A Review of Technology Acceptance Models and Theories

Sultan Hammad Alshammari[1*], Mohd Shafie Rosli[2]
[1]Faculty of Education, Department of Educational Technology, University of Ha'il, Saudi Arabia
[2] School of Education, Universiti Teknologi Malaysia, Malaysia
*sh.alshammari@uoh.edu.sa; sultan9573@hotmail.com

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ABSTRACT

In the contemporary world, technology and information systems are perceived as mandatory aspects for many organisations and companies to attain their goals. Thus, several technology theories and models have been formulated and adopted in various fields to increase the usage of technology. Many studies have adopted different models and theories to examine the factors that can affect and lead to the successful utilisation of technology. Therefore, through a critical review of the literature, the current study aims to critically discuss the strengths and limitations of some of these technology acceptance models, namely technology acceptance model, theory of reasoned action, unified theory of acceptance and use of technology and extended technology acceptance model. Based on the review, this study illustrates that no theory is free from limitations and that each theory has both strengths and weaknesses. This study offers future researchers an opportunity to adopt a suitable model for performing their empirical studies with different technologies.

Keywords
TAM, TRA, UTAUT, technology, technology acceptance model, theory of reasoned action

Introduction

Generally, acceptance is defined as the antagonism towards refusal and the positive choice of an individual to use innovation (Simon, 2001). Decision-makers need to have insights into the issues that can affect the behaviour and decision of users to use and adopt a particular technology so that they can account for them during the development phase (Mathieson, 1991). Why and how users usually accept any new technology are popular questions for most practitioners and researchers. The response to this issue can help them produce an excellent method for predicting, designing and evaluating the response of users to new technologies (Dillon and Morris, 1996). In this regard, technology acceptance models and various theories have been widely applied in predicting and understating the behaviour and intention of users to use in various fields, such as consumer satisfaction, consumer buying behaviour and technology.

Several studies developed models and frameworks to explain and examine the factors affecting users' adoption of various new technologies, such as technology acceptance model (TAM), theory of reasoned action (TRA), extended technology acceptance model (TAM2) and unified theory of acceptance and use of technology (UTAUT). Many studies used these models without any extension, whereas others combined various previous models or extended them to include new constructs to develop these models and perform their studies.

Previous studies have shown that choosing a suitable theory or model is a critical task for most researchers, especially for those who are interested in the information system. Few studies have reviewed and compared the acceptance theories and models at a personalised level (Tarhini, Arachchilage, Masa'deh and Abbasi, 2015). Therefore, this study aims to critically review the most common acceptance theories and models in terms of their strengths and limitations. Several databases such as ProQuest ERIC and google scholar have been used for conducting this review. The different key words have been utilized for reaching the needed articles. For example, "UTAUT, TAM, TAM2, TRA, unified theory of acceptance and use of technology, technology acceptance model, An extension to the technology acceptance model, Theory of Reasoned Action". This review can provide future researchers with an opportunity to carefully adopt the best model to perform their empirical studies with different technology adoption.

Theory of Reasoned Action

Ajzen and Fischbein (1975) developed TRA, which is among the first theories on technology acceptance. TRA served as a basis and as a fundamental theory for many other theories that were later developed, such as UTAUT, TAM2 and TAM. It mainly explains the individual behaviours for technology acceptance from the perspective of social psychology. TRA claims that individuals' behaviour is affected by their behavioural intention, which is affected by two main factors: subjective norms and attitude towards behaviour. TRA assumes that people are makers for rational decisions who calculate continuously and evaluate their appropriate behavioural assertions through their attitude formation towards behaviour. Lai (2017) described attitude as the negative and positive feelings that an individual has when performing the intended behaviours. Subjective norm is another critical construct in the TRA model. It is the perception of individuals about the people essential them who believe that they need to do or not do the required behaviour (Fishbein and Ajzen, 1975).

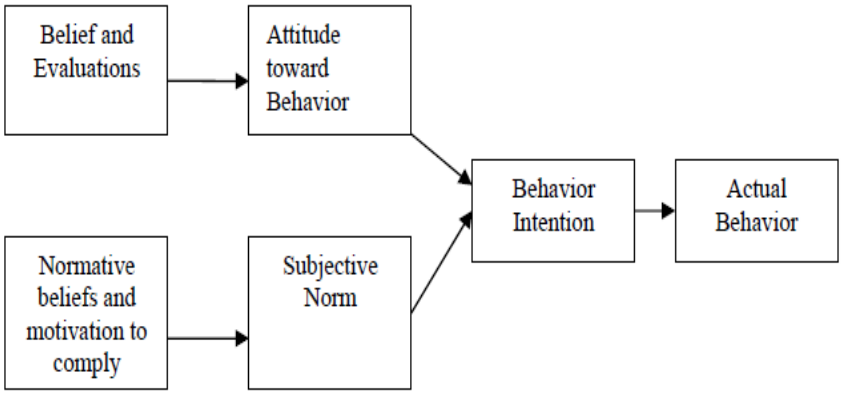

Figure 1. Theory of reasoned action model

Technology Acceptance Model (TAM)

Davis (1989) developed TAM, which is a theory of information system that provides and models an explanation of how an individual accepts and uses technology. TAM elucidates the technology determinant acceptance, which can explain the behaviour of a user from a broad array of emerging end-user technologies of computing together with the user populace while simultaneously justifying the theoretical and economic viewpoints (Davis, 1989).

Five constructs establish an aspect of TAM: perceived ease of use (PEU), perceived usefulness (PU), attitude towards use (ATT), behavioural intention (BI) and actual use (AU). These constructs are considered the primary determinants for users with regard to application and technology acceptance. According to Davis (1989), PEU is the level at which an individual assert that using a given technology will require less effort. PU is the level at which an individual believes that by using a given technology, his or her job performance will be increased (Davis, 1989). ATT is an individual's negative or positive viewpoint towards conducting the intended behaviour in the application of a given system. BI is the level at which particular technology users have shaped a plan of intent to continue utilising or not a particular technology with their future behaviour (Davis, 1989). AU is the degree of usage application of a specific technology in terms of frequency (how often) and the measured volume (how much) when using a given technology by users.

According to TAM, PEU affects PU. If users perceive any given technology as easily usable, then there is a high chance for them to perceive such technology as useful. TAM claims that both PEU and PU affect the attitudes of individuals towards the use of technology. When users perceive a specific technology as easy to use and useful, they can formulate a positive attitude towards the use of this specific technology. Davis found that ATT and PU affect users' BI to use a technology: when individuals consider a technology useful, they can create a positive BI of users towards the use of technology. Eventually, this positive BI of users towards a given technology defines the real use of such technology known as AU. Therefore, if users have a positive intention towards a given technology, they are likely to use it in their daily lives. Figure 2 illustrates the TAM.

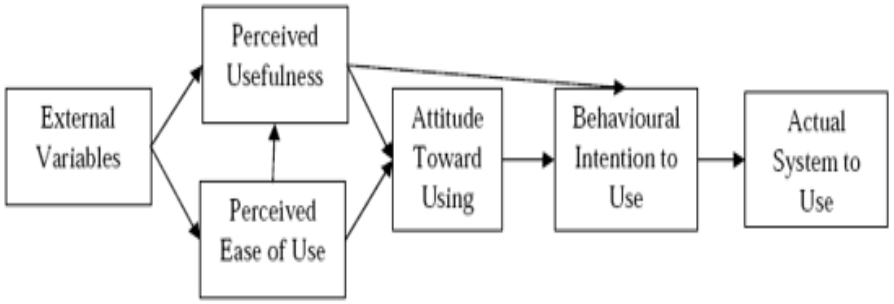

Figure 2. Technology Acceptance Model

The construct of attitude towards using a technology was omitted from many previous studies (Yi and Hwang, 2003; Davis et al., 1992). The main reason for the exclusion is the robust relationship between PU and BI and the weak relationship between BI and ATT. Moreover, BI, which leads to the real use of the system (i.e., AU), was directly driven by PEU and PU but not ATT. This was clarified by the findings of Davies, Bagozzi and Warshaw (1989). Thus, their study indicated a robust association among PU, PEU and BI. The findings showed that both PEU and PU directly affected BI, and the authors suggested the need for removing the ATT construct.

Extended TAM

Venkatesh and Davis developed TAM2 in 2000. TAM2 maintains the basic determinants of the initial TAM: PEU and PU. It also accounts for the effect of social influence on subjective norm and image together with the cognitive instrumental process, which entails the quality of output, job relevance and result demonstrability. Both TAM2 and TAM have been used broadly to explain the behaviour of the acceptance of different forms of technologies using the various settings of organisations. TAM2 asserts that individuals use mental representation to assess the link between the important work aims and the effects of considering the use of a given system mainly as a basis for the formation of judgment about performance contingency such as PU.

According to the theories on the matching mental process, the judgment of potential users on job relevance passes typically through a compatibility test (Venkatesh and Davis, 2000). Therefore, job relevance is mainly defined as a personal perception on the level at which the system target applies to one's job. TAM2 claims that job relevance has a positive effect on PU. Output quality also affects PU. According to Venkatesh and Davis (2000), quality output judgment assumes a typical profitability test form in which a given set of decisions contains various systems that are relevant to an individual when selecting the system that provides the highest output quality. TAM2 asserts that output quality has a positive effect on PU. For this reason, result demonstrability is considered the third PU determinant. Result demonstrability is defined as the result tangibility of utilising a given innovation (Moore and Benbasat, 1991, p. 203). TAM2 also shows that outcome demonstrability positively affects PU, as shown in Figure 3.

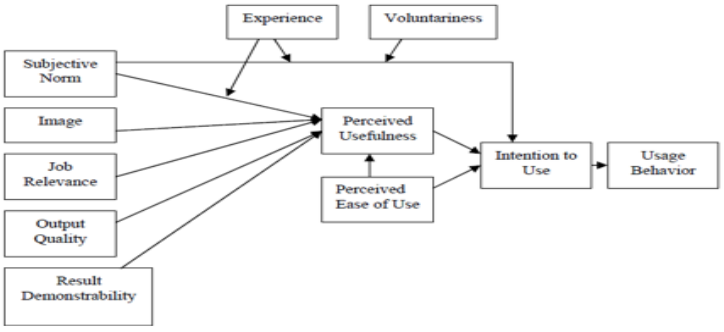

Figure 3. Extended Technology Acceptance Model

UTAUT

UTAUT was developed by Venkatesh et al. (2003) in an attempt to solve the weaknesses of previous theories. The theory incorporates eight of the most common previous theories. Therefore, it is grounded on some important constructs from the eight models and theories. Venkatesh et al. (2003) also formulated another model known as the UTAUT, which indicates that three constructs show the key intention in using the determination of information technology (IT): effort expectancy, performance expectancy and social influence. These three items are encompassed by the most popular constructs of the eight theories and models.

Performance expectancy is the level at which users anticipates that utilising a given system will assist them in attaining gains in their job performance. Therefore, the construct has five other construct roots: PU from TAM/TAM2, TPB and TAM combined, extrinsic motivation from the motivational model, relative advantage from division innovation theory and expectation/outcome from social cognitive theory.

Effort expectancy is the level of ease that is related to the application of a specific system, and social influence is the level at which individuals perceive that essential people believe that they need to use the recommended different system. Venkatesh et al. (2003) found that the effect of facilitating condition on the application of a system is primarily moderated by the experience and age of an individual. Venkatesh et al. (2003) defined facilitating condition as the level at which a user asserts that a technical and organisational infrastructure exists normally to assist the use of a given system. Among the survey instruments incorporating some constructs that are most influential from the eight theories and models of technology acceptance, UTAUT was found to share the significant assumptions of TAM and other models, as shown in Figure 4.

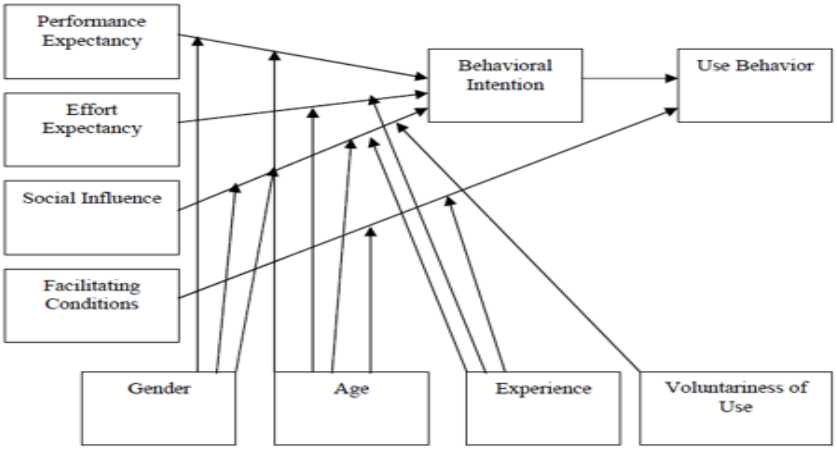

Figure 4. Unified Theory of Acceptance and use of technology model

Discussion: Review of the Models

The researcher conducted a review of the most popular models utilised for explaining and predicting technology usage in terms of their limitations and strengths. These models incorporate TRA, TAM, TAM2 and UTAUT. A critical review of each theory is presented.

Theory/Model	Developed by	Strength	Limitation
Reasoned Action (TRA)	Ajzen and Fishbein (1975)	Was a base and fundamental of most theories. Explaining the user behaviour from the view of social psychology.	General in nature. Ignoring the situational factors that may influence in user's behaviour intention as it claimed that the behaviour intention is influenced only by the attitude and subjective norms. Extending it usually does not increase the explanatory power of the model. A Clear risk of confounding between subjective norms and attitude constructs as attitude can be often reformed as norms.
Technology Acceptance Model (TAM)	Davis (1989)	Overcome the limitation of TRA. Including the users' belief factors in the model: Perceived ease of use and perceived usefulness. Can be extended to study any external factors with the chosen of different application, culture and work-settings. Extending it could improve the explanatory power of the model. A valid and robust model which were tested widely in a different situation, context and application to explain the acceptance and usage of systems.	Using the original TAM without extending it, is considered as general theory and might not provide a clear explaining about how users accept technology. The belief factors PU and PEU can be also influenced by many external factors that may influence on the usage of technology.
Extended Technology Acceptance Model (TAM2)	Venkatesh and Davis (2000)	Extended the Original TAM to overcome its limitation.	All of the external factors influenced on users' behaviour intention through only the PU, but the model did not measure their influence through the PEU constructs which may show more existing relationships.

		Take into consideration both Social influence and cognitive instrumental process.	The belief factors PEU and PU can be also influenced by other various factors such as facilitating condition, self-efficacy, computer anxiety etc.
Unified Theory of Acceptance and Use of Technology (UTAUT)	Venkatesh et al (2003)	Integrated 8 of most popular previous theories. Provide a higher explanation power in behaviour intention. (could explain 70% of variance explained). Considering the power role of moderating variables.	Inflexible Model to be adapted in different context such as non-western culture, which results in lower explanatory power in behaviour intention variance (only explained 39.1 in the variance of behaviour intention when it was applied in different context) The consensus in the nature of the relationships between its factors does not always exist, especially when it is applied in different context. UTAUT is not perfect to be applied with some applications such as m-commerce as it needs modification. It leads to a low parsimony because of the complex relationships among constructs which also implied by different effects of moderations.

The review of the models show that each model has its own strengths and weaknesses. Furthermore, no model overcomes all the limitations of previous models, and no model can be considered as one that is free from limitations. Several models use various terms to characterize some of their elements, even if they share similar concepts with different theories. A good example is UTAUT: its performance expectancy construct is similar to the usefulness construct of TAM.

Similarly, the effort expectancy construct of UTAUT is considered the PEU construct of TAM. Alternatively, several models have various names for their constructs, even though some of them share similar terms of these variables with different elements that have various names in different theories. Generally, most models have similar constructs with different theories. There is no model that is free from limitations (Nguyen et al., 2019). Consequently, many of these models have been utilized broadly in the literature, whether in a unique form or by developing them to incorporate different elements, which should be studied.

TRA was created by Ajzen and Fishbein (1975). It served as the core and principal theory for most theories that came later, for example, TAM, TAM2 and UTAUT. It clarifies human behaviour for the adoption of technology from the perspective of social psychology. The theory asserts that human behavioural intention is his behavioural intention, and that BI is affected by two main constructs: subjective norms and attitude towards the behaviour.

Although TRA has been utilized broadly for explaining and predicting many various behaviours (Venkatesh et al., 2003), it has several disadvantages. TRA is viewed as a general theory that attempts to clarify human behaviour (Jong and Wang, 2009). Moreover, it fails to consider other situational elements that may affect an individual's behaviour, attitude and BI (Yousafzai, 2012). Expanding it by adding different variables that may affect attitude does not always lead to an increase in the model's explanatory power.

Shih and Fang (2006) expanded TRA by incorporating the attributes of system quality, for example, ease of use, security, data quality and exchange speed, to examine their effects on attitude concerning BI. They found that even though the external constructs were included, the model's explanatory power did not improve. Moreover, there is an apparent confounding risk between attitude and subjective norms, as attitude can usually be referred to as a subjective norm (Samaradiwakara and Gunawardena, 2014). Owing to these disadvantages, the need for a theory that overcomes the disadvantages of TRA was necessary. As a result, TAM was developed to overcome the various weaknesses of TRA.

TAM was developed by Davis (1989) to overcome the limitations of TRA. TAM adopts the relationships of TRA and adds the belief constructs (PEU and PU) and these constructs' attitude, AU of technology and BI. PEU and PU are considered the main constructs of individuals' acceptance of technology. Thus, the subjective norm factor in TRA is not included in TAM. Davis, Bagozzi and Warshaw (1989) clarified the explanation behind excluding subjective norms from TAM: social norms have a weak psychometric point of view and do not affect an individual's BI. For this reason, TAM has become well known and been used in studies focusing on users' adoption and use of technology (Lai, 2017; Lee, Kozar and Larsen, 2013).

Even though TAM is broadly used in various circumstances and samples and is considered a reliable and substantial model for clarifying system usage and acceptance (Davis and Venkatesh, 1996), several studies have expanded it and used it in various applications and various settings (Venkatesh, Speier and Morris 2002; Venkatesh and Davis, 2000; Al-Aulamie et al., 2012; Al-hawari and Mouakket, 2010; Cheng, 2013; Lai, 2016; Bousbahi and Alrazgan, 2015). Expanding TAM plays an important role in increasing the model's explanatory power. For example, Luarn and Lin (2005) expanded TAM by including some external factors, such as self-efficacy and perceived credibility, and the outcomes showed an improvement in the model's explanatory power compared with the original TAM.

Mathieson (1991) found that even though the original TAM was predictive, it could not give enough explanation for users' adoption of technology based on its main principal constructs (i.e., PU and ease of use) because of its generality. Brezavšček et al. (2012) argued that the acceptance of technology using two constructs (e.g., perceived ease and usefulness) could also be affected by other external factors, which could influence users' behaviour towards the use of a specific system. Therefore, it is not surprising that the latest research extended the original TAM to examine the constructs to provide a deeper understanding of how users accept and use technology and to increase the model's explanatory power.

Venkatesh and Davis (2000) developed TAM2 to overcome the drawbacks of TAM and enhance the model's explanatory power (R^2). TAM2 has the primary determinants of the original TAM, namely PU and PEU. It also considers social impact, including subjective norms, image and the cognitive instrumental process that includes output quality, job relevance and result demonstrability. TAM2 and TAM are widely utilised for explaining an individual's adoption and technology acceptance in various settings and contexts (Jong and Wang, 2009).

Nevertheless, TAM2 has its drawbacks. It examines the social impact factor and the cognitive instrumental process factors of users' BI only through the PU construct. Thus, existing relationships in BI through PEU were not analysed. Moreover, Venkatesh (2000) recommended analysing the effect of other external constructs, for example, perceived self-efficacy, computer playful and facilitating condition in BI through PEU and PU. Note that TAM2 is not the only model developed based on the original TAM. Many studies have expanded TAM, included various external factors, and analysed their effects on users' BI in different applications and settings. TAM2 is included in this study because it was developed by Davis, who also developed the original TAM.

UTAUT was constructed by Venkatesh et al. (2003) to address the various weaknesses of previous theories. It integrates eight of the most well-known previous theories (Venkatesh et al., 2003) and includes four determinant constructs: social influence, facilitating condition, effort expectancy and performance expectancy, all of which affect BI. UTAUT is more credible than other theories because it has a higher explanatory power and can explain 70% of the variance in the BI construct (Venkatesh et al., 2003).

Nevertheless, UTAUT can be inflexible if used in alternative settings. For example, it can result in low explanatory power with the variance explained in the BI of users in a non-Western context. Al-Gahtani et al. (2007) used the UTAUT model in a non-Western culture, specifically in the Kingdom of Saudi Arabia, and found that UTAUT explained only 39.1% of the variance in the BI construct and 42.2% of the variance in the usage construct. Moreover, the two fundamental determinants construct of facilitating condition and effort expectancy in UTAUT did not affect the BI towards the use of IT. Other studies showed the same lower explanatory power of UTAUT, for example, 64.5% (Wang and Shih, 2009), 35.3% without moderation and 39.1% with moderation (Teo, 2011). Therefore, applying UTAUT to obtain a higher exploratory power does not guarantee that the model will be highly predictable and will prompt a high percentage in the explained variance in BI when utilised in various settings and cultures.

Another drawback of UTAUT is that an agreement in the nature of the relationships in UTAUT does not always exist when applied in an alternative setting (Thomas et al., 2013). Additionally, UTAUT shows low parsimony due to the complex relationships among its constructs, as implied by various effects and moderations (Venkatesh et al., 2016). Clearly, although UTAUT integrates eight of the most well-known theories, it is not free from limitations and cannot overcome all the weaknesses of previous theories.

Previous Research Using Each of these Models

Several studies have recently implemented some of these different models to investigate and examine the factors that influence the user' behaviour and acceptance of technologies. A study of Cai and Zheng (2017) used a theory of reasoned action for explaining the phenomena of using the digital libraries. The results of their study showed that theory of reasoned action was a proper theory that explain the users' adoption of digital libraries. Sheldon (2016) applied Theory of reasoned action to examine the factors that influence students' and professors' intention to add each other as friends on social media, namely through the Facebook. The results showed the consistency with the theory of reasoned action as intention was the strongest predictor that let them add each other, while personal attitude was the strongest significant predictor among faculty members, and subjective norm was the most significant predictor of intention among students toward adding professors as friend on Facebook. Regarding TAM model, recent studies used TAM to investigate the adoption of technology. A study of Teeroovengadum et al (2017) assessed the factors that influence on educator's' adoption of ICT and results showed that PU and PEOU had a significant influence on ICT adoption among educators. Another study of Patil (2016) examined the determinants on the adoption of Internet of Things and the results showed that PU, PEU, trust, attitude, behaviours control and subjective norms were a predictor of adopting Internet of Things. TAM2 was also used in several recent studies for examining the determinant of accepting teaching online and using Learning Management systems (Wingo et al, 2017; Khoa1 et al, 2017). Applying UTAUT for examining the adoption of different technologies has received more attention among researchers. A study of Rahi et al (2018) applied UTAUT to examine users' intention toward adopting Intent banking, and the results showed that all of UTAUT factors such as PU, PEU, SI and FC were significant and influenced the users' adoption of Internet

banking. A similar recent study was conducted by Aliaño et al (2019) to examine the factors that determine the use of Mobile learning in university context. All these studies showed the value of adopting different models and theories for examining and understanding which factors play a huge role on influencing users' adoption of multiple technologies.

Conclusion

This study discussed the advantages and disadvantages of several acceptance models and reviewed the most common acceptance models used in the adoption of technology, namely TRA, TAM, TAM2 and UTAUT. No theory is free from limitations, and thus all of them have been broadly utilised in various technologies. Nevertheless, UTAUT has the advantage of providing a high explanatory power, as it can explain 70% of the variance explained in the BI construct. This research provides future researchers an opportunity to adopt a convenient model for conducting their empirical studies on different technologies. This study is limited by the fact that it is broad and does not cover the applications of these theories in specific domains. Future studies should consider applying each theory to a specific area to provide in-depth information. Therefore, this study can be applied in various fields to improve the understanding of the strengths and limitations of each theory based on this review of the literature.

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