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Behavioural Intention to Use Building Information Modelling (BIM) among Community College Students in Malaysia

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Abstract

Building information modelling (BIM) is one of the new technologies being used in architectural and constructions projects. At present, BIM curricula are being taught in many Malaysian higher learning institutions, including at the certificate level in community colleges. Even though many studies have investigated behavioural intention to adopt BIM in the industrial setting, studies on the intention to use BIM among students during their training or learning have not received the same level of attention. This study, therefore, investigated the extent to which community college students are willing to accept and use BIM. Factors that influenced their behavioural intention to use BIM, as well as the relationship between the factors and intention to use were also examined. The Technology Acceptance Model (TAM) was used as the theoretical framework to guide the research, where students' behavioural intention to use BIM was explained through their perceptions of its usefulness and ease of use, as well as their attitude towards BIM utilization in the classroom. A total of 144 community college students enrolled in the architecture programmes in Malaysia were selected as the sample using convenience sampling. The findings show that the students' behavioural intention to adopt BIM is high. They also perceive BIM as useful and easy to use, and their attitude towards BIM usage appears to be positive. The regression model produced an adjusted R-squared value of 0.790 indicating that 79% of the total variance in the students' intention to use BIM can be explained by the three independent variables, i.e., perceived usefulness, ease of use, and attitude.

Keywords: *Building information modelling, perceived usefulness, perceived ease of use, attitude, intention to use, behavioural intention, Technology Acceptance Model*

INTRODUCTION

In the field of architecture, building information modelling, or BIM, technology was introduced after the industries have tried many methods to reduce project costs, increase quality and productivity, and decrease project delivery time. BIM is seen as a potential solution to the many problems or concerns resulting from these issues (Azhar *et al.,* 2008). BIM is a form of digital documentation technology that amasses holistic data about the serial phases of a construction project spanning -- the different stages of design, construction planning, construction activities,

facility management, and operations. Kumar and Mukherjee (2009) stated that BIM is good for estimating, scheduling, coordinating design and visualising operation for the architecture, engineering and construction (AEC) industries. To realise BIM's potential in spurring the growth and development of the country, the Malaysian government decided to empower relevant agencies in the construction industry, including the Jabatan Kerja Raya (JKR or the Public Works Department), the Construction Industry Development Board (CIDB), and other professional bodies through the Construction Industry Transformation Programme (CITP) to adopt the technology. The move is hoped to elevate the productivity of the local construction industry, improving compliance with international standards, and turning it into a major contributor to the nation's economy by 2020 (Enegbuma *et al.*, 2014).

This development in the use of BIM has resulted in a growing need for skilled workforce and the implementation of mandatory agreements between governments and corporate organisations in construction projects. As the use of BIM in the industry continues to rise, the integration of BIM education in higher learning institutions, the main source or provider of skilled workforce, is critically needed. Memon *et al.* (2014) mentioned that one of the effective strategies to enhance BIM usage is through training and integration of BIM in the university curriculum. However, such a strategy has yet to be adopted widely in higher learning institutions.

Badiru *et al.* (2015) claimed that the teaching and training of BIM in higher learning institutions is still far from sufficient. On the industrial side, the number of available skilled workforces with BIM training is still low (Yusuf *et al.*, 2017). Becerik-Gerber *et al.* (2011) found that some educators viewed BIM as another form of a computer-aided design (CAD) programme that students should learn on their own instead of being treated as an increasingly important industrial practice. Not surprisingly, resistance to the use of new technology in teaching and learning among educators is identified as one of the major barriers to collaborative teaching practices in universities (Pressman, 2007). Given this context, this study sought to understand the extent to which students in Malaysian higher learning institutions are willing to accept and use new technology, such as the BIM, even when the educators are not showing as much interest in the technology as they should.

This study utilised the technology acceptance model (TAM) to understand students' behavioural intention to adopt BIM. Davis' (1989) TAM is a model that explains users' behavioural intention to use a particular technology by measuring perceived usefulness,]\perceived ease of use, attitudes towards using the technology and behavioural intention to use. Hence, this study investigated the levels of BIM's perceived usefulness, its perceived ease of use, and attitude towards its use, and examine their collective influence on behavioural intention to use BIM among Malaysian community college students.

Understanding the Technology Acceptance Model (TAM)

TAM is an expansion of the Theory of Reasoned Action (TRA) developed by Fishbein and Ajzen (1975) and is based on social psychology. The TRA proposes that two main constructs determine behavioural intention, namely attitude towards the behaviour and the subjective

norms associated with the behaviour. In short, a person's intentional behaviour is dependent on his or her attitude and subjective norms. Attitude is defined as a person's judgment of an act or object, and belief is the connection between an object and some attributes. The TRA postulates that a person's behaviour is the outcome of judgment and intention. For example, positive attitude is the result of positive judgment and positive intention. Behaviour also involves a person's decisions and the resulting outcomes of those decisions. The theory highlights the importance of attitude (i.e., judgment) in influencing behavior. On the other hand, subjective norm is a form of social pressure exerted on a person to perform a behaviour. It is the belief that people important to you will support your decision to perform or engage in a given behaviour. In spite of its predictive and explanatory power to explain behaviour, there are limitations to the TRA, one of which is its lack of explanation on the role of habits, cognitive and moral factors, and voluntary behaviour considerations in influencing behaviour (Otieno *et al.*, 2016).

Davis (1989) extended the TRA into TAM to include users' acceptance of a given technology, as shown in Figure 1. In this model, subjective norm was eliminated (Muk & Chung, 2015). TAM proposes that an individual's information technology adoption or intention to perform a behaviour can be predicted by their behavioural intention. Behavioural intention is defined as an individual's readiness to accept a given behaviour. The attitudinal constructs of perceived usefulness and perceived ease of use influence actual system usage. TAM also includes other constructs, such as external variables (e.g., user training, system characteristics, user participation in design, and nature of the implementation process) which are considered important elements in understanding behaviour (Lin, Fofanah, & Liang, 2011).

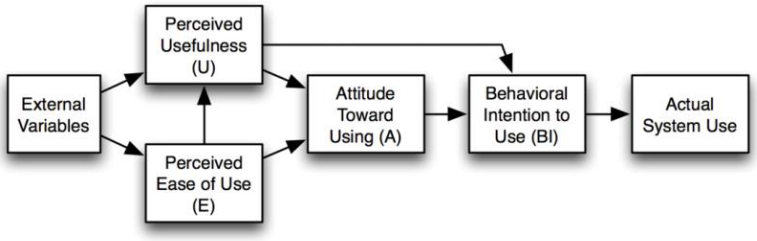

Figure 1: Technology Acceptance Model (TAM)

Perceived usefulness can be explained as a person's belief that using technology would enhance his or her task performance. Perceived ease of use refers to the user's perception of the amount of effort that he/she has to put in to utilise the system effectively. The model maintains that perceived usefulness and perceived ease of use have a direct influence on behavioural intention. Studies on BIM users' behavioural intention have shown that perceived usefulness and perceived ease of use significantly affect their attitude towards BIM usage (Wang & Song, 2017; Son *et al.*, 2014; Lee *et al.*, 2003; Merschbrock & Nordahl-Rolfsen, 2016). Thus, this study proposed that perceived usefulness and perceive ease of use would have a direct relationship with behavioural intention to use BIM.

Davis (1986) suggests that behavioural intention to use is mediated by attitude. Attitude is one's judgment, whether positive or negative, concerning the use of technology. TAM proposes that attitude has an indirect influence on intention to use. However, the construct of

attitude was not included as a mediating variable in the TAM2 model, developed by Venkatesh and Davis (2000). TAM2 instead theorises a direct relationship between the constructs and intention to use (Mun, Joyce, Jae & Janice, 2006). Previous studies also have shown that attitude could have a direct influence on behavioural intention. Therefore, this study proposed that attitude will positively affect the respondents' behavioural intention to use BIM. However, the conceptual framework used for this study differs from TAM or TAM2 in terms of the position of attitude as a factor that contributes to behavioural intention to use BIM (as shown in Figure 2).

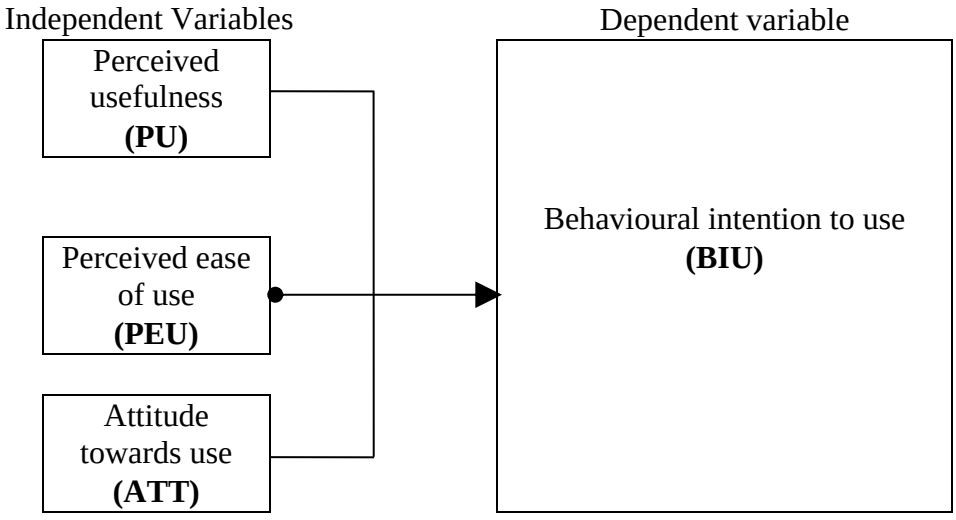

Figure 2: Conceptual Framework

The concept of intention is related to an act or an action. Islam views intention as being superior to action. Hassan (1981) argued that human beings are inherently good, meaning that they are inclined to do good with good intentions that will lead to good deeds. Furthermore, Al Syaibani (1979) explained that there is a strong relationship between intention and values. In this regard, the widespread use of information and computer technology can be beneficial for educational purposes, to transmit the knowledge of Islam and its teachings and to inculcate good values (Saifee, 2012). Islam promotes the search for knowledge and encourages innovations in science and technology. In this pursuit, the use of technology in education should not be separated from Islamic teachings, and should be aligned with the belief in God and divine values, morality and *adab* (Mustaffa & Rashid, 2019). Hence, every Muslim student and educator has a duty to learn the necessary *adab* and ethics of using new technology in accordance with Islamic teachings.

Objectives of the Study

The study has two main objectives. The first is to examine the levels of perceived usefulness, perceived ease of use, attitude towards BIM and behavioural intention to use BIM among the community college students in Malaysia; and the second is to examine the relationship between perceived usefulness, perceived ease of use and attitude towards BIM and the behavioural intention to use BIM.

METHODOLOGY

Research Design and Framework

This study followed the quantitative approach using the cross-sectional survey design. The study was based on a conceptual framework (see Figure 2) adapted from the Technology Acceptance Model (TAM) developed by Davis (1989). The constructs of perceived usefulness, perceived ease of use and attitude are the independent variables, while behavioural intention to use is the dependent variable. Therefore, all of the three independent variables are hypothesised to have a relationship with behavioural intention to use technology, which is referred to as an individual's inclination to adopt a given innovation or behaviour. Behavioural intention to use is postulated to be influenced by attitude, subjective norms and perceived behavioural control. An individual's evaluation of the performance effect of a particular behavior creates the internal drive or intention to do or not to do something.

Respondents

The population of this study was all community college students in West Malaysia that had registered for the Architectural Technology Programme and had been using BIM for 14 weeks. During the period that this research was conducted, there were approximately 300 students registered in this programme altogether. Nonetheless, it is not feasible to collect data from all members of the target population due to the constraints of time and cost. Thus, a sample was taken from the accessible population according to zone clusters. The community colleges were divided into four zones – north, east, south, and west—with 45 students selected from each zone using convenience sampling. A total of 144 students from all zones completed the questionnaires, consisting of 50 per cent male and 50 per cent female respondents. Table 1 presents the sample's demography.

Table 1
Sample Characteristics by Gender, Age and Zone (N = 144)

Demography		**Frequency (*n*)**	**Percentage (%)**
Gender	Male	72	50.0
	Female	72	50.0
Age	<18	2	1.4
	19-21	137	95.1
	>22	5	3.5
Zone	North	33	22.9
	East	34	23.7
	West	41	28.4
	South	36	25.0

Instrument

The instrument used in this study was adapted from Acquah (2017) which was originally meant for industry users. Modifications were made to suit the respondents who came from the background of education and had been using BIM as a tool for learning in the classroom. The original versions of the instruments were developed by Davis (1989) to measure perceived usefulness, perceived ease of use, attitude towards use and intention to use BIM. It consisted of 20 items measured on a five-point Likert scale, ranging from 1 (Strongly Disagree) to 5 (Strongly Agree). Table 2 shows some sample items for each of the variables as well as their reliability coefficients. Prior to its use in this study, the instrument was content validated by experts from the field of education and technology. The instrument was also pilot tested with a different set of students from the Kuantan Community College, and hence, these students were not included in the real sample.

Table 2
Content of the Instrument

Variable	Operational Definition	Sample Items	Cronbach's Alphas
Perceived usefulness	Community college students' belief that using BIM would enhance their task performance.	▪ Using BIM raises my chances to increase knowledge. ▪ The advantages of using the BIM outweigh the disadvantages of using other software.	0.957
Perceived ease of use	Community college students' belief that using BIM would be free of effort.	▪ Learning to operate BIM is easy for me. ▪ It is easy to use BIM to perform tasks on site or industrial training.	0.915
Attitude towards use	Community college students' attitude that influences their choice of action, and responses to challenges, incentives, and rewards towards the application of BIM for certain tasks.	▪ It is worthwhile to use BIM. ▪ Overall, I like the idea of using BIM.	0.946
Intention to use BIM	Community college students' evaluation of the performance effects of using BIM that creates the aim to use or not to use BIM.	▪ I will frequently use BIM in the future. ▪ I will recommend BIM for others to use BIM.	0.950

RESULTS

The results that address the study's two objectives are presented and discussed in two subsections.

Levels of Perceived Usefulness, Perceived Ease of Use, Attitude towards BIM and Intention to Use BIM among Community College Students

Table 3 shows the results (i.e., means and standard deviations) that address the study's first research objective, which was to examine the levels of perceived usefulness, perceived ease of use, attitude towards BIM, and behavioural intention to use BIM among the respondents, i.e., community college students in Malaysia.

Table 3
Levels of Perceived Usefulness, Perceived Ease of Use, Attitude towards BIM and Intention to Use BIM among Community College Students (N = 144)

Factor	Mean	SD
Perceived usefulness	4.15	.78
Perceived ease of use	3.82	.77
Attitude towards use	4.03	.85
Intention to use BIM	4.07	.96

The table shows the mean scores of behavioural intention to use BIM, and the factors influencing it. The mean scores of all the four factors range from 3.82 to 4.15, which suggests that almost all scores are high and confirm the respondents' agreement to the items measuring them. The mean score for perceived usefulness of BIM is the highest (M = 4.15, SD = 0.780), where the values indicate that the respondents agreed the BIM was useful. Their attitude towards using the BIM was also inclined towards the positive (M = 4.03, SD = 0.85). Additionally, the respondents agreed they had an intention to use or continue using BIM (M = 4.07, SD = 0.96). The lowest respondent agreement among the TAM factors was recorded for *ease of use*, where the respondents' perception of it almost bordered on the agreement that BIM was easy to use (M = 3.82, SD = 0.77).

Next, Table 4 summarizes the levels of behavioural intention to use BIM among community college students surveyed in this study. The results show that a majority of the respondents (75.1%; n = 109) demonstrated a high level of behavioural intention to use BIM, while 18.1% (n = 26) showed a moderate level of intention to do so. Only 6.3% of the respondents (n = 9) showed a low level of behavioural intention to use it. This finding makes sense when it is read with the levels of perceived usefulness, ease of use and attitude, all of which are high. The findings are in line with that of Aquach *et al.* (2018) which suggest that behavioural intention to use BIM among existing users tends to be high, rather than low or moderate.

Table 4
The Levels of Perceived Usefulness, Perceived Ease of Use, Attitude towards BIM and Behavioural Intention to Use BIM among Community College Students in Malaysia (N = 144)

Level	Perceived Usefulness		Perceived Ease of Use		Attitude towards Use		Intention to Use BIM	
	n	**%**	***n***	**%**	***n***	**%**	***n***	**%**
Low	8	5.6	8	5.6	8	5.6	9	6.3
Moderate	7	4.9	38	26.4	23	16.0	26	18.1
High	129	89.6	98	68.1	113	78.5	109	75.1

Mean indicators: low= <2.33; moderate= 2.34- 3.67; high >=. 3.68

Relationship Between Perceived Usefulness, Perceived Ease of Use and Attitude towards BIM and Intention to Use BIM among Community College Students

Table 5 shows the results of correlation analyses that address the study's second research objective, which was to examine the relationship between perceived usefulness, perceived ease of use and attitude with behavioural intention to use BIM among the community colleges students.

Table 5
Relationship Between Perceived Usefulness, Perceived Ease of Use and Attitude with Behavioural Intention to Use BIM (N = 144)

Factor	Behavioural Intention to Use BIM	
	R-value	**p-value**
Perceived usefulness	0.843	0.00
Perceived ease of use	0.832	0.00
Attitude	0.834	0.00

A set of Pearson product-moment correlation analyses was conducted to determine the relationship between the three independent variables (i.e., perceived usefulness, perceived ease of use, and attitude) and behavioural intention to use BIM as the dependent variable. As shown in Table 5, there is a strong and positive relationship between perceived usefulness and behavioural intention to use behaviour, where $r = 0.843$, $p = 0.00$. The results also indicate a strong and positive relationship between perceived ease of use and attitude with behavioural intention to use, where $r = 0.832$, $p = 0.00$, and $r = 0.834$, $p = 0.00$, respectively.

A multiple regression analysis (MRA) was performed to further investigate the contribution of the independent variables (i.e., PU, PEOU and ATT) to the variance in the dependent variable (BI), and to test a regression model that predicts the contribution of each independent variable towards explaining the variance in the dependent variable. The three independent variables, namely perceived usefulness (PU), perceived ease of use (PEOU) and attitude to use BIM (ATT) were entered into a multiple regression model to identify which among them would be significant predictors of behavioural intention. The final estimated multiple regression model indicates that all three predictors are statistically significant and account for 79% of the explained adjusted variance in behavioural intention to use BIM.

Table 6 shows the results of the MRA. The collinearity tolerance values of between 0.224 to 0.287 are acceptable and show that no adverse effects to the results are associated with the study's multiple regression model. This observation is supported by the VIF values of less than 5, which indicate the three predictors of the model are moderately correlated and free from the issue of multicollinearity.

Table 6
Predictors of Behavioural Intention to Use BIM: MRA Results (N = 144)

Variables	**Unstd Coefficient (B)**	**Std Coefficient (β)**	**t**	**p**	**Collinearity Tolerance**	**Statistic VIF**
Constant	-0.024		-0.136	0.892		
Perceived usefulness	0.326	0.303	3.740	0.000	0.224	4.468
Perceive ease of use	0.330	0.332	4.637	0.000	0.287	3.490
Attitude to use	0.309	0.315	4.203	0.000	0.261	3.835

F-statistic = 180.329, sig.<0.05, R^2 = 0.794, Adjusted R^2 = 0.790

All three constructs were found to be statistically significant predictors of intention with perceived ease of use exerting the strongest influence on intention, followed by perceived usefulness and attitude. Hence, a practical model for intention to use BIM among community college students who were enlisted in the architecture course can be proposed as follows:

$$Y = -0.024 + 0.326X_1 + 0.330X_2 + 0.309X_3$$

where Y = Intention to use BIM, X_1 = Perceived usefulness of BIM, X_2 = perceived ease of use of BIM and X_3 = attitude towards using BIM

DISCUSSION AND CONCLUSION

The objectives of this study were to investigate factors that influenced the behavioural intention to use building information modelling (BIM) among Malaysian community college students in the Architectural Technology programme. Specifically, this study examined whether psychological factors, such as perceived usefulness, perceived ease of use and attitude, could influence behavioural intention to use BIM among the respondents of the study. The results indicate the factors did indeed influence BI. Among other things, this study has produced empirical evidence that the community colleges students' behavioural intention to use BIM technology was high.

Additionally, the students perceived BIM to be useful and easy to use, and their attitude towards its use was highly positive. These tendencies in turn influenced their intention to use the technology. Venkatesh and Bala (2008) argued that understanding behavioural intention to use technology is important because such an understanding would provide information that would assist stakeholders and educational managers in the technology adoption process. In other words, if developers can ascertain suitable system characteristics to maximise users' behavioural intention, they are more likely to increase their target users' inclinations or

tendencies to use the technology. On top of these findings, this study has demonstrated how perceived usefulness, perceived ease of use and attitude have a direct influence on behavioural intention, which is consistent with the results of previous research by Nair and Da (2012), Weng, Yang, Ho, and Mei Su (2018), and Merschbrock and Nordahl-Rolfsen (2016).

The findings also indicate that the intention to use BIM was 79% influenced by perceived usefulness, ease of use, and attitude. More importantly, all the independent variables correlated positively and strongly with behavioural intention to use BIM. Future research should consider examining the effects of other determinants of intention to use technology, such as computer anxiety, self-efficacy, perceived enjoyment, and internal and external loci of control. This importance of this study could be expanded using larger and more inclusive samples and by utilising a mixed-methods approach as well as a longitudinal research design. Further studies should also look deeper into how the use of BIM helps to develop capable students, hence a competent workforce, for the architecture, engineering and construction industries in Malaysia.

This research is one of the very few studies looking into BIM usage and adoption among community college students, and the factors associated with the adoption decision. It helps to understand the interrelationships among the variables that influence such a decision, and find a way to define the direction for community colleges to establish a proper BIM education. It is important for BIM facilitators, especially, to realize that for students to have the behavioural intention to use the software, they should create a learning environment that first and foremost makes BIM easy and comprehensible for students, showcases its benefits and usefulness, and develops in students a positive attitude towards its use. The statistically significant beta weights of the predictors (i.e., PU, PEU and ATU) show their strength and importance in shaping intention to use or adopt BIM or any other new technology. Educators who understand the dynamics among these variables are in a better position to make the use of BIM more widespread among community college students. Knowledge and skills of using BIM will indeed be instrumental to these students later on when they are part of the industry. Additionally, awareness of BIM technologies should be promoted among the students and in the workplace. Therefore, BIM training and preparation must be an ongoing endeavour to improve competencies in the software.

Overall, the findings suggest that educators, human resource managers and policymakers should look into the implementation of BIM training in higher education. Educators and administrators in higher learning institutions need to consider how they can increase their students' behavioural intention towards BIM, which in turn would support the students' motivation to learn and use the technology for their added value skills. In many industries, the implementation of new technology has been met with failure (Aziz & Salleh, 2011). Cultural issues and employee resistance within the industry, for example, have been found to impede new information and technology implementation (Davis & Songer, 2008). Therefore, the findings of this study provide useful insight for educators and administrators of higher learning institutions for the implementation of BIM in student learning and training. With proper BIM training, tertiary learning administrators can better equip their students with the relevant knowledge, skills and abilities for the architecture, engineering and construction industries, hence providing the industries with higher skilled workforces. One of the ways to achieve this aim is by understanding their behavioural intention to use BIM during their study and later in

their future career.

The positive results notwithstanding, this study has several limitations. The findings obtained cannot be generalised to students of all architectural programmes since the sample was a sample of convenience, and only included architectural students from community colleges in Malaysia whose characteristics and psychological mindsets might differ from the larger population of college students. Larger samples drawn from random sampling procedures involving a greater diversity of university and college student bodies should be used in future studies. Future research that employs a combination of quantitative and qualitative approaches might uncover new perspectives in the use of BIM, and reveal underlying challenges related to BIM learning and training in Malaysian higher education.

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