ACTIVATION TRIGGER FOR ORGANISATIONAL BIM LEARNING: VIEWS FROM MALAYSIAN CONSTRUCTION STAKEHOLDERS

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Building Information Modelling (BIM) is one of the current initiatives by the construction industry to escalate the performance and productivity in managing construction projects. Despite various initiatives that have been taken to encourage construction organisation to adopt BIM in Malaysia, the response remains unfavourable. As part of a wider study to understand the concept of Absorptive Capacity (AC), this study aims to explore the critical activation triggers for construction organisations in Malaysia towards BIM learning. Data were gathered and analysed quantitatively and qualitatively through a questionnaire survey and semi-structured interviews research method involving a wide range of construction organisations. The findings revealed that the top five activation triggers were; initiatives by construction constitutional bodies; BIM standard manual and guidelines; appointment of well experienced BIM manager; established BIM monitoring unit and opportunity for collaboration and susceptible to new environments using BIM. The study gives an initial insight on what it takes to drive Malaysian construction organisations towards BIM implementation. Future research is recommended to further explore the other elements of AC in developing a framework for BIM learning among local organisations.

Keywords: absorptive capacity, organisation, Malaysia

INTRODUCTION

Poor project delivery is one of the main issues in the construction industry in Malaysia. This issue associated with problems of fragmentation, including the isolation of professionals, lack of coordination between design and construction and as it is carried out in a sequential manner, it leads to time delays, poor communication, conflicts and misunderstanding between design consultants and contractors (Nawi, Lee, Kamar and Hamid, 2012). Building Information Modelling (BIM) can be seen as a solver in tackling these problems and thus bringing the much needed improvements in the construction industry. BIM technology can be utilized to enhance construction project performance in all stages of construction namely planning, design, construction as well as maintenance and operations of buildings (Hamid and Embi, 2016).

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Despite many advantages of BIM, the usage of BIM in Malaysia is still at infancy stage. Like other developing countries, the adoption of BIM is still in the discussion on the boundary of Government mandate, software usage, policies and standards, education, possible drivers and barriers of implementing the technology (Ismail, Chiozzi and Drogemuller, 2017).

BIM in Malaysia started in 2010, where the National Cancer Institute became the first government project to implement BIM (Latiffi, Mohd, Kasim and Fathi, 2013). In year 2012, the Public Works Department (PWD) formed the Project unit under the complex project division, also known as PROKOM, which consists of architects, civil and structural engineers (CandS), mechanical and electrical engineers (MandE) as well as quantity surveyors (QS). The first BIM guideline for projects intending to use BIM was published by PWD in order to encourage the usage of BIM amongst construction practitioners.

However, although the relevant constitutional bodies have introduced measures to increase the usage of BIM in Malaysia, these efforts have not been very successful due to lack of involvement from construction stakeholders. This is mainly due to lack of awareness, which could be overcome through training and seminars on BIM (Latiffi, Brahim and Fathi, 2016) (Harris, Ani, Haron and Husain, 2014). Construction stakeholder's organisation have had difficulties for various reasons in acquiring and using BIM technology for more effective project delivery. Based on BIM report 2016 by Construction Industry Development Board (CIDB) (CIDB, 2017), the readiness levels of BIM among the construction players in Malaysian is low due to lack of clear policies and financial incentives to support the implementation of BIM.

On the other hand, some organisations may simply be unaware of the potential of BIM to improve the process in their construction projects. To enhance BIM implementation, it is crucial for the top management as decision makers in an organisation to first realise the potential of BIM (Latiffi *et al*., 2016; Harris *et al*., 2014). Nevertheless, a strategic model is required to assist construction players in implementing BIM in construction projects as it will lead to improved cooperation among BIM practitioner and for researchers to educate and expose BIM (Latiffi *et al*., 2016; Harris *et al*., 2014). Incentives can also be introduced to increase demand on application of BIM in their project.

To enable a better understanding of BIM implementation in construction projects, Absorptive Capacity (AC) concept can be used as a strategic model in assisting the construction stakeholders to recognize knowledge on BIM and its implementation. According to Cohen and Levinthal (1990), the new knowledge application and implementation is to be reviewed in terms of the concept of knowledge source, driven factor and the organisation performance. The AC concept is a systematic approach of organisation behaviour study on individual, group, firm and national levels of a new knowledge adoption to enhance their process and productivity (Cohen and Levinthal, 1990). In the case of BIM implementation, AC serves to provide an additional approach to see the overall implementation beginning with recognizing the knowledge of BIM, what motivates the organisation to implement BIM, its activation triggers and how the organisation assimilate this new knowledge. Hence, producing a better result will further encourage the construction stakeholders to utilize BIM at their own capacity as required by their top management or other relevant parties in the construction industry. One of the elements that give a significant impact on AC of

BIM implementation is the Activation Trigger. This paper will discuss the factor that activated BIM implementation among Malaysian Construction Stakeholders.

The activation trigger is defined as an event that encourage or compel a firm to respond to specific internal or external stimuli. In a product innovation research by Kocoglu, Akgün and Keskin (2015), activation trigger is a dynamic element of AC that is presented as influencing the responses a firm gives to external stimuli, such that enabling the firms to achieve intensified learning skills and efforts. In the construction industry, BIM can be seen as a push factor in escalating the performance and productivity of construction projects. As for the implementation of BIM, CIDB plays a significant role to educate and increase the awareness on BIM in order to encourage all the construction stakeholders to implement BIM in their construction project.

Building Information Modelling In Malaysia

According to Latiffi *et al*., *(*2013), the idea of implementing BIM in Malaysia was introduced by the Director of Public Work Department (PWD) in 2007. In August 27 of the same year, PWD committee was formalized by the government to decide on BIM platform based on the availability of computer systems and software. BIM is briefly defined as a process supported by a technology of computer software generated model used in both to populate information and simulate the construction stages including planning, design construction and operation of facility management (Takim, Harris and Nawawi, 2013). BIM is known as the new technological approach software which provides an integrated accomplishment and able to improve the client satisfaction on time, cost, safety and functionality of construction projects (Takim *et al*., 2013).

According to Takim *et al*., *(*2013), one of the Malaysian government agenda in the 12 National Key Economic Area (NKEAs) under the Economic Transformation Program involves upgrading and escalating business growth in the architectural, engineering and construction industry. It aims to comprise selected sectors of economic opportunity for private sector, which will drive Malaysia towards high-income status and global competitiveness.

The government of Malaysia plays the principal role to ensure successful BIM implementation in the industry through the constitutional body, which is CIDB and PWD (Latiffi, Brahim, Mohd and Fathi, 2014). Thus, the benefits include having an integrated software application and standardisation for achieving operative workflow for progress and application of a project (Harun, Samad and Haron, 2016). The massive potential that BIM has on solving problems of construction projects, have prompted the government to put great efforts in encouraging the stakeholders to implement BIM throughout the project lifecycle (Latiffi *et al*., 2014).

Examples of BIM projects in Malaysia are National Cancer Institute of Malaysia located in Putrajaya, Educity Sport Complex in Nusajaya and Ancasa Hotel in Pekan, Pahang (Mohd and Ahmad Latiffi, 2013). All of these projects are pilot projects initiated by the PWD (Harun *et al*., 2016).

The PR1MA Corporation Malaysia has initiated BIM through their development of affordable residential house to deliver quality houses (Harun *et al*., 2016). The Multimedia Super Corridor (MSC) have also invited undergraduate students and organisations for training on BIM, covering BIM guidelines and utilization of BIM tools (Latiffi *et al*., 2014). Similarly, according to Latiffi *et al*., *(*2014), Construction

Research Institute of Malaysia is also providing education and training on BIM in order to create awareness and readiness to implement BIM among construction stakeholders.

The focus of CIDB currently in improving the construction industry is through the implementation of BIM under its productivity P4 initiative "Construction Industry Transformation Programme (CITP 2016-2020)" which is to roll out technology advantage across the project life cycle. Under this initiative, CIDB facilitates BIM adoption in the construction industry via regulations and to establish a reference centre to support the development and adoption of BIM and modern methods.

Although all the initiatives played by constitutional bodies in encouraging the construction industry player using BIM, the usage is still low as majority of the stakeholders still prefer traditional approach to execute construction project. Implementing BIM without knowing the benefits and how to deliver project-using BIM may result in project delay, major changes during construction and other issues. To relate to this situation, Mohd Harris Ismail Director of building SMART Malaysia in May 2018 wrote an article entitled understand BIM-what kind of result, emphasising that BIM should be used to deliver project not the other way around. The study on AC enables the organisation to gauge their overall capacity and the organisation in implementing BIM.

Absorptive Capacity of BIM Implementation

AC was first defined by Cohen and Levinthal (1990) as a firm's ability to recognize the value of new information, assimilate it and apply it to commercial ends. Osman, Mazlina, Khuzzan and Razaksapian (2015), stated that a strong AC in an organisation will improve the productivity of an organisation by synchronizing peoples' capabilities, processes involved and technology used.

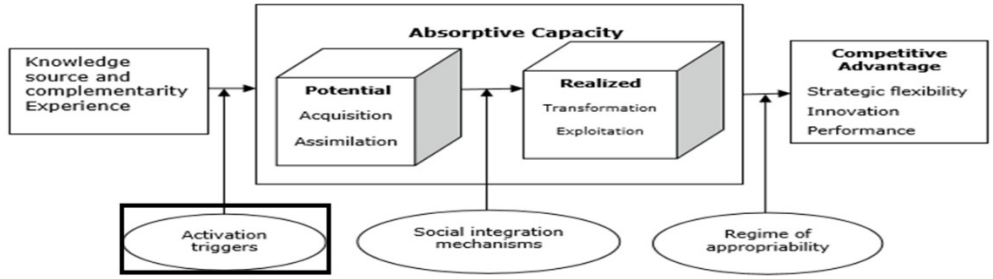

Figure 1: A model of an AC (Zahra and George, 2002)

Based on model of AC develop by Zahra and George (2002), the firm's potential AC influence by external knowledge sources which is experiences. They also added that, external knowledge and experience from past projects is not sufficient to create an AC development in an organisation. The model signifies that activation triggers have the biggest impact to an organisation in development of AC.

AC is divided into two component subsets, which are potential AC (PACAP) and realized AC (RACAP) PACAP, involves acquisition and assimilation of the knowledge. Between both PACAP and RACAP, social integration mechanism is developed based on the communication skill of the top management on how they deliver the knowledge to the staffs in application of the new knowledge. Reducing the obstacles for information sharing is one of the aim in a successful AC development. Transformation and exploitation lies under component subset of RACAP (Gluch, Gustafsson and Thuvander, 2009). Gluch *et al*., *(*2009), further simplify that

transformation defines as organisation's ability to develop and clarify the routine of new environment. In sense of BIM implementation, the organisation needs to synchronize routine by incorporating recent knowledge and to apply it throughout the operation and practices. Likewise exploitation, the theory behind BIM implementation reflects the organisation's ability to exploit the knowledge and assign it as common practices (Mustafa Kamal and Flanagan, 2012). AC provides the theoretical basis for comprehensive understanding of the usage of new knowledge to be implemented in the company (Park, Suh and Yang, 2007) A research concluded by Belso-Martínez, Expósito-Langa and Tomás-Miquel (2016) a company with a low AC tend to be left on the side-lines and face greater difficulties in accessing valuable technical knowledge. According to Saša and Andy (2018), diversity of knowledge is critical for potential AC, knowledge overlap is critical for realizing AC.

There is a strong basis to develop the AC of a construction organisation in the process of adopting a BIM as a new knowledge in the construction project execution. The external knowledge in AC is referred to BIM implementation among construction stakeholders. For example, how the construction stakeholders managed to handle the BIM knowledge and apply it to the construction project with compromising the project. To relate to Zahra and George (2002) model, regime of appropriability defines as the organisation ability on protect and value their new product of BIM where all the advantages comply in regime of appropriability being maintained. Lastly, according to Gluch *et al*., *(*2009), an organisation with well-developed AC will create business advantages through innovation and technological advanced. For example, for a company to sustain in this construction industry, it is crucial to enhance the performance of working environment for positive effects to the company. Once the company has positive effects, it will improve productivity as well as integrity of the company (Kamal, 2013).

Activation Trigger of AC in BIM Implementation

Activation triggers of AC are approached through studies on the role of internal and external innovation intermediary in technology transfer and diffusion (Todorova and Durisin, 2007). Two main roles played by different stakeholders using BIM are described in the triggering phase of AC. Firstly, it is a modern tool that is proven to benefit construction stakeholders' organisation as usage of BIM in construction project improves coordination of all discipline. Secondly, are the roles of BIM consultants or BIM manager as coordinator to capture and to solve design issues before getting to the construction stage. The other mechanisms that are directly related to knowledge and activated differently, the triggering sequences are (1) selection (2) adoption (3) contextualization and (4) preservation of knowledge (Servajean-Hilst and Picaud, 2014). These mechanisms affect the AC on BIM implementation in Malaysia.

The selection of a BIM tool to be used in the construction project execution is based on construction project lifecycles. The activation trigger relates with the process of coordination of all discipline in one project which my result in the project delivery effectiveness and efficiency. Furthermore, BIM is adopted due to its capability that suits to the construction stages appropriability. Encouraging factor in adopting those BIM tools is based on the project needs. Thus, the guideline develop by constitutional bodies is to assist the assimilation of new knowledge in enhancing productivity. Selection of relevant BIM tools to be used at every stage of construction is crucial. For example, in design stage the BIM design tools must be able to cater respective

fields and to enable coordination of all the design. This improves the Bill of Quantities (BQ) accurateness for the tender process. Preservation of knowledge is required to achieve the productivity and efficiency in project implementation and to enhance it further. BIM knowledge in project execution is preserved to maintain the momentum of the construction industry. Internal knowledge is also preserved by innovation to enhance the overall process in the long-run.

RESEARCH METHOD

The research is conducted by linking the concept of AC from previous studies by various industry in measuring their movement toward a new knowledge. The AC concept is used to study the movement towards BIM implementation in construction projects in Malaysia. The element of activation triggers is a dynamic element in AC presented as influencing the response a firm gives to external stimuli, such that enabling the firms to achieve intensified learning skills and efforts (Kocoglu *et al*., 2015). Zahra and George (2002) model is used as a basis to explore BIM where is starts with the external knowledge source and experience on BIM implementation. This is followed by awareness on the potential of BIM by acquisition and assimilation element. The organisation will then realize BIM implementation by transformation. Finally, the output of BIM implementation is the business advantage by a better performance in project execution. The most important element is the activation trigger where it is a dynamic element prior to BIM implementation. Activation triggers of BIM implementation among construction stakeholders is an important element in the AC as this is an indicator on what trigger the stakeholders to use BIM at the first place. BIM implementation is a continuous and inter-related process among construction stakeholders. Therefore, the feedback from various stakeholders in different stages of construction is required.

Data were gathered and analysed quantitatively and qualitatively through a questionnaire survey and semi-structured interview research method involving the range of construction organisations to identify activation triggers for BIM implementation among the construction players. The survey questions were designed based on literatures on BIM in the Malaysian Context by gathering all trigger factors on what makes the construction players use BIM. A total of 89 respondents responded to the survey from all construction stakeholders' organisations namely architect, engineering consultants, contractor and quantity surveyors (Table 1). The analysis is based on relative important index (RII) and mean ranking of a Likert scale of RII. The Activation trigger is first quantified by the relative importance index (RII) method prior to mean ranking.

Data is further comprehended using semi-structured interview question and the analysis using content analysis to correlate with questionnaire result by broader patterns of meaning in interviews answers. Semi-Structured interview allowed the discussion on the BIM progress in Malaysian context. The first theme identified from interview analyses relate to their opinion as representative of the organisation what motivates their organisation to use BIM was based on appropriability of the tools and the benefit on BIM in construction project execution. Based on the content analysis, the similarity on the statement given by these three respondents is mapping to the result of survey on RII and Mean ranking. The enquiries are to comprehend the questionnaire data on activation triggers in adopting BIM in Construction project. The findings are revealed through analysis of interview sessions and the survey from construction stakeholders on what motivates them to used BIM.

Table 1: Population size and respondents

Construction Stakeholders	Description	Population size	Sample size required	response	%
Contractor	Registered with CIDB	1744	315	13	4.13
Architect	Registered with Ministry of Finance Malaysia	152	109	33	30.28
Quantity Surveyor	Registered with Board of Quantity Surveyors Malaysia	132	98	29	29.59
Consultant	Registered with Ministry of Finance Malaysia	312	171	14	8.19
Total				89	72.18

RESULTS AND DISCUSSION

Table 2: Comparison RII and mean ranking of Activation Trigger of BIM Implementation

No	Activation Trigger	Mean	Ranking	RII
1	Construction Industry Development Board (CIDB) initiative approach by providing BIM Portal, Seminar and Workshop	4.16	1	0.831461
2	Public Work Department initiative approach for preparing BIM Standard Manual and Guidelines for construction stakeholders	4.13	2	0.826966
3	Establishment of BIM Unit Projects by Complex Project Management Branch (PROKOM)	4.08	3	0.81573
4	Well experience of project manager handling construction project	4.08	3	0.81573
5	Opportunity from other parties to collaborate implement BIM in construction project	4.07	4	0.813483
6	Susceptible to new environment of construction phase	4.02	5	0.804494

Table 3: Mapping of Interview and Questionnaire Result

Interviewee	Stage of Construction	Activation Trigger (Interview)	ranks	Top 5 Activation trigger (Questionnaire)
Respondent 1 (Client firm)	All Stage	The Awareness on the movement toward BIM by Constitutional bodies such as CIDB and PWD.	1	Construction Industry Development Board (CIDB) initiative approach by providing BIM Portal, Seminar and Workshop
			2	Public Work Department (PWD) initiative approach for preparing BIM Standard Manual and Guidelines for construction stakeholders
			3	Establishment of BIM Unit Projects by Complex Project Management Branch (PROKOM)
Respondent 2 (Engineering Firm)	Design Stage	The benefit of solving the issues in design stage by coordinate all discipline in the project before goes to awarding the tender to the contractor	3	Well experience of project manager/BIM consultant handling construction project
			4	Opportunity from other parties to collaborate implement BIM in construction project
Respondent 3 (Engineering Firm)	Construction stage	The Industry Foundation Classes (IFC) format of drawing can be used to visualize the building in 3D. it benefit to all the stakeholders in term of visualization. Enhance the construction method that contributes to better planning.	4	Opportunity from other parties to collaborate implement BIM in construction project.
			5	Susceptible to new environment of construction phase

Based on the relative important index (RII) and mean ranking analysis, the top ranks Activation Trigger of AC (ATAC) of BIM implementation in construction project was the initiative of Construction Industry Development Board (CIDB) by providing BIM Portal, seminar and workshop. That factor is supported by several authors. According to Takim *et al*., *(*2013), the technical committee and workshop formed by CIDB is the initial effective initiative to discover the technical limitation in implementing BIM in construction industry. The other author, which is Bin Zakaria *et al*., *(*2013), state that the government through CIDB could promote the benefits of BIM thus directly can spark the curiosity about BIM among construction stakeholders as individual and as an organisation. A research concluded by Park *et al*., *(*2007) effective knowledge transfer requires an individual to understand acquired knowledge in the new context and synthesize it into their task environment.

The other ATAC of BIM implementation in construction project lies in second ranks was a Public Work Department initiative approach to prepare BIM Standard Manual and Guidelines for construction stakeholders. The statement is quite similar with (Bin Zakaria *et al*., 2013) which government through PWD should provide grant scheme for BIM training. According to Latiffi *et al*., *(*2013), the encouragement from government to initiate the BIM implementation can be increase by providing training and appropriate guideline for BIM as one of the condition imposed in project documentation tender. The ranks followed by the establishment of BIM unit by PWD lies in third rank and same par as the roles of BIM manager and BIM consultants in handling project-using BIM. The fourth and fifth activation triggers ranked by respondents are the opportunity in collaboration among parties involve in construction project and susceptible to new environment of BIM implementation in construction project, respectively.

The ATAC of BIM implementation activated by the construction project is a sign that their level of awareness and understanding on BIM is high and parallel to the government's direction towards the executions of the project using BIM in enhancing the project delivery in terms of productivity, efficiencies and effectiveness toward triple constraint of the construction project. The BIM movement driven by CIDB and PWD as the constitutional bodies in Malaysia that governs and provides further direction to the construction industry in increasing its effectiveness in the project execution.

CONCLUSIONS

The AC concept starts with external knowledge source and experience on BIM implementation. Prior to implementation of BIM, the activation trigger is the most important element for an organisation to realize the potential of BIM and implement it in their organisation.

This paper presented the top five (5) activation triggers in AC study that drives Malaysian Construction stakeholders to adopt BIM in their construction projects. It can be concluded that the constitutional bodies in Malaysia namely CIDB and PWD have a major role in providing the awareness and support that can further activate the adoption of BIM amongst construction organisations. The role of BIM managers or BIM consultants are also among the top of activators of BIM implementation in Malaysia. The opportunity to collaborate in the coordinating process and susceptibility of the new environment during construction project execution among various disciplines in a construction project is also another activator of BIM implementation in Malaysia.

Knowledge and awareness on the potential of BIM, is the major activation trigger of BIM implementation among construction project stakeholders, which is driven by CIDB and PWD. Constitutional bodies in Malaysia act as external intermediaries that facilitate the knowledge transfer across people, organisations and industries via linking BIM knowledge bases and helping the recipient and the source to transform the transferred knowledge. This will be followed by the execution of the project by experience project managers and BIM consultants that will further initiate collaboration across all discipline in the construction project.

With the fact that the takers of BIM are still limited, the role of the constitutional bodies namely CIDB and PWD are ranked as the top activation trigger of BIM

implementation in Malaysia. In future, the activation trigger will change as the BIM takers increases among construction industry players.

The AC approach can be applied to study BIM knowledge of individual, group, firm and at national levels. The government and all other construction stakeholders can use the AC concept to explore the BIM potential at their own capacity of discipline in construction project. This will further contribute to BIM awareness systematically and increasing the maturity level of BIM implementation in Malaysia.

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