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# Theories and Models of Technology Acceptance Behaviour: A Critical Review of Literature

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**Abstract:** The inception of various theoretical models to increase the explanatory and predictive power with a parsimonious structure within technology acceptance has lasted more than 20 years. In this vein, researchers have attempted to constitute new models or derivatives from already existing models (e.g., TAM, TRA, and TPB). At the beginning, each of the models was doing well on approaching the problem with a specific theoretical stance; however, they were criticised at a later stage with some common features and limitations. Therefore, for IS researchers selecting an appropriate model has always remained a critical task. To overcome the problem, this study aims to critically examine the most prominent models (i.e. TAM, TRA and TPB) that are widely accepted as predicting and explaining human behaviour towards acceptance of various technologies. The critical evaluation of the previous theories and models would help future researchers in selecting appropriate single/multiple theoretical models/constructs based on their strength(s) and weaknesses in terms of explanatory power and path significance.

**Keywords:** Technology acceptance model (TAM), Theory of reasoned action (TRA), Theory of planned behaviour (TPB)

## 1. INTRODUCTION

Even though research on the acceptance /adoption and usage of information technology (IT) is considered to be one of the most mature areas within the modern information system (IS) literature (Hu *et al.*, 1999; Benbasat and Zmud, 1999), the selection of an appropriate model or constructs from a number of multitude models is a persistent problem for researchers in making decision to introduce new technologies in organisations (Venkatesh *et al.*, 2003). Rationally, over the past many years a variety of theoretical models have been applied, modified and integrated from diverse disciplines such as social psychology, sociology and marketing in order to provide an understanding and predict the validated determinants of IT acceptance /adoption and usage (Benbasat and Zmud, 1999; Venkatesh *et al.*, 2003). Consequently, a large number of theories and models posed difficulties for researchers when selecting an appropriate model for specific problems was required. For instance, if a single model is selected for a specific objective/context then it seems to be ignorant of the other models' contribution and also it is not necessary for the constructs within the selected model to perform equally as they were applicable in previous studies. Consequently, selecting a specific model may produce overflow (i.e., extra number of constructs which may have no impact on required objective) and underflow conditions (i.e., still number of constructs are needed to achieve required objective) within the analysis process. One possible solution for this problem can be the selection of various constructs from multiple models and integration of them into an extended model. However, selecting a number of theories and constructs of interest with warranted theoretical underpinnings is considered to be a challenging task (Venkatesh *et al.*, 2003). Taking this challenge, the aim of the present study was to critically review and compare three prominent models in the Information Systems (IS) research i.e., TRA, TAM and TPB and their constructs in previous literature.

## 2. REVIEW OF THOERIES AND MODELS

### 2.1. Theory of Reasoned Action

The fundamental theory of human behaviour, which has remained a focal point for other theories and models to extend, is the theory of reasoned action (TRA). Originally TRA was introduced by Fishbein and Ajzen (1975) and Ajzen and Fishbein (1980).

In TRA, beliefs influence attitude to shape intention, which in turn guides or dictates behaviour to perform an action (Chau and Hu, 2001). According to Ajzen and Fishbein (1980), TRA is based on the assumption that individuals are usually rational and make systematic consideration of their actions' implications 'before they decide to engage or not engage in a given behaviour'. Whereas the process of behaviour establishment based on intention's significance is defined as: 'most behaviours of social relevance are under volitional control and are thus predictable from intention' (ibid, p.41). TRA is based on three major constructs **(see Fig. 1)** and their relation to each other as follows:

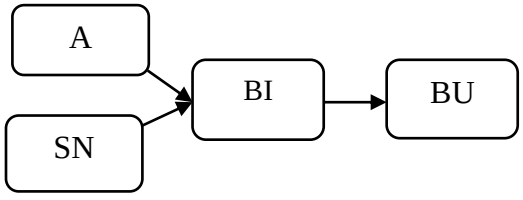



**Fig.1 Theory of Reasoned Action**
**Source: Ajzen and Fishbein (1980)**

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*Behavioural intention (BI):* BI is an immediate antecedent of behaviour (Ajzen, 2002). It is a cognitive process of an individual's readiness to perform a specific behaviour. Whereas behaviour is an observable action performed by an individual on his/her experience or mediated by some vicarious observations to a given target (LaRose and Eastin, 2004). This implies that BI is the extent to which an individual formulates a conscious plan to perform or not perform some specified future behaviour towards a target (Warshaw and Davis, 1985). According to TRA, BI, which is an individual's relative strength to perform a task, is dependent upon a person's attitude towards the behaviour and/or the subjective norms (Ajzen and Fishbein 1980 Fishben and Ajzen, 1975).

*Attitude (A):* explains human actions (Ajzen and Fishbein, 1980) and is defined as an 'individual's positive or negative evaluation of performing the behaviour' (Fishbein and Azjen, 1975). It is determined by a person's evaluated beliefs about the performed behavioural consequences. Therefore, if past experience about targeted behaviour is positive then A will also have a positive impact on BI or else it will have a negative effect. Attitude is the product of important behavioural beliefs and the individual's outcome evaluation (Fishbein and Azjen, 1975); whereas behavioural beliefs are a subjective probability that behaviour leads to a particular outcome.

*Subjective norm (SN):* is defined as 'the person's perception that most people who are important to him or her think he/she should or should not perform the behaviour in question' (Azjen and Fishbein, 1975, p.302). SN is also considered with the concept of social influence (Agarwal and Prasad, 1998), which is examined by the opinions of friends, family, colleagues, peers and social groups (Miller, 2005). Consequently, these opinions become an individual's normative beliefs with which he/she complies (Scheper and Wetzels, 2007,. Ajzen, 1985) defined normative beliefs as the 'likelihood that important referent individuals or groups would approve or disapprove of performing the behaviour'. According to TRA, the strength of SN is based on an individual's normative beliefs multiplied by the motivation to comply with the opinion of important referents (ibid).

TRA can be understood by the notation of BI=A+SN, which means beliefs (i.e., underlying individual's attitude) affect intentions and behavioural consequences either through A or SN (Madden *et al.*, 1992). In other words, TRA explains an individual's volitional BI (i.e., likely to do it) which is dependent on the individual's A towards BI and SN.

***Critics on TRA***

Despite its wide applicability and extendibility, including its conceptualisation of the TAM, TRA possesses number of limitations. Out of many, one major limitation is its assumption of measuring the behaviour under volitional control. That is, beliefs depend upon the will of the individual to perform the behaviour (Ajzen, 1985). Thus, in situations when volitional control is low (i.e., individual's will is difficult to know), TRA was unsuccessful at predicting the expected significant relationship between BI and BU. Apart from volitional control limitation, Foxall (1997) highlighted three more perspectives where TRA failed to explain the expected behaviour. Firstly, TRA limits from the perspective of beliefs that establish the A. For instance, TRA was too general model and did not specify the beliefs that are in operation for any specific behaviour. In other words, the model fails to include the non-attitudinal personal and situational beliefs that are likely to influence the strength of A→BI relationship or increase the prediction of usage behaviour. This limitation suggests that, prior to applying TRA, it is essential to examine the individuals' salient beliefs about the behaviour under investigation (Davis *et al.*, 1989), which in some situations seems impractical or expensive due to time and cost constraints. Secondly, TRA has limitations from the perspective of predicting future usage behaviour (Foxall, 1997). For instance, TRA was developed to examine the predicted BI rather than the outcome of the behaviour itself (ibid). According to Davis *et al.*, (1989) in order to examine TRA, actual usage behaviour should be measured objectively and unobtrusively, so there should be a clear distinction between prior and present BI towards the usage behaviour. Contrary to Davis' caution, originally in TRA conceptualisation, behaviour is a direct determinant of BI and both BI and behaviour (B) are measured at the same time. That is, the outcome of the behaviour itself or predicting models' power to measure future usage is not true, rather than the model is predicting only the power for the current usage behaviour (i.e., similar to intention). Put simply, TRA limits its predictability in situations when BI and B are highly correlated or measured at the same time. This limitation was also reported by Ajzen & Fishbein (1980) who acknowledged that explaining future usage behaviour was difficult to achieve, due to the time interval, which might invite unforeseen events. This in turn may affect the factors and disturb the relationship(s) proposed. Thirdly, TRA is limited from the perspective of BI (Foxall, 1997). That is, BI completely mediates the effect of the A on B (ibid). According to Bagozzi and Yi (1989), the degree to which intentions are well-formed effects the way in which attitude influences the B. Thus, the conceptualisation of TRA i.e., A→BI→B is ill-equipped to predict situations when intentions are ill-formed (i.e., partial or no mediation effect). Consequently, attitude produces a direct effect on behaviour (i.e., A→B).

## 2.2. Theory of Planned Behaviour

Overcoming the limitations of TRA to predict behaviour in situations where individuals have a low

level of violation control, (Ajzen, 1988, 1991) proposed a revised succession of TRA known as the Theory of Planned Behaviour (TPB). Ajzen (1991) incorporated an additional exogenous construct, namely perceived behaviour control (PBC), in addition to TRA's earlier constructs (i.e., A to BI and SN) to predicate planned and deliberate behaviour. The inclusion of PBC was made to account for conditions when individuals intend to carry out some behaviour but the original behaviour was not satisfied because of a lack of confidence or control over behaviour (Miller, 2005). The effect of PBC in TPB was added by Ajzen (1985) as a direct determinant of behaviour and indirect determinant through BI to behaviour. (Ajzen, 1991) defined the PBC as the 'perceived ease or difficulty of performing the behaviour'. Later on, specifically in the context of IS research, (Taylor and Todd, 1995a,) defined PBC as the 'perception of internal and external constraints on behaviour'. Behavioural control was defined as beliefs about the presence of some factors that may facilitate/impede the performance of behaviour (ibid). Behavioural control is different from SN, which is perceived social pressure or normative expectations from others and also has an impact on BI to use.

As with TRA, in TPB an individual's behaviour is examined by his/her BI, which is affected by A toward BI, SN and additional construct of PBC. Furthermore, these constructs are influenced by a human's individual beliefs, namely as behavioural beliefs (i.e., likely consequences or others' attributes of behaviour), normative beliefs (i.e., normative expectations of other people's beliefs) and control beliefs (i.e., presence of factors that may support or hinder behaviour) respectively (Ajzen, 2002) **(see Fig. 2).** (Ajzen, 1991) predicted that if A→BI and SN→BI have a favourable effect, then the PBC will be greater and an individual's BI to perform the behaviour will be higher/stronger.

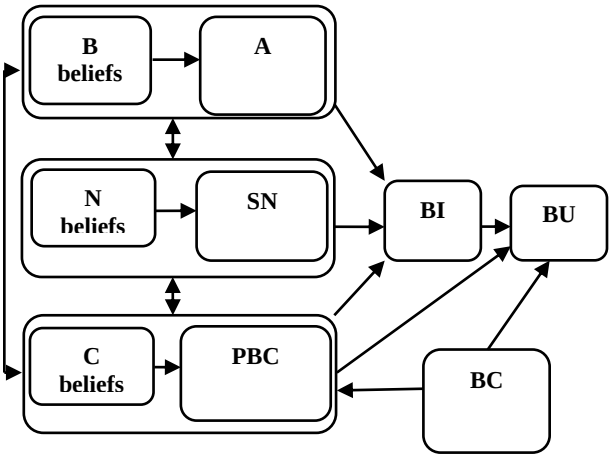



**Fig. 2: Theory of Planned Behaviour: Source: Ajzen (1991)**

***Critics on TPB***

Ajzen (1988, 1991) incorporated the additional construct in TRA because of the assumption that most human social behaviour is under volitional control that can be predicated from intentions alone. However, argument was not effective in many cases and has been challenged by many researchers (e.g., Taylor and Todd, 1995a), even by Ajzen himself (2002). It is a general observation that in some situations even people wish to deal with some favourable behaviour but fail due to a lack of volitional control e.g., the intention to visit a doctor to get positive results about a disease is not completely under an individual's control but is based on others' actions and produces a lack of control over their own actual behaviour. This argument was also highlighted by Sheppard *et al.,* (1988) who accepted TRA but differed on volitional control, which they defined as: 'behavioural intention will predict the performance of any voluntary act, unless intent changes prior to performance or unless the intention measure does not correspond to the behavioural criterion in terms of action, target, context, time-frame and/or specificity'.

Nevertheless, TPB filled the gap of TRA for volitional control but still holds acceptable criticism. For instance, (Eagly and Chaiken, 1993) identified some factors that may exhibit an impact on BI and behaviour (e.g., habit, moral obligation and self-identity) within TRA, but have not yet been addressed in TPB. Secondly, as an extension of TRA, TPB holds an inherent assumption of proximity between BI and behaviour, which still requires specific situational conditions to predict the actual behaviour (Foxall, 1997). In other words, it can be stated that beliefs are still context-specific and cannot be generalised; therefore, it is necessary every time to modify the measurement items according to the specific context and population (Ajzen, 1991). According to Eagly and Chaiken (1993), the relationship between PBC and BI presumes that individuals decide to carry out behaviour because they feel they can achieve it. However, TPB fails to explain how an individual will presume and what mechanism would be needed to engage in specific behaviour (Taylor and Todd, 1995a). In addition, TPB is criticised due to the operationalisation of its additional construct i.e. PBC. It is assumed that the single construct PBC is enough to answer all the non-controllable factors predicting behaviour. More specifically, measurements of PBC are directly aggregated from the beliefs recording the control and predicted behaviour, which might overlook the presence of additional salient factors that predict BI and behaviour (Taylor and Todd, 1995c).

## 3. TECHNOLOGY ACCEPTANCE MODEL

In search of a parsimonious model, which presents an equally good explanatory power, Davis (1989) proposed a theory to be specifically modelled for

the domain of IT in the form of the now widely accepted conceptualisation of IT acceptance: the Technology Acceptance Model (TAM). Originally, the TAM was an adoption of TRA where attitude (A) predicts intention (BI), and intention predicts behaviour (BU). However, unlike TRA, the TAM does not include subjective norms (SN) as a determinant of BI because of the uncertain theoretical and psychometric properties (Davis *et al.,* 1989). The use of SN in TRA was also cautioned by Fishbein and Ajzen (1975) who posit that SN can create theoretical and empirical problems due to the difficulty of differentiating the direct effect of SN on BI from indirect effect via A. Another feature of the TAM, which distinguishes it from TRA is that, unlike expectancy formulation of beliefs within TRA, the TAM suggests only two beliefs i.e. perceived usefulness (PU) and perceived ease of use (PEOU) to predict an individual's A towards using technology. In addition to their indirect effect on BI via A, PU is also expected to exhibit a direct effect on BI **(see Fig. 3).** In addition to the TRA constructs, TAM's two specific beliefs i.e. PU and PEOU are described as follows:

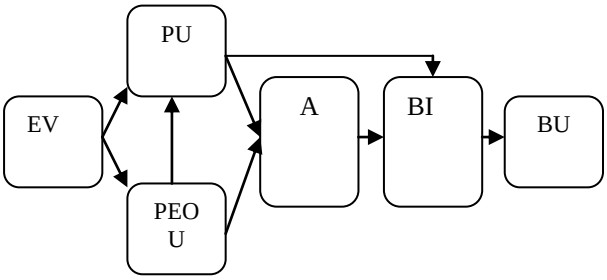



**Fig. 3. Technology Acceptance Model (Davis et al., 1989)**

*Perceived usefulness (PU):* is defined as the prospective user's subjective probability that using a specific application system will increase his or her job performance within an organisational context (Davis *et al.,* 1989).

*Perceived ease of use (PEOU):* is defined as the degree to which the prospective user expects the target system to be free of effort (Davis *et al.,* 1989).

*External variables (EV):* are defined as the explicitly included factors in the model that have an expected impact on BI and BU through the meditation of PU and PEOU (Davis *et al.,* 1989, p.987). According to the authors, external variables might include: system design characteristics, training, documentation and support, and decision-making characteristics (ibid).

Davis *et al.,* (1989) noticed the inherent limitation of TRA in the TAM and modified the model by un-weighting its core constructs PU and PEOU instead of eliciting PU and PEOU for each specific technology and context. Nevertheless, omitting the multiplicative evaluation of beliefs invites possible misleading results (e.g., in a single study some people give a positive evaluation whereas others hold a negative evaluation of the same outcome), but it facilitated the TAM to differentiate between A, BI, the two beliefs PU and PEOU with the impact of external stimuli across different settings. After evaluating the TAM in voluntary settings, Davis *et al.,* (1989) found that the model predicted well expected explanatory power in intention (i.e., 45% at the start and 57% after 14 weeks), except for the partial mediation effect of construct A (i.e., a weak relation between PU→A, and a strong relation at PU→BI). Hence, in revision, the authors removed the A construct and established a direct link of beliefs over BI (ibid), which is also supported in social psychology research and suggests that attitude can be omitted if the desired impact of beliefs on behaviour is warranted (Ajzen, 1991).

***Critics on TAM***

Despite the widespread acceptability of the TAM within IS research, it is not without limitations. The first and the most common limitation reported within TAM studies is its self-reported usage (Lee *et al.,* 2003, Davis, 1993). The self-reported usage is known to be subject to the common method bias, which either distorts or overstates the casual relationship between independent and dependent variables (Agrwal and Karahanna, 2000). The second limitation of the TAM is that it has not been tested with actual measures of usage behaviour but only various parts have been examined separately using measurement of beliefs, attitude and intentions collected coincidently with linear-regression, and hence, shown reasonable variance in BI and BU when examined in different settings (Taylor and Todd, 1995a; Mathieson, 1991). For instance, Taylor and Todd (1995a) examined the TAM and found that the model had a reasonable explanatory power but the tests between the relationships of the model did not produce consistent results in all cases for validating its generalisibility. The third limitation within the TAM studies is related to its explanatory power. Although the model has consistently produced up to 40% variance in BI, it fails to explain the reasons for the remaining 60% variance that is unexplained. Finally, the TAM since its creation has remained successful in predicting system acceptance but has remained weak at explaining the design process, which fosters the acceptance behaviour (Venkatesh and Davis, 1996; 2000). The model offers feedback on PU and PEOU but does not provide feedback about aspects of improvement, such as flexibility, integration, completeness and currency of information (Taylor and Todd, 1995a; Venkatesh *et al.,* 2003).

## 4. CROSS-COMPARISON

### *4.1. TAM vs. TPB*

Both the TAM and TPB are grounded in Social Cognitive Theory and are immediate successors to the

TRA. The review presented in the previous relevant sections 3 and 4 reveals that two models share points of similarity due to a causal uni-dimensional view of relationships among the constructs. Specifically, both models suggest that environmental beliefs influence cognitive beliefs, which in turn influence attitude and targeted behaviour. Conversely, two models differ in the perspective of beliefs, for example, the TAM believes that A towards BI is the result of beliefs i.e. PEOU and PU (Davis *et al.*, 1989; Davis, 1989); whereas the TPB believes that BI is the result of the beliefs defined in the TAM as well as explicit situational beliefs (i.e., SN) and control beliefs (i.e., PBC) (Ajzen, 1991; Methieson, 1991).

This difference can be understood by the categorisation of beliefs factors as external control beliefs, which deal with the time, opportunity and cooperation constructs; and internal control variables, which incorporate one's skills and motivational strengths (Ajzen, 1985). Davis *et al.*, (1989), within the TAM, did not explicitly examine both external and internal beliefs; however, they considered them as part of the situational beliefs, which were measured by the PEOU. After examining the model in mandatory situations, Davis found that the TAM produced significant explanatory variance in internal situational beliefs (i.e., self-beliefs and skills) but remained less satisfactory in explaining the variance within external controlled beliefs. This suggests that the TAM, like its predecessor TRA, is based on the assumption of volitional control, and performs less effectively in situations where volitional control is perceived as low.

Contrary to this, the TPB has an advantage over the TAM because the former includes PBC factor, which explains a person's perception of control over performing behaviour. Due to volitional control, the TPB is empirically favoured. For instance, the literature suggests that, within mandatory settings, the TPB, compared to the TAM, added about 4% to 5% variance in explaining BI and 1% in explaining BU (Taylor and Todd, 1995a, Mathieson, 1991). However, from generality perspective, the TPB compared with the TAM is less applicable. The TAM assumes that beliefs about behaviour are measured in a similar way in all situations, whereas TPB assumes that beliefs are context specific (Taylor and Todd, 1995a). Therefore, the TPB requires an extra step (i.e., usually piloting) to identify those situations specific to the particular organisational context, individuals' needs, and hence becomes more complex if different groups of individuals or situations exists within a single context of the study.

Nevertheless, from the explanatory perspective (i.e., $R^2$), both models remain successful at par. However, within voluntary settings the TAM has a slight advantage over TPB. An illustration of this can be inferred from the studies by Mathieson (1991), Taylor and Todd (1995a) and Chau and Hu (2002). Mathieson (1991) compared the two models (i.e. TPB and TAM) with the objective of predicting the user's intention to accept spreadsheet programmes within a sample of students. The authors found that the TAM performed slightly better than the TPB. For instance, the TAM explained 69% variance, whereas TPB explained 60% variance. In addition, within TPB, the authors did not find a significant impact of SN over BI (ibid). This supports the TAM's framework, which excludes SN and asserts that social pressure is an inherent part of behavioural beliefs and its explicit inclusion in a model only increases the model's complexity rather than the explanatory power to predict the intention (Davis *et al.*, 1989). However, contrary to the TAM's assumptions, as theoretically supported in psychology literature, Mathieson (1991) found a significant impact of PBC on BI. Mathieson's results were echoed by Chau and Hu (2002) during a study of the physicians to predict the acceptance of telemedicine technologies. The authors found the TAM to be slightly better than the TPB in explaining BI, i.e., 40% by TAM and 32% by TPB. In addition, similar to Mathieson's study, they found a significant impact of the PBC and not significant impact of SN on BI (ibid). One major difference between the two studies was the effect of beliefs of PEOU on the A. Mathieson found a significant effect of PEOU and PU on the A in the TAM, whereas Chau and Hu found no significant effect of PEOU on the A. This result is contrary to the general perception of the TAM and suggests that the TAM, identical to the TPB, produced differences in results when context/situations were different /changed.

Contrary to these two studies, during the development of Decomposed TPB (DTPB) Taylor & Todd (1995a) compared the two models in a sample of students and found the TPB better than the TAM. The authors found that the TAM explained 52% variance in acceptance intention whereas the TPB explained 57% variance. In addition, as theorised with TPB and contrary to the TAM, both social beliefs (i.e., SN) and control beliefs (i.e., PBC) produced significant impact on BI. Observing mixed results favouring two models, Taylor and Todd (1995b) combined the two models and presented an integrated model known as the augmented TAM (A-TAM). The authors examined A-TAM within the context of both experienced and inexperienced users' context and found that the model produced 43% variance within BI for experienced users and 60% variance for inexperienced users. Similar to the TAM, A-TAM produced an no significant impact of SN within the context of both experienced and inexperienced users. The merger of two models within the A-TAM suggests that either the TAM or the TPB was not enough to obtain the required objectives and leaves a gap for further exploration and extension of theoretical conceptualisations.

In the light of reviewed studies and the discussion mentioned above, it is concluded that the

TAM is easier to use and is useful for predicting users' intentions in situations where contextual information is not needed. Additionally, due to the parsimonious structure and explanatory power the TAM has gained advantage over the TPB. However, the TPB has remained advantageous over the TAM when designing and predicating specific user behaviour in diverse situations. However, context specification undermines the TPB due to its complexity when approaching comparative reference points between all individuals' and organisational needs during the implementation process.

### *4.2. TRA vs. TPB*

The first extension of the TRA was the TPB. The two theories/models were similar because the dependent variable of interest was an overt and observable manifestation of the focal behaviour. Specifically, both theories posit that BU is influenced by an individual's BI, which in turn is determined by the individual's A and SN towards BI (Ajzen, 1985). However, unlike the TRA, the TPB introduced an additional construct i.e. PBC as a predictor of BI as well as BU. The inclusion of this additional construct within the TPB was to overcome the limitation of the TRA when predicting behaviour under conditions where individuals were having low or no volitional control (Ajzen, 1991; Taylor and Todd, 1995a). According to the TPB, volitional control of individuals is unpredictable towards behaviour, which needs to be observed with the PBC as an external variable (Ajzen 1985; Madden *et al.,* 1992). Examining the effect of newly added PBC construct within the TRA, Madden *et al.,* (1992) compared two models within a student sample to examine 10 behavioural activities. The authors found that PBC presented a significant increase in the prediction of BI, on average, $R^2$ from 48% to 59%, and within BU, $R^2$ from 28% to 38% (ibid). These results suggest that inclusion of PBC significantly enhances the prediction of BI as well as target behaviour.

Although the TPB provided a solution for the TRA's volitional control assumption, it still lacks a solution for the inherent assumption of the proximity between BI and BU, which requires specific situations to predict the actual behaviour. In other words, beliefs to measure were still context specific (Foxall, 1997). This limitation was acknowledged in a model comparison study by Taylor and Todd (1995a). The authors decomposed beliefs of TPB that were generalisable across the situations and named the model as DTPB. When comparing the three models, i.e. the TAM, TPB and DTPB, Taylor and Todd found that DTPB provided increased explanatory power compared to other two, however, it had a less parsimonious structure. Recently, (Shish and Fang, 2004) compared the TRA with its two extensions i.e. TPB and DTPB by examining the acceptance of Internet banking in Taiwan. As expected, the authors found that DTPB was the most successful model followed by the TPB and the TRA respectively. With respect to explaining the variance in BI and BU, the authors found that DTPB explained 66% and 23% variance, TPB explained 54% and 24% variance, and TRA explained 46% and 20% variance respectively. In summary, it is observed that DTPB was more favoured over other models from the perspective of the context of generalisability as well as the explanatory power. Therefore, it can be argued that extending the model to understand the in-depth knowledge is an essential requirement rather than just desirable.

### *4.3. TAM vs. TPB vs. TRA*

In line with the discussion on comparing the extensions of the TRA with its original conceptualisation and empirical findings, this section aims to examine another extension i.e., the TAM with the TRA and its extension i.e. the TPB. Before commencing the discussion, it is worth noting that a comparison of the TAM and the TPB has already been discussed in section 5.1, and a comparison of the TRA and the TPB is presented in section 5.2. Therefore, here, the researcher only highlights the main differences between the TRA and the TAM in the light of some empirical evidence.

The TAM is an immediate succession of the TRA. The two models (i.e. TRA and TAM) share a point of similarity that is BI which is the major determinant of BU. Both models share the limitation of volitional control, where it is assumed that individuals are usually rational when making the decision to engage in a specific behaviour (Fishbein and Ajzen, 1975; Davis *et al.,* 1989). The two models differ from each other due to two main reasons as follows. First, unlike the TRA, the TAM does not include SN as a predictor of BI due to its uncertain theoretical and psychometric properties (Davis *et al.,* 1989). Second, unlike expectancy formulation of beliefs examined in the TRA, the TAM posits only two beliefs i.e. PU and PEOU to predict an individual's A (however, A was removed in the final TAM due to partial mediation effect) and BI. The two differences mentioned above make the TAM more advantageous compared with the TRA. For instance, it was noticed previously that SN remained an unstable predictor to explain BI (Chau and Hu, 2002; Shish and Fang, 2004; Lin, 2007); therefore, its inclusion in a model only increases the complexity rather than explanatory power. The other difference i.e. the addition of normative beliefs (e.g., system design characteristics, individuals' characteristics, task characteristics, nature of development process, political factors, and organisational factors) and their expectancy formulation with A is also considered to be a limitation of TRA, because for each new context new beliefs need to be elicited that are idiosyncratic in nature and cannot be generalised for other systems (Davis *et al.,* 1989).

Overall, the importance of the two models remains unarguable. Davis *et al.,* (1989) in a paper

entitled 'User acceptance of computer technology: a comparison of two theoretical models' compared two models in a longitudinal study with a sample of 107 MBA students. Upon comparing the results of two models in voluntary settings, the authors found the TAM to be better than TRA in explaining BI. Specifically, at two time interval the TRA explained 32% and 26% variance, whereas the TAM explained 47% and 51% variance. Additionally, as theorised in TRA, Davis did not find a significant impact of SN on BI, which supported the TAM's conceptualisation.

A very little research is found in published literature on comparing the three models, i.e. the TRA and its two extensions i.e. the TAM and the TPB. One reason could be their dichotomous differences in conceptualisation. For example, there are studies that compare the conceptualisation of the TAM vs. the TRA (Davis *et al.,* 1989), the TAM vs. the TPB ( Mathieson, 1991), or the TRA vs. the TPB (Madden *et al.,* 1992), but studies that compare all the models together are very scarce. Gentry and Calantone (2002) compared three models to examine the buyer intention on the web and found that the TAM explained higher variance in BI i.e., 91% followed by TPB with 85% and TRA with 57%. In a study, (Venkatesh *et al.,* 2003), during the development of UTAUT, compared the results of eight prominent models including the TRA, TAM, TPB and DTPB. The authors found that within voluntary settings the TAM was better than the other two models. For instance, explaining BI, the TAM explained 38% variance, the TRA explained 30% and TPB/DTPB explained 37% variance. In addition, in mandatory settings unexpectedly the TAM was better than the other two. For example, TAM explained 39% variance, TRA explained 26% variance, and TPB/DTPB explained 34% variance in what? (ibid).

In conclusion, all three models have clear strengths over each other. However, the TAM precedes the other two due to its simple structure and a consistent explanatory power, while in the design and implementation process, the other two models are considered to be better than the TAM. Considering the advantages, (Venkatesh and Davis 2000) integrated all three models together and named it the TAM2. The authors' integration approach was successful and the model explained 60% variance in BI within four different organisational contexts (ibid). The lesson learned from (Venkatesh and Davis' 2000) findings suggest that selecting constructs from the multitude models is the favoured approach to overcome the limitations of earlier models and equally contributes to extending the present theoretical frameworks.

## 5. CONCLUSION

For developing a strong theoretical basis for the future extended models, the most important theoretical models used in technology acceptance research were reviewed and compared, their limitations and advantages critically examined. The present review has revealed that predominantly models were favoured either due to their parsimonious structure with an acceptable predictive power (e.g., TAM) or their explanatory power (e.g. TBP). A review of the empirical comparisons between these models showed that the TAM exhibited considerable advantages over others due to persistent predictive power (i.e., 40%) and its parsimonious structure. The parsimony of the TAM attracted a number of researchers to extend/replicate the TAM's conceptualisation in diverse fields of studies. However, this led to an inherent limitation in the ability of TAM to extend it beyond its core constructs (PU and PEOU) into specified fields of investigation.

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