. To explore the solutions to promote BIM implementation in SMEs within Malaysian construction sector.

BUILDING INFORMATION MODELLING (BIM)

Autodesk, the multinational software corporation that designed BIM, portrays it as the "intelligent 3D model-based process that equips architecture, engineering, and construction professionals with the insight and tools to more efficiently plan, design, construct, and manage buildings and infrastructure". Construction Industry Development Board (CIDB) Malaysia has also defined BIM back in 2013 as "the process supported by technology of computer generated model used in collaboration to populate information and simulate the planning, design, construction and operation of a facility". This value-creating collaboration throughout the project enables BIM to underpin the creation, collation and exchanging aspects of 3D models, attached with intelligent and structured data (UK BIM Task Group, 2013). It is the process where geometric aspects of a "building" in 3D meets the integrated "information" such as cost, quantities, financial, performance, time and other aspects, resulting the "model" which delineates the collaborated data on a mutually-shared platform throughout different stages of a project.

BIM IMPLEMENTATION

Richards and Brew (2010) classified the BIM adoption levels based on the extent of maturity as follows:

- BIM Level 0: With lack of CAD coordination, the primary data exchange mechanisms used at this stage are mostly paper-based formats and 2D-generated formats such as Pdf extensions.
- BIM Level 1: Coordination of 2D or 3D CAD with a collaboration tool such as Extranet where at least a common database environment is present, likely with some standard data structures and formats established.
- BIM Level 2: Coordination of 3D environment using 'BIM' models and tools. Primary data exchange mechanism is based on proprietary exchange formats. In this stage, program data from 4D and cost data from 5D may be involved.
- BIM Level 3: A single BIM project model with completely open process whereby data integration and exchange principles are based on IFC standards and the entire process is managed via a collaborative model server.

BARRIERS IN IMPLEMENTING BIM

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eISSN: 2600-7920
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Every time a new technology is to be implemented in an industry, it is a norm to encounter challenges and obstacles. Therefore, ipso facto, it is understandable that BIM also has its issues that needs to be brought attention to. After the review of the past literature, the barriers that are hindering and preventing the successful implantation of BIM can be classified into cost, attitude, awareness, expertise, government involvement, IT, personnel, nature of the industry, contentment and education.

RESEARCH METHODOLOGY

The strategy used for this research paper is by conducting quantitative research approach for achieving primary data and through literature review for the secondary data. Primary data comes from online questionnaire survey that was sent out via email to 300 small and medium enterprises in construction sector across Malaysia that are registered under SME Corporation Malaysia, which is the central coordinating agency under Ministry of International Trade and Industry Malaysia. Out of the 300 questionnaires that were sent out, only 96 questionnaires have been collected back, amounting to the response rate of 32%. Secondary data comes from various literature sources. The methods used for data analysis are Relative Importance Indices (RII), Variance and Standard Deviation (SD) which are similar to those used by Zahrizan et al. (2013).

DATA ANALYSIS

The BIM maturity level or BIM implementation level among SMEs in Malaysian construction sector is only in Level 0 and Level 1 with 5.2% and 94.8% respectively, as indicated in Table 1. This finding is proven to be the same with the findings made by previous researchers such as Zahrizan et al. (2013) who first identified that BIM level in Malaysian construction industry is between Level 0 and Level 1. The results also co-align with the stance of Kasim and Ang (2010), who stated there is only an average level of acceptance towards the ICT transformation and implementation among construction projects in Malaysia. It points out that despite there is very low extent of BIM maturity or implementation level, there is indeed some certain form of BIM awareness and knowledge among the respondents and this has proven the research of Teo (2012), which stated that Malaysia construction industry does have BIM-benefit awareness and potential for emergence of BIM-implementation readiness, and the research of Enegbuma and Ali (2011) who highlighted the existence of increased level of BIM awareness.

The majority of the SMEs in Malaysian construction sector are highly familiar with the paper-based formats, 2D drawings in pdf files, printed drawings and documents as well as the 2D CAD formats. Only a minority of them are familiar with 3D CAD formats and none of them uses BIM tools, models and project models, which means that the utilization of 4D BIM and onwards is not observed. This puts the implementation level of BIM among the SMEs within Malaysian construction sector between Level 0 and Level 1, which is considered to be at an early stage only.

The most critical barrier that should be brought to attention is largely related to cost issues, as shown in Table 2. The SMEs within Malaysian construction sector seem to be facing difficulties with the affordability of BIM, be it in terms of software and hardware costs, start-up costs, training costs or upfront expenses. Moreover, the attitude of the stakeholders are found to be rather sceptical towards BIM, which further hinders its implementation progress. The insufficiency of government involvement are also found to be bringing adverse impacts to BIM implantation among SMEs within Malaysian construction sector. In addition to this, the lack of sufficient BIM knowledge, BIM education and BIM expertise in a fragmented nature of the industry, where the stakeholders with diverse objectives and requirements feel content with the current traditional practices,

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eISSN: 2600-7920
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intensifies the restricting force against the successful implementation of BIM among the SMEs within Malaysian construction sector.

To assuage the criticality of the barriers that are preventing the SMEs within Malaysian construction sector from adopting BIM, the most vital solution that should be offered is the initiatives. Initiatives can be provided in the form of seminars, conferences, roadshows, campaigns, workshops, awareness programs, motivation programs, training sessions, BIM standard guidelines, certification, accreditation, pilot projects, periodical or pay-per-use BIM-licenses. Secondly, the most effective solution that should be supplied is the incentives. For instance, the government could provide more of the special discount rates and prices to use, train, or educate BIM; reward those who use or register BIM; and provide more financial assistance to implement BIM. Lastly, the SMEs within Malaysian Construction sector who are keen to implement BIM should consider conducting their own research and development, where they could invest in the pilot projects; develop and set up research teams; self-educate and train staffs; or adopt BIM phase by phase such as 2D BIM to 3D BIM, then 3D BIM to 4D BIM and so on.

All in all, it is safe to infer that although there is a mixture of interest and resistance currently, SMEs in Malaysian construction sector has a great potential for BIM growth in the future. Only if the solutions most required by them are provided and the biggest obstacles that are challenging them are eliminated, will the SMEs from the Malaysian construction sector be able to fully utilize BIM to its utmost potential, through the transition from the traditional practice to this cutting-edge technology, to bring profound benefits to the nation's economy and development progress.

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Table 1: BIM Implementation Level of SMEs within Malaysian Construction Sector

Formats/Systems Used	BIM Implementation Level	No. of Respondents	Percentage (%)
With lack of CAD coordination, the primary data exchange mechanisms used at this stage are mostly paper-based formats and 2D-generated formats such as Pdf extensions.	Level 0	5	5.2
Coordination of 2D or 3D CAD with a collaboration tool such as Extranet where at least a common database environment is present, likely with some standard data structures and formats established.	Level 1	91	94.8
Coordination of 3D environment using 'BIM' models and tools. Primary data exchange mechanism is based on proprietary exchange formats. In this stage, program data from 4D and cost data from 5D may be involved.	Level 2	0	0
A single BIM project model with completely open process whereby data integration and exchange principles are based on IFC standards and the entire process is managed via a collaborative model server.	Level 3	0	0

eISSN: 2600-7920
INTI JOURNAL
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Table 2: Barriers of BIM Implementation in SMEs within Malaysian Construction Sector

Barriers	Rank	RII	SD	Variance
Cost (e.g. expensive software & hardware costs, high start-up cost, training cost, upfront expenses)	1	2.167	1.862	3.467
Attitude (e.g. people's mindset and opinion, mistrust and reluctant to use BIM)	2	3.396	2.464	6.073
Government Involvement (e.g. lack of BIM enforcement as a contractual or tender requirement; standard form of contract issues, legal issues, lack of BIM standard guidelines)	3	4.677	2.085	4.347
Awareness (e.g. lack of BIM knowledge, lack of awareness and information about BIM)	4	5.542	2.839	8.061
Expertise (e.g. lack of skill/training/experience in BIM)	5	5.604	2.573	6.621
Nature of Industry (e.g. fragmented nature; lack of trust from stakeholders with different objectives, working practices; and lack of collaboration or corporation)	6	5.729	1.928	3.715
IT (e.g. BIM's software/hardware issues/requirements/rooms for improvements)	7	6.219	2.531	6.404
Personnel (e.g. issues related to stakeholders)	8	6.885	2.671	7.134
Contentment (e.g. does not require BIM; believing that current working practices are working fine and cannot be replaced by BIM; comfortable and satisfied with traditional methods)	9	7.208	2.423	5.872
Education (e.g. lack of BIM education in university on importance, existence, benefits and consequences of BIM)	10	7.573	2.338	5.468

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CONCLUSION

In a nutshell, the research can be concluded that although the extent of BIM implementation level among the SMEs within Malaysian construction sector is only between Level-0 and Level-1 where the use of paper-based formats and 2D CAD formats are the most predominant, the awareness towards the existence, use, and benefits of BIM do exist among them. The barriers, among many, that are jeopardizing the successful implementation of BIM are largely related to cost, attitude, and government involvement issues. Should the aforementioned barriers be controlled appropriately, there is a potential growth of BIM in the future among the SMEs within Malaysian construction sector since there are indications of the existence of interest towards BIM.

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