Individual Adoption of Information Systems in Organisations: A Literature Review of Technology Acceptance Model

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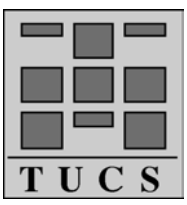

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Abstract

Users' perceptions of and intentions to adopt IS and the rate of diffusion and penetration of technology within and across organisations are two important foci of IS research. In the past several decades, many studies have been made to explain, predict and increase user acceptance of information systems at work based on different theoretical approaches, e.g. the Innovations Diffusion theory (IDT), the intention-based theories of IT adoption, i.e. the Technology Acceptance Model (TAM), (e.g., Davis et al. 1989), the Theory of Planned Behaviour (TPB), (e.g., Mathieson 1991), Social Cognitive Theory (SCT) (Compeau and Higgins 1995a, 1995b, 1999) and Triandis' model.

In this paper, we make a thorough review of the technology acceptance model--TAM (Davis et al 1989), about its development, its extensions, its limitations and its component constructs, e.g. perceived usefulness--PU and ease of use—EOU. This review covers literature published in the five top IS journals from 1989 till March 2003. TAM has been empirically approved to be parsimonious and robust across a broad range of end-user computing technologies and user groups. The fact observations conducted in the review also support it.

Supported by the literature and its technology focus, we might conclude that the TAM is appropriate for examining acceptance of any technology by individuals with different characteristics in various organisations. The TAM seems to be a useful model, but it is essential to extend and modify it with other relevant variables and theories. It is potentially possible to use TAM to understand end-user adoption of mobile applications or mobile commerce services.

Our contributions are (i) to build solid knowledge about TAM, (ii) to analyse TAM extensions and limitations critically, and (iii) to find potential ways to adapt the model to the wireless world.

Keywords: technology acceptance model, individual adoption, information systems, usage

TUCS Laboratory
Mobile Commerce Laboratory

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1. Introduction

Users' perceptions of and intentions to adopt IS and the rate of diffusion and penetration of technology within and across organisations are two important foci in IS research (e.g. Straub et al, 1995; Taylor and Todd, 1995a). They are understood to represent or stand for the essential aspect, property or value of the information technology (Orlikowski and Iacono, 2001). It is generally accepted that the usage of information systems at work could increase employees' productivity in their working time, and improve individual and organisation performance. System Usage is an important dimension to measure IS success (DeLone and McLean, 1992 and 2003).

In the past several decades, many studies have been made to explain, predict and increase user acceptance of information systems at work based on different theoretical approaches. For example, the Innovations Diffusion theory (IDT) suggests that the user's perception of the characteristics of an innovation affect adoption (e.g. Moore and Benbasat 1991, Plouff et al, 2001, Rogers 1995). The intention-based theories of IT adoption, i.e. the Technology Acceptance Model (TAM), (e.g. Davis et al. 1989, Venkatesh and Davis 1996, 2000), and the Theory of Planned Behaviour (TPB), (e.g. Mathieson 1991, Taylor and Todd 1995a, Venkatesh and Brown 2001) have shown that user adoption and usage of an IT innovation is ultimately determined by his/her beliefs and attitudes toward the information systems. There are also other theories, e.g. Social Cognitive Theory (SCT) (Compeau and Higgins 1995a, 1995b, 1999) and Triandis' model (e.g. Thompson et al 1991,1994,Cheung et al 2000) that have been applied to user adoption of IS studies. These studies have produced useful insights into the cognitive, emotion, affective and behavioural reactions of individuals to technology, and into the external variables that influence the formation of these reactions or even directly influence the user's intention or behaviour.

Among these theoretical models, the Technology Acceptance Model (TAM) is tailored to study user acceptance of computer technology. Fred D. Davis developed this model in 1986 in his unpublished dissertation and published it with other scholars in 1989 in Management Science. Since then, TAM has emerged as an important widely applied model to explain and predict a user's behaviour in adopting and using information systems in organisations. It has been applied across different user populations and a broad range of end-user computing technologies, and empirically approved to be a robust model for studying user acceptance behaviour in the IS research field. The research done in the last decade and more has contributed useful knowledge and possible extensions of the model, which requires us to understand them all.

In this paper, we will do a thorough review of the TAM model, its development, its extensions, its limitations and its component constructs, e.g. perceived usefulness--PU and ease of use--EOU. Our contributions are (i) to build solid knowledge about TAM, (ii) to analyse TAM extensions and limitations critically, and (iii) to find potential ways to adapt the model in the wireless world.

In the following, we will review 42 relevant articles (see appendix 1) published in the top 5 information systems research journals (Vessey et al, 2002), i.e. Information Systems Research-ISR, Management of Information Systems Quarterly-MISQ,

Decision Science-DS, Management Science-MS, and Journal of Management Information Systems-JMIS from 1989 till March 2003. These articles used PU as an internal belief to explore its role in end-user's behaviour towards information systems, and used TAM as the theoretical basis to find the causal links between (i) external variables and EOU to PU, (ii) PU-A, (iii) PU-BI and (iv) PU's relationship with usage behaviour. Moore and Benbasat (1991) based on Rogers' (1983 and 1995) work on the diffusion of innovations, have proved that perception of the characteristics of an innovation (PCI) affect the end-user's adoption behaviour. Relative advantage is one of these PCI instruments that shares some similarity with PU. Thus, in this review, we include several articles that use relative advantage instead of PU to study its role in user's behaviour to IS. In appendix 1, we list all these reviewed articles and present them in chronological order. We briefly overview their target IS applications, research context, subjects, research methods, PU and findings. Our list is numbered in order to analyse them easily in the following discussion.

This paper is organised in 5 sections. In section II we will review the original work on TAM. Section III will explore its adoption, validation and extensions. Section IV will discuss some main limitations of TAM. A discussion follows with a conclusion at the end.

2. Technology Acceptance Model (TAM): An Overview

TAM is an adaptation of the Theory of Reasoned Action (TRA), which was specifically introduced to explain computer usage behaviour. TAM uses TRA as a theoretical basis for identifying the strong causal links between two key beliefs-- (i) Perceived usefulness (PU) and (ii) Perceived ease of use (EOU), and user's attitude (A), intentions (BI) and actual computer adoption and usage behaviour. Therefore, TAM is a causal model that studies the covariance of these constructs to determine if there exists a causal relationship among them.

Generally, the goal of TAM is " *to provide an explanation of the determinants of computer acceptance that is in 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 et al. 1989, p985)

According to TAM, BI is a major determinant of usage behaviour; behaviour can be predicted by measuring BI. BI is viewed as being jointly determined by the person's attitude toward using the system— A and PU. PU and EOU have been hypothesised to have positive influences on A. EOU influences attitudes and behaviour through two mechanisms: self-efficacy and instrumentality. This means the easier the system is to use, the greater will be the user's efficacy felt to be regarding his or her capacity to use the system. To the extent that increased EOU leads to improved performance, EOU will have a direct influence on PU. External variables represented in TAM provide the bridge between the internal beliefs (PU and EOU), attitude (A) and intentions (BI) and various individual differences, situational constraints, organisational characteristics and

system characteristics etc impacting on behaviour. Just as Davis et al (1989, p985) demonstrated: " *A key purpose of TAM, is to provide a basis for tracing the impact of external factors on internal beliefs, attitudes, and intentions*."

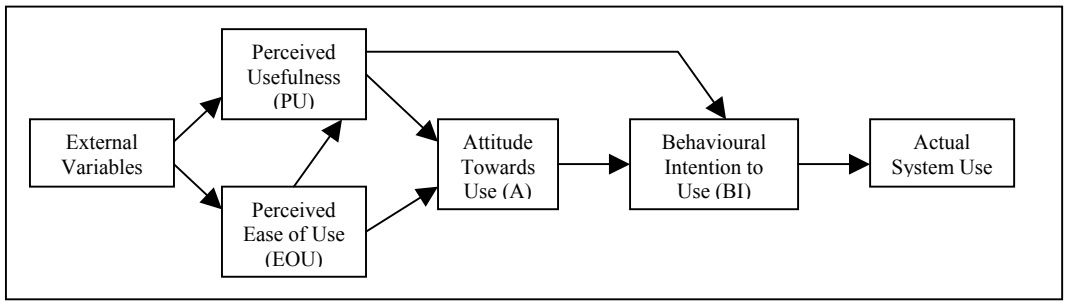

Figure 1: Technology Acceptance Model (Davis et al. 1989)

TAM's "*PU and EOU are postulated a priori, and are meant to be fairly general determinants of user acceptance*"(Davis et al., 1989) This approach was chosen in order to construct a belief set that can more readily generalised to different computer systems and user populations. In contrast, TRA and TPB (Technology of Planned Behaviour, another theoretical extension of TRA) need to elicit the specific perceived beliefs held by specific subjects targeting the specific system under investigation. Davis (1989) defines PU as "the degree to which a person believes that using a particular system would enhance his or her job performance", EOU as "the degree to which a person believes that using a particular system would be free of effort". He develops scale items based on their definition and pre-tests and tests their content validity, reliability and construct validity. The final scales have been refined and reduced to two six-item lists with reliabilities of .98 for PU and .94 for EOU.

In reviewing these two original papers (Davis et al 1989 and Davis 1989, No.1 and 2 in the appendix 1), we could make primary conclusions about TAM.

1. TAM is a specific model developed to explain and predict users' computer usage behaviour in organisations.

2. TAM is a causal model. The BI-actual usage and the PU-BI relationship observed in the studies are very strong. BI is a proper predictor of Behaviour. It fully mediated the effects of how other variables affected usage. PU has great impacts on BI over time beyond A. The A-BI relationship changes over time. Its link became non-significant when users used the system for a longer time. Attitude is found not to fully mediate the effect of PU and EOU on behaviour; it only partially mediated these relationships.

3. PU and EOU correlated significantly with both self-reported current usage and self-predicted future usage. But PU had a greater effect on usage behaviour than EOU when users had used the system for a longer time. Because users seemed to process EOU from a self-efficacy perspective in early exposure to the system, they were concerned about the likelihood of succeeding in learning to use the

system. As learning progressed and more experience was gained over time, this consideration became less important. Users evolved EOU into a more instrumental perspective, considering how much of the relative effort of using the system would influence their performance. The importance of PU in determining usage behaviour should be emphasised. The usefulness of the system may encourage users to surmount the difficulties in their interaction with it. The greatest EOU of the system may not lead to usage of it if it does not do useful work.

4. TAM does not include social norms (SN) as a determinant of BI, which is an important determinant theorised by TRA and Technology of Planned Behaviour (TPB). SN refers to " a person's perception that most people who are important to him think he should or should not perform the behaviour in question" (Fishbein and Ajzen 1975, p.320). The SN-BI relationship was not observed to be strong in their studies. Davis et al (1989) explained that SN scales have a very poor psychometric standpoint. It may not exert any influence on BI, especially when IS applications are fairly personal and individual and usage is voluntary.

5. Davis and his colleagues claimed that system usage is only a necessary, not a sufficient condition for fulfilling performance improvements due to IS. PU and EOU are user's subjective appraisal of performance and effort respectively; they cannot be regarded as surrogates to reflect objective phenomena.

6. Finally, they call for future research to apply the model to other contexts. They pointed out that practitioners evaluated systems for two purposes. One is to predict acceptability, the other is to diagnose the reasons resulting in lack of acceptance and to take proper measures to improve user acceptance. Therefore, we should pay attention to external variables that influence the user's internal behavioural determinants to computer usage behaviour in order to meet the two evaluation purposes, particularly the second one.

3. Model Adoption, Validation and Extensions

IS researchers who are interested in studies of user acceptance of technology, have been adopted, validated and extended the original TAM to explain and predict users' computer usage behaviour across different IS applications and organisational contexts.

3.1 Model Adoption

TAM aims to be parsimonious and theoretically justified in predicting and explaining user behaviour across various IS and organisational contexts. Davis and his colleagues tested TAM in studying user behaviour about WriteOne, a word processing program, PROFS email, XEDIT file editor and IBM PC-based graphic systems, i.e., Chart-Master and Pendraw in the context of universities and an organisation in Canada, using both

students and knowledge workers as subjects. The reviewed articles showed that TAM has been tested and adopted across a wide range of IS applications and other contexts. For examples, key office IS applications, e.g. Spreadsheet Lotus 1-2-3, WordPerfect, Word, Excel (see appendix 1 No. 3,5,6,7,11,13,16,18,23); communication technologies, e.g. Email, voice mail, Customer dial-up system and fax (see appendix No.5, 7,8,12,17,18,21); Database systems (see appendix No.6, 9,23,39); microcomputers (No.10, 15, 25); workstations (No.4, 26); telemedicine technology for physicians (No.29, 36,40); specific systems for specific organisations (No.31, 33), etc. With Internet being adopted by the business world, some researchers studied TAM to explain user behaviour about Internet-related IS applications. For example, WWW (No. 30), WWW information services (No.22), Online services (No.24), Virtual workplace systems (No.27, 39), digital libraries (No.36). As consumers increase their purchases through Internet, TAM has been adopted to study consumer behaviour about B2C e-commerce applications, such as web-based bookstores (Koufaris 2002 and Gefen et al 2003, No.37, 41 in the appendix).

TAM-based studies also have been conducted in many organisations, such as a large financial institution in America (No.12), a large Canadian integrated steel company (No. 14), accounting firms (No.20), public tertiary hospitals in Hong Kong (No.29, 36,40), investment bank (No. 26) and some Fortune 100 corporations (No.25), etc. Universities are the other research context, mostly universities in North America, for examples, University of Michigan (No.1), Boston University (No.2), Temple and Minnesota University (No.18), and in other countries, e.g. the open university of Hong Kong (No.38), etc. When B2C e-commerce became an important research issue, on-line services firm (No.24) and on-line bookstores (No.37, 41) and other such virtual organisations emerged as research contexts.

Knowledge workers and students in different organisations and universities are usually the "user population" in TAM-based studies. These users constitute large numbers and a great diversity of users base. As we indicated before, on-line e-commerce consumers are a new user group.

Although the reviewed articles have adopted TAM across different IS applications, research contexts and various user populations and shown it to be both parsimonious and theoretically justified, many of them do not apply the original TAM exactly into their own research design. They validate it and extend it by developing other important variables or constructs. Some of these studies are summarised in the next two sections.

3.2 Model Validation

The validation of TAM goes two ways. One is to validate its PU and EOU instruments to prove their psychometric properties. The other is to validate its supported causal links among its component constructs, i.e. BI-behaviour, A-BI, PU-BI, EOU-BI, EOU-PU, EOU-PU-BI, PU-A, EOU-A, and external variables to EOU and PU relationships.

3.2.1 PU and EOU instrument validation: measurement and psychometric characteristics

In the TAM, Perceived usefulness – PU, together with perceived ease of use—EOU are indicated as fundamental and distinct constructs that influence in individual's decision to use information technology (or systems) (Davis 1989).

Davis (1989) introduced a detailed scale and items used to measure perceived usefulness (PU) and perceived ease of use (EOU). The frequently used PU items in most research are: Using a particular system, 1) would improve individual's job performance, 2) would increase the individual's productivity, 3) would enhance individual effectiveness on the job, 4) would enhance the individual to accomplish tasks more quickly, 5) would make it easier to do the job, and 6) the individual would find the particular system useful on the job. This 6-item scale has been adopted in many empirical studies, and almost all had significant statistical explanation and prediction power to illustrate the phenomena of user's behaviour towards IS or IT (e.g., Davis 1989 study 2, Mathieson 1991, Adams et al 1992, Szajan 1994 and 1996, Venkatesh 1999, etc). Some researchers may use a 4-item scale, mainly items 1,2, 3 and 6 to measure an individual's perception of usefulness about using a particular system and validated in the relevant empirical settings (Davis et al 1989, Lucas and Spitler 1999, Venkatesh and Morris 2000, Koufaris 2002). Researchers usually ask users to rate their agreement with the statements by choosing a number based on 5-point or 7-point Likert-type scale.

PU is a construct to measure an individual's psychological belief about using a particular IS, thus the scale must possess "content validity", defined as " the degree to which the score or scale being used represents the concept about which generalizations are to be made" (Bohrnstedt, 1970, p91, quoted from Davis 1989). The Spearman-Brown Prophecy formula was used to choose the number of items for the PU scale. Therefore, 6-item scale was developed. Construct convergent reliability and discriminant validity were tested and were all statistically significant. Davis' PU scale has high content validity and has been used by other researchers. Since researchers adopted PU in different studying settings, the PU construct reliability and validity are performed firstly in these various situations; all had statistically significant reliability and validity. In order to detect whether PU is a different construct from EOU or other constructs, factorial validity is usually done as follows. The pattern of factor loadings will confirm the structure of PU, with its items loading highly on this factor. Using these techniques, will confirm the psychometric strength of the PU scale.

The frequently used EOU items are: 1) Learning to operate the system would be easy for me; 2) I would find it easy to get the system to do what I want it to do; 3) My interaction with the system would be clear and understandable; 4) I would find the system to be flexible to interact with; 5) It would be easy for me to become skilful at using the systems; 6) I would find the system easy to use. As with the PU instruments, this 6-item EOU scale has been adopted in the reviewed articles and mostly got statistical support showing it to be valid and reliable in measuring individual perceptions of ease of use of the system. Some studies, used only 4-items i.e. items 1,2,5, and 6 (Davis et al 1989, Subramanian 1994); item 2,3,6 and re-word a new item,

interaction with the system does not require a lot of my mental effort (Venkatesh and Morris 2000). Sometimes, researchers used only 2items, items 2 and 6 (Lucas and Spitler 1999). Researchers use the same methods as studying PU to ask users to rate their agreement and to validate its psychometric properties.

The psychometric properties of the two measures developed by Davis appear to have been robust across studies and user groups. Still, we may find that there is no absolute measure of EOU and PU across varying technological and organisational contexts. Minor changes may be necessary in some of the variables used in measuring these constructs. User perceptions of these constructs may vary with time and experience for any given application (Adams et al 1992). It seems plausible that both task and user characteristics alter the nature and importance of perceptions that explain technology use (Segars and Grover, 1993). Doll et al. (1998) conducted a confirmatory and multi-group invariance analysis of Davis' original PU and EOU instruments. Their results are mixed, indicating that PU and EOU instruments are not invariant across different types of applications, different users with no prior computing experience, novices, and experienced users, and across gender. PU is invariant across three applications, i.e. graphics, spreadsheet and database, but not for word-processing. PU is invariant across two groups, novice and experienced users, not for users with no prior computing experience. PU is invariant across gender. But EOU is invariant across applications and users with different experiences, not across gender.

Thus, we may conclude that PU and EOU are very powerful beliefs constructs to determine user behaviour about computer technologies in organisations. Their measurement scales and psychometric properties are empirically shown to be robust. But we have to aware that for different users, their perceptions of PU and EOU may vary across contexts in term of technology and organisation.

3.2.2 Validation of casual links

TAM supports strongly the causal links between BI-behaviour, PU-BI, EOU-BI, EOU-PU and external variables to PU and EOU relationships.

The empirical testing and validation of the TAM-theorised causal links are summarised in Table 1. The relationships are theorised and tested by original TAM work (Davis et al 1989 and Davis 1989).

BI-Behaviour

The TAM asserts that intention is a proper proxy to examine and predict a user's behaviour towards information systems. System use was usually voluntary and was measured as frequency of use, diversity of use, predicted future usage, initial (immediate) usage or continued sustained usage (Venkatesh et al 2002), or discontinuance usage (Parthasarathy and Bhattacherjee 1998). Empirical results from literature (No. 1,11, 13,32, 33 and 39) tested the correlation between behaviour intention and behaviour, and the correlations were found to be significant in each of the

studies. The results from No.13 (Taylor and Todd 1995 b) found that behavioural intention predicted behaviour more strongly for experienced users. The results from No.39 (Ventatesh et al 2002) further pointed out that behaviour intention fully mediated the influences of other factors on immediate use or short-term use of a system but did not have effects on continued use. Their results showed that short-term use is the sole predictor of continued usage, not behaviour intention.

PU-BI and behaviour

More than 20 studies have tested PU effects and its correlations with users' behaviour and behaviour intention to use a specific system. Their results found this link was statistically significant. PU is proved to be a major determinant of behaviour intention (No. 1,2,16, 25,28,29,30,31,38,39,40,41) and to correlate highly with various usage dimensions. For examples, self-reported current usage (No.1, 2,17), self-predicted future usage (No.1, 2,5,10,19), variety of use (No.10,), choice behaviour of software packages (No.9), user's behaviour in both the pre-implementation and post-implementation stages of a system (No.17), continued sustained usage (No.19), subsequent discontinuance behaviour (No.24) and mandatory use (No.33). There is empirical evidence shows that PU is a stronger predictor for inexperienced users' intention towards using systems (No.13).

EOU- BI and behaviour

Some 18 studies have found EOU relationships with BI or behaviour to be significant. Compared with PU, EOU is the second most important determinant of a user's behavioural intention toward a system. In the pre-implementation stage, EOU does not have a significant and direct effect on users' behaviour intention to use a system, but does affect intentions only through PU in the post-implementation stage (No.17, Szajna 1996). It indicated that unless users perceived an IS as being useful, its ease of use has no effect on the formation of intentions. When we analyse how EOU influences the user's intention to use only directly via PU, Chau 1996 (No.16) found that it was only through near-term usefulness, not long-term usefulness.

Attitude

Because attitude appeared to have no sustained effect on individual behavioural intention and only partially mediated the belief-intention link, this construct is frequently not included in empirical testing. About 10 studies tested attitude effects on behaviour intention and its antecedent belief constructs, i.e., PU and EOU. PU and EOU are usually the positive direction to one's attitude towards using the system (No, 1,3,5,11, 20, 25,36,40). Together with PU, attitude was a significant predictor of intentions (No.25, 29). The relationship between attitude and behavioural intention will be stronger for users than for potential adopters, and PU is the only belief underlying potential users' attitude to adopting and users' attitude to continuing to use (No.28, Karahanna et al 1999).

PU, EOU and external variables (EV)

TAM emphases the importance of how external variables affects on the individual internal decision process when it comes to using a system within organisations. Nearly 20 studies have found such effects. EOU has positive effects on PU (No.1, 3, 5, 18, 26, 35,39). EOU only influenced the user's near-term perception of usefulness, not long-term (No.16). External variables affect PU directly or indirectly via EOU. For example, user training, end-user policy, management support, system quality and EOU have a direct effect on PU, and explained 48% of variance of PU (No.10); No.14 found information-centre product specialists and end-users may have a different assessment of PU. User skills, organisational support and perceived complexity of a system had significant effects on PU (No. 15). Intrinsic involvement in software development may influence the user's perception of how usefulness the system is (No.20). Gender, perceived social presence and information richness of the medium (e.g. Email, voice mail) (No.21), individual difference (i.e. participation in training) (No.25), intrinsic motivation (e.g. cognitive absorption) (No. 30, 39) and relevance of the system to the task (No.38) have all been found as predictors of PU. Venkatesh and Davis (2000)(No.33) have incorporated additional theoretical constructs spanning social influence processes (SN, voluntariness and image) and cognitive instrumental processes (job relevance, output quality, result demonstrability and EOU) as antecedents of PU. Their results confirmed the important of these processes on the user's perception of usefulness and explained 60% of the variance of PU.

EOU and external variables (EV)

Eleven studies validated EOU relationships with external variables. The results are statistically significant. System quality, user training, organisational support, end-user computing support, management support, and computer experience have been found to have significant direct effects on EOU (No.10). Interaction between systems, direct experience with a system, system characteristics (No. 18, No, 38), gender (No.21), individual difference (i.e. individual organisation role with regard to technology, prior experience with similar systems, and their level of education, No.25; knowledge of search domain No.38) all determine the user's perception of ease of use of a system. Individual computer self-efficacy (No. 18, No.31, No.38), intrinsic motivation (No.39) (e.g. playfulness No.27, No. 31, cognitive absorption No.30) and computer anxiety (No.31) were all determinants of EOU. The study of on-line consumer behaviour showed that EOU fully mediated the effects of a consumer's familiarity on the trust issue (No.41).

Table 1 Validation of Casual Linkages

Relationships	Supported Literatures[1]
Individual's use of systems can be predicted well from its intentions (BI-Behaviour)[2].	No.1, 11, 13,17, 32,33,39
PU is a major determinant of individual's intentions to use systems (PU-BI), has a high correlation with usage behaviour.	No.1, 2,3, 5,8, 9, 10, 13, 16, 17, 19, 24, 25, 28, 29, 30, 33, 35, 36, 37, 38, 39, 40,41
EOU is a significant secondary determinant of individual's intentions to user systems (EOU-BI). But this effect may subside over time, mostly through PU to influence BI (EOU-PU-BI).	No.1, 2,3, 5, 9, 10, 16, 17, 18, 20, 25, 27, 31, 33, 35, 38, 39, 41
Attitude effects on BI become less significant over time (A-BI). Attitude partially medicated belief-BI link (PU-A, EOU-A).	No.1, 3, 5, 11, 13, 20, 25,28, 29,36
PU is affected by various external variables (EV) over and above EOU (EOU-PU, EV-EOU-PU and EV-PU).	No.1, 3, 5, 10, 14, 15,16,17, 18, 20, 21,25, 26, 30, 33, 35, 37, 38, 39, 42
EOU is to be determined by external variables (EV-EOU).	No.10, 18, 21,25,26, 27,30,31, 38,39,41

3.3 Model Extension

In addition to the many papers that have tested and validated the TAM model, many studies also included other variables to extend the model itself. They have contributed to a better understanding of the way individuals adopt information systems and to elaborate the TAM more comprehensively, its antecedents of beliefs, moderating role of experience and voluntariness and different dimension and measurement of usage. We summarise these extensions below.

3.3.1 Extensions of PU and EOU

PU and EOU are formulated as two fundamental beliefs determining a user's behaviour to computer technology. These two constructs are parsimonious and empirically validated across various IS applications and usage contexts. There are two main extensions of understanding PU and EOU. One is the extension of the constructs themselves; the other incorporates relevant external variables as important antecedents of PU and EOU. Segars and Grover (1993) took a confirmatory approach to re-

[1] Number shows in the same order as that in the appendix.

[2] Since Intention is a proper predictor of individual's behaviour. Not all the following studies presented the correlations between BI-Behaviour (actual use of systems); they considered behavioural intention as their study outcomes instead of actual behaviour. That does not mean that they do not support the link between BI-Behaviour. Here, we only give the references that presented BI-Behaviour correlations.

examining PU and EOU. They found that a third underlying construct termed " Effectiveness" should be introduced into the original two-factor structure postulated by Davis (1989). The three-factor model exhibits sound psychometric properties and a certain degree of validity. It is interesting that very few researchers used these three factors in their empirical studies in our reviewed article. According to motivation theory, PU is considered as an extrinsic motivation, and means performing behaviour to achieve a specific goal (Venkatesh 1999, Venkatesh and Speier 1999, Venkatesh et al, 2002). Combining Triandis' theory (Thompson et al 1991 and 1994) about the "perceived consequences" of behaviour, Chau (1996) expanded PU into two different constructs, perceived near-term usefulness and perceived long-term usefulness. Near-term PU can be improving job performance or enhancing job satisfaction, long-term PU means improving one's career prospects or social status (future consequences). His results showed that perceived near-term usefulness was the most significant factor affecting the user's intention to use a system. Also, it had a significant and positive influence on perceived long-term usefulness. That implies that a user who finds a technology useful in accomplishing current tasks is predisposed to believe it will help in his or her future career. In this case, EOU was found to have no significant direct relationship with long-term usefulness. Its effects on intention to use were only through near-term usefulness.

As we indicated above, external variables determine EOU and PU to some extent. Therefore, the second extensions of TAM go to the development of the antecedents of EOU and PU. The major contributions are from Venkatesh and Davis (1996), Venkatesh (2000) and Venkatesh and Davis (2000). Venkatesh (2000) improved the work of Venkatesh and Davis (1996) and made a comprehensive study of the determinants of EOU. He demonstrated an anchoring and adjustment-based theoretical model for the antecedents of EOU, or system-specific EOU to be precise. The model proposes control (internally and externally-defined as computer self-efficacy and facilitating conditions), intrinsic motivation (defined as computer playfulness), and emotion (defined as computer anxiety) as anchors that influence users' early perceptions about the EOU of a new system. With increasing experience of using the system, users' perception about the EOU of the system will be still anchored in general computer beliefs, also will be adjusted regarding objective usability, perceptions of external control specific to the new system environment and system-specific perceived enjoyment. His results strongly supported this proposed model and explained up to 60% of the variance in EOU. Venkatesh and Davis (2000) published their TAM2 model. TAM2 extends original TAM by explaining PU and usage intentions in terms of social influence and cognitive instrumental processes. They defined social influence processes (subjective norm, voluntariness, and image) and cognitive instrumental processes (job relevance, output quality, result demonstrability, and EOU) as determinants of the user's formulation of PU. Their results derived from four longitudinal studies showing the theoretical rationale for the causal relationships of the model. SN effect on PU was significantly moderated by experience, Image was not found to be significant for PU. Job relevance and output quality influence PU interactively. TAM2 explained up to 60% of the variance in PU and up to 52% of the variance in the intention to use.

Beside these important external variables, innovation characteristics (No.19), individual differences (role with regard to technology, tenure in workforce, level of education,

prior similar experiences, participation in training) (No. 25), individual traits (such as personal innovativeness in the domain of IT-PITT (No.22), cognitive absorption- CA (No.30) and the relationship of these traits to computer self-efficacy and computer anxiety (Thatcher and Perrewe, 2002)) and situational factors (the positive, neutral and negative mood when the individual participated a training programme) (No.39 and Venkatesh and Speier 1999) are proved to be antecedents of PU or EOU.

Such extension fulfils the key purpose of TAM to "*tracing the impact of external factors on internal beliefs, attitudes, and intentions*." Meanwhile, a thorough understanding of the antecedents of EOU and PU could help practitioners to diagnose the reasons for resistance to technology. If would also help them to take proper efficient external measures to improve user acceptance of technology.

3.3.2 Moderators: experience and voluntariness

The original TAM did not include any moderating effects either of experience or voluntariness. The reviewed literature has suggested the importance of these two dimensions being incorporated into TAM to predict and explain user behaviour with regard to a given technology.

Experience is basically conceptualised as one of individual differences factors that influence a user's formation of beliefs about using a system. Experience gained through direct use or past usage affects the user's perception of relevant beliefs concerning the target systems, current attitude and usage of the system positively in most cases. It is one of the most important sources of information about the target object and one's self-efficacy in computer technology. Five of the reviewed articles examine the effects of experience in terms of individual differences (No.13, 14,17,23,25). No. 13 found that users' prior experience of using a system influenced their assessment of system usage. The results showed that the experienced users assessed the relationships of BI to Behaviour and behavioural control to behavioural intention much more strongly than inexperienced users. PU and EOU were stronger predictors of intention for inexperienced users. However, neither experienced nor inexperienced users differed much in their assessment of attitude to behavioural intention and social norms to behavioural intention relationships. No.17 studied the beliefs-intention-acceptance relationship at both the pre and post-implementation stage. They argued that the determination of the role of experience might be the key to understanding this relationship. They also pointed out that when an individual becomes more experienced with the given technology, PU directly determines not only intention to use but also usage behaviour. It is important to address the experience dimension with TAM. No.23 conducted an invariant analysis of the PU and EOU instrument; the authors suggested that PU was invariant across novice and experienced users, but not comparable for users with no prior computing experience. However, the EOU instrument is invariant across user groups with or without experience. No. 25 supported the significant effects of prior similar experience to EOU. In general, we may conclude that experience is important variable affecting the formation and change over time of user beliefs and decisions to adopt an IT innovation (Xia and Lee, 2000). But the results of the study No.14 showed that years of computer experiences did not have a significant effect on the PU and EOU of the software package.

Four studies tested the moderating effects of experience (No.18, 31,33,42). No.18 tested the role of experience in determining EOU and its moderating effects in determining other factors influencing EOU. The results showed that direct experience with the system was important for users to formulate system-specific EOU perceptions. Such perception was not possible formed after only seeing a video mock-up, which is confirmed by the significance of the interaction between system and direct experience in determining EOU. The moderation test suggested that objective usability effects on EOU were moderated by direct experience. No.31 pointed out the importance of experience in influencing and moderating users' general assessment and adjustment of determinants to EOU over time. No.33 clearly theorised experience as a moderator in TAM2. No.42 found that when recipients received advice messages from their colleagues, their expertise and involvement moderate effects of the argument quality of the advice on information usefulness significantly, but only marginally for source credibility. Experience influences utilization of PC use directly (Thompson et al 1994). The results from this study also suggested that the moderating influence of experience on the relations between other constructs, e.g. job fit, technical support, to utilisation was generally quite strong.

One assumption of TAM is that usage of a system is voluntary. The empirical studies in our review mostly followed this assumption. No.3 developed a perceived voluntariness scale to help clarify assumptions about the freedom of choice in adopting innovations. No.19 examined its role in user acceptance of IT. The results showed that perceived voluntariness was significant in explaining current usage, but did not affect the intention to continue use. In TAM2, presented in No.33, voluntariness was theorised as an important moderator, a control variable influencing a user's internal beliefs, attitude and intentions with regard to a system. The results showed that effects of social norms on behavioural intention were significantly moderated by both experience and voluntariness. When usage is mandatory, social norms will directly affect intention. The result from No.26 indicated much the same.

3.3.3 Dimension of usage

Information technology can probably improve individual and organisational performance. The systems, that are available in organisations, cannot be fully demonstrated their value until they are used. In the review of extant literature, there are different dimensions of usage behaviour. From the temporal dimensions, we may categorise behaviour into two groups. One is initial adoption behaviour i.e. initial adoption, first-time usage, and rejection at the pre-implementation stage; the other is post-adoption or post implementation behaviour, i.e. sustained continuous usage, discontinuance (replacement or disenchantment). From the volitional perspective, usage could be mandatory or voluntary.

(i)Temporal dimension of system usage

One of the main purposes of the intention-based theory is to explain and predict initial adoption behaviour (Davis et al 1989, Moore and Benbaset 1991). In this dimension,

frequency and volume of system usage are adapted to measure the initial adoption behaviour, besides variety of use, e.g. accomplishing a number of tasks or using a number of applications (e.g. Igbaria et al., 1995). ISs diffuse because of the cumulative decision of individuals to adopt them. Users maybe persuaded to use a new system early in the implementation process but the benefits offered may never be achieved in the absence of continued sustained usage (No.17, 19, 28). Some discontinuance behaviour may happen as well. Two types of discontinuance behaviour may occur. Replacement means users use an alternative system instead of the original one that they use in the initial time. Disenchantment means users become dissatisfied with the systems or services and thus not use them any more (No.24).

The temporal dimension of system usage may give rise to different behaviour intentions, attitudes and beliefs towards the system being formed. These are used in turn, to predict the probability of usage.

(ii) Mandatory use vs. Voluntary use

As we indicated above, one assumption of the TAM is that, given sufficient time and knowledge about a particular behavioural activity, an individual's stated preference to perform the activity (i.e. behavioural intention), will, in fact, closely resemble the way they do behave. This assumption only applies, however, when the behaviour is under a person's volitional control (Ajzen and Fishbein 1980)

The major differences between Ajzen's (1985) volitional control and the volitional control associated with mandatory behaviour is that, in the former category, the absence of volitional control hinders a person's will to perform the behaviour, whereas mandatory use of technology hinders a person's will not to perform the behaviour. Thus, Ajzen introduced perceived behaviour control, a measure of the extent to which the individual feels control over performing the behaviour rather than not performing the behaviour. Moore and Benbaset (1991) introduced perceived voluntariness to measure the degree of volition in performing behaviour. Venkatesh and Davis (2000) used this voluntariness as one of the control variables in their study.

Although most previous studies have been designed in the context of voluntary use, mandatory use is becoming an important research issue as it becomes increasingly prevalent in organisations (Rawstorne 2000).

4. Model Limitation

Beside the many papers that have adopted and validated the TAM, several articles have been published that challenge and criticise the model. On balance, these articles have contributed to a better understanding of limitations of the TAM. These articles and the issues they raise to the TAM are summarised below.

4.1 Cultural dimension of TAM

The reviewed articles, No.21 and No.33, examined the impact of gender on IT diffusion. They argue that gender is a fundamental aspect of culture; it does affect IT adoption process. But these two studies did not address the cultural dimension of the TAM. The obvious reason of why discussion of cultural effects on IT adoption is lacking is that most empirical studies have been conducted in North American culture, mostly in U.S firms. Culture does have an impact on an individual's decision-making to adopt and use a specific system. The examination of cross-cultural working and IS is dominated by Hofstede-type studies (Myers and Tan 2002).

Straub, Keil and Brenner (1997) discussed the issue in an article published in Information & Management. They conducted a three-country study to test the TAM across cultures— Japan, Switzerland and the United States. The study administered the same TAM construct instruments to employees in three different airlines companies, all of them had access to the same IS, i.e. email. The results demonstrated that TAM holds for both the U.S. and Switzerland, but not for Japan. This implies that TAM may not predict technology use across all cultures in the world. The study results from articles No. 29, No.36, No.38 and No.40 in our review which were conducted in Hong Kong, did not arrive at a similar conclusion. But one result might be enough to question whether the TAM cannot equally predict user behaviour across culture. It calls our attention to considering the cultural dimensions of the TAM when studying user behaviour in other cultures than just North America.

4.2 Applicability and generalisability issue

Four articles (No.26, 29,36,40) questioned the applicability of the TAM in their studies. Lucas and Spiter (1999) (No.26) found that in the field setting of broker workstations, the individual perception variables PU and EOU in the TAM did not approach significance in predicting use. Surprisingly, PU and EOU correlated at 0.62. They argued that, in this circumstance, combing these two into a single variable, would make it a significant predictor of use for a full sample at the 0.05 level, including brokers and sales assistants, and a sample of sales assistants at the 0.10 level. Such a combination provided limited support for the original TAM model. Obviously, the TAM does not support it; PU and EOU are postulated as two distinct constructs. Their explanation for the TAM's weak support lay in the nature of the system, not enough voluntary use of the system and the field environment in which their study was conducted. They concluded that it was possible the TAM could not work well for a modern, complex technology, i.e. multifunctional workstations where usage is mandatory in nature and there are no alternative systems to complement it. They found similar results in the following studies published in Information & Management (Lucas and Spiter, 2000).

The empirical results from Hu et al (1999)(No.29) and Chau and Hu (2001 and 2002)(No.36 and No.40) found that EOU had no significant influence on PU and attitude. They suggested that this might reflect limitations in the TAM's applicability to

technologies, user populations or both. They explained that their study subjects, physicians, might differ subtly from the subjects commonly examined in prior technology acceptance/adoption studies. Physicians are professionals and might exhibit considerable differences in general competence, adaptability to new technologies, intellectual and cognitive capacity and the nature of their work. They concluded that the explanatory power of the TAM, particularly the EOU factor, might weaken as the competency of the users increases.

4.3 Measurement of usage

Different empirical designs usually have different indicators to measure system usage. Behavioural intention is a proper predictor for current and future usage. " Assuming the system were available in my job, I predict that I will use it on a regular basis in the future", such self-predictions, or "behavioural expectations", are among the most accurate predictors available for individual future behaviour. Not enough is currently known about how accurately self-reports reflect actual behaviour. Szajna (1996) (No.17) argued that the intention-usage link appeared to be dependent on the method for measuring usage. Intentions predict self-reported usage but do not predict actual usage well. His results showed that intentions explain 32% of the variance in self-reported usage, only 6% of the variance in actual usage. Self-reported usage and actual usage correlated at 0.26. This implied the necessity to validate self-reported usage as a construct.

Some researchers use computer-recorded system usage to measure actual usage (e.g., Straub et al; Szajna 1996). But these two constructs do not appear to be strongly related to each other, counter to the expectations of earlier MIS research. In the face of this contrariety, it would be tempting to argue that *research that has relied on subjective measures for dependent variables, such as system usage, may not be uncovering the true, significant effects, but mere artifacts (Straub et al., 1995)*(No.12).

Agarwal and Prasad (1997) (No. 19) proved that current usage was not a significant predictor of future use intentions. This suggested that factors generated by initial use couldn't be relied on to explain and predict continued, sustained use of the target innovation. Initial usage is an outcome of individuals' assessment of utility offered by the innovation. They argued that " *at this point (initial usage), the technology is essentially an addition to other options, potential adopters may have to accomplish their work and does not entirely replace any of these options. Thus, the technology is not at the stage of maturity where adequate work-related benefits have been unequivocally established, consequently, initial use is not instrumental in predicting future use."* Venkatesh et al (2002)(No.39) also reported that short-term use is the sole predictor of continued usage. All other variables measured at the time of initial adoption were non-significant predictors of continued use.

Therefore, the temporal dimension of system usage draws attention when design empirical studies to explore system usage behaviour. The momentum generated by initial use should be reconsidered or modified when we take the temporal dimension into consideration.

5. Comparison with Other Theories

Not all the researchers have attempted to test or modify the TAM model. Some have tested and developed other models, e.g. the theory of reasoned action (TRA), the theory of planned behaviour (TPB), Decomposed theory of planned behaviour (DTPB) and perceived characteristics of innovations (PCI), etc. for predicting user's behaviour to technologies within organisational context. The detailed description of these theories is beyond the scope of this paper; we only briefly present them here. TRA is a general well-researched intention model that has been applied extensively in predicting and explaining behaviour across many domains—"virtually any human behaviour" (Ajzen and Fishbein 1980, p.4). Thus, IS researchers use it to study the determinants of IT innovation usage behaviour as a special case. TRA postulates that beliefs influence attitude and social norms, which in turn shape a behavioural intention guiding or even dictating an individual's behaviour. The TPB is proposed as an extension of the theory of reasoned action. Because of the limitations of TRA in dealing with behaviours over which people have incomplete volitional control, the TPB introduced a third independent determinant of intention—perceived behaviour control (PBC). This refers to the perceived ease or difficulty of performing the behaviour and it is assumed to reflect the internal and external constraints on behaviour. Decomposed TPB (Taylor and Todd 1995a)(No.11) decomposes beliefs constructs and points out self-efficacy, resource facilitating conditions and technology facilitating conditions as the most relevant determinants of behavioural control. Moore and Benbasat (1991)(No.2) developed PCI scales. These scales are based on Rogers' innovation diffusion theory (IDT).

Several of our reviewed papers made comparison studies of the TAM with these competing models. We summarise them below.

Davis et al (1989) (No.1) have compared the TAM with TRA in studying usage of the word processing program, WriteOne. Their data provided mixed support for the two specific theoretical models. The confluence of TRA and TAM led to the identification of a more parsimonious causal structure based on only three theoretical constructs: BI, PU and EOU. Social norms as an important determinant of behavioural intention were found to be weak in this case. Mathieson (1991) (No.3) compared the TAM with TPB. The results indicated that the TAM and TPB explained intention very well; the information TPB derived was probably more useful during system development and post-implementation evaluation than the information TAM provided; TAM was easier to use than TPB. TAM provides a quick and inexpensive way to gather general information about an individual's perception of a system; TPB delivers more specific information, giving more insight into why an individual or group might not use a system. Taylor and Todd (1995a) (No.11) decomposed the belief structures in the TPB and proposed Decomposed TPB. They compared this model with TAM and TPB. The results suggested that all three models supported behavioural intention as the primary direct determinant of behaviour. The addition of subjective norms and perceived behavioural control and the decomposition of beliefs provided some additional insight into behavioural intention. These factors were more likely to influence system use through the application of both design and implementation strategies. Plouffe et al (2001) compared TAM with PCI in understanding merchant adoption of a smart card-

based payment system. The results showed that PCI belief constructs explained substantially more variance in intent to adopt than the TAM antecedents did. The PCI provide IS researchers with a descriptive richness that is largely missing from TAM. Chau and Hu (2001) (No.36) compared TAM, TPB and Decomposed TPB in understanding individual physicians' usage of telemedicine technology. The results illustrated that TAM explained 40% of the variances, TPB explained 32% and DTPB explained 42% in physicians' acceptance of telemedicine technology. PU was a significant determinant of attitude and BI in both TAM and DTPB models. EOU did not have any effects on PU or attitude in all models. The findings suggested that instruments that have been developed and repeatedly tested in studies involving end-users and business managers in ordinary business settings may not be equally valid in a professional setting, i.e. physicians.

The comparisons generally confirmed that TAM is parsimonious and easy to apply across different research settings, but it has to pay the trade-off of losing information richness derived from the studies. TAM compared favourably with TPB and TRA. Venkatesh and Davis (2000) stated that TAM has become well established as a robust, powerful and parsimonious model for predicting user acceptance (p187).

6. Discussion

This paper reviewed the TAM model and its adaptations to explain and predict individual behaviour across a broad range of end-user computing technologies and user groups within organisational contexts. Supported by the literature and its technology focus, we might conclude that the TAM is appropriate for examining acceptance of any technology by individuals with different characteristics in various organisations. The validation of its PU and EOU instruments and its theorised causal links between model constructs indicates that it is a robust and powerful theoretical model in explaining and predicting user behaviour towards a given technology.

6.1 Interpretation of TAM: context consideration

TAM traces how external variables affect individuals' internal decision processes. Many contributions to the literature have been covered in our discussion about external variables relationships with PU and EOU and model extensions As a whole, we find that in order to comprehensively understand individual acceptance of technology, we need to interpret user behaviour within at least four contexts: the cultural (national) context, organisational (implementation) context, individual context and system (technology) context.

The cultural (national) context refers to the macro environment in which the investigated user acceptance behaviour may occur and the specific organisation is located. Culture has been defined as a set of core values that shape the behaviour of individuals as well as the whole society. As we indicated above, culture does have impacts on an individual's decision–making process towards using a system. For example, that TAM may not hold for Japanese culture was found in Straub et al (1997),

and that culture was an antecedent of PU (Gefen and Straub 1997, No.21). Igbaria and Iivari (1995) published US and Finnish comparison studies on computer self-efficacy. Culture exerted effects on the computer self-efficacy of Finns. Because Finland is a more feminine and a slightly more collective society, perceived usefulness may not be the dominant factor affecting usage. An individual's abilities (self-efficacy) and experiences as well as organisational support are likely to play major role in affecting usage. But it does not imply that culture is a rigid factor that influences a user's behaviour. Walsham (2002) examined cultural (Jamaican and Indian cultures) impacts on software production and use based on structuration theory. His case studies gave insights into cross-cultural work and pointed out that culture is not static. A cross-cultural team needs mutual respect from different individual cultures. It provides the opportunity for team members to move to a more negotiated culture of cooperation, and increase the usage of IS in their work. The interpretation of user acceptance behaviour within a cultural context will make clear how important a role culture plays in IT adoption. We have to be cautious in applying knowledge derived from studies in North America to other cultures.

The organisational (implementation) context refers to the specific environment where the individual works and the investigated technology acceptance takes place. A system is usually deployed in an organisational setting; thus individual adoption of system is a secondary adoption decision-making (Chin and Gopal, 1995). This means the decision is made by individual users once the organisational decision to adopt is made. In order to increase the user's acceptance of IS, organisations have to create a favourable environment to support and encourage usage of IS at work. The organisation's computing policy, management support and encouragement are empirically proved to be very important. Many researchers have drawn attention to effects of the training on user acceptance of IS. Traditional training, game-based training, or a specifically designed training program for specific user groups does help users to increase their knowledge about the IS, so that they are more likely to have a positive intention to use it in their work. Workers in a team or community could get benefits from informal training, just as knowledge sharing in the group could increase willingness to use a system. This factor is very crucial today since most workers operate in a team (Gallivan 2000). Cooper (1994) found that the organisational cultural role was significant in new IT implementation. The interpretation of TAM in the organisation context will help us examine the effects of organisational factors on individual behaviour. Organisations as the first adopter of the system have to create a secondary adoption environment which is closely related to individual behaviour. The usage of a specific system by the individual aims to improve his/her job performance, and so get rewards from related organisations. Measurements or factors that increase user acceptance in one organisation may not function well in another organisation.

The individual context refers to those essential characteristics of individual users that are germane to system usage. An individual may exhibit characteristics completely different from others in various organisations and from different cultures. Individual differences refer to user factors that include traits such as personality and demographic variables, as well as situational variables that account for differences attributable to circumstances such as experience and training (Agarwal and Prasad, 1999). We have presented their effects on the formation of individual beliefs and changes in previous

discussion in this paper. Demographic variables, such as age, gender and level of education, personality variables related to computer technology, such as computer anxiety, computer self-efficacy, computer skills, cognitive style etc, and situational variables, such as employment categories, cognitive absorption with computers and experiences of general computer usage or specific system usage etc, are all empirically examined as important factors that influence individual technology acceptance behaviour. The "individual" is the one who takes action to perform adoption behaviour. The individual context defines the boundary that one user's perception and assessment of using a system is not the same as that of others. TAM aggregates these differences in most cases. Such aggregation may segment users into similar groups and help organisations to design proper promoting measurements or environments to increase usage. The interpretations of TAM from the individual context clarify the importance of individual characteristics in determining usage behaviour.

The system (technology) context refers to the end-user computing technologies under investigation. Such technologies are information systems applications, communications systems, and any IT innovations. The system context defines the factors of a system and their effects on usage behaviour. System factors include systems usability, interface, interaction style and system quality, etc. For systems related to Internet technologies, the characteristics of web-page design, response time, information location on the web etc have been tested in empirical studies. For communications technologies, factors such as system social presence and information richness, system accessibility etc has significant impact on user's beliefs about using the systems. TAM takes technology as the focus; system is the "target" of the user's adoption behaviour. Without the system context, TAM loses its applicability base. The interpretation of TAM from the system context will distinguish the results of "apple" from "orange".

Comparatively, the cultural (national) context serves as the macro environment, the individual context defines the microenvironment, and the organisational context is in the middle and system context circles the target of individual technology acceptance behaviour. The understanding of these contexts and their effects on user behaviour will provide a solid base to explain why users accept or reject a system in a specific environment. The recognition of these contexts may limit generalisation of findings from one study to other cases.

6.2 Supplementation of TAM

The original TAM has been extended in many studies, mainly by examining the effects of external variables on internal beliefs, attitude and behavioural intention. The extension of PU constructs highlights its important role in determining user acceptance behaviour. The temporal dimension of usage behaviour improves our understanding of how beliefs and attitudes change over time. The factors initiating first-time usage differ from those influence post-adoption behaviour. The limitation of TAM calls for considerations of its applicability to complex and modern systems and to professional user groups. As mandatory use becomes popular in organisations nowadays, the importance of social norms in determining user behaviour should be reinforced in future studies. A series of studies of the acceptance of telemedicine technology by individual

physicians in Hong Kong (No. 29,36,40) revealed an insignificant link between EOU to attitude and behavioural intention. The recent results (No.40) of an exploratory study found compatibility of telemedicine technology with physicians' working practice was a significant predictor of PU and had a very strong indirect effect on physicians' behaviour intention through PU. The authors argue that TAM is a proper model to explain and predict physicians' intention to use telemedicine technology, but has to be supplemented by other theories in order to gain more insights into factors influencing physicians' behaviour. There is a big difference between a physician's micro working environment and work practice and those of common users or knowledge workers in other business organisations. Therefore, the role of compatibility in determining an individual professional's acceptance behaviour should be considered.

So far, PU and EOU have been postulated as fundamental determinants of individual technology acceptance behaviour. Social norms postulates from TRA and TPB together with compatibility from PCI and Rogers' innovation diffusion theory have reinforced their determining power as individual usage becomes more and more mandatory in nature and users are professionals. Therefore, possible extensions of TAM by other theories seem to be important.

7. Conclusion

In this paper, we conduct a thorough review of TAM. We reviewed the original work published in year 1989 and various adaptations. TAM focuses on user technology acceptance behaviour in organisations. It is proposed to be parsimonious and theoretically justified. After just over a decade of research, TAM has fulfilled this aim and empirically proved to be robust across a broad range of end-user computing technologies and user groups.

The interpretation of TAM from the cultural, organisational, individual and system contexts respectively will help researchers and practitioners gain more insights into what promotes user acceptance and what hinders acceptance. It is crucial to understand these contexts and their effects on user behaviour towards a given technology comprehensively. But, it may be hard to generalise from the findings across different research settings.

The limitation of TAM is minor in comparison with its great supportive achievements. But it draws attention to the need to be cautious when applying it to a specific case or a specific user population. The comparison of TAM with other competing models has indicated its robustness. Owing to its intended generality and parsimony, possible supplementation of TAM from other theories is necessary in some cases.

Literature review is analysing the past to prepare for the future. This review helps us build a strong knowledge of user acceptance behaviour in IS research. With the explosion and development of wireless networks and technologies to 3G or nG, mobile commerce (m-commerce) has in recent years become a new research issue on the IS agenda (e.g. Müller-Versee 2000, May 2001; Kalakota and Robinson 2001). Some

researchers have adapted TAM to explore user adoption of mobile applications, and m-commerce services.

Pedersen (2002) made an exploratory study about earlier adopters' behaviour towards using mobile Internet services. He decomposed TAM and TPB to a new research model in order to understand the phenomenon. He found that at least from a measurement perspective, adoption research models might successfully be applied to the study of mobile service adoption. But, he argued that simple IS adoption research models, e.g. the technology acceptance model-TAM, should be extended with both subjective norms and behavioural control when explaining the adoption of mobile commerce services. He also recommended that his modified model in studying the adoption of mobile Internet services needs further modification when applied to other mobile commerce services. Pedersen, Nysveen and Thorbjornsen (2003) implemented cross-service studies, focusing on four different mobile services, i.e. text messaging, contact services, mobile payment and mobile gaming, which further modified and extended IS adoption research models by integrating the multi-disciplines they proposed and introducing a new belief construct—self-expressiveness. Expressiveness is an instrumental attribute of a communication service partly influencing usefulness and partly influencing attitudes and intentions directly. Based on the purposes of mobile services to afford in terms of entertainment and utilitarian and their presentations in interactive media in term of communication and transaction, they define text messaging and contact services as communications services. The other two services, mobile payment and mobile gaming are seem as transaction services. Contact services and mobile gaming may be grouped as entertainment and expressiveness-oriented services, while text messaging and mobile payment services may be characterised as services having a utilitarian purpose. They conclude that perceived usefulness is still an important determinant for a consumer when deciding to adopt a particular mobile service. But perceived enjoyment and self-expressiveness have significant effects on consumer adoption of these four mobile services; they exhibit positive effects on perceived usefulness as well. Contradictory to the mobile Internet services study aforementioned; this study surprisingly finds that social norms do not have significant effects on consumer behaviour. Pedersen and Nysveen (2003) extend the TAM to include a new construct—self-expressiveness to study users' adoption of a mobile parking service in a trail. Mobile parking services have been designed to meet the functional needs of the car driver, not like text messaging for utilitarian needs and mobile gaming for entertainment needs, for examples. Even in such a context, trial users' decision to use the services is determined both by self-expressiveness and perceived usefulness. Besides the contributions from the "Norwegian school", two researchers from Hong Kong applied one of the traditional IS adoption models, i.e. theory of planned behaviour-TPB to study consumer's adoption of m-commerce (Khalifa & Cheng 2002). They maintain that exposure of an individual to m-commerce influences positively the individual's intention to adopt m-commerce.

The results of these studies confirm that in the mobile technology context, the traditional adoption models, e.g. TAM, in information systems research could apply but need modification and extension in order to increase their prediction and explanation power. Perceived usefulness (PU) is still the most important determinant influencing a consumer's intention to adopt a particular mobile service, but other constructs, e.g.

enjoyment, expressiveness and behaviour control, have significant effect on the consumer's intention as well. They also conclude from their empirical studies that context-based perceived usefulness needs attention in future research. As context-based perceived usefulness was proposed as relative to the intended instrumental gratification of a service, and replaced the absolute components of perceived usefulness, i.e., time-saving, effectiveness, productivity, for example (Pedersen et al., 2003).

For our future studies, we will combine new research concerns on users' adoption of mobile commerce services with the TAM tradition. We hope to find out the possible extensions and modifications of the TAM to explain and predict a user's behaviour in the wireless world.

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Appendix 1 TAM Literature

No.	Author(s)	IS applications	Research context	Subjects	Research methods	Perceived Usefulness (PU)	Findings
1	Davis et al 1989	word processing program WriteOne	Univ.of Michigan, MBA program	107 full time MBA students	Experiment 14 weeks longitudinal study	Improve performance Increase productivity Enhance effectiveness Find WriteOne useful	TRA and TAM comparison. PU scale 0.95 and 0.92 reliability for time 1 time 2 PU-BI 0.48 and 0.61 for time1 time 2 PU-A, 0.61 and 0.50 respectively EOU indirect effect to BI through PU in time 2 SN no effect on intentions
2	Davis 1989	Study 1: PROFS-email XEDIT file editor (IBM mainframes accessible through 327X terminals) Study 2: IBM PC-based graphic system—Chart-Master & Pendraw	Study 1: IBM Canada's Toronto Development Laboratory Study 2: MBA at Boston University	Study 1: 120 knowledge workers Study 2: 40 evening MBA students	Experiment	Study 1: 1 Quality of Work; 2 Control over work; 3 Work more quickly-; 4 Critical to my job; 5 Increase Productivity; 6 Job performance; 7 Accomplish more work; 8 Effectiveness; 9 Makes job easier; 10 Useful Study 2: 3,6,5,8,9,10	Study 1: PU correlated .56 to PROFS mail usage; .68 to XEDIT usage; EOU correlated PU .56 for electronic mail, .69 for XEDIT, .64 for overall. Effects of PU on electronic mail usage b=.55, XEDIT b=.69, pooled b=.57 Study 2: PU reliability 0.98; Chart-Master, PU-self predicted usage r=0.71 Pendow, PU-usage r=.59, EOU-PU r=.38 Pooled: PU-Usage r=0.85, EOU-PU r=0.56 (p<.001)
3	Mathieson 1991	Spreadsheet or calculator	A western univ. juniors and seniors students in an management course	TAM program 149, TPB 113	Experiment	Same as Davis 1989 study 2	TAM: PU= EOU b=0.667; PU-A b=.0.694; PU-BI b=0.481 TAM is successful in explaining intention, having a slightly empirical advantage, easier to apply, only supply general information on user's opinions about a system
4	Moore and Benbasat 1991	PWS- personal work station	First pilot: business faculties of two univ. Second pilot: head office of a utility company Field Test: 7 companies from a variety of industries	First pilot: 20users and nonusers Second pilot: 75 individuals, 66 usable Field test: 800 questionnaires, 540 usable	Experiment, field survey	Relative advantage: (Perceived characteristics of innovation--PCI)	Instrument development procedures, to measure the perception of adopting an IT innovation. To be a tool for the study of the initial adoption and eventual diffusion of IT innovation within organisation.

No.	Author(s)	IS applications	Research context	Subjects	Research methods	Perceived Usefulness (PU)	Findings
5	Adams et al 1992	Study 1: voice and email Study 2: WordPerfect, Lotus 1-2-3, Harvard Graphics	Study 1: 10 different organisations Study 2: undergraduate and MBA students	Study 1: 118 respondents Study 2: Of 73 returned, 64 WordPerfect, 67 Lotus 1-2-3, 54 Harvard Graphics after three quarter usage.	Survey Experiment (study 2)	Same as Davis 1989 study 2	Davis instruments validation and replication Study 1: (homogeneous technology, heterogeneous user group) Email: PU-usage r=.347, EOU-PU r=.0.600; Vmail: PU-usage r=.445, EOU-PU r=.625; pooled, PU-usage r=.0.413, EOU-PU r= 0.688 LISREL structural equation analysis, Email PU-usage r=.36, Vmail r=.31. Study 2: (homogeneous user groups, heterogeneous technologies) Structural equation analysis: WordPerfect: PU-usage not significant, r=-0.03, Lotus: PU-usage r=0.85 significant, Harvard Graphics PU-usage r=0.06 not significant, EOU importance to use. Captive usage (no alternative to complete the job) explained WordPerfect low significant PU-usage; EOU is an important determination of the intention only significant early in the use (Harvard Graphics, users have 13 months average experiences, twice lower than use WordPerfect 28 months and Lotus 33 months)
6	Hendrickson et al 1993	Spreadsheet and database	Undergraduate students in a major Midwestern university	Spreadsheet, 51, database 72	Experiment	Same as Davids 1989 study 2	Test-retest the reliability of PU and EOU. Initial admin, T1, 3days second admin. T2. Spreadsheet reliability .89 TI, .95 T2, Database .94, & .96.Correlation T1-T2, spreadsheet, .85 PU; database .81 PU
7	Segars and Grover 1993	Same as Adams et al 1992 Using Adams' et al data				Spilt Davis 1989 PU into PU and effectiveness (effectiveness, job performance)	LISREL Confirmatory factor analysis: Adams et al 1992 do not appear well-modelled by the two factor structure; Effectiveness seems the third underlying construct; eight indicators, three factor model seems well-suited to the underlying pattern of correlations.
8	Subramanian 1994	Voice mail and customer dial up system	An organisation	Vmail: 75 of 102; dial up: 104 of 200	Survey	Increase productivity Enhance effectiveness Makes it easier to do job	PU and EOU measurement method through structural equation modelling, build better structural model, PU is a determinant of predicted future usage. Vmail: PU-predicted usage r=.562, Dial up, .437 significantly

No.	Author(s)	IS applications	Research context	Subjects	Research methods	Perceived Usefulness (PU)	Findings
9	Szajan 1994	Database management systems (choose packages to build bibliographic database)	MBA students in MIS course	Sample 231 based on 47 subjects, 6 selection of DBMSs,	Experiment	Same as Davis 1989	Discriminant analysis (Chi Square), predictive validity. PU/EOU instrument can predict the choice behaviour of subjects in a software evaluation project, it is a logical candidate for use in the evaluation and choice of software package.
10	Igbria et al 1995	microcomputer	Part-time MBA students at an eastern university	280, 236 returned, 214 usable	Survey	Improve performance Increase productivity Enhance effectiveness Find Microcomputer useful	Test of measurement model (sample 1): PU reliability .82, user training .09, EUC support .35 management support .23 system quality .12 EOU .50 have direct effects on PU, explain 48% variance. PU-perceived usage .33, variety of use .16. Assessing the revised measurement model (sample 2): PU reliability .82; User training and system quality strong direct and indirect effects on PU. Computer experiences, EUC support effects on PU. PU positive effect on perceived usage and variety of use.
11	Taylor and Todd, 1995a	Various systems available at computing resource centre-CRC	Business school students	786 users, 3,780 visits, 12-weeks period	Survey	The CRC will be of no benefit to me; Using the CRC will improve my grades; The advantages of the CRC will outweigh the disadvantage; Overall, using the CRC will be advantageous.	PU-A path coefficients .79, to BI 1.56, total effects to behaviour .54, to BI 1.41. TAM, TPB and decomposed TPB comparison.
12	Straub et al 1995	Voice mail	A large financial institution in America (final data)	870 randomly users, 458 responded	Field interview Survey	Voice mail is very important in performing my job; Because of information I now get through voice-mail, my decision-making is far more effective.	LISREL, nomological network analysis, subjective (self report or predict) and objective (computer-recorded)measures of system usage Nomological net model: PU-self reported system usage r=0.623, PU –Computer- recorded system usage r=0.173 Rely on subjective measures of system usage may be artifactual.
13	Taylor and Todd, 1995b	CRC	Business school students	430 experienced and 356 inexperienced users	Survey	Same as Taylor and Todd 1995 a	PU was a stronger predictor of intention (BI) for inexperienced users, it did not differ between the two groups in its impact on A

No.	Author(s)	IS applications	Research context	Subjects	Research methods	Perceived Usefulness (PU)	Findings
14	Montazemi et al 1996	30 software package (29 microcomputer application package, 1mainframe)	A large Canadian integrated steel company	24 information centre product specialists, (ICPS) 22 end users	Survey	Same as Davis 1989 study 2	The selection of packages by ICPS can compromise end users' usage, but whether they are able to correctly evaluate PU and EOU than end users are questioned. ICPS and end users have different assessment of PU. None of the covariates of gender, educational background, level of computer literacy, years of computer experience, the level of computer anxiety had a significant effect on PU and EOU of the software package.
15	Igbaria et al 1996	Micro computer	Companies in North America	766 of 62 companies, 519 from 52 companies returned, focus on managerial usage	Survey	1 Using a microcomputer improves my productivity on the job; 2 Using a microcomputer helps me make better decisions by giving me access to higher quality information; 3 Using a computer allows me to be more innovative by providing the opportunities for more creative analysis and output; 4 Using a microcomputer gives me the opportunity to enhance my managerial image	Skills .13 organisational support .16 perceived complexity -.38 have significant effects on PU.PU has the strongest direct effect on usage (b=.26) PU is a principal motivator, perceived complexity is a key intervening variable. Skills promote usage

No.	Author(s)	IS applications	Research context	Subjects	Research methods	Perceived Usefulness (PU)	Findings
16	Chau 1996	Word and Excel, WordPerfect and Lotus as alternatives	An organisation	285 of 330 returned, 192 use Word, 176 use Excel	Survey	Perceived near-term usefulness, same as Davis 1989, Perceived long-term usefulness 1Knowledge of ..can increase my flexibility of changing jobs; 2Knowledge of .. can increase the opportunity for more meaningful work; 3Knowledge of .. can increase the opportunity for preferred future job assignments; 4Knowledge of ..can increase the opportunity to gain job security.	Accomplish tasks more quickly, enhance effectiveness AND increase opportunity for preferred future job assignments omitted in the final data. EOU influences the user's intention to use indirectly via perception of near-term usefulness. Perceived near-term usefulness was found to be the most significant factor affecting intention to use. Also, has a significant and positive influence on perceived long-term usefulness. A user fins a technology useful in current work is predisposed to believe it will help in the future career. Perceived long-term usefulness has direct and statistically significant influence on BI. No significant, direct relationship between EOU-perceived long-term usefulness.
17	Szajna 1996	Email	University	61 graduate business students	Experiment, 15 weeks longitudinal study	Same as Davis 1989	Pre-implementation: PU has a significant direct effect (b=.72) on intentions, EOU does not, and no effect on PU. Post-implementation: PU has a direct and significant effect on intentions (b=.31), EOU to PU b=.29, no direct effect on intention. PU has a direct and significant relationship with self-reported usage .23. When an individual becomes more experienced with the IT, usefulness directly determines not only intentions to use but also the usage behaviour.

No.	Author(s)	IS applications	Research context	Subjects	Research methods	Perceived Usefulness (PU)	Findings
18	Venkatesh and Davis 1996	Experiment 1: IBM PC-based graphics system, ChartMaster, Pendraw Experiment 2: Word Perfect, Lotus Experiment 3: PINE for Email, Gopher for information access (UNIX-based)	E1: Boston University E2: Temple University, Philadelphia E3: University of Minnesota	E1: 40 MBA students E2: 36 undergraduate students E3: 32 part-time MBA students	Experiment	Study EOU and its antecedents	E1: Training effects on BI fully mediated by TAM. Direct-interaction with system has an effect on EOU, and form system-specific EOU perceptions. After hands-on experiences, system characteristics became significant in explaining EOU perception. The possibility of computer self-efficacy serves as an anchor for EOU perceptions. E2: Before direct experience, computer self-efficacy b=.57 was significant in determining EOU. After direct experience, both computer self-efficacy b=.51 and objective usability b=.25 were significant. Moderation test, computer self-efficacy determines EOU b=.48, but the effect of objective usability is moderated by direct experience. E3: Similar results as E2. Two systems are found to be harder than users had expected.
19	Agarwal and Pradad 1997	WWW services available on the Internet-Web	University	73 Part-time MBA students-professionals	Experiment	Innovation characteristics, current and future use intentions (Moore and Benbasat 1991 25 instruments)	Current usage: Visibility b=.29, compatibility b=.31 and Trialability b=.19 to acceptance, voluntariness b=-.27. Compatibility b=.31, the most important predictor of current usage. Lack of significance of relative advantage. Future intention: relative advantage (b=.49) and result demonstrability (b=.34) are significant. The two work in tandem. Current usage(initial use) is not instrumental in predicting future use. EOU was not significant, since Web is inherently ease of use.
20	Jackson et al 1997	A wide range of IS (financial system) development projects	6 large accounting firms, involved in IS projects with regional system development firms	585, 139 returned, 111 usable	Survey	Situational, intrinsic involvement. PU items same as Davis et al 1989	EOU, situational involvement, prior usage and argument for change no correlation to PU. Only intrinsic involvement r=.628 significantly related to PU. PU no effects to A and BI. EOU to A and BI are significant. Situational involvement to BI and A, intrinsic involvement to A, and prior usage to BI, these relationship are significant.

No.	Author(s)	IS applications	Research context	Subjects	Research methods	Perceived Usefulness (PU)	Findings
21	Gefen and Straub 1997	Email	US. Swiss and Japan three airline companies	392 usable	Survey	Gender, SPIR (social presence and information richness of the medium) PU as Davis 1989	Gender on SPIR b=-.1429, on PU b=-.1088, on EOU b=.1306 significant at .05 level, not significant on use Gender has an impact on ht IT diffusion process. SPIR and culture as antecedents to PU in the case of email. SPIR to PU .2863, SPIR and covariate of culture on PU is respectable R square is .59.
22	Agarwal and Prasad 1998	WWW information services on the Internet	University	175 MBA students-business professionals	Survey	PIIT(personal innovativeness in the domain of IT) PU similar as Davis 1989, without useful item.	PIIT to BI .47 significant. PIIT moderates effects of compatibility perceptions, not PU and EOU. PIIT could be used as a control variable in individual level studies
23	Doll et al 1998	Spreadsheets, Word processing, database, graphics	Two large universities	Of 902, 244 spreadsheet, 156 database, 292 word processing, 210 graphics. Of 581, 105 no experiences, 244 novices, 232 experienced. 355 females, 371 males	Lab experiment (Initial exposure situation)	Confirmatory and Multi-group invariance analysis. PU and EOU same as Davis 1989	PU-type of applications (rejected): the word processing subgroup had poor data fit. PU is invariant across other three applications. PU –experience (rejected): no experience subgroup had poor model data fit. PU is invariance across novice and experienced users. PU –gender accepted: PU instrument is invariant across gender. EOU-types of applications invariance accepted. EOU –experience invariance accepted. EOU-gender (rejected): Both male and female subgroups had good model data fit. EOU scores are not comparable, the scale differences are probably inconsequential for most practical decision making purpose
24	Parthasarathy and Bhattacherjee 1998	Online services	Online service firm	This sample, 214 continuing adopters and 229 discontinuers	Field Survey	Innovation diffusion theory, post-adoption behaviour: continuous usage, discontinuance usage (replacement and disenchantment), relative advantage (PU), EOU, compatibility as perceived services attributes	PU and compatibility measured at the time of initial adoption, can be significant predictors of subsequent discontinuance behaviour. EOU did not have a continuing impact on subsequent discontinuous decisions. Network externality (use of complementary products) during the initial adoption process is a significant predictor of future discontinuance. Early adopters are more likely to be replacement discontinuers, later adopters are more likely to be disenchantment discontinuers.

No.	Author(s)	IS applications	Research context	Subjects	Research methods	Perceived Usefulness (PU)	Findings
25	Agarwal and Prasad 1999	PC	A Fortune 100 corporation, IT vendor	Of 468, 230 usable	Survey	Individual differences (Role with regard to technology, tenure in workforce, level of education, prior similar experiences, participation in training) PU: 1accomplish tasks quickly, 2improve performance,3greater control over work, 4improve the quality of the work, 5 improve productivity, 6 enhance effectiveness, 7 easier to do job 8 useful	A+PU-BI 26% variance. PU+EOU-A 63% variance. EOU-PU, b=.74;. PU and EOU had an equivalent total effect on BI (.39 and .40) EOU +Participation in Training have a significant and positive effect on PU, 57% variances. Other individual differences have indirectly effects through EOU. Role with technology, prior experiences, level of education were all significant determinants for EOU, collectively 18% variance. Beliefs mediated the external variables' effects on attitude toward and behaviour intentions to use.
26	Lucas and Spitler 1999	Broker workstations (Sun workstation, windowed interface with Unix operating system, networked to servers and to corporate mainframe computer, includes three main applications: market data, office software, and mainframe access)	An investment bank	Final sample 49 brokers, 58 sales assistants	Survey	Perceived system quality, Norm-Use/intended use, performance, PU: Workstation improves performance, productivity, effectiveness, is useful Two control variables: workload and Job	Perceived quality is an important predictor of PU in the full sample and for sales assistance, not for brokers. EOU is predictor of PU. In the field setting of broker workstations, the individual perception variables PU and EOU in TAM do not approach significance in predicting use. PU and EOU correlated at .62. Combining the two to be a single variable, it is a significant predictor of use for the full sample and sales assistance. TAM does not support it. Norms are predictor of use for all groups, not broker. Low performance (of prior performance of similar system) is associated with higher levels of use and intended use for brokers and full sample. Performance of prior systems is the best predictor of performance of new systems. Job differences or tasks may be an important predictor of use.

No.	Author(s)	IS applications	Research context	Subjects	Research methods	Perceived Usefulness (PU)	Findings
27	Venkatesh 1999	Virtual workplace system(Internet-based telecommuting application)	Organisations	Study 1: Of 320, 69 attended; Study 2: Of 500,146 usable, knowledge workers	Survey	Game-based training vs. traditional lecture-based training, intrinsic motivation (playfulness) PU Davis 1989	Game-based training intervention has higher levels of EOU. EOU leads to enhanced BI to use in comparison with users in the traditional training interventions. Game-based methods will potentially allow users to scale initial hurdles to acceptance and usage, also create higher-level of intrinsic motivation, which is more likely to lead to sustained usage behaviour. PU is not statistically different across interventions
28	Karahanna et al 1999	Windows 3.1 software package	A large financial institution	Final sample, 77 potential adopters, 153 users	Survey	Pre-adoption and post-adoption. Instruments based on Moore and Banbaset 1991. PU: accomplish task more quickly, improve quality of work, enhance effectiveness, make job easier	PU (.42 and .82) is the only belief underlying A to adopting and to continuing to use. Image .32 is significant for users. Visibility, result demonstrability .35, EOU.06, Trialability -.40 are significant for potential adopters. Prior to adoption, behavioural and normative beliefs influence A to adoption. Post-adoption, only PU and Image enhancements influence A.
29	Hu et al 1999	Telemedicine technology	Public tertiary hospitals in Hong Kong	Physicians, of 1728, 421 returned, 408 usable	Survey	PU: enable to complete patient care more quickly; CANNOT improve patient care and management; increase productivity in patient care; CANNOT enhance effectiveness; Make patient care and management easier; Not useful for patient care and management.	PU has a significant and strong influence on physicians' BI to the technology .36, to A.45. PU total effects on BI is .47 EOU has no significant influence on PU and A. Reflect limitations of TAM's applicability with respect to technologies, user populations or both. The explanatory power of TAM, particularly the EOU factor, may weaken as the competency of the users increase, like physicians.

No.	Author(s)	IS applications	Research context	Subjects	Research methods	Perceived Usefulness (PU)	Findings
30	Agarwal and Karahanna 2000	WWW	A large state university	288 junior students	Experiment	PU: using the web enhances effectiveness in college, enhance productivity, improve performance in college, using web useful in my college activities. EOU, self efficacy (SE), playfulness (CPS), PIIT, Cognitive Absorption (CA)	Without CA direct impact on BI: CPS-CA b=.360, PIIT-CA b=.408, CA-PU.517, CA-EOU .587, SE-PU.057, SE-EOU.230. EOU-PU not significant. PU-BI .475, EOU-BI .307. Totally explained 48% variances With CA direct impact on BI: PU-BI .367, EOU-BI .208, CA-BI .246, totally explained 50.7% variances. Neither PIIT or CPS are statistically significant predictor of PU and EOU, CA mediated the effects with respect to beliefs about IT.
31	Venkatesh 2000	Study 1: a new interactive online help desk system Study 2: a new multi-media system for property management Study 3:PC-based (windows 95) payroll application	Study 1: a medium-sized retail electronic store Study 2: a large real estate agency Study 3: a medium-sized financial services firm	Study 1:Of 70, 58 usable Study 2a: Of 49, 41 usable, 2b: of 107, 104 usable Study 3:Of 52. 43 usable	Survey (voluntary use, initial training T1, 1 month T2, 3 months T3)	EOU and its antecedents. Anchors (computer self-efficacy, perception of external control, computer anxiety, computer playfulness); adjustments (perceived enjoyment, objective usability). Experience is moderating variable	PU and EOU explained 35% variances in BI. EOU fully mediated the proposed antecedents to BI. EOU has a direct and indirect (via PU) to BI. At T1, the proposed anchors were only determinants of EOU, explain 40% variances. With increasing experience, adjustments play a key role in determining system-specific EOU, 60% variances explained. The general anchors continued to be important factors, e.g., computer self-efficacy and facilitating conditions were stronger determinants than were adjustments resulting from the user-system interaction.
32	Venkatesh and Moriis 2000	Data and information retieval system	5 organisation	Of 445, 324 usable response, 156 female, 186 male	Survey	Gender, experience, five months period. PU: improve performance, increase productivity, enhance effectiveness, useful	After initial exposure: men placed a greater emphasis on U-BI than women, women weighted EOU-BI more strongly, not significant for men. There were no gender difference in the role of EOU to U. SN was a significant factor influencing BI for women, not significant to men Long term: men were more strongly influenced by U to BI, than women. Women continued to weight EOU as a direct determinant of BI more strongly than men. No difference in the EOU-U relationship between men and women. SN did not influence men in the long term. women were still influenced by SN after one month sustained technology use. SN is not significant to women after 3 months.

No.	Author(s)	IS applications	Research context	Subjects	Research methods	Perceived Usefulness (PU)	Findings
33	Venkatash and Davis 2000	Study 1: a proprietary system (floor and machine scheduling and personnel assignment) Study 2: System project (move current mainframe operations to a Windows-based environment) Study 3: Windows-based customer account management system Study 4: Stock management system	Study 1: a medium-sized manufacturing firm Study 2: A large financial services firm Study 3: A small accounting services firm Study 4: A small international investment banking firm	Study 1: Of 48 floor supervisors, 38 usable Study 2: Of 50, 39 usable Study 3: Of 51, 43 usable Study 4: Of 51, 36 usable	Survey, longitudinal field studies	PU and its antecedents, two processes: social influence processes (SN, voluntariness and image) and cognitive instrumental processes (job relevance, output quality, result demonstrability, and EOU). Scales of PU, EOU, BI same as Davis 1989 and Davis et al 1989.	**Results of pooled across studies and time periods (n=468)** Consistent with theory, the basic TAM relationships, BI—use .52, PU-BI .55,EOU—BI.17, EOU-PU.30, were well supported, with full mediation by intention and no moderation by either voluntariness or experience. SN-BI was significantly moderated by both experience and voluntariness. SN significantly affects intention directly only when usage is mandatory and experience in the early stages. SN-PU (internalisation) was significantly moderated by experience. Image –PU (identification) no significant. Job relevance and output quality –PU are interactive. .40 TAM2 explained 60% variance of PU, SN exerts a significant direct effect on BI over and above PU and EOU for mandatory (not voluntary) systems.
34	Venketesh and Brown 2001	PC use in Household	American households	733 completed response at phase 1, 87.9% follow up response in phase 2 (after 6 months)	Mail survey, telephone interview	Attitudinal beliefs (utilitarian outcomes, hedonic outcomes, social outcomes); normative belief SN (social influences); Control beliefs (PBC)	Utilitarian outcome, hedonic outcome and social outcome drive adoption. Rapid technology changes and fear of obsolescence drive non adoption.
35	Plouff et al 2001	Exact Smart card-based payment system	Canadian merchants involving in system trial	Of 379, 176 usable response	Survey	TAM & PCI comparison PU similar with Davis 1989, PCI as Moore and Benbasat 1991	TAM: EOU-PU .531 28.2% variances explained, PU-BI.507, EOU-BI .108, 32.7% variance explained. PCI: relative advantage .291, EOU .005, compatibility .167…BI, 45.0% variance explained. Full set of PCI adds significantly to predict BI.

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36	Chau and Hu 2001	Telemedicine technology	Public tertiary hospitals in Hong Kong	Physicians, of 1728, 421 returned, 408 usable	Survey	TAM, TPB & decomposed TPB comparison PU: Using telemedicine technology cannot improve my patient care and management, cannot enhance my effectiveness, not useful	TAM 40%, TPB 32% and DTPB 42% variances explained. PU was a significant determinant of A &BI in both TAM & DTPB. EOU not in all models. Compatibility –PU .70 (DTPB) is significant, not EOU. PU exhibited the strongest direct and total effects on BI. EOU was not found to have any effects on PU or A. Compatibility has greater indirect effect on BI than direct effect.
37	Koufaris 2002	B2C e-commerce web-based store	Booksamillion.com customers	Online users, 300 complete first part, and 280 of those filled out the second part	Online survey, questionnaire ran for one week	TAM and flow theory. PU: using booksamillion.com can improve my shopping performance, increase shopping productivity, increase shopping effectiveness, useful.	Shopping enjoyment b=.345 and PU .415 have significant effect on intention to return. Product involvement .280, challenges .216 and skills .142 have significant effect on customer concentration. Involvement .218, challenges .338, skills .180 and value-added use .207 have significant effect on customer shopping enjoyment Confirm the dual nature of the online consumer as a traditional shopper and a computer user.

No.	Author(s)	IS applications	Research context	Subjects	Research methods	Perceived Usefulness (PU)	Findings
38	Hong et al 2001-2002	Digital Library: E-library	The open University of Hong Kong	Non-traditional students, 1244 interviewed, 585 retained	Telephone interview (17min)	Individual differences (computer self-efficacy, knowledge of search domain), systems characteristics (relevance, terminology, screen design) PU: Using the E-library would enable me to accomplish my study more effectively, improve my performance, make it easier for me to do my assignments and prepare for the examination, useful in my study	EOU=computer self-efficacy .18+knowledge of search domain.11+relevance .14-terminology.37+screen design.29, 69% variances explained PU=EOU.39+relevance.61, 57% variances explained BI=PU.51+EOU.17, 52% variances explained
39	Venkatesh et al 2002[3]	database and virtual work place	Same as Venkatesh 1999 and Venkatesh and Speier 1999	Same as Venkatesh 1999 and Venkatesh and Speier 1999	Same as Venkatesh 1999 (add longitudinal study) and Venkatesh and Speier 1999	User acceptance enablers (UAE), (training environment, Pre-training mood, control), intrinsic motivation IM, extrinsic motivation (PU), EOU, BI, short-term use, continued use	IM-EOU .45, IM-PU .27, EOU-PU .27. EOU-BI.23, PU-BI .44 have significant effect on BI. IM no direct effect on BI, only through EOU and PU. BI-immediate use (short term) .59, fully mediating the influence of IM,EOU,PU; Short-term use-continued use .59, it is the sole predictor of continued usage. All other variables measured at t1 and t2 were non-significant predictors of continued use.

[3] This work is based on the publications of (Venkatesh 1999, Venkatesh and Speier 1999). Authors integrated these two works together and made a longitudinal study of Venkatesh 1999. Venkatesh and Speier 1999 is not concluded in this appendix. Their work "Computer technology training in the workplace: a longitudinal investigation of the effect of mood", Organizational Behaviour and Human Decision Processes, 79, 1-28

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40	Chau and Hu 2002	Telemedicine technology	Public tertiary hospitals in Hong Kong	Physicians, Of 1728, 408 usable response	Interview and survey	PU same as Chau and Hu 2001. EOU, Compatibility, peer influence, perceived technology control, attitude, BI	Proposed a three-layer hierarchical framework for professionals acceptance of technology. Individual context at the inner core, the implementation context on the outermost layer, the technological context in the middle Model results: 43% variance explained. PU determines A and BI. EOU influences perceived technology control, not PU and A. Compatibility determines PU, not EOU, has strong indirect effects on BI through PU. Peer influences no effects on A or BI. A has direct effects on BI, weaker than PU, greater than perceived technology control to BI.
41	Gefen et al 2003	Online shopping, E-commerce (B2C, low-touch low risk items)	Business school in the mid-Atlantic region	Of 400 students, 213 usable (experienced online shopper)	Field survey	Same as Davis 1989. Trust (Calculative-based, institution-based, i.e., structural assurances, situational normality, knowledge based familiarity)	Consumer's intention to transact with an e-vendor depends on trust, PU and EOU. PU is stronger direct predictor than trust. The effect of familiarity on trust was fully mediated by EOU. Institution-based beliefs of structural assurances and situational normality have the most effect on trust.
42	Summan and Siegal 2003	Information adoption	A multinational public accounting firm (North American operations)	46 interviewed, Of 178 survey, 63 usable	Interview, survey	PU transferred as information usefulness (information is valuable or worthless, informative or uninformative, helpful or harmful), Argument quality, source credibility as antecedents for usefulness, recipient expertise and involvement as moderators	Integration ELM with TAM. Argument quality and source credibility are significantly associated with usefulness. Usefulness associated with information adoption highly. Usefulness mediated effects of argument quality and source credibility on adoption. Recipients expertise and involvement moderated effects of argument quality on usefulness significantly, but only marginally for source credibility External validity of knowledge(usefulness for problems at hand) is more important than internal validity of that knowledge.

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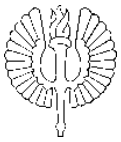

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