



Research Paper

The Efficacy of Technology Acceptance Model: A Review of Applicable Theoretical Models in Information Technology Researches

Thomas Olushola Phd¹, James O. Abiola Phd²
Department of Accounting Lagos State University, Lagos, Nigeria

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ABSTRACT: This is a review of theoretical models most recently used in Information Technology adoption research. A literature review approach has been adopted. More than 25 literatures were reviewed in the area of information adoption covering the last 30 years. We identified the strengths and weaknesses of each of the theory used. It is found that Technology Acceptance Model is by far the most used to underpin research work in this area follow by Theory of planned behaviour.

Keywords: Technology Accepted Model; Theory of Planned behaviour; Theoretical models; Behavioural intention; Perceived usefulness

I. INTRODUCTION

There are well known research models applied to information technology (IT) system adoption such as the Theory of Reasoned Action (TRA) (Fishbein, 1967; Fishbein and Ajzen; 1980); the Theory of Planned Behaviour (TPB) (Ajzen, 1991); and the Technology Acceptance Model (TAM) (Davis, 1989; Davis *et al.*, 1989). In addition, recently, the Diffusion of Innovation (DOI) (Rogers, 1995) and the Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkateshet *al.*, 2003) identified factors that affect an individual's intention to use or actual use of information technology.

“How and why individuals choose to adopt new technologies has forever been the focal point of information system (IS) research,” (Schaupp and Carter, 2009). According to Moody *et al.* (2010), “the heart of any research field is its theories and the core theories of a field define its distinct identity”. Theory is also a necessary prerequisite for conducting research; collecting data without theory is not research but observation or reporting (Dubin, 1978).

A survey of commonly used theories in information technology research especially those associated with technology usage, is necessary to consider the merits and demerits of each of the theories used.

II. THEORY OF REASONED ACTION (TRA)

The Theory of Reasoned Action (TRA) was originally developed by Fishbein (1967) and extensively refined and tested by Fishbein and Ajzen (1975). The Theory of Reasoned Action defines relationships between beliefs, attitudes, norms, intentions and behaviour, as shown in Figure 1 below. The Theory of Reasoned Action predicts and understands an individual's behaviour by considering the effect of personal feelings (attitude) and perceived social pressure (subjective norm). The Theory of Reasoned Action posits that beliefs influence attitudes, which in turn lead to intentions and then generate behaviour. “The Theory of Reasoned Action is one of the basic theories in psychology that has been utilized broadly to predict behaviour”, (Fishbein and Ajzen 1975).

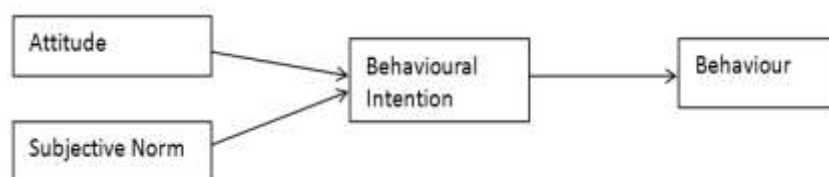


Fig. 1 Theory of Reasoned Action (TRA)

Source: Ajzen and Fishbein (1980)

The strengths and weaknesses of the Theory of Reasoned Action (TRA) are stated in Table 1 below.

Author	Strengths	Weaknesses
Theory of reasoned action (TRA) proposed by Fishbein and Ajzen (1975)	1) Strong predictive power of consumer's behavioural intention that has been demonstrated with a wide variety of consumer products 2) TRA is a well-researched theory designed to explain virtually any human behaviour.	1) Consumers do not have complete control over their behaviour in some conditions. 2) The direct effect of subjective norms on behavioural intention is difficult to isolate from the indirect effects of attitudes 3) Did not include personality characteristics, demographic or social roles that influence behaviours

Table 1: The strengths and weaknesses of the Theory of Reasoned Action (TRA)

Source: Author

2.1: The Theory of Planned Behaviour (TPB)

The Theory of Planned Behaviour (TPB) was developed by Ajzen (1985), and it extended the Theory of Reasoned Action (TRA) by incorporating an additional construct, namely perceived behavioural control (PBC) to account for situations in which an individual lacks substantial control over the targeted behaviour (Ajzen, 1991; cited in Wang, 2012), as shown in Figure 2 below. It was proposed that, in addition to attitudes toward use, subjective norms and perceived behaviour control such as skills, opportunities and resources needed to use the system also influence behaviour. “[The] Theory of Planned Behaviour is one of the most influential models in predicting behavioural intentions and behaviours, and it has been comprehensively validated in the behavioural domain” (Ajzen, 1991; Ajzen and Driver, 1991; Madden *et al.*, 1992; Parker *et al.*, 1995 and Ajzen, 2010). “[The] Theory of Planned Behaviour provides more specific information that guides development” (Mathieson, 1991). “Theory of Planned Behaviour (TPB) posits that individuals make rational choices to engage (or not engage) in the behaviour of interest” (Ajzen, 1991). The choices made are influenced by individuals’ own beliefs about the outcome and the evaluation of the favourableness (or unfavourableness) of the outcomes from engaging in the target behaviour. According to Smart (2013), “these beliefs and expected outcomes underlie three conceptually distinct salient beliefs, which are central to the TPB Model: behavioural beliefs (perceived beliefs about the likely outcomes from engaging in the target behaviour and the evaluation of the desirability of these outcomes); normative beliefs (perceived social pressure); and control beliefs (perceived ease or difficulty of engaging in a desired/undesired behaviour)”. Collectively, these elements influence individuals’ intentions to engage in the target behaviour. According to Chau and Hu (2001), “an individual’s behaviour can be explained by his or her behavioural intention, which is jointly influenced by attitude, subjective norms and perceived behavioural control”. “[An] attitude variable can be regarded as the mediating variable which influences the behaviour intention and subjective norm (SN) is the social pressure exposed to the person or the decision maker to perform the behaviour” (Benk and Budak, 2011). TPB has been successfully applied to the understanding of individual acceptance and the use of many different technologies (Harrison *et al.*, 1997; Mathieson, 1991; Taylor and Todd, 1995b).

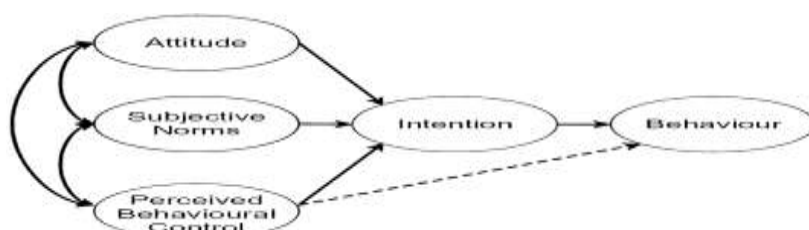


Fig.2 The Theory of Planned Behaviour (TPB)

Source: Ajzen (1985, 1991)

The strengths and weaknesses of the Theory of Planned Behaviour (TPB) are stated in Table 2 below.

Authors	Strengths	Weaknesses
Theory of planned behaviour (TPB), proposed by Ajzen (1985)	1) A broader model compared to TRA 2) The theory has received substantial empirical support for predicting behaviour in information systems and other domains	1) Constructs are difficult to define and measure in the study. 2) The model suffers from multicollinearity among the independent variables.

Table 2: The strengths and weaknesses of the theory of planned behaviour (TPB)

Source: Author

The next section discusses the Technology Acceptance Model (TAM).

2.2: Technology Acceptance Model (TAM)

The Technology Acceptance Model (TAM), developed by Davis (1989), was adapted from the Theory of Reasoned Action (TRA) by Ajzen and Fishbein (1980) and Theory of Planned Behaviour (TPB), developed by Ajzen (1985) and tailored to the context of technology acceptance and usage. The final conceptualization of the Technology Acceptance Model (Davis, 1989; Davis *et al.*, 1989), unlike the Theory of Reasoned Action, excludes the attitude construct in order to better describe intention parsimoniously. It has two constructs, which are perceived ease of use (PEOU) and perceived usefulness (PU), and these constructs determine a user's attitude towards use of that technology, which in turn, influences the behavioural intention to use technology. Perceived usefulness (PU) is defined as the user's perception of the degree to which using the system will improve his or her performance in the workplace, while perceived ease of use (PEOU) refers to the user's perception of the amount of effort needed to use the system (using a particular system would be free of effort). The TAM is illustrated in Figure 3 below.

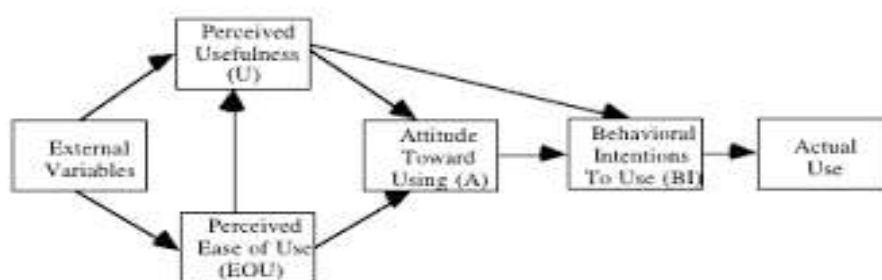


Fig. 3 Technology Acceptance Model (TAM)

Source: Davis (1989)

Alryalat *et al.* (2013) examined the role of usefulness, ease of use and social influence on Jordanian citizens' intentions to adopt e-government. The study aimed at developing and empirically testing an extended technology acceptance model (TAM) that integrates social influence with the TAM constructs. The study used the survey method, since the study involves formulating and testing hypotheses (Choudrie and Dwivedi, 2005; Galliers, 1992). The findings of the study revealed that all three independent constructs significantly affected Jordanian citizens' behavioural intentions to adopt e-government. The literature review revealed that there has not been any study in the context of Jordan which has attempted to empirically examine either citizens' or organisations' perspectives of e-government adoption. The findings from this research are likely to be useful for the Jordanian government in terms of developing a user-friendly system that encourages citizen and organisational participation in e-government adoption.

2.2.1: External Variables

A key purpose of TAM is to provide a basis for tracing the impact of external variables on internal beliefs, attitudes, and intentions, and it suggests that perceived ease of use (PEOU) and perceived usefulness (PU) are the two most important factors in explaining and predicting system use (Davis, 1989). However, some scholars confirm that external variables are mediated by PEOU and PU and that any additional variable contributes little to the explanation of the variance in IT systems. Some scholars also say that the external variables provide a better understanding of what influences PU and PEOU, and their presence guides the actions required to influence greater use of IT systems. Table 3 presents the external variables considered by some scholars.

Author and Date	External variable
Park (2009)	Individual factor; social factor and organisational factor
Chuttur (2009)	Actual system's features and capabilities
Burton-Jones and Hubona (2006)	System experience, level of education and age
Jackson <i>et al.</i> (1997)	Situational involvement, intrinsic involvement, prior use, argument of change
Igbaria <i>et al.</i> (1997)	Internal computing support, internal computing training, management support, external computing support, external computing training
Dishaw and Strong (1999)	Tool functionality, tool experience, task technology fit, task characteristics
Agarwal and Prasad	Role with regard to technology, tenure in workforce, level of education,

(1997)	prior similar experiences, participation in training
Lucas and Spitler (1999)	Quality perceived subjectiveness
Karahanna <i>et al.</i> [1999]	Compatibility, trainability, visibility, result demonstrability
Venkatesh and Davis (1996)	Subjective norms, voluntariness, image, job relevance, output quality, result demonstrability
Venkateshand Morris (2000)	Gender, experience
Chau (1996)	Implementation gap, transitional support
Davis <i>et al.</i> (1989)	Computer self-efficacy, objective usability, direct experience

Table 3 External variables

Source: Adapted from Legris *et al.* (2003)

The strengths and weaknesses of the Technology Acceptance Model (TAM) are stated in Table 4 below.

Authors	Strengths	Weaknesses
Technology of Acceptance Model (TAM) proposed by Davis (1989)	1) Numerous empirical studies have found that TAM consistently explains a substantial proportion of the variance in usage intentions and behaviours with a variety of information technologies. 2) The direct effect of subjective norms on behavioural intention has yielded mixed results in the past. This theory used perceived usefulness and perceived ease of use to replace the subjective norm. 3) TAM is a robust, powerful, and parsimonious model for predicting user acceptance of information technologies. 4) It has been used in many empirical studies and proven to be of quality and statistically reliable.	1) Ignores some important theoretical constructs 2) TAM does not reflect the variety of user task environments and constraints

Table 4. The strengths and weaknesses of the Technology Acceptance Model (TAM)

Source: Authors

In a related study, Chen and Huang (2006) predicted taxpayers' acceptance of online taxation use. The study proposed an extended model to predict users' acceptance of an online taxation system for their personal income based on TAM and diffusion of innovation (DOI). The findings revealed that taxpayers' attitudes toward using online taxation are strongly and positively correlated with users' acceptance. The empirical results confirm that PEOU, PU, compatibility, and Perceived Risk (PR) significantly influence taxpayers' attitudes toward using Online Tax Systems (OTS). It also confirmed the significant effect of PEOU of the OTS on perceived usefulness. The findings also show that compatibility, PU, PR and the attitude toward using OTS influence taxpayers' intentions to use an online taxation system.

The summary of prior studies about understanding perceived ease of use (PEOU) in various contexts and the scopes of research are shown in Table 5 below.

Author(s)	Research setting	Study sample(s)	Instruments /model	Key findings on perceived ease of use (PEOU)
Fu <i>et al.</i> (2006)	Taiwan	Individuals	TAM	A manual taxpayer's decision to adopt e-tax method is influenced by perceived ease of use (PEOU) and social pressures. Perceived usefulness (PU) was found to be the strongest determinant and explained most of the variance in Behavioural Intention (BI).
Ramayah (2006a)	Malaysia	Students	TAM	This study on the subject of perceived ease of use (PEOU) of USMs' digital ranked highest in the order of influence on ease of use, followed by organisational context and individual differences.
Ramayah (2006b)	Malaysia	Students	TAM	Interface characteristics were found to be strong predictors of perceived ease of use (PEOU). Screen design was found to be a significant predictor of perceived

				ease of use (PEOU). Navigational clarity was only weakly correlated to PEOU. Perceived usefulness (PU) was also found to be positively related to the intention to use online.
Gopi (2006)	Malaysia	Individuals trading in Bursa Saham, Malaysia	Compared DTPB, ITPB, TAM and IDTPB	Perceived usefulness (PU) is the most significant factor in determining the attitude towards using internet stock trading compared to perceived ease of use (PEOU). There was a significant positive relationship of perceived ease of use (PEOU) towards perceived usefulness. The integrated DTPB model was concluded to be the better model.
Vennila (2006)	Malaysia	College students	Social Cognitive theory/TAM	CANX has a negative effect on perceived ease of use (PEOU). Personal innovativeness is positively correlated to perceived ease of use (PEOU). Computer playfulness has a direct relationship with perceived ease of use (PEOU)
Ndubisiet <i>al.</i> (2005)	Malaysia	Malaysian entrepreneurs	TAM	Perceived ease of use (PEOU) has no direct relationship with usage. Perceived usefulness has a strong influence on entrepreneurs' system usage.
Lu <i>et al.</i> (2003)	USA	Students	TAM	The attitude towards using is jointly determined by perceived near-term and long-term usefulness and perceived ease of use (PEOU). Perceived near-term usefulness is also influenced by ease of use.
Jantanet <i>al.</i> (2001)	Malaysia	SMI	TAM	Management support was found to be a determinant and have a positive direct influence on both perceived ease of use (PEOU) and perceived usefulness. External computing support has a positive direct influence on perceived ease of use (PEOU) only.
Venkatesh (2000)	USA	Employees of three organisations	TAM	Determinants of system specific perceived ease of use (PEOU) as individuals evolve from early stages of experience to later stages of experience. With experience, general beliefs regarding the computer, perceived enjoyment and objective usability were important in perceiving the ease of use of a system. Perceived ease of use influences behaviour intention.

Table 5: PEOU in various contexts and the scopes of research

Source: Authors

The next section discusses the Unified Theory of Acceptance and Use of Technology (UTAUT).

III. THE UNIFIED THEORY OF ACCEPTANCE AND USE OF TECHNOLOGY (UTAUT)

The Unified Theory of Acceptance and Use of Technology (UTAUT) model was developed by Vankatchet *al.* (2003). It integrated the elements of eight prominent theories and models: including the Theory of Reasoned Action (TRA) (Fishbein and Ajzen, 1975), Technology Acceptance Model (TAM) (Davis, 1989; Davis *et al.*, 1989), Motivational Model (MM) (Davis *et al.*, 1992, as cited in Venkateshet *al.*, 2003), Theory of Planned Behaviour (TPB) (Ajzen, 1991), combined TAM-TPB (Taylor and Todd, 1995), Model of Personnel Computer (PC) Utilization (MPCU) (Thompson, Higgins, & Howell, 1991), Innovation Diffusion Theory (IDT) (Roger 1995) and Social Cognitive Theory (SCT) (Bandura, 1986).

The Unified Theory of Acceptance and Use of Technology (UTAUT) is modelled in Figure 4. below.

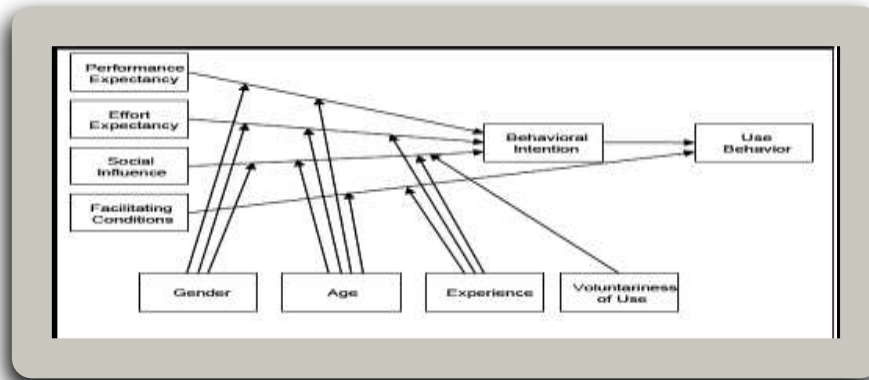


Fig. 4. The Unified Theory of Acceptance and Use of Technology (UTAUT)
Source: Venkateshet *al.* (2003)

The Unified Theory of Acceptance and Use of Technology (UTAUT) contain four core determinants of intention and usage: performance expectancy, effort expectancy, social influence and facilitating conditions (Venkateshet *al.*, 2003). The variables of gender, age, experience and voluntariness of use moderate the key relationships in the model. The UTAUT is able to account for 70% of the variance in usage intention – a considerable improvement over any of the original eight models and their extensions.

IV. THE SUMMARY OF OTHER THEORETICAL FRAMEWORKS APPLIED TO IT SYSTEM ADOPTION

Summaries of other theoretical framework applied to IT system adoption are stated in Table 6 below.

Theory and Author	Model and Discussion	Core Constructs
Social Cognitive Theory (SCT) (Compeau and Higgins (1995b))	SCT is one of the most powerful theories of human behaviour (Bandura, 1986). Compeau and Higgins (1995b) applied and extended SCT to the level of computer utilization (Compeau <i>et al.</i> , 1999). Although Compeau and Higgins (1995b) studied computer use, the nature of the model and the underlying theory allow it to be extended to the acceptance and use of information technology in general (Venkateshet <i>al.</i> , 2003)	Outcome Expectations-Performance Outcome Expectations-Personal Self-Efficacy Affect Anxiety
Decomposed Theory of Planned Behaviour (DTPB) (Taylor and Todd, 1995)	The decomposed theory of planned behaviour (DTPB) was derived from the theory of planned behaviour (TPB) and the Technology Acceptance Model (TAM) to a certain extent. Empirical evidence suggests that DTPB is comparable to TPB but holds the advantage of providing a deeper understanding of acceptance. Contrary to TPB but similar to TAM, DTPB “decomposes, attitude, subjective norms and perceived behavioural control into the underlying belief structure within technology adoption contexts” (Taylor and Todd, 1995b).	Attitude toward Behaviour Subjective Norm Perceived Behavioural Control
Innovation Diffusion Theory (IDT) Diffusion of Innovation (DOI) (Rogers, 1995)	The innovation diffusion theory (IDT) has its roots in sociology and has been in use since the 1960s to study an array of innovations ranging from agricultural tools to organizational innovations. Moore and Benbasat (1991) adapted innovation characteristics presented in Rogers (1995) and refined a set of constructs that could be used to study individual technology acceptance. Agarwal and Prasad (1998) explored the role of these characteristics in predicting acceptance and found that there was	Relative Advantage Ease of Use Image Visibility Compatibility Results Demonstrability Voluntariness of Use

	modest support for the predictive validity of innovation characteristics. In terms of the overlapping constructs with other models, the relative advantage and ease of use of IDT are similar to perceived usefulness and perceived ease of use of TAM, and the compatibility of this model is similar to the one used in DTPB.	
Extended Technology Acceptance Model (TAM2)(Venkatesh and Davis, 2000)	“TAM2 extended TAM by including subjective norm as an additional predictor of intention in the case of mandatory settings” (Venkatesh and Davis, 2000).	Perceived Ease of Use Perceived Usefulness Subjective Norm
IS Success Model (DeLone and McLean, 1992 and 2003)	The IS success model as a taxonomy and framework for measuring the complex-dependent variables in IS research. DeLone and McLean (2003) discussed many of the significant IS research efforts that have applied, validated, challenged, and proposed enhancements to their original model, and they then proposed an updated DeLone and McLean (2003) IS Success Model	Information Quality System Quality Service Quality
Hofstede’s Cultural Dimensions (Hofstede, 1980)	Hofstede’s research on cultural dimensions provides a theoretical foundation for exploring the influence of cultural differences on the adoption and diffusion of IT based innovations. Hofstede (1980) proposed four widely cited dimensions of national culture. Latter long-term orientation (Hofstede and Bond, 1988) was added as a fifth dimension.	Power Distance Individualism / Collectivism Masculinity Uncertainty Avoidance Long-Term Orientation

Table 6 Summary of all the theoretical frameworks applied to IT system adoption
Source: adapted from Rana *et al.* (2012)

However, Venkatesh *et al.* (2003) developed the Unified Theory of Acceptance and Use of Technology (UTAUT) model to consolidate previous TAM related studies. UTAUT aims to explain user intentions to use an IS and subsequent usage behaviour. UTAUT suggests four core constructs to explain and predict user acceptance of technology adoption, which are: performance expectancy (equivalent to perceived usefulness), effort expectancy (equivalent to perceived ease of use), facilitating conditions and social influence. These constructs explain up to 70% of the variance in usage intention. According to Saliza and Kamil (2012), “a unified model is being accepted and integrated in many studies of various fields, their results revealed some inconsistencies when applied in different areas or situations; in other words, there is no universal UTAUT that can explain all situations of acceptance”. It indicates that the UTAUT model of technology acceptance established in developed countries revealed some inconsistencies when applied in different areas or situations; in other words, there is no universal UTAUT that can explain all situations of acceptance”. It indicates that the UTAUT model of technology acceptance established in developed countries can only be transferred to developing countries with varying degrees of explanatory power. Despite being predictive, UTAUT is more integrative; however, the UTAUT model is weak in explanatory ability. The UTAUT model is considered a reflection of an individual’s internal schema of beliefs, where the external part is being ignored (Brown *et al.*, 2010). Significantly, the UTAUT model successfully integrated 32 variables with four moderators, but the application is too general in terms of incorporating classes of technologies (Venkatesh and Bala, 2008).

Utaut Is Found To Be Deficient To The Following Extent:

- i) May not be useful to underpin sensitive and confidential studies that may attract the use of insignificant complex data collection.
- ii) The UTAUT model does not include cultural factors, which may be important in most countries of the world. Efendioglu *et al.* (2005), cited in Chiemeke and Ewwiekpaefe (2011), noted that, “even though a developing country (like Nigeria) government may make the necessary investments in infrastructure (as China has done to a significant degree), unless e-commerce industry participants understand and address cultural issues that are unique to that country and relate to off-site transactional process, the large scale diffusion and success of such endeavours will be greatly impeded”.

V. JUSTIFICATION FOR POPULARITY OF THE TECHNOLOGY ACCEPTANCE MODEL (TAM) AND THE THEORY OF PLANNED BEHAVIOUR (TPB)

The Technology Acceptance Model (TAM) and the Theory of Planned Behaviour (TPB) are well established in the IT arena and appear to be widely accepted. TAM was chosen after considering merits and demerits of other possible models and theories that might be suitable for most research studies in technology acceptance and usage.

i) Technology Acceptance Model (TAM)

The main aim of TAM is to find out what factors cause people to accept or reject an information technology. The Technology Acceptance Model, has two determinants, which are perceived ease of use and perceived usefulness. Since its introduction by Davis (1989) and Davis *et al.* (1989), the Technology Acceptance Model has been widely used for predicting the acceptance, adoption and use of information technologies.

“Understanding...technology acceptance has been a priority for a couple of decades and several models have been proposed and suggested, but TAM has been the most popular of these models” (Chuttur, 2009; Gefen and Straub, 2000; Taylor and Todd, 1995).

The Technology Acceptance Model is more appropriately applied in online contexts in light of several advantages it offers:

- 1) It is specific to information system usage in applying the concepts of ease of use and usefulness.
- 2) It is more parsimonious (economical). Additionally, it adopts the simplest assumptions when formulating or interpreting data.
- 3) It is more robust in various information system applications.
- 4) It is a robust but parsimonious theory and it is useful to explain a particular information system or technology.
- 5) TAM helps to understand and explain use behaviour in information system implementation.
- 6) It has been tested in many empirical studies, and the tools used with the model have proven to be of quality and to yield statistically reliable results.
- 7) TAM has been the only model that has widely captured the attention of the information systems community.
- 8) TAM is advanced theory derived from the theory of reasoned action (TRA) and the theory of planned behaviour (TPB); it is expected that it should explain or predict actual behaviour more accurately than TRA and TPB.
- 9) TAM could be useful in predicting end users’ acceptance of an e-learning system in organisations (Davis *et al.*, 1989; Wu *et al.*, 2011).
- 10) TAM offers a basic framework to explain the influence of external variables towards
- 10) TAM offers a basic framework to explain the influence of external variables towards behavioural ideas (Davis, 1989), and TAM has been applied to different technologies such as word processors, email, the World Wide Web and hospital information systems.
- 11) TAM predicts IT acceptance under different conditions, such as time and culture, with different control factors. The UTAUT model is less parsimonious than TAM
- 12) TAM has been applied in different forms to explain technology adoption in a wide variety of contexts, ranging from individual to organisational technology acceptance.

According to Legris *et al.*, (2003) “TAM has proven to be a useful theoretical model in helping to understand and explain use behaviour in IS implementation, and it has been tested in many empirical studies. The tools used with the model have proven to be of quality and to yield statistically reliable results”. TAM is superior to both the TRA and the TPB for explaining the variance in actual behaviour and in terms of model fit.

The use extension of the Technology Acceptance Model

However, the use extension of the Technology Acceptance Model is an ongoing process to assess the modern technologies context, including mobile service, cloud computing applications, ubiquitous computing applications which are also applicable to this study. TAM has arguably become the most influential theory in the IS field; with the various extended TAMs, the structure and main assumptions of these models remain the same as the original Technology Acceptance Model (TAM). The new variables that were added to the Technology Acceptance Model are shown in Table 8 below.

Author and Date	The added construct
Agarwal and Prasad (1998a, 1998b)	Compatibility
Dishaw and Strong (1999)	Task-technology fit
Agarwal and Karahanna (2000)	Cognitive absorption, playfulness and self-efficacy
Venkatesh and Davis (2000)	Subjective norms

Moon and Kin (2001)	World Wide Web
Chau and Hu (2002)	Peer influence
Chiu et al. (2005)	Personal innovativeness
Gefenet al. (2003) and Wu and Chen (2005)	Trust
Walczuchet al. (2007) and Lin et al. (2007)	Readiness
Lin et al. (2007)	E-stock users' behavioural intentions
Stern et al. (2008)	Online auctions
Chen et al. (2009)	Self-service
Chen and Chen (2009)	Automotive telematics users' usage intention
Lee (2009)	Perceived risk and perceived benefit
Muller-Seitz et al. (2009)	"Security" to understand customer acceptance of Radio Frequency Identification (RFID).

Table 4.8 New variables added (Extensions) based on the Technology Acceptance Model
Source: Author

Some scholars have stated that, "TAM posits that perceived usefulness is the strongest predictor of an individual's intention to use an information technology" (Davis, 1989; Venkatesh and Davis, 2000; Venkatesh *et al.*, 2003). TAM suggests, "Perceived ease of use has a significant influence on perceived usefulness, behaviour attitude, intention, and actual use" (Davis, 1989; Mathieson, 1991; Moore and Benbasat, 1991). Regarding perceived ease of use and perceived usefulness, Davis (1989) suggests, "From a causal perspective, the regression results suggest that ease of use may be an antecedent of usefulness, rather than a parallel, direct determinant of usage". "The goal of TAM is to offer a parsimonious explanation of the determinants of adoption of IT" (Davis *et al.*, 1989). Venkatesh (2000) concludes that "TAM is the most widely applied research paradigm to understand user acceptance of technology and one of the most widely used in the information systems field". According to other scholars, "TAM is a valid and robust model of technology acceptance (King and He, 2006) across levels of user expertise" (Gefen, 2002) and across various contexts including social networks (Hossain and de Silva, 2009), health IT applications, online trading (Lee, 2009) and software firewalls (Kumar *et al.*, 2008). TAM was developed as an attempt "to provide an explanation of the determinants of computer acceptance that is general, capable of explaining user behaviour across a broad range of end-user computing technologies and user populations, while at the same time being both parsimonious and theoretically justified" (Davis, 1989: 985). According to Azmi *et al.* (2010), "TAM is widely used and accepted to explain the relationship between perceptions and the use of technology and the two main constructs that influence behavioural intention are PU and PEU; PU is defined as the user's perception of the degree to which using the system will improve his or her performance in the workplace and PEU is defined as the user's perception of the amount of effort they need to use the system". Past researchers have provided evidence of the significant effects of PEU and PU on BI (Venkatesh and Davis, 1996; Davis *et al.*, 1989; Agarwal and Prasad, 1999). Similar to Davis *et al.* (1989), the attitude construct is dropped from this extended TAM model because of its weakness in mediating the impact of beliefs on behavioural intention (cited in Azmi *et al.*, 2010). Regarding predicting usage, TAM models might be useful within and across organisations for evaluating applications or technologies or to make comparisons between user groups or applications (Fu *et al.*, 2006). According to Moody *et al.* (2010), "there is a large gap between the technology acceptance model (TAM) and the rest: it is more than 3 times as influential as the next most cited theory, the information systems success model (ISM), was developed only 3 years after TAM, which makes it a clear choice as the leading paradigm in the information systems field". Benbasat and Barki, (2007) also confirmed that "TAM being the most influential information systems theory and the Technology Acceptance Model (TAM) is generally referred to as the most influential and commonly employed theory in information system which is also considered to be the only well-recognised theory in information systems field".

ii) The Theory of Planned Behaviour (TPB)

The Theory of Planned Behaviour (TPB) was proposed by Ajzen (1985) and is also widely accepted and adopted in management information systems (MIS) research and has the following advantages:

1) The limitation of TAM is that it does not reflect the variety of user task environment and constraints, but the Theory of Planned Behaviour incorporates subjective norm and perceived behaviour control to predict behaviour intention for using the system. The theory of planned behaviour has also been widely used to understand individual acceptance and use of different technologies.

2) Many studies have applied the Theory of Planned Behaviour to investigate behaviour prediction using attitudinal variables and found that TPB is one of the most influential models in predicting behavioural intentions and behaviours. It has been comprehensively validated in the behavioural domain (Ajzen, 1991; Ajzen and Driver, 1991; Madden *et al.*, 1992; Parker *et al.*, 1995 and Ajzen, 2010).

3) The Theory of Planned Behaviour provides more specific information that guides development (Mathieson, 1991).

4) The researcher considers the Theory of Planned Behaviour to be relevant to some aspects of studies in technology adoption as it involves human behaviour, technology, professional groups, organisations and general management. There is overwhelming support for the theory of planned behaviour model's ability to predict behaviour; researchers continue to call for additional variables to be added to the model in an attempt to further enhance the model's predictive capability (Conner and Armitage, 1998; Lutz, 2011). The Theory of Planned Behaviour explains and predicts all human behaviour and not just IT usage behaviour. Paul and John (2003) suggested that TAM should combine a broader one which includes variables related to human and social factors which Theory of Planning Behavioural incorporates.

Table 9 summarises the progress of technology adoption research using the Technology Acceptance Model (TAM) and the Theory of Planned Behaviour (TPB).

Major Areas of Progress	Technology Acceptance Model (TAM)		Theory of Planned Behaviour (TPB)	
	Key Examples	Cites	Key Examples	Cites
Influential models	i)Technology Acceptance Model: ii)Theory of Planned behaviour: iii)Innovation Diffusion Theory:	i)Davis (1989); Davis <i>et al.</i> (1989) ii)Ajzen (1985, 1991); Mathieson (1991); iii)Taylor and Todd (1995a, 1995b) Agarwal and Prasad (1998) Moore and Benbasat (1991)	i) For the purpose of the model: centric comparison	i)Theory of Planned Behaviour: Ajzen (1985, 1991)
Replication and generalizability	i)Population: ii) Countries: iii)Technologies: iv)Organizational systems—	i)Adams <i>et al.</i> (1992); Hendrickson <i>et al.</i> (1993); Mathieson (1991) ii)Japan—Straub <i>et al.</i> (1997); Saudi Arabia—Abdulgader and Kozar (1995) iii) Email Karahanna and Straub (1999); Calculator—Mathieson (1991); Spreadsheet—Mathieson (1991) and Venkatesh and Davis (1996); iv) Venkatesh <i>et al.</i> (2003)	i)Cross-cultural examinations ii)Goal-directed behaviours iii)Health behaviours iv) Weight loss	i)Godin <i>et al.</i> (1996); Hanson (1999) ii)Ajzen and Madden (1986) iii)Connor and Sparks (1996) iv)Schifter and Ajzen (1985)
Predictive validity	i)Actual use: ii) Choice: iii)Intention: iv)Self-reported use:	i) Straub <i>et al.</i> (1995); Venkatesh and Morris (2000); Venkatesh <i>et al.</i> (2003) ii) Szajna (1994) iii) Davis <i>et al.</i> (1989); Mathieson (1991) iv) Davis <i>et al.</i> (1989)	i)Blood donation ii)Consumer behaviour iii)Household cycling of newspapers iv)Negotiation v)Rehabilitation	i) Armitage and Conner (2001b) ii) East (1996); Fortin (2000); Notani (1998) iii) Boldero (1995) iv) Shapiro and Watson (2000) v) Blanchard, Courmeya, Rodgers, Daub, and Knapik (2002); Godin <i>et al.</i> (1996)
Competing models	i)Decomposed theory of planned behaviour: ii) Innovation diffusion theory: iii) Social cognitive theory: iv)Triandis' model:	i) Taylor and Todd (1995a, 1995b) ii) Moore and Benbasat (1991) iii) Compeau and Higgins (1995a, 1995b) iv) Thompson <i>et al.</i> (1991)	i)Health models ii)Triandis' model: iii)Volunteer motivation	i) Quine <i>et al.</i> (1998) ii) Triandis (1977) iii) Harrison (1995)
Theory base to study unique	i)Advertising:	i) Rogers and Chen (2002)	i)Adherence to speed limits	i) Elliott <i>et al.</i> (2003)

problems	ii) Dairy farming: iii) Green electricity: iv) Information adoption: v) Marketing: vi) Trust:	ii) Flett <i>et al.</i> (2004) iii) Arkesteijn and Oerlemans (2005) iv) Sussman and Seigal (2003) v) Dabholkar and Bagozzi (2002) vi) Gefenet <i>et al.</i> (2003a, 2003b)	ii) Ethical decision making: iii) Smoking cessation behaviour: iv) Technology adoption:	ii) Flannery and May (2000) iii) Bennett and Clatworthy (1999) iv) Taylor and Todd (1995a, 1995b); Venkateshet <i>et al.</i> (2000)
Temporal dynamics and other contingencies	i) Age: ii) Gender: iii) Higher-order interactions: iv) Temporal dynamics: v) Voluntariness:	i) Morris and Venkatesh (2000) ii) Gefen and Straub (1997); Venkatesh and Morris (2000) iii) Morris <i>et al.</i> (2005) iv) Karahanna <i>et al.</i> (1999); Taylor and Todd (1995a); Venkatesh and Davis (2000) v) Hartwick and Barki (1994); Venkatesh and Davis (2000)	i) Age: ii) Gender: iii) Temporal dynamics:	i) Armitage <i>et al.</i> (2002) ii) Armitage <i>et al.</i> (2002); Taylor, Bagozzi, and Gaiher (2001) iii) Doll and Ajzen (1992); Conner <i>et al.</i> (2000); Sheeran and Abraham (2003)
Temporal dynamics and other contingencies	i) Age: ii) Gender: iii) Higher-order interactions: iv) Temporal dynamics: v) Voluntariness:	i) Morris and Venkatesh (2000) ii) Gefen and Straub (1997); Venkatesh and Morris (2000) iii) Morris <i>et al.</i> (2005) iv) Karahanna <i>et al.</i> (1999); Taylor and Todd (1995a); Venkatesh and Davis (2000) v) Hartwick and Barki (1994); Venkatesh and Davis (2000)	i) Age: ii) Gender: iii) Temporal dynamics:	i) Armitage <i>et al.</i> (2002) ii) Armitage <i>et al.</i> (2002); Taylor, Bagozzi, and Gaiher (2001) iii) Doll and Ajzen (1992); Conner <i>et al.</i> (2000); Sheeran and Abraham (2003)
Determinants and other interventions	i) Determinants of usefulness and ease of use ii) Training interventions	i) Karahanna and Straub (1999); Venkatesh (2000); Venkatesh and Davis (2000) ii) Olfman and Mandviwalla (1994); Venkatesh (1999); Venkatesh and Speier (1999)	i) Cognitive behavioural therapy interventions ii) Determinants of blood donation behaviour iii) Determinants of condom use iv) Determinants of exercise intention v) Determinants of vegetable consumption	i) Fishbein and Ajzen (2005) ii) Armitage and Conner (2001b) iii) Albarracin <i>et al.</i> (2001) iv) Blanchard <i>et al.</i> (2002) v) Bruget <i>et al.</i> (1995)
Construct refinement and alternative mechanisms	i) Expectation-disconfirmation: ii) Habit iii) Post-adoption:	i) Bhattacharjee (2001); Bhattacharjee and Premkumar (2004) ii) : Morris <i>et al.</i> (2005) iii) Jaspersonet <i>et al.</i> (2005)	i) Behavioural expectation: ii) Dimensionality of PBC: iii) Habit: iv) Refinement of PBC: v) Role of self-identity:	i) Warshaw and Davis (1985) ii) Chan and Fishbein (1993) iii) Ouellette and Wood (1998) iv) Terry (1991, 1993) v) Sparks (2000)
Synthesis	Gefen and Straub (2000); Lee <i>et al.</i> (2003); Legris <i>et al.</i> (2003); Venkateshet <i>et al.</i> (2003)		Albarracinet <i>et al.</i> (2001); Armitage and Conner (2001a); Fishbein and Ajzen (2005)	

Table 9 Summary of the progress of technology adoption research using the Technology Acceptance Model (TAM) and the Theory of Planned Behaviour (TPB)

Source: Adapted from Davis and Morris (2007)

Mathieson's (1991) study compared the Technology Acceptance Model (TAM) with the Theory of Planned Behaviour (TPB) and identified that: i) the Technology Acceptance Model (TAM) was specifically designed by Davis (1986) to predict use of an IS; ii) the Theory of Planned Behaviour (TPB) was discussed by Ajzen (1985, 1989); iii) the Theory of planned behaviour (TPB) was designed to predict behaviour across many settings and can be applied to IS use; and iv) These models were compared using three criteria: (1) How well do they predict the user's intention to use an IS? (2) How valuable is the information provided by the model? (3) How difficult are the models to apply?

There are three differences between the Technology Acceptance Model (TAM) and the Theory of Planned Behaviour (TPB), which are as follows:

1. Generality

The Technology Acceptance Model assumes that beliefs about usefulness and ease of use are always the primary determinants of use decisions. Its constructs are measured in the same way in every situation. The advantage of the Theory of Planned Behaviour's approach is that all respondents are making the same comparison. It uses beliefs that are specific to each situation. The disadvantage of the approach is that this reference point may not apply to all individuals. TPB's items require an explicit behavioural alternative if they are to be as specific as possible. This theory is more difficult to apply across diverse user contexts than the Technology Acceptance Model.

2. Social variables

The Technology Acceptance Model does not explicitly include any social variables. Thus motivation is more likely to be captured by the Theory of Planned Behaviour than by the Technology Acceptance Model. The Theory of Planned Behaviour incorporates social norms and perceived behaviour control.

3. The models treat behavioural control differently.

Referring to the skills, opportunities, and resources needed to use the system, the only variable included in TAM is ease of use (internal control factors), while the external control factors such as time, opportunities and cooperation of others were included in TPB.

7. Findings and Conclusions

We have covered well-established research theories and models that have contributed to the development of the conceptual framework of technology adoption such as the Theory of Reasoned Action (TRA) (Fishbein, 1967, Fishbein and Ajzen, 1980), Theory of Planned Behaviour (TPB) (Ajzen, 1991), Technology Adoption Model (TAM) (Davis, 1989, Davis et al., 1989) and the Unified Theory of Acceptance and Use of Technology (UTAUT) model. Attempt was made to summarise other theoretical frameworks applied to IT system adoption; suggested justification for choosing the Technology Acceptance Model (TAM) and the Theory of Planned Behaviour (TPB) in most research work involving technology adoption. We identified three significant differences between TAM and TPB.

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