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Evaluating the Influence of Training on Attitudes to Building Information Modelling (BIM) Adoption in Malaysian Construction Industry by using Extended Technology Acceptance Model (TAM)

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Abstract. The adoption of Building Information Modelling (BIM) as technological advancement in the construction industry has become a main concern among its stakeholders. Research and expert advice have claimed that the BIM adoption rate can be increased by giving an in-depth understanding in the importance and benefits of BIM implementation. Training is one of potential factors that could expedite the adoption of BIM. BIM training is a significant aspect in BIM implementation due to its role not only to expand the knowledge, but also as a means of facilitating BIM adoption. Therefore, the aim of this dissertation is to investigate the influence of BIM training on attitudes to BIM implementation among Malaysian construction players by using extended technology acceptance model (TAM). The beliefs of ease of use, usefulness and employee resources were utilised as TAM variables for explaining the relationships between training variables and behavioural intention to use. In order to achieve this aim, an online survey was conducted among professional employees of government agencies. The findings demonstrated that extent of training was not related to TAM variables suggesting that a high amount of training would not positively affect the BIM adoption. In addition, TAM variables had significant positive relationships with behavioural intention to use. Finally, this study suggested the perspectives of ease of use, usefulness and employee resources should be taken into consideration by training organisers in organising BIM training in order to create an effective training that can facilitate BIM adoption.

Keywords: Building Information Modelling(BIM), BIM Training, BIM adoption, Extended Technology Acceptance Model

1 Introduction

Despite of BIM popularity in Malaysian construction industry, the utilisation of BIM among construction players is still at the lower level as they perceive BIM as a new technology (Zakaria et al., 2014). BIM adoption in Malaysian construction industry is very low (Memon et al., 2014), stagnant (Zakaria et al., 2013), and limited in term of implementation (Gardezi et al, 2014). Embracing and adopting BIM has encountered a number of barriers which include the reluctance of changing current work practice (Johnson and Laepple, 2003), lack of clarity on responsibilities and roles (Holzer,

2007) and lack of training (Bernstein and Pitmann, 2004). In Malaysia context, training is becoming a significant factor that affect BIM adoption. Lack of BIM knowledges (Zakaria et al., 2013), lacked of trained people (Baba, 2010; Rogers et al., 2015) and lack of training (Rogers, 2013) are several major barriers that are related to BIM training in Malaysia construction.

The awareness of BIM in Malaysian construction industry has grown rapidly (Hussain et al., 2015) and the Malaysian construction players have started utilising BIM in their project management especially the high profile construction projects. However, the utilisation of BIM technology by construction players is not widely used and is still at the early phase (Hussain et al., 2015). The initiative of BIM implementation in Malaysia was a consequence of the government's awareness of the BIM benefits to handle the construction project issues in design and construction phase and to control the project cost. The government took a step forward by forming a committee which will responsibly select the best BIM platform to be used and identifying suitable projects as BIM's pilot projects. Also, preparing BIM standard manual for the use of construction players as a guideline.

2 Literature Review

There are many organisations actively involved and provide BIM training to Malaysian construction players. These organisations consist of government agencies, professional bodies (architect, engineer and quantity surveyor) and private organisations. Nonetheless, the focus is more on BIM training provided by government agencies, namely the Construction Industry Development Board Malaysia (CIDB) and the Malaysian Public Work Department (PWD). This is because both agencies have significant roles in designing and organising BIM training and these organisations also are the most active organisations in providing BIM training in Malaysia.

CIDB and PWD also organised an intensive training for practitioners who want to deepen their knowledge and skill of BIM in greater depth, particularly for the use of BIM software called technical training. The key purpose of technical training is to convey the right techniques and tools in the use of BIM and train participant to practice BIM software during the training or workshop to ensure the participant can effectually adapt the use of BIM software and apply the BIM in their work efficiently, thus, eventually improve their work performance. This training has been carefully designed to ensure that every training programme provided suits the participant's professions such as architects, engineers and quantity surveyors accordingly. The example of technical trainings provided by CIDB and PWD are Autodesk Navisworks, Revit Architecture Essential, ArchiCAD, Revit MEP and Revit. BIM, as one of the emerging IT application in construction, has grown exponentially and being used widely in many countries in designing, construction and operating the facilities (Wong et al., 2009).

Construction Industry Transformation Plan (CITP) 2016 - 2020 is a Malaysian agenda to transform construction industry and has highlighted several challenges of

BIM implementation in Malaysia. The challenges include; a) lack of skilled personnel who is competent and has capability in using BIM effectively and, b) lack of proper training by the local authorities and have a little knowledge of BIM. Additionally, lack of training is a major barrier in attaining satisfactory level of BIM adoption (Memon et al., 2014; Zakaria et al., 2014). Thus, a proper training has to be designed and properly provided to ensure participants could gain adequate BIM knowledge and skill which eventually lessen the resistance from people in the BIM adoption (Pfitzner et al., 2010).

Apart from the mentioned issues, another major issue that can be related to BIM training is the lack of awareness of BIM potential benefits in BIM implementation (Gu and London, 2010; Talebi, 2014). Latiffi et al. (2013) stated that the awareness of BIM benefits among construction players is important to improve the construction processes. There is a lack of understanding on the integration between BIM technology and current work practice. According to Gu and London (2010), there is a frequent misunderstanding among participants in BIM concept that the work practice has to be totally changed in order to adopt BIM approach. Fundamentally, this is due to BIM users fail to notice that the use of BIM approach is utilised for only parts of the project implementation to meet the project requirement.

Training is an organisational environment which is related with success of technology implementations. Marler and Dulebohn (2005) advocated at least two significant objectives could be attained from successful IT system training. Firstly, it facilitates potential users to be familiar with the use of the system and aid to diminish their anxiety and uncertainty. Secondly, which is the most important, the training programme can be used by organisations to convey the benefits of the new system to acquire users' acceptance and commitment.

For researches in BIM adoption, Son et al. (2015) and Yang (2015) have used extended TAM to examine factors that influence BIM acceptance in perspective of architect and facility management respectively. Both studies showed similar results which perceived ease of use and perceived of usefulness have significant positive relationship with behavioural intention.

3 Methodology

This research applied the quantitative approaches to examine the influence of BIM training on BIM adoption among construction professional in Malaysian construction Industry. The experience and opinions of the construction professionals are needed from the perspectives of those directly involved in the industry. In order to support the theoretical study and hyphotheses, a large number of primary data is collected and analysed. For the purposed of this study, questionnaire is used as a survey tool to collect adequate primary data. This method involves the design and management of an online questionnaire-based survey to professionals in construction industry. A total of 204 online questionnaires was received and have been completely answered by the respondents. Personal information in the answered questionnaire showed that the respondents consist of various professional backgrounds in the following proportions:

architecture (12%), civil and structural engineering (34%), mechanical engineering (18%), electrical engineering (10%), quantity surveyor (23%), building surveying (2%) and project management (1%). While, in term of respondent roles, there is slightly difference compared to their professional background as the followings: architect (12%), civil and structural engineer (30%), mechanical engineer (17%), electrical engineer (10%), quantity surveyor (22%), building surveyor (2%) and project manager (7%). The majority of respondents were from a range of low-medium level of working experience (1 to 15 years), making up 80% of the respondent.

3.1 Extended technology acceptance model (Extended TAM)

Extended TAM for technology implementation training invented by Marler et al. (2006) was utilised as a means for measuring the influence of training on behavioural intentions to use BIM. Marler et al. used this extended TAM for their research on technology implementation training to investigate the influence of training in helping acceptance of the technology by employees in mandated organisation-wide information technology implementations. This extended TAM asserts that perceived resource is an additional key belief together with ease of use and usefulness as internal variables that could mediate relationships between external variables and intentions to use a new technology (Mathieson et al., 2001). Marler et al., (2006 and Mathieson et. al., (2001) added that the perceived resources would contribute positive impact on intention to use a technology because it has a direct relationship with the potential barrier to use and organisational support. Thus, the extended TAM related to technology training is particularly focus on the specified external variables of extent of training and training reaction that affect the intention of use the technology with influence of internal belief of ease of use, usefulness, employee resources (Marler et al, 2006) as shown in Figure 1:

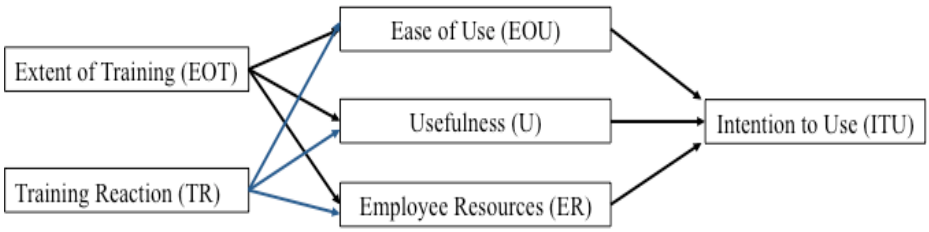

Fig. 1. Extended technology acceptance model (Marler et al.,2006)

TAM have been acknowledged to be the most accepted research model of information system among researchers, possibly due to its profusion of empirical study on IS/IT acceptance (Agarwal and Prasad, 1999). Extended TAM has been choosen as the research model because it provides sufficient information compared to the basic model regarding the relationship between training and intention to use BIM.

4 Results and Discussions

Table 1 highlighted the level of BIM awareness and its use. Although many researchers have analysed these matters, ongoing research is necessary to support the earlier results or find a new findings. From the survey, the results indicated that the level of BIM awareness is very high where 95% of the respondents are aware of BIM. On the contrary, the usage of BIM is very low where only 8% of the samples are currently using BIM and 10% of the samples have used BIM. These results are illustrated in Table 1.

Table 1. Level of BIM awareness and use

Item	Frequency	Percent
Aware and currently using BIM	17	8%
Aware and have used BIM	21	10%
Aware of BIM but have not used it	157	77%
Not aware of BIM	9	5%

The samples for this study consists of respondent who have attended BIM training and also who have not participated any BIM training. The result showed that 58.3% (n=115) have not participate any BIM training and 41.7% (n=89) have participate BIM training organised by PWD or CIDB. In the questionnaire, the respondent had been given opportunity to choose more than one training that they have attended either introductory training or technical training. From 89 respondents who have participated BIM training, 79% has participated introductory training and 50% has participated technical training

Pearson's correlation coefficient approach was employed to measure the linear relationship (correlation) between the variables in the research model. A pair of the variables in the hypotheses were tested in order to examine if there is a significant relationship between two variables in each hypothesis. In determining the level of significant correlation, the guide proposed by Evans (1996) was used to determine the significant level of value of r which consisting 'very weak' (0.00 - 0.19), 'weak' (0.20 – 0.39), 'moderate' (0.40 – 0.59), 'strong' (0.60 – 0.79), 'very strong' (0.80 – 1.00).

Table 2. Correlation coefficients

Variable	EOT	TR	EOU	U	ER	ITU
EOT						
TR	0.19					
EOU	0.17	.68**				
U	0.15	.58**	.68**			
ER	.30**	.49**	.50**	.57**		
ITU	.23*	.43**	.47**	.58**	.53**	

**Correlation is significant at the 0.01 level (2-tailed)

*Correlation is significant at the 0.05 level (2-tailed)

SPSS (version 22) was used to analyse the data from the survey to provide information for the significant correlation for all variables in order to test the hypotheses. Table 2 and Figure 2 demonstrated the results and it is clear that all the variables has either positive or no significant correlation.

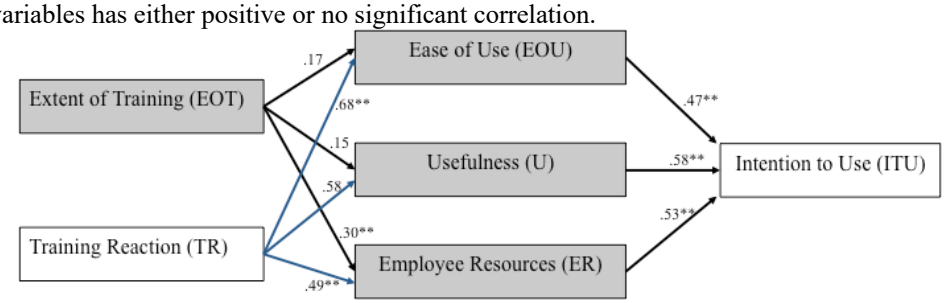

Fig. 2. Relationship between Training and TAM

4.1 Relationships between EOT and TAM variables (U, EOU and ER)

In voluntary context, the unsupported hypotheses (***H1a*** *– there will be a significant relationship between extent of training and perceived ease of use* and ***H3a*** *– There will be a significant relationship between extent of training and perceived usefulness*) have revealed that EOT does not predict perceptions of either EOU or U. In other words, the number of days training has no influence on EOU and U which might be explained with relation to characteristics of BIM adoption.

For perceived EOU, there is similarity between non-significant relationship with EOT in this study and those described by Marler et al. (2006). Furthermore, this finding also further support the idea of Agarwal and Prasad (1999) in their TAM research who have suggested training of new information technologies is lack of significance on EOU. To explain the reasons, they have specified that two possible explanation about their research results on graphical user interface (GUI) training. First, the training lacks effect due to the use of GUI is so easy and second, the reason was derived from previous study on GUI (Olfman and Mandviwalla, 1994) that found effectual GUI training is intrinsically hard to deliver. From the analysis, specifically, the lack of a relationship between perceived EOT and EOU is more puzzling as one might expect that more training would increase the trainees' confidence in using BIM.

For perceived U, this finding is in agreement with those of Marler et al. (2006) who found that EOT has no significant correlation with U in the context of mandated organisation-wide information technology execution. However, in contrast, Agarwal and Prasad (1999) found that there is a significant training's effect on perceived U as training might be used as a mechanism to spread new information technologies by its influence on beliefs. They also suggested training might have been influential in displaying users to the extra functions offered by the system. From the result of Agarwal and Prasad's study, it might be speculated that EOT had little opportunity to influence this perception due to the general benefits of BIM that were already considered to be high. Alternatively, another possible explanation is that the usefulness of BIM could not be covered at the early stage in any combination of

trainings and consequently subsequent additional days of training do not contribute further. As the BIM implementation is still in its infancy in Malaysia, it is likely that the individuals in the construction sector might not be able to see more positive results that can be achieved when using BIM. However, as only 18% of the respondents are currently and have used BIM, the BIM benefits might not be fully gained because most of the respondents are not directly involved in the use of BIM. As a result, they might lack of interest in learning BIM and only participating in training just to obtain a certificate of attendance.

As two previous hypotheses were not supported, the result of this study indicates EOT has a weak significant positive relationship with the ER (***H5a*** – *There will be a significant relationship between extent of training and perceived employee resources*). The finding supports previous research (Marler et al., 2006) into this relationship which links EOT and ER. It might means that EOT has positively influence participants by providing information regarding availability of support resources, timing of project execution and opportunities to be proficient in BIM implementation. Thus, in general, it seems that more training participation might lead trainees to allocate time for implementing BIM in their work and would try to access BIM documents such as manuals, circulars and online library. Meanwhile, the reason of weak significant relationship might be due to extra effort that should be put to be able to access of these documents, hence, could lessen behavioural ITU among the trainees.

5 Conclusions

Given that TAM variables demonstrate positive influence to behavioural ITU, the BIM training organisers should be sensitive to the current needs of the potential participants and not just provide the training to fulfil their training schedule. Although there was a weak significant positive correlation between EOT and ITU, as compared to the relationship between EOT and TAM variables, the number of days training may not be able to contribute a strong positive impact on the participants because the knowledge and skills they have learned in training were still unable to help them understand and explore the uses and benefits of BIM. Therefore, it could be concluded that possibly there is a lack of training quality in terms of content and trainer. With the view of BIM adoption in Malaysian construction industry, it seems that providing effective training programmes is essential to support the professional in using BIM efficiently. It is clear in the findings that professionals still lack intention in using BIM despite that they have participated BIM training. In stepping ahead to utilise BIM, government agencies and BIM specialist would be the most appropriate organisations to organise BIM training sessions for Malaysian professionals. As a result, an effective BIM training could be provided to the potential participants and conducted by experienced trainer.

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