Why do people use information technology? A critical review of the technology acceptance model

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Why do people use information technology? A critical review of the technology acceptance model

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Abstract

Information systems (IS) implementation is costly and has a relatively low success rate. Since the seventies, IS research has contributed to a better understanding of this process and its outcomes. The early efforts concentrated on the identification of factors that facilitated IS use. This produced a long list of items that proved to be of little practical value. It became obvious that, for practical reasons, the factors had to be grouped into a model in a way that would facilitate analysis of IS use.

In 1985, Fred Davis suggested the technology acceptance model (TAM). It examines the mediating role of perceived ease of use and perceived usefulness in their relation between systems characteristics (external variables) and the probability of system use (an indicator of system success). More recently, Davis proposed a new version of his model: TAM2. It includes subjective norms, and was tested with longitudinal research designs. Overall the two explain about 40% of system's use. Analysis of empirical research using TAM shows that results are not totally consistent or clear. This suggests that significant factors are not included in the models.

We conclude that TAM is a useful model, but has to be integrated into a broader one which would include variables related to both human and social change processes, and to the adoption of the innovation model.

Keywords: Technology acceptance model; Information technology; Ease of use; Usefulness; IS use; Change management; Innovation

1. Introduction

1.1. Problem statement

Enterprises decide to invest in information systems (IS) for many reasons; among these are: pressures to cut costs, pressures to produce more without increasing costs, and simply to improve the quality of services or products in order to stay in business.

Despite considerable investments in IS, research reports mixed results. A study performed in 1998 by the Standish Group[1] once again found that only 26% of all MIS projects, and less than 23.6% of large company projects, are completed on time and within budget, with all requirements fulfilled. In excess of

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[1] Chaos: charting the seas of information technology, a special compass report, The Standish Group International.

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46% of projects were over budget, late, and with fewer features and functions than originally specified. Almost one third of the projects (28%) were cancelled.

Since the seventies, researchers have concentrated their efforts on identifying the conditions or factors that could facilitate the integration of IS into business. Their search has produced a long list of factors that seem to influence the use of technology [4]. From the mid-eighties, IS researchers [6,7] have concentrated their efforts in developing and testing models that could help in predicting system use. One of them, technology acceptance model (TAM) was proposed by Davis in 1986 in his doctoral thesis. Since then, it has been tested and extended by many researchers. Overall, TAM was empirically proven successful in predicting about 40% of a system's use [3,14].

1.2. Research objectives

This article first discusses research using TAM, with three main objectives in mind: (1) to provide a critical analysis of the research methods; (2) to highlight the convergence or divergence in results; and (3) to bring out the added value of TAM in explaining system use. This is done by studying the various parts of the model and discussing the results of a meta-analysis of empirical research done with TAM.

1.3. Background: origin and overview of TAM

In their effort to explain system use, researchers first developed tools for measuring and analysing computer user satisfaction. As indicated by Bailey and Pearson, it was natural to turn to the efforts of psychologists, who study satisfaction in a larger sense. In general terms, satisfaction is considered as the sum of one's feelings or attitudes toward a variety of factors affecting the situation. Therefore, it is defined as the sum of m user's weighted reactions to a set of n factors.

$$\text{Satisfaction} = \sum W_{ij}R_{ij} \quad (j = 1, \ldots, n, \quad i = 1, \ldots, m)$$

where R_{ij} is the reaction to factor j by individual i and W_{ij} is the importance of factor j to individual i.

Bailey and Pearson identified 39 factors (see Appendix A) that can influence user satisfaction. Faced with such a long list of factors, Bailey and Pearson and others, worked to abbreviate it and thus make it more practical. Cheney et al. grouped factors into three categories of variables: (1) uncontrollable (task technology and organisational time frame); (2) partially controllable (psychological climate and systems development backlog); and (3) fully controllable (end-user computing (EUC) training, rank of EUC executive, and EUC policies).

Davis [8] and Davis et al. [10] proposed TAM to address why users accept or reject information technology. Their model is an adaptation of the theory of reasoned action (TRA, see Fig. 1) proposed by Fishbein and Ajzen [12] to explain and predict the behaviours of people in a specific situation. Fig. 2 present original version of TAM [8].

A key purpose of TAM is to provide a basis for tracing the impact of external variables on internal beliefs, attitudes, and intentions. It suggests that perceived ease of use (PEOU), and perceived usefulness (PU) are the two most important factors in explaining system use.

TRA and TAM propose that external variables intervene indirectly, influencing attitude, subjective

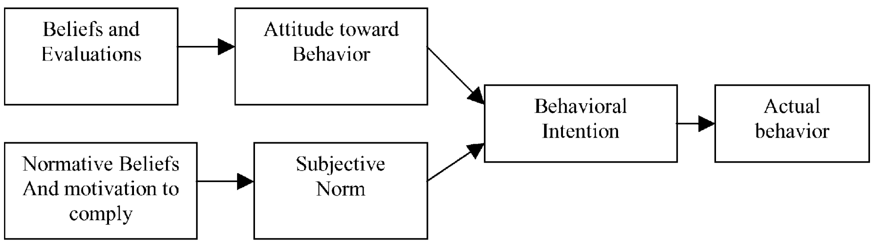

Fig. 1. Theory of reasoned action.

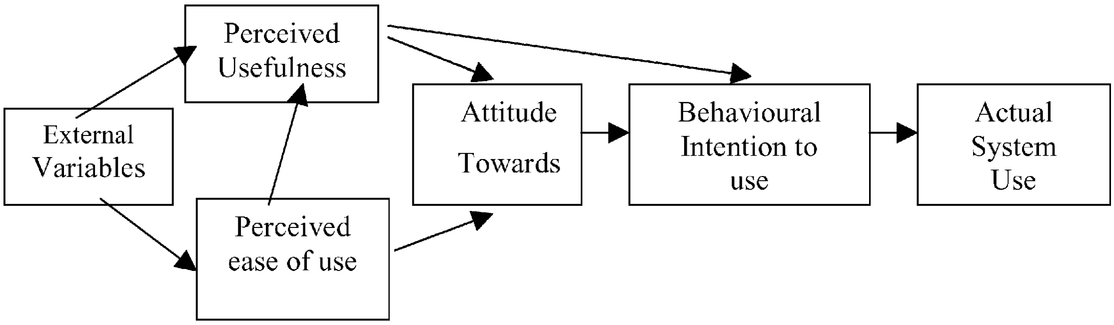

Fig. 2. Original technology acceptance model.

norms, or their relative weight in the case of TRA, or influencing PEOU and PU in the case of TAM.

Attitude towards using (AT) and behavioural intention to use (BI) are common to TRA and TAM, and Davis used Fishbein and Ajzen's method to measure them. Davis chose not to keep the variable subjective norms, because he estimated that it had negligible effect on BI. In TAM2, Venkatesh and Davis reconsidered this choice [29].

2. Methodology

We reviewed the articles published from 1980 to the first part of 2001 in periodicals known to include this type of study. They were in:

- MIS Quarterly;
- Decision Sciences;
- Management Science;
- Journal of Management Information Systems;
- Information Systems Research and
- Information and Management.

The bibliographical references of the articles initially selected also allowed us to trace a number of research findings. We also explored specialised databases and other information sources available on the WEB. Out of more than 80 articles consulted, we kept 22 (covering 28 measurements) for analysis. They were selected using the following criteria:

1. TAM is used in an empirical study;
2. the integrity of TAM is respected;
3. the research methodology is well described and
4. the research results are available and complete.

3. Findings

3.1. Diversified settings

In our review we examined the type of software introduced, the size of the sample, and the presence of the models tested. Table 1 presents the overall results. To analyse this data, we grouped the studies under three software tool categories: (1) office automation; (2) software development; and (3) business application (Table 2).

TAM was compared four times to either the TRA or the theory of planned behaviour (TPB). Five times subjective norm was added to the model.

3.2. Versions of TAM

In its original version, TAM had the following components: PU, PEOU, AT, BI, and actual use (U). Thus on the basis of the five components present and taking into account the structure of the model, 10 relations could potentially be examined: (1) PEOU–PU; (2) PU–AT; (3) PEOU–AT; (4) PU–BI; (5) PEOU–BI; (6) AT–BI; (7) AT–U; (8) BI–U; (9) PEOU–U; and (10) PU–U.

As shown in Table 3, no single study incorporated all these relations, but they are all measured in at least one study. Results of this analysis are summarised in Table 4. This shows a high proportion of positive results for all relations, but with a number of inconsistencies. These favourable results highlight variables that are related to IT adoption intention, but it does not mean that these variables are sufficient to predict IT adoption.

Table 1
Methodological details

Author	Software	Sample size	Model used (usually TAM)
Davis et al. [8]	Text-editor	107 full time MBA students	TAM + TRA
Davis [9]	E-mail, text-editor	112 professionals and managers	TAM
Mathieson [20]	Spreadsheet	262 students course intro-management	TAM + TPB
Davis et al. [10]	Writeone, chartmaster	200 and 40 MBA students	TAM, TAM
Subramanian [24]	Voice mail system, customer dial-up system	75 and 104 subjects	TAM
Taylor and Todd [26]	University computing, resource centre, business school student	786 students	TAM + subjective norm + perceived behavioural control
Taylor and Todd [27]	University computing, resource centre, business school student	786 students	TAM + TPB + decomposed TPB
Keil et al. [18]	Configuration software	118 salespersons	TAM
Szajna [25]	Electronic mail	61 graduate students	TAM
Chau [6]	Case	2500 IT professionals	TAM modified for long- and short-term usefulness
Davis et al. [28]	Three experiences with six software	Total of 108 students	TAM model of antecedents of perceived ease of use
Jackson et al. [16]	Spreadsheet, database, word processor, graphics	244, 156, 292, 210 students	TAM validation of perceived usefulness and ease of use instruments (each six items tools)
Igbaria and Craig [15]	Personal computing	596 PC users	TAM in small firms
Bajaj et al. [5]	Debugging tool	25 students	TAM + loop back adjustments
Gefen and Keil [13]	Configuration software	307 salesman	TAM testing for effect of perceived developers responsiveness
Agarwal and Prasad [2]	Word processing spreadsheet graphics	205 users of a Fortune100 company	TAM testing for individual differences
Lucas and Spitler [19]	Multifunctional workstation	54 brokers, 81 sales assistant of financial company	TAM + social norms and perceived system quality
Straub et al. [17]	Microsoft windows 3.1	77 potential adopters, 153 users in a corporation	Adaptation of TAM + subjective norms
Hu et al. [14]	Telemedicine software	407 physicians	TAM
Dishaw and Strong [11]	Software maintenance tools	60 maintenance projects in three Fortune50 firms, no indications of the number of subjects	TAM and task technology fit
Venkatesh and Davis [29]	Four different systems in four organisations	48 floor supervisors, 50 members of personal financial services, 51 employees small accounting firm, 51 employees of small investment banking	Extension of TAM including subjective norms and task technology fit
Venkatesh and Morris [30]	Data and information retrieval	342 workers	TAM + subjective norms, gender and experience

Table 2
Software categories

Office automation tool [11]	Software development tool [6]	Business application tool [5]
Software used in the operation of an office environment	Software used in application development	Software used in the core business process
Text-editor	Programming tools	
Spreadsheet	Case tools	MIS software (ERP)
Graphics presentation	Debugging tools	Production control tools
Electronic mail	Software maintenance tools	
Voice mail		

Table 3
Type of relations found[a]

Author	PEOU–PU	PU–AT	PEOU–AT	PU–BI	PEOU–BI	AT–BI	AT–U	BI–U	PEOU–U	PU–U
Davis et al. [10]										
Post training	Yes	Yes	No	Yes	Yes	Yes		Yes		
End semester	Yes	Yes	Yes	Yes	Yes	Yes		Yes		
Davis [8,9]	Yes	Yes	Yes				Yes			Yes
Mathieson [20]	Yes	Yes	Yes	Yes		Yes				
Davis et al. [10]										
Writeone	Yes			Yes	Yes			Yes	Yes	Yes
Chartmaster	Yes			Yes	Yes			Yes	Yes	Yes
Subramanian [24]										
Voice mail	No			Yes	No					
Customer dial-up	No			Yes	No					
Taylor and Todd [26,27]										
With experience	Yes	Yes	Yes	Yes		No		Yes		
No experience	Yes	Yes	Yes	Yes		No		Yes		
Taylor and Todd [26,27]	Yes	Yes	Yes	Yes		No		Yes		
Keil et al. [18]	Yes								No	Yes
Szajna [25]										
Pre-implementation	Yes			Yes	Yes			Yes	No	No
Post-implementation	Yes			Yes	Yes			Yes	No	No
Chau [6]	Yes								Yes	Yes
Davis et al. [10]	Yes			Yes	Yes					
Jackson et al. [16]	No	No	Yes	No	Yes	No				
Igbaria et al. [15]	Yes								Yes	Yes
Bajaj and Nidumolu [5]	No	Reverse	Yes				Yes			No
Gefen and Keil [13]	Yes								No	Yes
Agarwal and Prasad [1,2]	Yes	Yes	Yes				Yes			Yes
Lucas and Spitler [19]	Yes			No	No				No	No
Karahanna et al. [17]										
Potential adopters		Yes	Yes			Yes				
Actual users		Yes	Yes			Yes				
Hu et al. [14]	No	Yes	No	Yes		Yes				
Dishaw and Strong [11]	Yes	Yes		No		Yes		No		No
Venkatesh and Davis [28,29]	Yes			Yes	Yes			Yes		
Venkatesh and Morris [30]	Yes			Yes	Yes					

[a] Yes indicates that the relation was found to be significant and positive, blank the relation was not measured, no the relation was found to be non-significant and reverse indicates that the relation was found to be significant but negative.

Table 4
Counting of relations

	PEOU–PU	PU–AT	PEOU–AT	PU–BI	PEOU–BI	AT–BI	AT–U	BI–U	PEOU–U	PU–U
Positive relation	21	12	10	16	10	7	3	10	4	8
Non-significant relation	5	1	3	3	3	4	0	1	5	5
Negative relation	0	1	0	0	0	0	0	0	0	0
Not tested	2	14	15	9	15	17	25	17	19	15

3.2.1. Attitude towards using and behavioural intention to use

In its original form (Fig. 2), TAM included both AT and BI as in TRA. Out of the 22 studies, only seven included both AT and BI. Three included only AT, while eight included only BI. This leaves four studies that ignored both AT and BI, measuring only the direct effect of PU and PEOU on use.

3.2.2. Use

The ultimate objective of TAM was to predict use, and for this, a linear regression model was most often used. To build the model, use has to be measured. In eleven of the 22 studies, use was measured through self-reporting. The method used normally consisted of two or three questions about the frequency of use and the amount of time spent using the system. In one study, use was measured by an automatic measuring tools. In 10 other studies, use was not measured: it was either mandatory or this variable was ignored.

3.3. External variables

TAM postulates that external variables intervene indirectly by influencing PEU and PU. Table 5 presents the external variables considered. We note that there is no clear pattern with respect to the choice of the external variables considered.

Table 5
External variables

Author	External variable
Jackson et al. [16]	Situational involvement, intrinsic involvement, prior use, argument of change
Igbaria et al. [15]	Internal computing support, internal computing training, management support, external computing support, external computing training
Bajaj and Nidumolu [5]	No external variable
Gefen and Keil [13]	Perceived developer responsiveness
Agarwal and Prasad [1,2]	Role with regard to technology, tenure in workforce, level of education, prior similar experiences, participation in training
Lucas and Spitler [19]	Quality perceived subjectiveness
Karahanna et al. [17]	Compatibility, trainability, visibility, result demonstrability
Hu et al. [14]	No external varibale
Dishaw and Strong [11]	Tool functionality, tool experinece, task technology fit, task characteristics
Venkatesh and Davis [28,29]	Subjective norms, voluntariness, image, job relevance, output quality, result demonstrability
Venkateshand Morris [30]	Gender, experience
Davis [8,9]	No external variable
Davis et al. [10]	No external variable
Mathieson [20]	No external variable
Davis et al. [10]	Output quality
Subramanian [24]	No external variable
Taylor and Todd [26,27]	Affect of experience
Taylor and Todd [26,27]	No external variable
Keil et al. [18]	No external variable
Szajna [25]	No external variable
Chau [6]	Implementation gap, transitional support
Davis et al. [10]	Computer self efficacy, objective usability, direct experience

Research results provided by these studies confirm that external variables are fully mediated by PEOU and PU and that the addition of such variables contributes marginally to the explanation of the variance in system use. Actually, external variables provide a better understanding of what influences PU and PEOU, their presence guide the actions required to influence a greater use.

3.4. Measures of PU and PEOU

3.4.1. Perceived usefulness

Table 6 presents the items used for measuring PU and, when available, the reported internal consistency of the resulting constructs. Davis, in his study of PU, proposed a six items measurement tool. The six items include the four items most commonly used: (1) using (application) increases my productivity; (2) using (application) increases my job performance; (3) using (application) enhances my effectiveness on the job; and (4) overall, I find the (application) useful in my job. All measures of PU are found to lead to an acceptable level of internal consistency (greater or equal to 0.83).

3.4.2. Perceived ease of use

Table 7 presents the constructs present in the tools for measuring PEOU. We observe that four items are more frequently used: (1) learning to operate (the application) is easy for me; (2) I find it easy to get the (application) to do what I want to do; (3) the (application) is rigid and inflexible to interact with; and (4) overall, I find the (application) easy to use. These are found to lead to a reasonable degree of internal consistency (with alpha most of the time greater than 0.79) in 12 articles or more.

Davis gave great attention to building a solid tool to measure PEOU. His 1989 study proposes a six items measurement tool, which includes the four most commonly used items.

3.4.3. Attitude towards using and behavioural intention to use

Where required, the studies use the constructs suggested by Fishbein and Azjen. These constructs demonstrated a good degree of reliability with all alphas greater than 0.8 in 16 out of the 18 studies.

4. A meta-analysis

Research results with TAM have been, over the years, generally consistent. When analysing the type of relation between the different components of TAM, we observed that in one case, the research findings were contradictory. The relation between PU and AT is found to be significant and positive in all but one study [5].

Meta-analysis aims at integrating a large number of results to determine if they are homogeneous. Statistical methods are applied to summary statistics. The focus is not on statistical significance but on the size of treatment effects. The objective is a detailed review that supports making a sound judgement on the average of the findings computed and on the reasons for inconsistencies.

It would be helpful to investigate the homogeneity of the relations between the components used in TAM across the different studies. In order to do this, the correlation coefficients between the components observed must be available. Unfortunately, the coefficient correlation matrices were present in only three of the 22 studies examined. In most studies, a measure of the strength of the relation was given through the result of the computed linear regression. In models that account for most of the factors, measuring the total effect (direct and indirect) will compare favourably to the results of the coefficient correlation matrix.

To validate the possibility of using the data available (from the model results) we undertook a comparison of the results from the three studies where the coefficient matrices were provided. In two, the results were the same. In the third, the coefficient correlations were slightly different from the total effect between the components measured in the models. For these reasons, we must be cautious, because we cannot rely on strong statistical evidence. Nevertheless, we conducted the meta-analysis to see if trends appear.

We proceeded first by grouping the studies by type of samples (students and non-students) and second by grouping with software categories. We used the meta-analysis procedure and software programs provided by Ralf Schwarzer on his WEB site (http://www.fu-berlin.de/gesund/gesu_engl/meta_e.htm) to process the data.

Table 6
Measuring PU[a]

Perceived usefulness	Davis [8,9]	Davis et al. [10]	Mathieson [20]	Davis et al. [10]	Subramanian [24]	Taylor and Todd [26,27]	Taylor and Todd [26,27]	Keil et al. [18]	Szajna [25]	Chau [6]	Davis et al. [10]
Alpha			0.902	0.91	0.963			0.94 pre, 0.95 post	0.95	0.9 short-term, 0.928 long-term	0.90
Using (application) improves the quality of the work I do	X							X			
Using (application) gives me greater control over my work	X										
Application enables me to accomplish tasks more quickly	X							X	X	X	
Application supports critical aspects of my job	X										
Using (application) increases my productivity	X	X	X	X	X			X	X	X	X
Using (application) increase my job performance	X	X	X	X		X	X	X	X	X	X
Using (application) allows me to accomplish more work than would otherwise be possible	X										
Using (application) enhances my effectiveness on the job	X	X	X	X	X				X	X	X
Using (application) makes it easier to do my job	X				X			X	X	X	
Overall, I find the (application) useful in my job	X	X	X	X		X	X	X	X	X	X
	Jackson et al. [16]	Igbaria et al. [15]	Bajaj and Nidumolu [5]	Gefen and Keil [13]	Agarwal and Prasad [1,2]	Lucas and Spitler [19]	Karahanna et al. [17]	Hu et al. [14]	Dishaw and Strong [11]	Venkatesh and Davis [28,29]	Venkatesh and Morris [30]
Alpha	0.83	0.94	0.96	0.93	0.95	0.91	0.90	0.89	0.98	0.86–0.98	0.93
Using (application) improves the quality of the work I do				X	X		X				
Using (application) gives me greater control over my work					X						
Application enables me to accomplish tasks more quickly[a]				X	X		X	X	X		
Application supports critical aspects of my job											
Using (application) increases my productivity[a]	X	X	X	X	X	X		X	X	X	X
Using (application) increases my job performance[a]	X	X	X	X					X	X	X
Using (application) allows me to accomplish more work than would otherwise be possible											
Using (application) enhance my effectiveness on the job[a]	X	X	X		X	X	X	X	X	X	X
Using (application) makesk it easier to do my job[a]					X	X	X	X	X		
Overall, I find the (application) useful in my job[a]	X	X	X	X	X	X			X	X	X

[a] Iitems proposed by Davis.

Table 7
Measuring PEOU

Perceived ease of use	Davis [8,9]	Davis et al. [10]	Mathieson [20]	Davis et al. [10]	Subramanian [24]	Taylor and Todd [26,27]	Taylor and Todd [26,27]	Keil et al. [18]	Szajna [25]	Chau [6]	Davis et al. [10]	Jackson et al. [16]	Igbaria et al. [15]	Bajaj and Nidumolu [5]	Gefen and Keil [13]	Agarwal and Prasad [1,2]	Lucas and Spitler [19]	Karahanna et al. [17]	Hu et al. [14]	Dishaw and Strong [11]	Venkatesh and Davis [28,29]	Venkatesh and Morris [30]
Alpha	0.91	0.93	0.938	0.88	0.903			0.82	0.96	0.900	>0.90	0.91	0.94	0.87	0.89	0.87	0.87	0.90	0.79	0.97	0.86–o.98	0.92
I find (application) cumbersome to use	X							X		X_1												
Learning to operate (application) is easy for me	X	X	X	X	X	X_1	X_1	X	X	X		X			X			X	X_1			
Interacting with the (application) is often frustrating	X							X														
I find it easy to get the (application) to do what I want to do	X	X	X	X				X	X		X	X	X	X		X	X		X	X	X	X
The (application) is rigid and inflexible to interact with	X				X_1				X_1	X_1	X_1		X_1			X			X_1	X_1	X_1	
It is easy for me to remember how to perform tasks using the (application)	X															X						
Interacting with the (application) requires a lot of mental effort	X							X			X		X	X					X_1	X_1		X_1
My interaction with the (application) is clear and understable	X							X							X						X	X
I find it takes a lot of effort to become skilful at using the (application)	X	X_1	X_1	X_1	X_1				X_1	X									X			
Overall, I find the (application) easy to use	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X, X_1	X	X	X	X

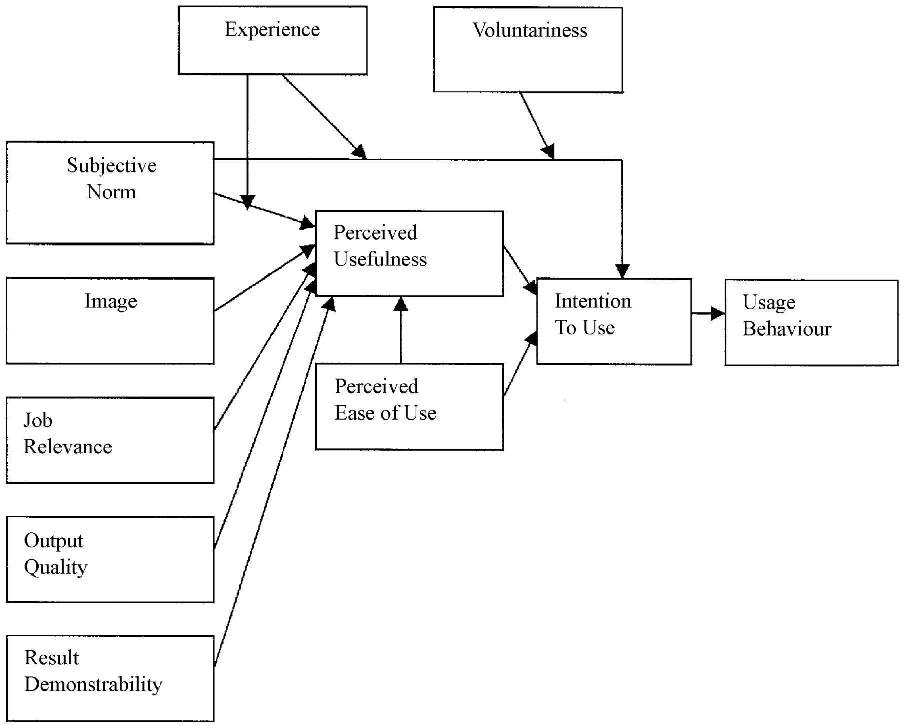

Fig. 3. TAM2.

Table 8
Summary of research findings

Article	Finding
Davis [8,9]	TAM fully mediated the effects of system characteristics on use behaviour, accounting for 36% of the variance in use Perceived usefulness was 50% more influential than ease in determining use
Davis et al. [10]	Perceived usefulness predicts intentions to use whereas perceived ease of use is secondary and acts through perceived usefulness Attitudes have little impact mediating between perceptions and intention to use Relatively simple models can predict acceptance
Mathieson [20]	Both models (TAM and TRA) predict intentions to use well TAM is easier to apply, but provides only general information TPB provides more specific information for developers
Davis et al. [10]	Together, usefulness and enjoyment explained 62% (study 1) and 75% (study 2) of the variance in use intentions Usefulness and enjoyment were found to mediate fully the effects on use intentions of perceived output quality and perceived ease of use A measure of task importance moderated the effects of ease of use and output quality on usefulness but not enjoyment
Subramanian [24]	Perceived usefulness and not ease of use is a determinant of predicted future use
Taylor and Todd [26,27]	Modified TAM explains use for both experienced and inexperienced users Stronger link between behavioural intention and behaviour for experienced users Antecedent variables predict inexperienced user's intentions better

Table 8 (*Continued*)

Article	Finding
Taylor and Todd [26,27]	All models performed well based on fit and explanation of behaviour TPB provides a fuller understanding of intentions to use In TAM attitudes are not significant predictors of intention to use
Keil et al. [18]	Usefulness is a more important factor than ease of use in determining system use Ask/tool fit plays a role in shaping perceptions of whether or not a system is easy to use
Szajna [25]	Questions self-report measures vs. actual measurement of use Experience component may be important in TAM
Chau [6]	Findings indicate that ease of use has the largest influence on software acceptance
Davis et al. [10]	Individual's perception of a particular system's ease of use is anchored to her or his general computer self-efficacy at all times Objective usability has an impacton ease of use perceptions about a specific system only after direct experience with the system
Jackson et al. [16]	Direct effect of situational involvement on behavioural intention as well as attitude is significant in the negative direction Attitude seems to play a mediating role Intrinsic involvement plays a significant role in shaping perceptions
Igbaria et al. [15]	Perceived ease of use is a dominant factor in explaining perceived usefulness and system use, and PU has a strong effect on use Exogenous variables influence both PEOU and PU particularly management support and external support Relatively little support was found for the influence of both internal support and internal training
Bajaj and Nidumolu [5]	Past use apparently influences the ease of use of the system and is a key factor in determining future use
Gefen and Keil [13]	Proposes that IS managesrs can influence both the perceived usefulness and the perceived ease of use of an IS through a constructive social exchange with the user
Agarwal and Prasad [1,2]	It appears that there may be nothing inherent in individual differences that strongly determines acceptance (use) Identifies several individual difference variables (level of education, extent of prior experiences, participation in training) that have significant effects on TAM's beliefs
Lucas and Spitler [19]	Field setting, organizational variables such as social norms and the nature of the job are more important in predicting use of the technology than are user's perceptions of the technology
Karahanna et al. [17]	Pre-adoption attitude is based on perceptions of usefulness, ease of use, result demonstrability, visibility and triability Post-adoption attitude is only based on instrumental beliefs of usefulness and perceptions of image enhancements
Hu et al. [14]	TAM was able to provide a reasonable depiction of user's intention to use technology Perceived usefulness was found to be a significant determinnt of attitude and intention Perceived ease of use was not a significant determinant
Dishaw and Strong [11]	Suggests an integration of TAM and task-technology fit constructs Integrated model leads to a better understanding of choices about using IT
Venkatesh and Davis [28,29]	The extended model accounted for 40–60% of the variance in usefulness perceptions and 34–52% of the variance in use intentions Both social influence process (subjective norm, voluntariness, and image) and cognitive instrumental processes (job relevance, output quality, result demonstrability, and perceived ease of use) significantly influenced user acceptance
Venkatesh and Morris [30]	Compared to women, men's technology use was more strongly influenced by their perceptions of usefulness Women were more strongly influenced by perceptions of ease of use and subjective norms, although the effect of subjective norms diminished over time

Because of the statistical shortfall, we limit the presentation of the findings to the general conclusion: in all grouping except one, the research findings were found to be heterogeneous.

The only situation where the results of the research findings were found to be homogeneous was when studies were grouped by type of software and only for students. The results from the meta-analysis tend to support the view of some researchers [1,19,25] who suggest that TAM should be modified to include other components in order to explain consistently more than 40% of system use. As for the homogeneity of the results with TAM when dealing with students, we believe that it reveals the robustness of TAM when not exposed to all the factors (structure, roles and responsibilities) of the real world environment, since students function in a simpler environment.

5. Conclusion

TAM has proven to be a useful theoretical model in helping to understand and explain use behaviour in IS implementation. It has been tested in many empirical researches and the tools used with the model have proven to be of quality and to yield statistically reliable results.

From its original model, TAM has evolved over time. This is the model used by Venkatesh and Morris [30] (Fig. 3). The notion of time has been included in the analysis of the factors that influence use. Research has shown that the influence of some factors on intention to use IS, varies at different stages in the IS implementation process. Rogers' work [23] on innovation introduced also: triability; relative advantage; complexity; compatibility; and observability.

The following Table 8, inspired by Lucas, presents the summary of our findings. Here we notice that, although the results are mostly convergent, there are situations where they are conflicting. A closer analysis of these situations [15–17] points out that the original model of TAM needed to be improved and that the latest model goes a long way in that direction. However, even if established versions include additional variables, the model hardly explains more than 40% of the variance in use.

In conclusion, we underline three limits of TAM research to date.

1. Involving students

   Nine of the studies involved students. Although this minimised the costs, we think that research would be more better if it was performed in a business environment.
2. Type of applications

   We also notice that most studies examined the introduction of office automation software or systems development applications. We think that research would benefit from examining the introduction of business process applications.
3. Self-reported use

   Since most of the studies do not measure system use, what TAM actually measures is the variance in self reported use. Obviously this [9,24] is not a precise measure. Not only is it difficult to measure rigorously, but it also involves problems. At best, self reported use should serve as a relative indicator.

The following is an example of the difficulty with self reported use (La Presse Montréal, Tuesday 17 October 2000).

> Observers in public washrooms in New Orleans, New York, Atlanta, Chicago and San Francisco noted that only 67% of the persons washed their hands after visiting the toilet cabinet. When 1201 Americans, in a telephone survey, were asked if they washed their hands after going to the bathroom, 95% answered yes.

Since our objective is to explain use, greater emphasis should be put on measurement. Another important limitation of TAM is in considering IS to be an independent issue in organisational dynamics. Research in the field of innovation and change management suggests that technological implementation is related to organisational dynamics, which will have a strong impact on the outcomes. Orlikowski and Hofman [21] acknowledge that the effectiveness of any change process relies on the interdependence between the technology, the organisational context, and the change model used to manage the change. This support the suggestion that it may be difficult to increase the predictive capacity of TAM if it is not integrated into a broader model that includes organisational and social factors. Orlikowski and Tyre [22] found that effective IS implementation tend to follow a pattern where the management proceeds with disjoint periods of intensive implementation, rather than with continuous improvement. This information is particularly useful for managers who have to make decisions about implementation strategies.

Appendix A. Factors affecting information system satisfaction (Bailey and Pearson)

Following are the factors affecting IS satisfaction:

1. Top management involvement
2. Organisational competition with the EDP unit
3. Priorities determination
4. Charge-back method of payment for services
5. Relationship with the EDP staff
6. Communication with the EDP staff
7. Technical competence of the EDP staff
8. Attitude of the EDP staff
9. Schedule of products and services
10. Time required for new development
11. Processing of change requests
12. Vendor support
13. Response/turnaround time
14. Means of input/output with EDP centre
15. Convenience of access
16. Accuracy
17. Timeliness
18. Precision
19. Reliability
20. Currency
21. Completeness
22. Format of input
23. Language
24. Volume of output
25. Relevancy
26. Error recovery
27. Security of data
28. Documentation
29. Expectations
30. Understanding of systems
31. Perceived utility
32. Confidence in systems
33. Feeling of participation
34. Feeling of control
35. Degree of training
36. Job effects
37. Organisational position of the EDP function
38. Flexibility of systems
39. Integration of systems

References

[1] R. Agarwal, J. Prasad, The role of innovation characteristics and perceived voluntariness in the acceptance of information technologies, Decision Sciences 28 (3), 1997, pp. 557–582.

[2] R. Agarwal, J. Prasad, Are individual differences germane to the acceptance of new information technologies? Decision Sciences 30 (2), 1999, pp. 361–391.

[3] I. Ajzen, M. Fishbein, Understanding Attitudes and predicting Social Behavior, Prentice-Hall, Englewood Cliffs, NJ, 1980.

[4] J.E. Bailey, S.W. Pearson, Development of a tool for measuring and analysing computer user satisfaction, Management Sciences 29 (5), 1983, pp. 530–545.

[5] A. Bajaj, S.R. Nidumolu, A feedback model to understand information system usage, Information and Management 33, 1998, pp. 213–224.

[6] P.Y.K. Chau, An empirical investigation on factors affecting the acceptance of CASE by systems developers, Information and Management 30, 1996, pp. 269–280.

[7] P.H. Cheney, R.I. Mann, D.L. Amoroso, Organizational factors affecting the success of end-user computing, Journal of Management Information Systems III (1), 1986, pp. 65–80.

[8] F.D. Davis, Perceived usefulness, perceived ease of use, and user acceptance of information technologies, MIS Quarterly 13 (3), 1989, pp. 319–340.

[9] F.D. Davis, User acceptance of information technology: system characteristics, user perceptions, and behavioral impacts, International Journal of Man Machine Studies 38, 1993, pp. 475–487.

[10] F.D. Davis, R. Bagozzi, P.R. Warshaw, User acceptance of computer technology: a comparison of two theoretical models, Management Science 35 (8), 1989, pp. 982–1003.

[11] M.T. Dishaw, D.M. Strong, Extending the technology acceptance model with task-technology fit constructs, Information and Management 36, 1999, pp. 9–21.

[12] M. Fishbein, I. Ajzen, Belief, Attitude, Intention, and Behavior: An Introduction to Theory and Research, Addison-Wesley, Reading, MA, 1975.

[13] D. Gefen, M. Keil, The impact of developer responsiveness on perceptions of usefulness and ease of use: an extension of the technology acceptance model, The DATA BASE for Advances in Information Systems 29 (2), 1998, pp. 35–49.

[14] P.J. Hu, P.Y.K. Chau, O.R. Liu Sheng, K. Yan Tam, Examining the technology acceptance model using physician acceptance of telemedicine technology, Journal of Management Information Systems 16 (2), 1999, pp. 91–112.

[15] M. Igbaria, N. Zinatelli, P. Cragg, A. Cavaye, Personal computing acceptance factors in small firms: a structural equation model, MIS Quarterly, September (1997) 279–302.

[16] C.M. Jackson, S. Chow, R.A. Leitch, Toward an understanding of the behavioral intention to use an information system, Decision Sciences 28 (2), 1997, pp. 357–389.

[17] E. Karahanna, D.W. Straub, N.L. Chervany, Information technology adoption across time: a cross-sectional comparison of pre-adoption and post-adoption beliefs, MIS Quarterly 23 (2), 1999, pp. 183–213.
[18] M. Keil, P.M. Beranek, B.R. Konsynski, Usefulness and ease of use: field study evidence regarding task considerations, Decision Support Systems 13, 1995, pp. 75–91.
[19] H.C. Lucas, V.K. Spitler, Technology use and performance: a field study of broker workstations, Decisions Sciences 30 (2), 1999, pp. 291–311.
[20] K. Mathieson, Predicting user intentions: comparing the technology acceptance model with the theory of planned behavior, Information Systems Research 2 (3), 1991, pp. 173–191.
[21] W.J. Orlikowski, J.D. Hofman, An improvisational model for change management: the case of groupware technologies, Sloan Management Review Winter (1997) 11–21.
[22] W.J. Orlikowski, M.J. Tyre, Exploiting opportunities for technological improvement in organizations, Sloan Management Review (1993) 13–26.
[23] E.V. Rogers, Diffusion of Innovations, 4th Edition, The Free Press, New York, 1995.
[24] G.H. Subramanian, A replication of perceived usefulness and perceived ease of use measurement, Decision Sciences 25 (5/6), 1994, pp. 863–874.
[25] B. Szajna, Empirical evaluation of the revised technology acceptance model, Management Science 42 (1), 1996, pp. 85–92.
[26] S. Taylor, P. Todd, Understanding information technology usage: a test of competing models, Information Systems Research 6 (2), 1995, pp. 144–176.
[27] S. Taylor, P. Todd, Assessing IT usage: the role of prior experience, MIS Quarterly, December (1995) 561–570.
[28] V. Venkatesh, F.D. Davis, A model of the antecedents of perceived ease of use: development and test, Decision Sciences 27 (3), 1996, pp. 451–481.
[29] V. Venkatesh, F.D. Davis, A theoretical extension of the technology acceptance model: four longitudinal field studies, Management Science 46 (2), 2000, pp. 186–204.
[30] V. Venkatesh, M.G. Morris, Why do not men ever stop to ask for directions? Gender, social influence, and their role in technology acceptance and usage behavior, MIS Quarterly 24 (1), 2000, pp. 115–139.

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