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Factors Influencing Ubiquitous Technology Usage Among Engineering Undergraduates: A Confirmatory Factor Analysis

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Abstract: Ubiquitous technologies such as laptops, smartphones and tablets have been widely used by many undergraduates in the institution of higher learning. However, little is known about the factors that contribute towards it utilisation as not many comprehensive studies have been done related to it. A review of related literature demonstrates that factors such as performance expectancy, effort expectancy, behavioural intention, facilitating conditions and social status influence technology usage. Thus, this study focuses on the determined factors which contribute towards the ubiquitous technology used among engineering undergraduates in the Malaysian Technical Universities Network (MTUN).This study was conducted based on a quantitative research in which the Structural Equation Modelling using AMOS was employed. The population of the study consisted of third-year undergraduates from four Malaysian Technical Universities (N= 4,247). The research instrument was in the form of a questionnaire.Of the 493 questionnaires distributed to the undergraduate students, 400 were validly responded and taken into consideration as part of the analysis.The results attained from the Confirmatory Factor Analysis (CFA) showed that the total number of confirmed items for performance expectancy factor had four items (PE1, PE2, PE4 and PE5), four confirmed items (EE1, EE2, EE3, EE4) for effort expectancy, four confirmed items (SS1, SS2, SS3, SS4) for social status, four confirmed items (FC1, FC2, FC3, FC4) for facilitating conditions and four confirmed items (BI1, BI2, BI3, BI4) for behavioural intention.

Key words: Ubiquitous Technology · Engineering Undergraduates · Confirmatory Factor Analysis · Unified Theory of Acceptance and Use of Technology

INTRODUCTION

Ubiquitous Technology: In the twenty first century and coupled with the fast paced development of technology, undergraduatestudents thrive more on mobility, where they expect to take their technology everywhere they go and immediate gratification, where they aim to get feedback straight away [1]. The undergraduatestudents also expect constant connections in using technology simultaneously either for social and academic lives [2]. The students' visions for an ideal learning are envisaged by using the latest and advanced technology during class as a way to look up information just in time on the Internet [3] and want their learning environment to look more like the 'world' in which they live now, where to use technology anywhere and anytime [4].

Therefore, these needs have led to the introduction of ubiquitous technology in education. Today, the most popular ubiquitous technology that has been used by many including students are laptops [5, 6], Smartphones [7] and tablets [8, 9].

Ubiquitous technology is a multipurpose and refined mobile communication which can be used to make calls, browse the Internet to find information or check e-mails, findthe location using a Global Positioning System (GPS) and take pictures and record videos [10]. These features

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ease the students' lives as there is certainty that they get everything they need in one technology [11]. Ubiquitous technology also permits learners to gain the latest information and knowledge easily when the Internet is affordable[12]. Apart from that, students can also experience learning in a real-world environment outside the physical classroom and still stay connected all the time with their family, lecturers, friends and community [13, 14].

Ubiquitous technology is viewed as a versatile device, combining the mobility and connectivity of many elements such as powerful processors which enable users to organise a number of computing tasks simultaneously [15]. Ubiquitous technology is lightweight and portable, therefore users can take the technology anywhere they like[16] and interactive due to the colourful interface, speed, response as well as its immediate feedback [17, 3].

The current economic challenges and globalisation are forcing employers in the engineering sector to seek for competent engineers. Consequently, the graduates have to prepare themselves with the skills desired by their future employers. It is important to produce a new breed of knowledge workers for the 21st century as well as to support learning, teaching, administrative and management processes within the education system with the utilisation of technology [18]. For engineering undergraduates, it is paramount for them not only to utilise the most reliable mobile technology for learning, but also to fully utilise the technology for various purposes [19].

Malaysian Technical University Networks (MTUN): The Malaysian Action Plan Phase 2 has put focus to increase the number of future technical-skilled workers by strengthening the field of study based on the engineering as well as Technical and Vocational Education and Training (TEVT). In this context, the Malaysian Technical University Networks (MTUN) plays an important role in this agenda, through the mainstream approach in engineering and technical education.

There are four MTUN namely UniversitiTeknikal Malaysia Melaka (UTeM), UniversitiTun Hussein Onn Malaysia (UTHM), Universiti Malaysia Pahang (UMP) and Universiti Malaysia Perlis (UniMAP). These four universities focus and function towards the betterment of education in terms of technology, technical and engineering field. Their programmes are designed to be more student-focused and conducted through experiential learning with the affordability of new and latest technology, such as the ubiquitous technologies [18].

Factors Influencing Ubiquitous Technology Utilisation: Successful utilisation of technology among students is not only depending on the equipment or software used but also relies on other influencing factors that enable to support the undergraduates in the ongoing engagement with the technology. The review of the Unified Theory of Acceptance and Use of Technology has identified a few factors that influence technology usage. The factors are performance expectancy, effort expectancy, behavioural intention, facilitating conditions and social status [20].

Performance Expectancy: Performance expectancy refers to the degree to which learners believe that using the technology will help them to achieve gains in learning [21]. Many researchers postulate that performance expectancy is the strongest factor of the four factors in UTAUT [22, 23, 9]. According to [22] the utilisation of tablets was theorised to be influenced by the students' performance expectancy. In their study, they find that there was a significant direct effect of performance expectancy on the use of tablets among undergraduates in higher institutions.

Research in the Malaysian context showed thatthe utilisation of educational computer games (ECG) using laptops was regarded as the useful and promising tool due to its fun and engagement features [24]. He stated that the use of technology will remain vital when students' perceived performance expectancy as one of the salient factors that directly influence their utilisation of technology. In his study, students found that the ECGs were useful and believed that ECGs were able to enhance their performance. Meanwhile, another study conducted among students from the institution of higher education in Malaysia, revealed that performance expectancy acted as one of the salient factors that influenced the students' utilisation of new developed software in learning the Computer Graphics and Image Processing subjects [25].

Effort Expectancy: Effort expectancy is a perception which a person believes that using a technology is free of physical and mental attempt [26]. Meanwhile, a study has identified perceived ease of use or effort expectancy is seen as one of the factors that influence the use of technology [27].

In another study also found that engineering undergraduates perceived tablets as excellent tools, as tablets were easy to use. The students agreed that while using the tablets, they did not have to put much effort in understanding and handling them. These benefits, encouraged the students not to use tablets only in their

engineering and technical subjects but also expanded their utilisation pattern as a tool for research purposes. For example to capture categorical data especially for data analysing as well as for filling out forms that focused on categorical information [28].

The effect between undergraduates' perceived effort expectancy and their utilisation of the newly developed software in learning the Computer Graphics and Image Processing subjects. Based on the results, effort expectancy was found to have the highest mean value after performance expectancy [29].

Social Status: In the era of modernisation and technology advancement, students' modes of life especially in learning environment have profoundly been altered [30]. Findings indicated a change in students' choices and preference in employing technology and how they perceived that the social status factor influence them in using it. Social status refers to the degree to which an individual perceives the importance of others believe he or she should use the technology [31, 20]. The importance of social status was more significant in a mandated environment and appeared to be significant only in the early stages with its effect eroding over time. Therefore, in some cases, social status can directly and indirectly influence the technology utilisation [31, 20].

A study found that learner's perception of their own social status may directly influence the utilisation of technology [32]. According to the study, students in higher learning who own a new technology believe that they will not have a harder time getting any information online and completing learning tasks through online. The study also found that due to the personal perception of themselves, has led to a high increase in technology utilisation.

In the context of learning, modern technology such as Smartphones act as a status symbol among students in higher learning [33]. A study conducted by them at Harvard University showed that students chose their technology devices based on what their lecturers, family and peers were using and largely driven by a desire to emulate those they admired. Here, utilisation of ubiquitous technology was a way to aspire to the status of others or oneself with a particular group as well as a way to impress others. A study also reported that students enjoyed showing their technology devices off, because it made them feel important and trendy. They also agreed with this 'feel' and respect they gained from lecturers and friends directly influenced their utilisation of technology [34].

Facilitating Conditions: Facilitating conditions refer to the degree to which an individual believes that organizational and technical infrastructure exist to support the utilisation of ubiquitous technology as a learning tool [34]. A study reported that facilitating conditions, in terms of administrative support can influence the success of technology utilisation among undergraduates. Administrators in the universities, such as lecturers, act as change agents to help increase the utilisation of technology and play a key role in supporting undergraduates to utilise technology [34, 35, 16, 36].

Another aspect is the technical support provided by the organisation. Technology or technical support refers to someone who has the access to personal guidance and help [43]. Technical support includes the ICT facilities vendor, internal helpdesk and their availability in helping and assisting users to solve any problems related to the technology used. Moreover, the support given is also to ensure that users are satisfied in using technology [37, 38].

Behavioural Intention: Behavioural intention is identified as a mediating factor that influences performance expectancy to technology utilisation. A study showed that performance expectancy had significantly affected the students' behavioural intention, which in turn has a positive effect to utilisation [39].

In terms of effort expectancy, behavioural intention was identified as a mediator that mediates the technology utilisation among students. A study showed a prominent influence of effort expectancy on students' behavioural intention towards the use of tablets [16].

A study in examining the core factors affecting the undergraduates utilisation of e-placement tests using technology confirmed that social status as one of the core factors that had a positive influence on behavioural intention, which in turn lead to an effective use of technology. The researcher found that the influence of lecturers, family and friends was important in influencing undergraduates behavioural intention to use e-placement tests continuously. Therefore, this shows that behavioural intention acts as a mediating factor that influence the students perception of social status towards technology usage [21].

Meanwhile, a study in Thailand showed that behavioural intention was able to mediate the influence of facilitating conditions towards utilisation of m-learning. The study found that administrator's support and the resources provided by the University Computer Centre influenced the students' intention to utilise the m-learning system which had led to the effectiveness in using it for learning purposes [40].

Statement of Problem: Studies in identifying the factors that contribute towards technology use among undergraduates in Malaysia were conducted by various researchers [41, 5,42, 43, 21, 44]. Findings showed that the technology utilisation were mostly being influenced by perceived ease of use, usefulness, motivation and environment. Although a lot of studies have been conducted in recent years on the use of technology for learning in Malaysia, little is known about the factors that contribute towards the use of ubiquitous technology as not many comprehensive studies have been done related to it. In MTUN itself, research that examines the factors related to the utilisation of technology only focused on the use of LMS and software and not on the ubiquitous technologies such as laptops, Smartphones and tablets. A study reported that the unattractive and dull interface is the main factor that hinders the utilisation of the LMS which had negatively affected the students' intention in using it continuously [45]. A study found that the software development of learning Calculus subject has brought students to perceive it as difficult to use since students have to put extra effort in understanding the software itself [24].A review of related literature demonstrates that factors such as performance expectancy, effort expectancy, behavioural intention, facilitating conditions and social status influence technology uptake. Thus, the focus of this study was to verify these determined factors which contribute towards the ubiquitous technology usage among undergraduates in MTUN.

Objective of the Study: The specific objective of this study is to validate the possible factors that influence towards the use of ubiquitous technology among the engineering undergraduates.

MATERIALS AND METHODS

The type of research that was carried out in the study was a survey and the accessible population were the selected third-year undergraduates from the four MTUN. In order to reconfirm the minimum recommended sample for this study, a Raosoft® software was employed. For sampling purpose, the proportional stratified sampling was used and the questionnaires were randomly distributed to the identified sample in each university faculty. Each questionnaire consists of 4 sections: Section A collected the student's demographic information; Section B was on technology utilisation; and Section C was on factors that influence the technology utilisation. For this paper, only CFA in Section C is discussed. A five-point likert scale used were as follows, (1) Strongly Disagree (SD), (2) Disagree (D), (3) Somehow Agree (HA), (4) Agree (A), (5) Strongly Agree (SA).

The questionnaire was validated by four panels of experts who have a vast experience in educational technology and teaching and learning. Of 493 questionnaires were distributed and 420 responses were returned. The 420 responses were then stored and directly imported to the SPSS Version 20.0 and AMOS Version 20.0. Prior to data analysis, the questionnaires were carefully screened by checking for missing data. Only 20 responses were found to contain errors and incomplete values. Therefore, only 400 responses were used as the actual data for this study. The reliability test was conducted in order to find the consistency of scores or answers provided by the instrument. From the analysis, the range of the instrument's reliability was between 0.82 and 0.90. Overall the reliability of the instrument was good.

Structural Equation Modeling (SEM): SEM is an extension of various multivariate methods encompassing a Confirmatory Factor Analysis (CFA), measurement model and structural model [46]. There are three characteristics that distinguish an SEM from the other analyses. The first characteristic is the ability to estimate the multiple and interrelated dependence influence simultaneously [46]. The second feature of SEM is its ability to include items in the analysis. By including the items in the analysis researchers will be able to define the individual constructs and test for convergent validity and construct reliability simultaneously. The last characteristic of SEM is its potential to define a model [47].

RESULTS

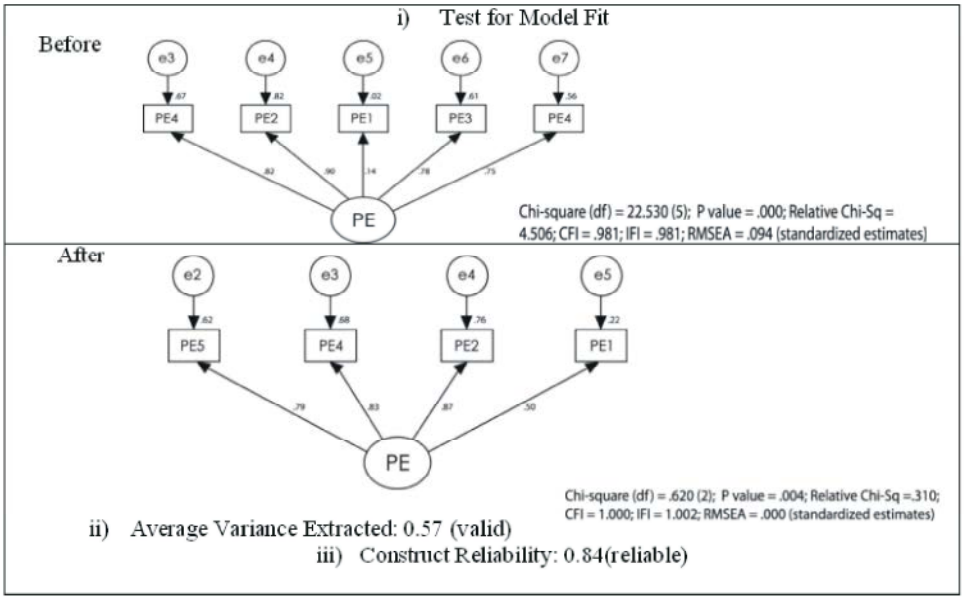
As the main objective of this study was to develop a predictive model on the utilisation of ubiquitous technology among undergraduates in MTUN, the R^2 for each construct (variable) and every β value for each structural path has taken into account.

Confirmatory Factor Analysis: The CFA was the first step in data preparation prior to SEM analysis. In this study, the CFA was meant to define the individual constructs and was employed for three major purposes, namely to test for; 1) model fit, 2) convergent validity and 3) construct reliability [46, 48, 49, 50]. The researchers were looking at two criteria to test for the model fit; the fit indices and the individual factor loadings of each item in a construct. The researchers decided to refer to the set of criteria for fit indices and their recommended value below.

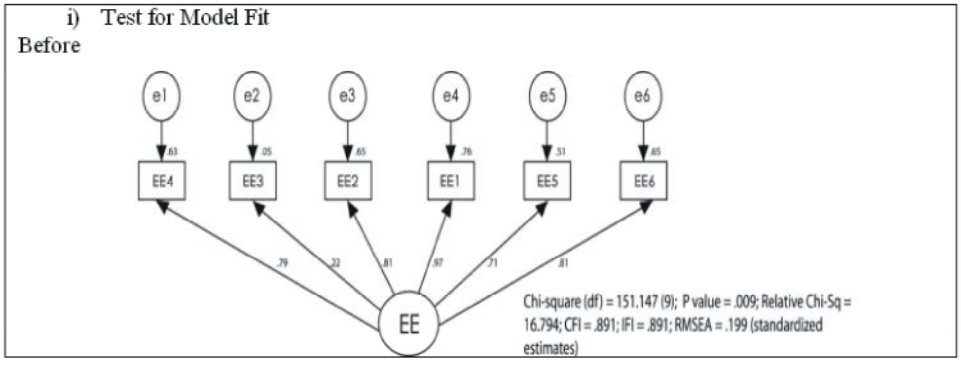
Fit Indices	Recommended value
CMIN/DF	□ 5.0
Relative x^2	□ 5.0
CFI	□ .90
RMSEA	□ .80
Factor loadings	□ .5 Positive □ 1.0

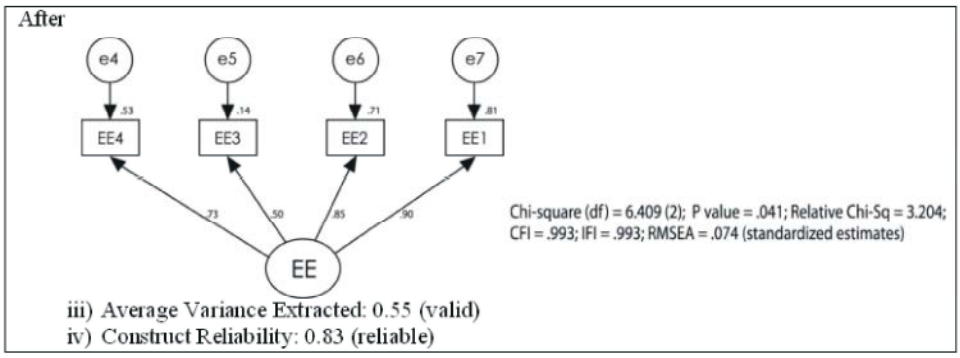
Once all the three analyses were conducted, it was expected that the number of items for each construct reduced. From the CFA analysis the confirmed items for Section D: factors that influence ubiquitous technology utilisation showed that performance expectancy factor had four items (PE1, PE2, PE4 and PE5), four confirmed items (EE1, EE2, EE3, EE4) for effort expectancy, four confirmed items (SS1, SS2, SS3, SS4) for social status, four confirmed items (FC1, FC2, FC3, FC4) for facilitating conditions and four confirmed items (BI1, BI2, BI3, BI4) for behavioural intention. As the confirmed items (PE1, PE2, PE4 and PE5) for performance expectancy were not in the sequel, therefore the items have been renumbered to PE1, PE2, PE3 and PE4 as shown in the following tables.

Performance Expectancy

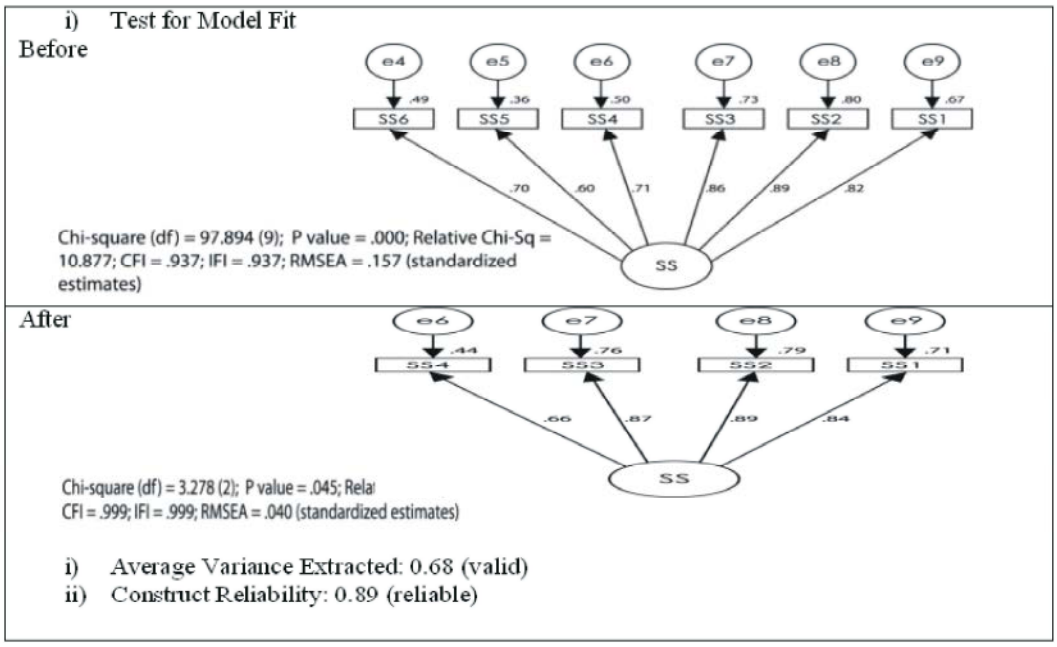


Effort Expectancy

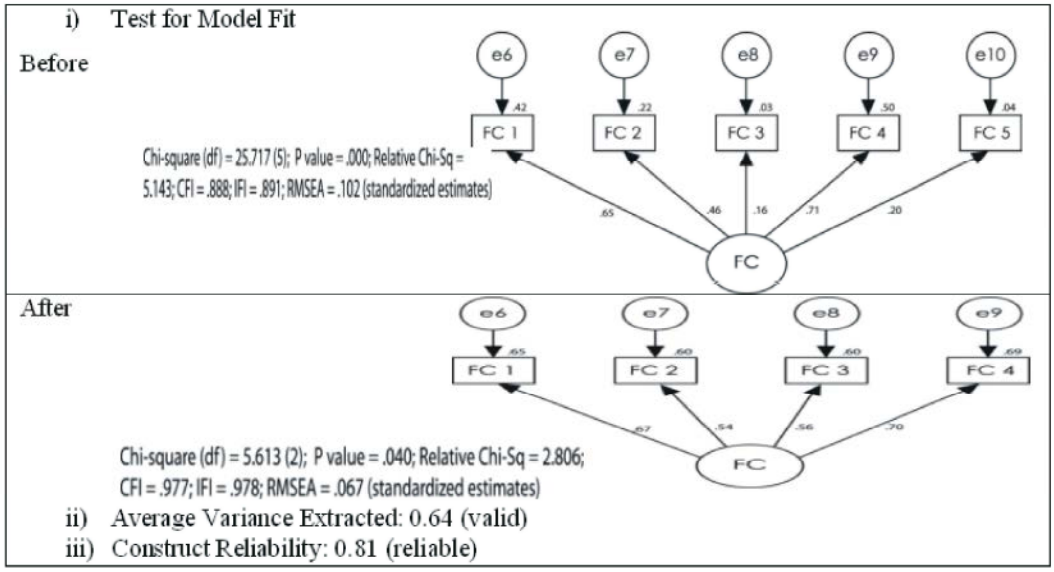




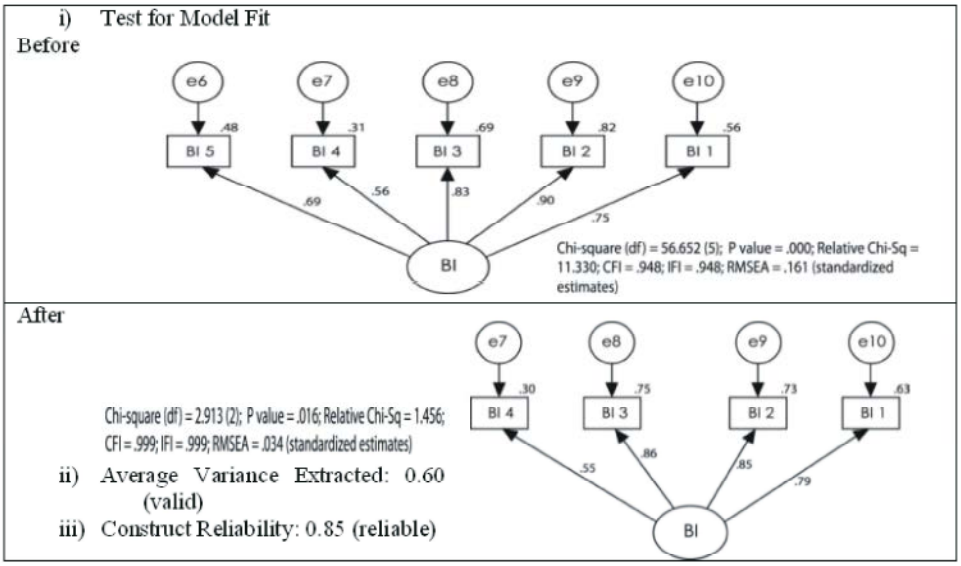
Social Status



Facilitating Conditions



Behavioural Intention



Implication and Recommendation

Theoretical Implications: Generally, the Unified Theory of Acceptance and Use of Technology (UTAUT) had provided a constructive framework for understanding and predicting variables influencing ubiquitous technology use. This study supports the findings that UTAUT provides an appropriate theoretical framework to explain ubiquitous technology utilisation among undergraduates at higher learning in Malaysia, particularly at MTUN. More importantly, this study has not only tested the UTAUT itself, but isalso expanded by adding one variable, a technology competency which is adapted from the Theory Acceptance Model (TAM).

The proposed predictive model and the results obtained from the study have provided a fuller understanding of ubiquitous technology utilisation of MTUN undergraduates' and its relation between the undergraduates' technology competency and perceptions of performance expectations, effort expectancy, behavioural intention, facilitating conditions and social status. Therefore, the outcome of this study may contribute in bridging the gap that existed in searching for the model that predicts the use of ubiquitous technology among undergraduates in Malaysia.

Practical Implications: The findings of this research provide productive directions for MTUN administrations and the Malaysian Ministry of Education to start an effective planning for subsequent policy and investment on the technology initiatives for learning. Continual resources, such as the technology educational tools, training sessions, technical support and so forth, should be provided for undergraduates and universities to strengthen the capacity of ubiquitous technology utilisation for learning purposes.

In brief, the findings of this study provide practical implications for further infuse technology, especially ubiquitous technology, as a learning tool. The investigated factors are manifested in different manners, depending on the individual, supporting environment and so forth. Consequently, it suggests productive directions for students, university administrators, curriculum planners, policy makers and other pertinent authorities to allow, adapt and alter not only the learning, but also the teaching environment to provide a superior education system for the 21st century learners. Hence, this study works as a catalyst to establish a deliberate vision mutually among the stakeholders and to successfully diffuse and utilise the ubiquitous technology as learning tools among the undergraduates in MTUN.

Recommendations for Future Research: There is a need to conduct future research to overcome the limitations in this study. This research employed entirely the ways of quantitative research in relevance to the particular study. The data collection of this study was assessed via self-reported questionnaires. Therefore, the qualitative studies such as interviews, observation and recording can be included in future studies to obtain the different forms of data and to yield a more in-depth understanding of the factors that influence the utilisation of ubiquitous technology among users.

More studies could be conducted to compare the level of technology utilisation and its impacts on undergraduates' achievements, such as grades or standardized tests. Furthermore, it is suggested to conduct a scientific study with a pre-test/post-test design in determining the effectiveness of ubiquitous technology usage for learning purposes.

Finally, the current research involved among the engineering and technical undergraduates in utilising ubiquitous technology namely laptops, Smartphones and tablets. The results of this study verified that the technology competency, performance expectancy, effort expectancy, facilitating conditions and social status are the factors in the influential to the utilisation of ubiquitous technologies. However, undergraduates from different fields may vary in their ubiquitous technology usage for learning depends on their subject specific-needs, environment and others. It is recommended in the future studies to examine other factors which may lead to the effective use of ubiquitous technology among undergraduates in different fields in higher learning in Malaysia. Consequently, the outcome may generate noteworthy findings to the body of knowledge concerning subject specific and programmed variation in the utilisation of ubiquitous technology.

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