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Re-examining the Unified Theory of Acceptance and Use of Technology (UTAUT): Towards a Revised Theoretical Model

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Abstract Based on a critical review of the Unified Theory of Acceptance and Use of Technology (UTAUT), this study first formalized an alternative theoretical model for explaining the acceptance and use of information system (IS) and information technology (IT) innovations. The revised theoretical model was then empirically examined using a combination of meta-analysis and structural equation modelling (MASEM) techniques. The meta-analysis was based on 1600 observations on 21 relationships coded from 162 prior studies on IS/IT acceptance and use. The SEM analysis showed that attitude: was central to behavioural intentions and usage behaviours, partially mediated the effects of exogenous constructs on behavioural intentions, and had a direct influence on usage behaviours. A number of implications for theory and practice are derived based on the findings.

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1 Introduction

The acceptance and use of information system (IS) and information technology (IT) innovations has been a major concern for research and practice. Over the last several decades, a plethora of theoretical models have been proposed and used to examine IS/IT acceptance and usage. These include the Theory of Reasoned Action, the Technology Acceptance Model, the Theory of Planned Behaviour, and Model of Personal Computer Utilization (Ajzen 1991; Davis 1989; Davis et al. 1989; Fishbein and Ajzen 1975; Thompson et al. 1991). Cumulatively, these theories offered different explanations of IS/IT acceptance and usage based on different factors such as technology attributes and contextual factors.

Based on a comprehensive review and synthesis of several theoretical models, Venkatesh et al. (2003) proposed the Unified Theory of Acceptance and Use of Technology (UTAUT), which has since been used extensively by researchers in their quest to explain IS/IT acceptance and use. While the original UTAUT model explained a considerable amount of variance in behavioural intention and usage behaviour, the model theorized some relationships that may not be applicable to all contexts, omitted some relationships that may be potentially important, and also excluded some constructs that may be crucial for explaining IS/IT acceptance and use.

In order to advance theory and identifying future research directions, we have attempted to critically review and refine the original UTAUT model. Specifically, we argue that the moderators specified in the original UTAUT model may not be applicable in all contexts, the path from facilitating

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conditions to behavioural intention missing in the original UTAUT model should be included, and individual characteristics such as attitude not theorized in the original UTAUT model should be introduced. We empirically examine our revised model using a combination of meta-analysis and structural equation modelling techniques.

The remainder of the paper is organized as follows. The next section introduces the alternative theories of IS/IT acceptance with attention to the UTAUT model and formalizes the revised theoretical model. The subsequent two sections describe the research methods and the results of our empirical analysis using meta-analysis and structural equation modelling. The paper ends with discussion and conclusion sections.

2 Theoretical Reframing of Research on IS/IT Acceptance and Use

2.1 Alternative Theories on IS/IT Acceptance and Use

User acceptance of new IS/IT innovation is often portrayed as one of the most mature areas of research in contemporary IS literature (e.g., Hu et al. 1999; Williams et al. 2009). Research in this area has resulted in various theoretical models for explaining individuals' intention to use innovations, which have their origins in information systems, psychology, and sociology (e.g., Davis et al. 1989; Taylor and Todd 1995b; Venkatesh and Davis 2000; Venkatesh et al. 2003).

Drawn from social psychology, the theory of reasoned action (TRA) (Ajzen and Fishbein 1980; Fishbein and Ajzen 1975) is a precursor to many models and a frequently-used theory of human behaviour for explaining technology adoption (Venkatesh et al. 2003). TRA posits that individual behaviour is driven by the individual's own behavioural intention, which is in turn a function of an individual's attitude toward the behaviour and subjective norms (Fishbein and Ajzen 1975). Sheppard et al. (1988) indicated that the predictive validity of the model remained high although many researchers extended this model beyond its stated boundary conditions.

TRA was the basis for two important theoretical directions: to develop a more comprehensive Theory of Planned Behaviour (TPB) (Ajzen 1991); and to develop a more parsimonious and widely used Technology Acceptance Model (TAM) (Davis 1989; Davis et al. 1989). Davis et al. (1989) used TRA to explain individual acceptance of technology and found that the variance explained was largely consistent with studies that had employed TRA in the context of other behaviours. Thus, Davis et al. (1989) and Davis (1989) developed TAM to explain the acceptance of IS/IT and found two important beliefs to influence the usage of IS: perceived usefulness and perceived ease of use.

According to TPB, user's actions are determined by their intentions and perceptions of control, while their intentions are influenced by their attitudes toward behaviour, subjective norms, and perceptions of behavioural control (Ajzen 1991, 2001). Ajzen (1991, 2001) also showed the ability of the TPB in providing a very useful theoretical framework for understanding and predicting the acceptance of new innovations including IS/IT based innovations (e.g., Harrison et al. 1997; Mathieson 1991; Taylor and Todd 1995b).

The Decomposed Theory of Planned Behaviour (DTPB) (Taylor and Todd 1995b) combined elements and characteristics from both TPB and TAM in order to provide a more comprehensive understanding of technology adoption. Although DTPB is identical to TPB in predicting intention, DTPB "decomposes" attitude, subjective norm, and behavioural control into its essential belief structure in the context of technology adoption (Venkatesh et al. 2003). A combined model of TAM and TPB (C-TAM-TPB) incorporates predictors from TPB and perceived usefulness from TAM (Taylor and Todd 1995a).

An extensive body of research in psychology has employed general motivation theory to examine individual behaviour. A number of studies (e.g., Igbaria et al. 1996; Venkatesh and Brown 2001) have adapted motivational theories for specific contexts (Venkatesh et al. 2003); see Vallerand (1997) for an exhaustive review of motivational theories. Within the IS/IT domain, Davis et al. (1992) used motivational theory to understand the adoption and use of new technology (see also Venkatesh and Speier 1999).

The model of PC utilization (MPCU) was derived largely from Triandis' (1977) theory of human behaviour. It presents a competing context to that proposed by TRA and TPB. Thompson et al. (1991) adapted and refined Triandis' model with attention to the IS/IT context and formulated MPCU for predicting usage behaviour rather than intention.

Rooted in sociology, the innovation diffusion theory (IDT) (Rogers 1995) has been used to study a number of innovations ranging from agricultural tools to organizational innovation (Tornatzky and Klein 1982). Further, Moore and Benbasat (1991) tailored the characteristics of innovations presented by Rogers and refined a set of constructs to use it for individual technology acceptance.

Social cognitive theory (SCT) has been used extensively to explain human behaviour (see Bandura 1986). Compeau and Higgins (1995) implemented and extended this theory from the perspective of computer utilization, but the nature of the model and the basic theory allowed it to be extended to acceptance and use of IS/IT in general (Venkatesh et al. 2003).

2.2 Unified Theory of Acceptance and Use of Technology (UTAUT, Venkatesh et al. 2003)

Based on an analysis of the alternative models explained above, Venkatesh et al. (2003) argued that researchers were faced with a large number of similar constructs offered by

many theories and found that they "pick and choose" constructs from the models or opt for a "favoured model", with the result that the other models were largely ignored. Consequently, they synthesized the propositions put forth by different models of acceptance, including TRA, TAM, TPB, C-TAM-TPB, MM, MPCU, SCT and IDT) and proposed the Unified Theory of Acceptance and Use of Technology (UTAUT; Venkatesh et al. 2003). Using data from four organizations with three points of measurement, Venkatesh et al. (2003) found that the eight models explained between 17 and 53% of the variance in users' intention to use IS/IT. However, the UTAUT outperformed all the eight models using the same data explaining about 70% of variance in behavioural intention (Venkatesh et al. 2003) and 50% in technology use (Venkatesh et al. 2012). One major difference between UTAUT and its precursors was that UTAUT proposed four moderators (i.e., gender, age, experience, and voluntariness) to further enhance the predictive power of the model. Since its inception, UTAUT has been used extensively in explaining the adoption of technologies by individuals.

While it has been tested and modified in various ways, studies that utilised UTAUT have illustrated (explicitly or implicitly) certain limitations—this suggests that there may be an opportunity to systematically reconsider the relationships proposed by UTAUT. First, the moderators proposed in the original UTAUT model may be reconsidered. Prior studies have generally not applied the complete UTAUT model as found in Venkatesh et al. (2003). A similar observation was made by Venkatesh et al. (2012), who noted that most studies employed only a subset of the model and that moderators were typically dropped. Among the studies that included moderators, few studies (e.g., Bandyopadhyay and Barnes 2012; Bhattarai et al. 2010; Fadel 2007; Venkatesh et al. 2011b) modeled the same four moderators as proposed by the original UTAUT model. A potential reason why prior studies may not have utilized moderators is because there may not be any variation in the moderator for the adoption and use context. For instance, the adoption and use of a specific IS/IT may have been mandated by the organization such that all individuals will have to adopt the technology—this results in a situation in which voluntariness as a moderator may not be readily applicable. Second, the relationships proposed in the original UTAUT model may be reconsidered for completeness. In formulating the UTAUT model, Venkatesh et al. (2003) argued that one would expect facilitating conditions to predict behavioural intention only if effort expectancy was not included in the model. This was a departure from prior theories of technology acceptance that explicitly modeled the relationship between facilitating conditions and behavioural intention. Prior studies (e.g., Duyck et al. 2010; Foon and Fah 2011; Yeow and Loo 2009) suggest that facilitating conditions influence behavioural intention even in the presence of effort expectancy. Finally, the original UTAUT model may be reconsidered from the light of other constructs that may explain adoption and usage behaviours of individuals. The four exogenous constructs in the UTAUT model may be viewed as representing technology attributes (i.e., performance expectancy and effort expectancy) and contextual factors (i.e., facilitating conditions and social influence) even when they may be viewed as perceptions held by individuals regarding the technology and the context. Despite the evidence that these four constructs explain a significant proportion of variance in the adoption and usage behaviours, a key element missing from the UTAUT model is the "individual" engaging in the behaviour—i.e., individual characteristics that describe the dispositions of the users may be influential in explaining their behaviours. Prior literature highlights several individual characteristics including attitude, computer self-efficacy, and personal innovativeness (e.g., Carter and Schaupp 2008; Chong 2013; Venkatesh et al. 2011a). Our literature review showed that only about 25% of studies that employed the UTAUT model did not include other constructs not in the original UTAUT model.

Table 1 presents prior literature examining theories and models of the IS/IT acceptance and use with an indication for the role of attitude in those studies. Our analysis indicates that that out of 16 theories/models explored, only five demonstrated a role for attitude in their theories/ models. Realising the significance of attitude in the acceptance of new technologies by individuals, it may be worthwhile to reconsider the inclusion of attitude in the models of technology adoption.

2.3 Proposed Model of IS/IT Acceptance and Use

Based on the foregoing, we first exclude the four moderators from the original UTAUT model and identify the remaining relationships in the original UTAUT model as the basic UTAUT model. We next include the relationship between facilitating conditions and behavioural intention to the basic UTAUT model. This is based on appropriate theoretical foundations (Ajzen 1991; Taylor and Todd 1995b) and empirical findings (e.g., Eckhardt et al. 2009; Foon and Fah 2011; Yeow and Loo 2009) that support the effect of facilitating conditions and behavioural intention even in the presence of effort expectancy—in contrast to original model. Further, we include user attitude as a mediating construct in the basic UTAUT model. The role of attitude in explaining technology acceptance has been acknowledged in prior literature (e.g., Bobbitt and Dabholkar 2001; Kim et al. 2009; Taylor and Todd 1995b; Yang and Yoo 2004).

The inclusion of attitude in models of IS/IT acceptance is consistent with TRA (Ajzen and Fishbein 1980; Fishbein and Ajzen 1975), TPB (Ajzen 1991) and DTPB (Taylor and Todd 1995b). TAM can be considered as a special case of the TRA with only two beliefs comprising attitude. The TRA model claims that attitude completely mediates the relationship

Table 1 Role of attitude in prior literature

Model	Dependent variables (DV)	Role of attitude	Additional independent variables affecting DV	Study
Theory of Reasoned Action	Behavioural intention, Behaviour	Attitude → Behavioural intention	Subjective norm	Fishbein and Ajzen (1975)
Technology Acceptance Model	Behaviour	NONE	Perceived usefulness Perceived ease of use	Davis (1989)
IS Success Model	Use, User satisfaction	NONE	System quality Information quality	DeLone & McLean (1992)
Theory of Planned Behaviour	Behavioural intention, Behaviour	Attitude → Behavioural intention	Subjective norm Perceived behavioural control	Ajzen (1991)
Model of PC Utilization	Utilization	Affect → Utilization	Long term consequences Job fit Complexity Social factors Facilitating conditions	Thompson et al. (1991)
Perceived Characteristics of Innovating	Behavioural intention, Behaviour	NONE	Relative advantage Compatibility Ease of use Result demonstrability Image Visibility Trialability Voluntariness	Moore and Benbasat (1991)
Task-Technology Fit Model	Utilization	NONE	Task-technology fit	Goodhue & Thompson (1995)
Social Cognitive Theory	Performance	NONE	Behaviour modelling Computer self-efficacy Performance outcome expectations Personal outcome expectations	Compeau and Higgins (1995)
Innovation Diffusion Theory	Adoption	NONE	Relative advantage Compatibility Complexity Trialability Observability	Rogers (1995)
TAM Extension (TAME)	Behavioural Intention	Attitude → Behavioural Intention	Situational involvement Intrinsic involvement Perceived usefulness	Jackson et al. (1997)
Extended TAM (TAM2)	Intention to use, Usage Behaviour	NONE	Subjective norm Image Job relevance Result demonstrability Perceived usefulness Perceived ease of use	Venkatesh and Davis (2000)
Unified Theory of Acceptance and Use of Technology	Behavioural intention, Behaviour	NONE	Performance expectancy Effort expectancy Social influence Facilitating conditions	Venkatesh et al. (2003)
Extended IS Success Model	System use	Attitude → Satisfaction Attitude → System use	Top management support User experience User participation System quality User training	Sabherwal et al. (2006)
TAM3	Behavioural intention, Behaviour	NONE	Perceived usefulness Perceived ease of use Subjective norm Image Job relevance Output quality Result demonstrability	Venkatesh & Bala (2008)

Table 1 (continued)

Model	Dependent variables (DV)	Role of attitude	Additional independent variables affecting DV	Study
			Computer self-efficacy Perceptions of external control Computer anxiety Computer playfulness Perceived enjoyment Objective usability	
Model of Acceptance with Peer Support (MAPS)	System use	NONE	Network density Network centrality	Sykes et al. (2009)
UTAUT2	Behavioural intention, Behaviour	NONE	Performance expectancy Effort expectancy Social influence Facilitating conditions Hedonic motivation Price value Habit	Venkatesh et al. (2012)

between these types of beliefs and intention (Taylor and Todd 1995b). Further, TAM postulates that the easier a technology is to use and the more useful it is perceived to be, the more positive one's attitude and intention toward using the technology will develop (Davis et al. 1989; Taylor and Todd 1995b). The relationship between attitude and behavioural intention represented in TAM implies that, all else being equal, people form intentions to perform behaviours toward which they have positive attitude. This relationship is central to TRA and related models presented by Triandis (1977) and Bagozzi (1981) (Davis et al. 1989).

While devising the TAM extension (TAME) model, Jackson et al. (1997) called the researchers to investigate whether perceived usefulness and perceived ease of use influence attitude. We position attitude as a mediator between performance expectancy and behavioural intention and between effort expectancy and behavioural intention. This is because the extent to which the IS/IT is useful and consistent with performance expectations and is easy to use can influence the individual's attitude leading to intention. A number of empirical studies (e.g., Aboelmaged 2010; Aggelidis and Chatzoglou 2009; Kim et al. 2010) have advocated the use of attitude as a mediating variable along with perceived usefulness and perceived ease of use of the TAM model. Attitude has also been used as a mediating variable of performance expectancy and effort expectancy in several studies that had used UTAUT (e.g., Alshare and Lane 2011; Knutsen 2005; Koh et al. 2010; Rana et al. 2017; Sumak et al. 2010). We also propose that attitude would influence behavioural intention (i.e., Ajzen 1991; Davis 1989; Dwivedi et al. 2017; Fishbein and Ajzen 1975; Rana et al. 2016; 2017, Taylor and Todd 1995b) based on prior empirical research (e.g., Chen and Lu 2011; Zhang and Gutierrez 2007). Figure 1 shows the proposed model of IS/IT acceptance and use whereas Table 2 presents the definition for the constructs used in our theoretical model.

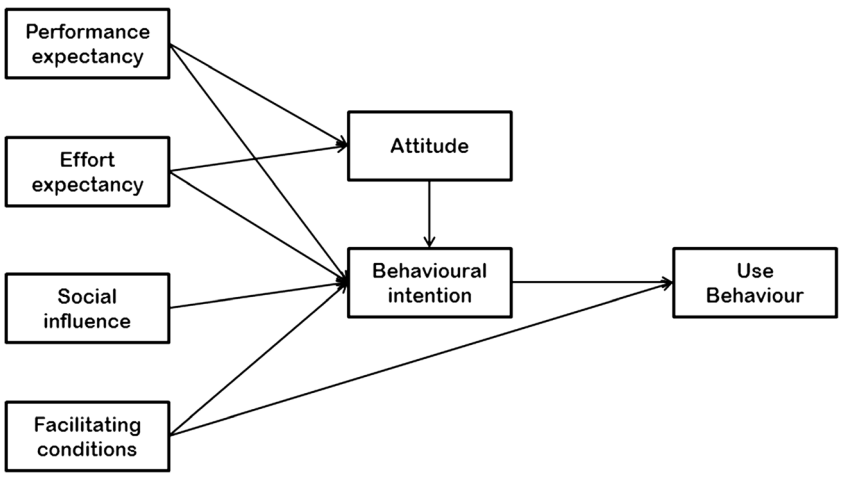

Fig. 1 Proposed theoretical model (Source: Adapted from Venkatesh et al. 2003)

Table 2 Definitions for constructs used in the proposed theoretical model

Construct	Definition
Performance Expectancy (PE)	Performance expectancy is defined as the degree to which an individual believes that using the system will help him or her to attain gains in job performance (Venkatesh et al. 2003).
Effort Expectancy (EE)	Effort expectancy is defined as the degree of ease associated with the use of the system (Venkatesh et al. 2003).
Social Influence (SI)	Social influence is defined as the degree to which an individual perceives that important others believe he or she should use the new system (Venkatesh et al. 2003).
Facilitating Conditions (FC)	Facilitating conditions are defined as the degree to which an individual believes that an organizational and technical infrastructure exists to support use of the system (Venkatesh et al. 2003).
Attitude (AT)	An individual's positive or negative feelings about performing the target behaviour (Davis et al. 1989; Fishbein and Ajzen 1975; Taylor and Todd 1995a, b).
Behavioural Intention (BI)	Behavioural intention is defined as a measure of the strength of one's intention to perform a specific behaviour (Fishbein and Ajzen 1975).

3 Research methods

We employed a combination of meta-analysis and structural equation modelling (SEM) techniques to examine our research model.

3.1 Meta-Analysis

Meta-analysis enables results from multiple studies (Glass 1976; Hunter and Schmidt 1990; Rana et al. 2015a; Wu and Du 2012; Wu and Lederer 2009) to be accumulated for estimates of the true effect sizes of relationships. Prior research shows that meta-analysis is a valuable tool for research synthesis (Hwang 1996; Lee et al. 2003; Ma and Liu 2004; Wu and Lederer 2009) and an operative instrument for hypothesis testing (Dennis et al. 2001; Sabherwal et al. 2006; Sharma and Yetton 2003; Wu and Lederer 2009). It allows the application of statistical procedures for correcting sampling and measurement errors typically found in research studies (Hunter and Schmidt 1990) and the inclusion of non-significant or inconsistent results for collective inference (Sabherwal et al. 2006). In comparison to the narrative review i.e., traditional way of drawing common inferences from the related studies, meta-analysis provides relatively unbiased, rigorous, and trustworthy (Glass 1976; Sharma and Yetton 2003) inferences. It has been used in IS/IT research to examine various issues (e.g., King and He 2006; Lee et al. 2003; Sabherwal et al. 2006; Sharma et al. 2009; Wu and Du 2012; Wu and Lederer 2009).

3.1.1 Sample

To identify studies for the meta-analysis, we searched the bibliographic databases such as *Scopus*, *Web of Knowledge* and *EBSCOHost*, and the *AIS Electronic Library*. In addition, we also searched the *Google Scholar* database. We used the keywords such as *Unified Theory of Acceptance and Use of Technology, Unified Theory of Acceptance & Use of Technology*, and *UTAUT* in the article title, abstract, and the keyword sections. As journals are typically known to publish studies with significant results (Rosenthal 1979; Sharma and Yetton 2003), it is important to consider studies from the non-journal sources (Wu and Du 2012) as well. Hence, we also searched for other potential sources of research findings including books and book chapters, doctoral dissertations, and conference proceedings. Our search spanned the period from 2003 to 2012.

Our search resulted in more than 525 articles across all electronic databases. Studies were chosen for meta-analysis only when they met the following criteria: 1) they were empirical studies and not conceptual studies; 2) they operationalized at least one construct from the originating article on UTAUT by Venkatesh et al. (2003); and 3) they reported Pearson correlations or other statistics that may be converted to Pearson correlations (see Wu and Lederer 2009). To ensure the independence of studies included in the meta-analysis, we carefully compared the description and statistical data of each study with those of others (Ma and Liu 2004; Wu and Du 2012). When two or more studies reported findings using the same data set, we included only one study in our analysis. When a study reported a multiple datasets gathered from the different samples, each dataset was treated as an independent study (Hunter et al. 1982; Wu and Du 2012).

After discarding articles that were not empirical in nature or did not report correlations between relationships and duplicate articles across the electronic databases, we identified 162 articles, which were unique, empirical, and correlation-based in

nature. These include 96 articles from journals, 49 conference proceedings, 16 dissertations, and one book chapter. This comprehensive search strategy allowed us to minimize the source bias, maximize the number of studies, and therefore increase the quality of the meta-analysis (Ma and Liu 2004) to be performed.

3.1.2 Coding

We coded a total of 1600 observations for the 21 relationships involving the seven constructs in our research model (See Table 3 for a distribution). For each observation, we coded the sample size, the reliabilities for both constructs in the relationship, and the effect size (i.e., Pearson correlation) from the original study. In addition, we also coded the means, standard deviations, and the range of the Likert scale reported in the original study.

3.1.3 Accumulation

First, *each* coded effect size was corrected for any measurement errors based on the reliabilities of the two constructs involved in a relationship, as: $r_m = \frac{r_o}{\sqrt{r_{xx}}\sqrt{r_{yy}}}$ where, r_m is the effect size corrected for measurement error, r_{xx} and r_{yy} are the reliabilities of the first and second constructs in the relationship respectively. For relationships where reliabilities were not reported in the original studies, we used the mean reliability for the constructs computed using the reliabilities reported across all studies in our sample. Then, the cumulative effect size for each relationship was obtained using the measurement-error corrected effect size and correcting for sampling error, as: $r_c = \frac{\sum[N_i r_{m,i}]}{\sum N_i}$ where, r_c is the corrected mean effect size, $r_{m,i}$ is the effect size corrected for measurement error in study i, and N_i is the sample size from study i.

Table 3 shows the results of the meta-analysis for all relationships: k refers to the number of studies contributing an effect size; N represents the total number of respondents across all studies, and r_c is the mean effect size corrected for measurement and sampling errors.

3.2 Meta-Analytic Structural Equation Modelling (MASEM)

MASEM involves the techniques of synthesizing correlation matrices to create a pooled correlation matrix, which can be analysed using SEM (Viswesvaran and Ones 1998). It refers to methods focused on contrasting and combining outcomes of various studies, in the hope of measuring patterns among study results, sources of divergence among those results, and other interesting relationships that may come to light in the perspective of multiple studies (Cheung and Chan 2005). MASEM technique allows the researchers to conduct a more precise and theory-driven quantitative review. A major advantage of this technique is that not all relationships specified by the theory need to be examined in each primary study, as the population correlations required can be meta-analytically computed (Joseph et al. 2007; Viswesvaran and Ones 1998).

3.2.1 Preparation

Before the SEM analysis can be done, the data need to be prepared. First, the SEM requires a single sample size for the entire model whereas meta-analysis yields a sample size for each relationship in the model (Carr et al. 2003; Sabherwal et al. 2006). Prior literature suggests various possibilities such as using the minimum sample size, average sample size and harmonic mean sample size (e.g., Tett and Meyer 1993; Viswesvaran and Ones 1998).

Second, the SEM requires the standard deviation for the constructs in the research model. We computed the standard deviation for each construct across all studies for which it was reported (see Table 4). Since individual studies differed in the measurement scale used (e.g., some studies employed a 5-point Likert scale whereas other studies utilized a 7-point Likert scale), we transformed all standard deviations into a common scale.

3.2.2 Analysis

Taking a more conventional approach, we utilized the minimum sample size (Carr et al. 2003; Sabherwal et al. 2006) for

Table 3 Meta-analysis results

	PE	EE	FC	SI	AT	BI	UB
PE		39,048 (129)	33,962 (98)	38,661 (111)	4706 (20)	43,388 (134)	22,282 (61)
EE	0.543		32,239 (99)	35,563 (107)	4413 (20)	41,450 (131)	20,662 (60)
FC	0.424	0.565		32,218 (92)	4319 (19)	36,223 (109)	21,723 (58)
SI	0.460	0.363	0.417		4752 (20)	42,397 (126)	22,378 (63)
AT	0.685	0.566	0.499	0.455		16,012 (56)	5098 (19)
BI	0.542	0.506	0.453	0.415	0.626		24,963 (68)
UB	0.389	0.314	0.359	0.248	0.475	0.437	

r_c in lower triangle and *N (k)* in upper triangle

Table 4 Descriptive statistics of constructs

Construct	Mean	SD	Reliability
UB	4.275	2.678	0.864
BI	4.487	1.938	0.886
PE	4.499	1.890	0.859
EE	4.399	1.905	0.869
FC	4.750	1.531	0.793
SI	4.274	1.612	0.824
AT	4.415	1.934	0.879

examining our research model. We performed path analyses on the matrix of corrected correlations obtained through the meta-analysis using AMOS 21 (Arbuckle and Wothke 1999). AMOS is a covariance based approach in which the covariance structure derived from the observed data is used to simultaneously fit both measurement and structural equations contained within the model.

We adopted the following general approach in examining our research models. In each case, we first began the analysis with the theoretical model. The significance of model paths was assessed using the critical ratios (CRs) (Byrne 2010) and the presence of unexpected paths was identified using the modification indices (MIs) (Denison et al. 1996; Sabherwal et al. 2006). The model fit was assessed using Chi-square goodness of fit test, root mean square error of approximation (RMSEA) (Steiger 1990), normed fit index (NFI) (Bentler and Bonett 1980), and comparative fit index (CFI) (Bentler 1990). We dropped non-significant paths from the model when CRs were below recommended levels of greater than 1.96 (Byrne 2010). We included emergent paths in our model based on theoretical considerations (Marcoulides and Heck 1993) and MIs of 10.0 or more (Denison et al. 1996).

We examined the research model using the harmonic sample size and the average sample size for the purposes of validating the main results. We found the results of the validation analyses were consistent with the findings of the main SEM analysis.

4 Results

4.1 MASEM Model for Basic UTAUT

We first examined the basic UTAUT model with the fundamental constructs in the original UTAUT model (Venkatesh et al. 2003), i.e., the four exogenous variables: PE, EE, SI, and FC and the two endogenous variables: BI and UB. Table 5 (in the Basic UTAUT column) shows the results of this model. All hypothesized paths in the model were significant and none of the paths were dropped. The model fit was reasonable: GFI,

Table 5 Results of the structural equation models

Relationship	Path status	Basic UTAUT	Proposed model	Emergent model
UB ← BI	H	0.35***	0.34***	0.12***
UB ← FC	H	0.20***	0.20***	0.10***
UB ← AT	E (MI = 138.47)			0.37***
BI ← PE	H	0.32***	0.13***	0.11***
BI ← EE	H	0.27***	0.14***	0.29***
BI ← SI	H	0.17***	0.10***	0.13***
BI ← FC	H		0.10***	0.14***
BI ← AT	H		0.37***	0.10***
AT ← PE	H		0.54***	0.47***
AT ← EE	H		0.28***	0.19***
AT ← FC	E (MI = 122.63)			0.20***
AT ← SI	E (MI = 59.17)			0.15***
N		4319	4319	4319
Model χ^2 (df)		215.20*** (4)	555.62*** (6)	24.43*** (3)
GFI		0.984	0.967	0.998
CFI		0.974	0.955	0.998
NFI		0.973	0.954	0.998
RMSEA		0.111	0.146	0.041
R^2 for UB		0.21	0.22	0.27
R^2 for BI		0.38	0.45	0.45
R^2 for AT			0.52	0.55

H Hypothesized, *E* Emergent, ***$p < 0.01$, **$p < 0.05$, *$p < 0.10$

CFI, and NFI were above the recommended minimum threshold of 0.90 whereas RMSEA was somewhat high (i.e., 0.111). The MIs did not show other paths for inclusion. The model explained 21% of variance in UB and 38% of variance in BI.

4.2 MASEM Model for Proposed Theoretical Model

We examined our proposed research model with four exogenous (i.e., PE, EE, SI, and FC) and three endogenous constructs (i.e., AT, BI, and UB). Table 5 (in the Proposed Model column) identifies the results of this model. All hypothesized paths in the model were found to be significant and hence none of the paths were dropped. The model fit was reasonable: GFI, CFI, and NFI were above the recommended minimum threshold of 0.90 whereas RMSEA was somewhat high (i.e., 0.146). However, the MIs showed several unexpected paths. Considering our proposed model as initial point of reference, we considered the paths suggested by MIs based on theoretical reasoning and added such paths where it was appropriate.

First, we considered the highest MI (i.e., 138.47) for the path AT → UB and included it in our model. Davis (1989) showed that attitude towards use had a direct effect on actual use. Further studies on TAM also revealed a strong theoretical support for a positive relationship between attitude towards use and actual use (Adams et al. 1992; Davis et al. 1989; Mathieson 1991). Surveying the attitudes of 118 respondents from 10 different organizations for their attitude toward two messaging systems (i.e., voice and electronic mail), Adams et al. (1992) emphasized the need of further research that directly addresses the influence of attitude on behaviour toward IS/IT use. This path has also been empirically supported in other studies (e.g., Bajaj and Nidumolu 1998; George 2004; Kim et al. 2008; Pijpers et al. 2001) of IS/IT adoption. The direct path from user's attitude to usage behaviour indicates that users with a positive attitude are more likely to use the given IS/IT, beyond the indirect effect on usage behaviour through intention to use.

Second, we considered the next highest MI (i.e., 122.63) for the path FC → AT and included this unexpected path in our model. This path has been hypothesized and explored in prior studies (e.g., Chen et al. 2011; Chiu et al. 2012; Park et al. 2007; Pynoo et al. 2007; Sahu and Gupta 2007) on IS/IT adoption. For example, analysing if attitude or behavioural intention is a better measure of technology acceptance, Pynoo et al. (2007) showed FC to be a significant predictor of AT in a mandatory setting. Facilitating conditions describes the perceived importance of organizational and technical infrastructure to support systems use (Venkatesh et al. 2003; Dwivedi et al. 2016). The direct path from FC to AT can also imply that the technical and organizational infrastructure relating to an IS/IT such as help desks and training programs may shape the user's attitude tow.ard the IS/IT.

Finally, we considered the next highest MI (i.e., 59.17) for the path SI → AT and included it in our model as well. Venkatesh et al. (2003) defined social influence as the individual's perception where the referents desire the individual to perform or not perform a behaviour in question. Davis (1986) observed that the individual may want to do what a referent thinks he or she should do, not because of referent's influence, but because the act is consistent with the individual's own attitude. It has been argued that social influence has an impact on individual behaviour through three mechanisms such as compliance, internalization, and identification (see Venkatesh and Davis 2000; Warshaw 1980). Venkatesh et al. (2003) argued that latter two mechanisms relate to altering an individual's belief structure, and causing an individual to reply to potential social status gains, which leads to individual's positive attitude toward behaviour (Fishbein and Ajzen 1975). Based on these, it is possible that social influence may influence an individual's attitude. This unexpected path has been hypothesized and empirically examined in other studies (e.g., Chen et al. 2011; Chiu et al. 2012; Park et al. 2007; Pynoo et al. 2007; Sahu and Gupta 2007; Sumak et al. 2010) of IS/IT acceptance as well.

The inclusion of each unexpected path progressively resulted in better fit statistics. Table 5 (in the Emergent Model column) shows the results of the final model. The final emergent model had excellent fit statistics: GFI, CFI, and NFI were above 0.90 and RMSEA was below 0.05. The MIs did not show other paths for inclusion. The emergent model explained 27% of the variance in UB and 45% of the variance in BI - which are considerably greater than the basic UTAUT model, and also 55% of the variance in AT (Fig. 2).

5 Discussion

5.1 Findings

This research critically reviewed the UTAUT model and proposed a revised theoretical model, which was tested using a combination of meta-analysis and structural equation modelling.

We found that attitude played a central role in acceptance and use of IS/IT innovations. More specifically: a) attitude was also influenced by facilitating conditions and social influence, b) attitude had a direct effect on behavioural intention, which implies that attitude partially mediated the effects of performance expectancy, effort expectancy, facilitating conditions, and social influence, and c) by attitude exerted a direct influence on usage behaviour. These findings are crucial since they underscore the importance of explicitly modelling individual characteristics in theories of IS/IT acceptance and use.

We had hypothesized performance expectancy and effort expectancy to influence attitude in our theoretical model

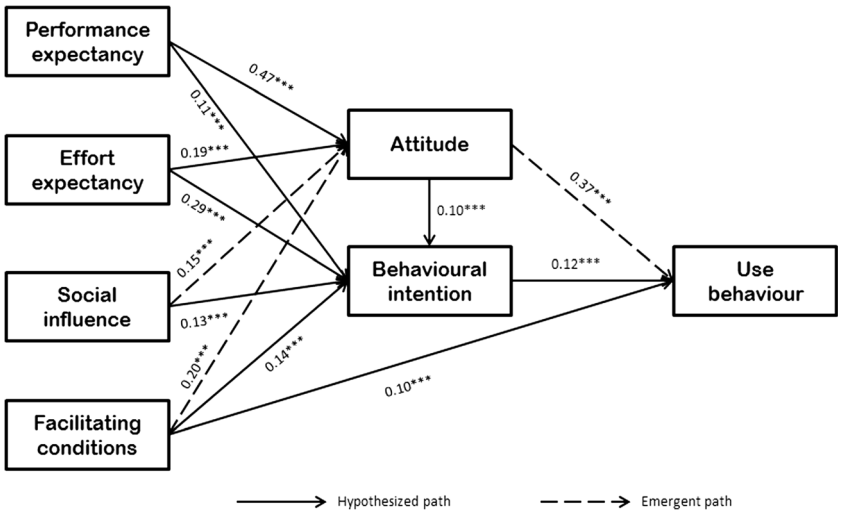

Fig. 2 Emergent model (***$p < 0.001$, **$p < 0.01$, *$p < 0.05$)

(Dwivedi et al. 2017; Khalilzadeh et al. 2017; Rana et al. 2016). This was because an individual's attitude may be shaped by the extent to which the technology may be easy to use (i.e., less complex) and the extent to which the technology may prove to be useful (i.e., greater performance)—in other words, the technology capabilities may influence the attitudes of individuals. However, we found that attitude may be influenced by facilitating conditions and social influence, which are the contextual factors in our model. This is perhaps not completely surprising—facilitating conditions such as training programs and help desks may be instrumental in enabling individuals to form positive attitudes about the technology (e.g., Chiu et al. 2012; Pynoo et al. 2007; Ravishankar 2008; Sahu and Gupta 2007; Sandeep and Ravishankar 2014) whereas individuals may also refine their attitudes based on information or stories shared by others who have already adopted the technology (e.g., Abubakre et al. 2015*;* Chiu et al. 2012; Pynoo et al. 2007; Sumak et al. 2010).

We had expected attitude to have a direct effect on behavioural intention and to partially mediate the effects of performance expectancy and effort expectancy on behavioural intention (Dwivedi et al. 2017; Rana et al. 2016). However, we found that attitude partially mediated the effects of facilitating conditions and social influence on behavioural intention as well. It may be tempting to relegate attitude from theoretical models due to partial mediation since it is still possible to account for the direct effects of performance expectancy, effort expectancy, facilitating conditions, and social influence. However, explicit modelling of attitude significantly improves the explanatory power of the theoretical model—i.e., 38% to 45% without and with attitude respectively for behavioural intention. The standardized path coefficients also show that the four exogenous constructs had stronger direct effects on attitude than on behavioural intention (e.g., the effect on performance expectancy on behavioural intention was 0.11 whereas on attitude was 0.47). Moreover, it places considerable emphasis on the individual intending to use or actually using the IS/IT innovation.

Finally, we had expected behavioural intention to fully mediate the effect of attitude on usage behaviour but we found that attitude had a direct effect on usage behaviour as well. This implies that individuals may use the IS/IT innovation based on the strength of their attitudes even when they may not consciously intend to use the innovation. Prior studies have demonstrated that the influence of behavioural intention on usage behaviour may not be particularly strong or predictable (e.g., Duyck et al. 2010; Gupta et al. 2008; Pardamean and Susanto 2012; Weerakkody et al. 2013), which further highlights the importance of the relationship between attitude and usage behaviour. Our findings also showed that the explanatory power of the theoretical model improved significantly when attitude is explicitly theorized (i.e., 21% and 27% of variance in usage behaviour explained without and with attitude respectively in the model).

5.2 Limitations and Directions for Future Research

Similar to the other meta-analytic studies (e.g., King and He 2006; Sabherwal et al. 2006; Wu and Du 2012), this study also assumes that it is meaningful to combine results for a set of similar variables and measures across different studies. Although we have taken appropriate precautions in conducting the meta-analysis, the findings of our research should be interpreted in the light of some limitations. First, the meta-analysis in our study is limited to those studies in prior literature that reported Pearson correlations or other statistics that may be converted to Pearson correlations. Consequently, prior studies that may have only reported results based on linear regression or structural equation modelling were not included in our meta-analysis. The future research can also gather such statistics between the UTAUT

variables to perform weight analysis. Second, we found that a moderate number of studies did not report relevant statistics such as reliabilities of the constructs, means, standard deviations, and Likert scale anchors. Since the combination of meta-analysis and MASEM requires such statistics, we computed the average and substituted them in case of missing values (e.g., reliability) or used only those values that were available (e.g., standard deviation). Such treatments may partially affect our meta-analytic and MASEM results. Finally, our research model did not include the four moderators (i.e., gender, age, experience, and voluntariness) found in the original UTAUT model (Venkatesh et al. 2003). This is partly because prior studies had not examined those moderators or not reported information about those moderators. While the absence of these moderators does not completely undermine the results of our theoretical model based on direct effects, it may be viewed as a limitation that prevented us from examining the original UTAUT model in its entirety. The future research would be considering the Pearson's correlations between the constructs of the UTAUT model under the influence of these moderators to understand whether the meta-analysis outcomes between these variables are different when seen under the direct effect and moderating impacts separately. The future researchers can also think of performing meta-analysis and MASEM for some other more frequently occurring additional variables including self-efficacy, perceived trust, perceived risk and anxiety along the UTAUT model as informed by the most recent and comprehensive literature review (i.e. Williams et al. 2015) on UTAUT.

5.3 Implications for Theory

The original UTAUT model proposed a parsimonious collection of four constructs that may explain individuals' acceptance and use of IS/IT. Two constructs (i.e., PE and EE) may be considered as IS/IT or technology attributes whereas the remaining two constructs (i.e., FC and SI) may be viewed as contextual or organizational factors that influence individuals' behaviour. A significant omission in the conceptualization of the original UTAUT model is the individual who intends to engage or actually engages with the IS/IT—i.e., the individual characteristics are not included in the original UTAUT model. In our synthesis of prior research, we determined that prior research had attached significant importance to the individual's attitude toward IS/IT (e.g., Aboelmaged 2010; Alshare and Lane 2011; Chen et al. 2011; Kim et al. 2008; Koh et al. 2010; Sumak et al. 2010; Yang and Yoo 2004). Therefore, this research also proposed and tested a theoretical model with *attitude* as one of the constructs along the basic UTAUT model. The analyses revealed that our proposed theoretical model performed better than the basic UTAUT model alone. Based on evidence from the existing research and our MASEM findings, we propose attitude as integral part of the UTAUT model in future research.

Moreover, our research uncovered certain relationships that were not found in the original UTAUT model. Several of these paths identified in our research were due to the introduction of a new construct (i.e., attitude) not found in the original model. These paths include EE → AT, PE→, FC → AT, SI → AT, AT → BI, and AT → UB, and offer new insights regarding the intentions and behaviours of individuals relating to the acceptance of IS/IT. However, our research showed that FC → BI, which is not found in the original UTAUT model, may be an important consideration in explaining the acceptance of IS/IT by individuals.

Finally, the original UTAUT model included four moderators (i.e., gender, age, experience, and voluntariness), which was a significant departure from the then models of acceptance and use such as TRA, TPB, and TAM. Although moderators can be valuable, they may be applicable and become relevant only when there is significant variation in those moderators across individuals within the *same* context. Voluntariness, for instance, assumes that individuals coming in contact with an IS/IT have considerable latitude in their adoption and usage decisions—this need not be true in settings where the senior management may mandate the adoption and use of an IS/IT by all individuals. In other words, moderators may not be universally applicable to all contexts and hence run the danger of being non-relevant in certain settings. Perhaps, this is one reason why a majority of the studies we included in our meta-analysis did not consider these moderators in their research models. Our MASEM analysis shows that it may be beneficial and momentous to theorize on direct effects that are currently missing in the original UTAUT model.

5.4 Implications for Practice

Our findings show that attitude played a central role in an individual's intention to use and usage of IS/IT innovations. Specifically, attitude had direct effects on both behavioural intention and usage behaviour—which implies that organizational managers may find it beneficial to shape the attitudes of individuals for influencing intentions and behaviours.

We found that the technology attributes (i.e., performance expectancy and effort expectancy) had direct effects on attitude and behavioural intention (Rana et al. 2017; Weerakkody et al. 2017). This implies that the individuals attribute considerable importance to the extent to which the technology in question may be useful and easy to use. Therefore, managers should concentrate on enhancing the ease of use and usefulness of the system such that acceptance and use of innovations may be managed more successfully. Possible ways to accomplish these objectives may include more accurate representation of

user requirements to software developers or selection of technologies that are more consistent with user requirements, emphasis on clean design or selection of technologies that embrace clean design, and effective communication of the technology's capabilities through product brochures, live demonstrations, and success stories (e.g., Alshare and Lane 2011; Dwivedi et al. 2015; Koh et al. 2010; Martin and Herrero 2012; Pynoo et al. 2011; Rana et al. 2015b; Yang 2010; Zuiderwijk et al. 2015).

We also found that contextual factors (i.e., facilitating conditions and social influence) had direct effects on attitude and behavioural intention. This suggests that individuals may associate importance to the facilitating conditions such as help desks and training programs as well as to the experiences of other individuals in using the technology. Hence, organizations should consider providing adequate infrastructural facilities and proper training to users so that they can be positively inclined to use new technologies. For instance, managers can organize users in-house and vendor-based IS/IT training (Sabherwal et al. 2006) and help desks on premises or at vendor sites to offer technical assistance to individuals to aspiring users (e.g., Chiu et al. 2012; Pynoo et al. 2007; Sahu and Gupta 2007). Managers may proactively manage social influence that may be exerted on individuals by organizing forums for sharing best use practices, instituting champions who are enthused about new technologies and can generate positive word-of-mouth, and planning counter-measures for any negative feedback (e.g., Chiu et al. 2012; Pynoo et al. 2007; Sumak et al. 2010).

6 Conclusion

This research critically reviewed the original UTAUT model and proposed an alternative theoretical model that emphasized the need to explicitly theorize individual characteristics. Specifically, we modelled attitude to mediate the effects of exogenous constructs on behavioural intention. We tested the revised model using a combination of meta-analysis and structural equation modelling techniques, with data on 1600 observations involving 21 relationships gathered from 162 prior studies on IS/IT acceptance and use. Our findings showed that attitude partially mediates the effects of performance expectancy, effort expectancy, facilitating conditions, and social influence on behavioural intention, and also has a direct effect on usage behaviour. Thus, our empirical investigation shows that our proposed theoretical model that reframed the propositions of the original UTAUT model may serve as a meaningful alternative for understanding IS/IT acceptance and usage.

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