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Keywords

where, information, mandatory, technology, user, model, usage, environments, satisfaction, valid, acceptance

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Is the Technology Acceptance Model a Valid Model of User Satisfaction of Information Technology in Environments where Usage is Mandatory?

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Abstract

The validity of the two models based on the extended Technology Acceptance Model (Venkatesh and Davies, 2000) in predicting user satisfaction of an incident reporting system in a mandated setting was tested using 84 employees from a large manufacturing company. The models differed in how the construct, subjective norm was represented. Although the results indicated that both models fitted the data, the anticipated relationship between subjective norms and user satisfaction was not supported. Furthermore, some of the antecedent factors did not predict perceived usefulness as anticipated.

Keywords

Use individual characteristics, user acceptance, user behaviour, user satisfaction

INTRODUCTION

Various models drawn from social and cognitive psychology have been developed to assist in explaining or predicting the acceptance of computer systems. The models commonly used by researchers have been based on theoretical perspectives such as Social Cognitive Theory (Bandura, 1986), Theory of Reasoned Action (Ajzen and Fishbein, 1980), Theory of Planned Behaviour (Mathieson, 1991; Ajzen, 1985), and Interpersonal Behaviour (Triandis, 1977). The Technological Acceptance Model (TAM) posits that an individual's intention to use information technology is determined by perceived usefulness and perceived ease of use (Davis, 1989). Although each model differs they all contain the central concept that an individual's beliefs and attitudes are key determinants of technology usage.

One of the most widely accepted models, the TAM (Davis, 1989), has undergone extensive validation (Mathieson, 1991; Szajna, 1994; Taylor and Todd, 1995; Davis and Venkatesh, 1996). The underlying motivation for developing the TAM was to have a parsimonious model that could be applied to a wide range of computer technologies and users. A further reported advantage of the TAM is that the constructs comprising the model could be measured in the same way unlike the Theory of Planned Behaviour that requires the identification of unique features of the technology so that a measurement scale could be developed (Mathieson, 1991).

In an earlier study, Rawstorne *et al.*, 2000 identified some of the limitations of operationalising the TAM and using the model to predict user acceptance in a mandatory setting. Subsequently, Venkatesh and Davis (2000) included two mandatory settings when they proposed and tested the extended TAM. The participants in their study were professional workers from two settings, namely, a small accounting firm and an international investment banking firm.

Reviews of the use of the TAM in the IT acceptance literature suggest that most of the studies are based on North American samples in which the participants are predominantly white collar workers (for reviews see Venkatesh, 1999; Lederer *et al.*, 2000). The need for studies in other organisational settings (for example, with blue collar workers) and cultures has been identified (Anandarajan *et al.*, 2002).

Therefore the purpose of this study is to investigate the external validity of the extended TAM in a mandatory environment with blue-collar workers as participants. A secondary objective is to test whether the antecedent factors identified by Venkatesh and Davis (2000) are predictors of the key model variables in a mandatory environment.

REVIEW OF THE CONCEPTUAL MODEL AND DEVELOPMENT OF HYPOTHESES

Most studies using the TAM report that perceived usefulness and perceived ease of use have a direct effect on computer usage (Davis, 1989; Davis *et al.*, 1992; Igbaria *et al.*, 1995; Igbaria and Iivari, 1995; Venkatesh and Davis, 2000). Davis (1993) found that usefulness had four times the strength of ease of use in predicting intention to use. This finding was accounted for by the increased productivity (usefulness) arising from a system that requires little effort. Igbaria *et al.* (1995) were concerned that the economic imperative to create profit in highly competitive industries might place greater emphasis on perceived usefulness than would be the case in a service industry, such as in the educational institutions.

Studies by Igbaria *et al.* (1997) and Agarwal and Prasad (1997) did not support the relative importance of usefulness over perceived ease of use. Igbaria *et al.* (1997) found that ease of use was judged to be more important than usefulness among employees of a small company. They suggested this result was a consequence of the highly user unfriendly nature of the system creating resistance to system use that in turn precluded appreciation of its usefulness. In the Agarwal and Prasad (1997) study, the authors attributed the fact that ease of use was also not significant to the system's inherent ease of use. Taken together, these findings imply that the relative importance of perceived usefulness and ease of use may be domain dependent.

The dependant variables of interest in the original TAM (and its extensions) are "intention to use" and "usage". Some studies have only used intention to use (Agarwal and Prasad, 1998; Chau, 1996) while others have used the actual behaviour at the same time as the predictor variables (Adams *et al.*, 1992; Igbaria *et al.*, 1996). There are a number of problems in using such dependant variables. When participants complete questionnaires comprising intentions and self-reported behaviour, there are psychological influences that would result in bias towards reporting consistent results. More importantly, usage as a dependant variable is rendered unacceptable in situations where the usage is mandated by the organisation (Rawstorne *et al.*, 2000).

Davis (1989), Davis *et al.* (1992) and Gatian (1994) reported that computer satisfaction is linked to a greater level of usage, performance and operational effectiveness. In the area of end-user computing Doll and Torkzadeh's (1991) end-user computing satisfaction scale is a well-known instrument used for overall *post hoc* evaluation of an information system. However, Chin and Lee (2000) contended that user satisfaction measures such as Doll and Torkzadeh's consist of perceptual measures of the system or gap measures of desire (needs). Consequently, they only represent a portion of the disconfirmation model of satisfaction. Chin and Lee argue that an end-user's overall feelings of satisfaction arise from both direct and multiplicative combinations of expectation-based satisfaction and desire-based satisfaction.

Past research has revealed mixed results of the role of subjective norms in determining user acceptance. For example, Matheison (1991) did not find any effect linking subjective norms and acceptance while Taylor and Todd (1995) found significant effects. However, Hartwick and Barki (1995) argued that subjective norms was significant when the situation was mandatory not voluntary. In the extension of the TAM, Venkatesh and Davis (2000) found that subjective norm exerts a significant direct effect on user acceptance (usage intention) over and above perceived usefulness and ease of use in mandatory settings only.

In proposing the extended TAM, Venkatesh and Davis (2000) used the theory of internalization of social influence to argue that, even when a system is mandated by the organization, perceptions of usefulness will respond to social pressure.

A number of other determinants of perceived usefulness were identified in the extended TAM (Venkatesh and Davis 2000). These antecedent factors were included on the argument

that people match important work goals with the use of information systems. The determinants included were job relevance, an individual's perception regarding the degree to which the target system is applicable to his/ her job; output quality, the match between the tasks a system performs and their job goals and results demonstrability, the tangibility of the results of using the system (Venkatesh and Davis, 2000).

Based on the review of the literature discussed in this section we can hypothesise that:

1. In a mandatory situation perceived usefulness is more important than perceived use of use for IT satisfaction.
2. In a mandatory situation subjective norm has a direct effect on the dependant variable.
3. Perceived usefulness mediates the effect of subjective norms to user satisfaction in a mandatory situation.
4. Job relevance, output quality and results demonstrability will have a positive effect on usefulness in a mandatory situation.

METHODS

Three years ago a large manufacturing company (employing approximately 7,000 people) began implementing a comprehensive safety management computer system at one of its plants. The initial module 'Incident Reporting' was proving in many workplace areas to be under-utilised. Due to the high importance placed on accident prevention, management in the plant was interested to identify factors that contributed to the non-acceptance of the system.

Participants

The questionnaire was issued to five major operational departments at the manufacturing company, 4 of which took part in the focus group sessions. The five departments covered a wide range of activities undertaken by the organisation. In total 30 people aged between 20 and 60 participated in the focus groups. The focus group participants were experienced users of the safety management system. They had been employed with the organisation for at least 10 years. Of the 84 respondents to the main survey, 65 were front line supervisors, 5 were departmental safety coordinators, and 13 were departmental managers. The ages of participants ranged between 25 and 62 (M= 43.14; SD=8.57). Only one of the respondents was female. The number of respondents from the individual departments ranged between 12 and 25. All participants were volunteers.

Measures and Procedure

Bandura (1986) and Agarwal and Prasad (1997) recognised that in order to improve the predicability of constructs in behaviour models it is necessary to target the domain of interest. The "one measure fits all" approach is not appropriate. Bandura (1997) suggests that if the intention of a theoretical model is to explain and predict the level of accomplishment achieved by an individual operating in a particular environment then it is necessary to assess the situation with highly specific measures.

Five focus group sessions were conducted in order to obtain qualitative information of users experiences with the reporting system. The findings provided confirmation that the factors in the TAM were relevant to the system. The responses from the focus groups were also used as source material for the creation of the specific scale items. A further objective was to confirm that the adoption of the computer system was indeed mandatory.

To develop specific measures for usefulness and ease of use, responses from the five focus groups were inspected to identify items that encapsulate key themes within the constructs of perceived usefulness and perceived ease of use. Five specific perceived usefulness and four specific perceived ease of use items were created based on themes arising from the focus group responses.

IT satisfaction was measured using a scale developed by Chin and Lee (2000). Their scale was based on Doll and Torkzadeh's (1998) methodology that addressed five different domains of satisfaction; content, accuracy, format, ease of use and timeliness. In our study,

the context of the items was changed from "wanted" to "want", as we are assessing the current impression of satisfaction with no explicit reference to original desires or expectations. It is anticipated that the responses would capture a combination of desire (does the system assist me now in managing safety) and expectation (was the system built such that my current desires can be achieved). Subjective norm was measured using four items based on a scale developed by Hartwick and Barki (1994). Hartwick and Barki's item "At work, my superiors think that I (should not/ should) frequently use the new system" was separated into two parts that reflected the two layers of superiors, departmental and upper management (external). This change provided an insight into how departmental personnel perceived the social pressures being exerted by management external to the department (upper management). Two items included in the four-item image scale were adapted from Moore and Benbasat (1991). The remaining items were derived from focus group responses. Job relevance items used by Venkatesh and Davis (2000) were too general and were not used. The job relevance responses across the focus groups were consistent and thus provided suitable material for item creation. Output quality was assessed using a four-item scale. One item was adapted from Venkatesh and Davis (2000). The balance of the items was based on focus group responses. The results demonstrability scale contained four items, three items were based on Moore and Benbasat (1991) and one item was developed from the focus groups.

With the exception of the satisfaction scales a 7-point Likert scale (1= strongly agree and 7= strongly disagree) was used to rate items. Satisfaction was measured using a 9-point Likert scale (-4 = far below what I want, and +4=far above what I want). The 9-point format was used to maintain the integrity of the original satisfaction scale. To confirm that the items were worded appropriately in terms of content, readability and format, five people piloted the questionnaire, resulting in minor changes to the questionnaire. The data from this pilot were excluded from the main analysis. The questionnaires were issued to the safety coordinators in the five departments for distribution. The safety coordinators were asked to follow up on non-respondents to ensure the questionnaires were returned within 3 weeks of issue.

RESULTS

Psychometric properties and correlations

A factor analysis of the items comprising usefulness, ease of use and user satisfaction was conducted to examine the construct validity of these measures. The items were factor analysed using principal components extraction and direct oblimin rotation. The results yield a three-factor solution, each factor representing the measures usefulness, ease of use and satisfaction, providing evidence of the construct validity of these measures. In addition, the items comprising subjective norm were also factor analysed using principal components extraction and direct oblimin rotation. The resultant solution yielded two factors, one corresponding to subjective norms relating to peers; the second corresponding to subjective norms relating to management.

Table 1 shows the correlation matrix and internal consistency coefficients for the measurement scales used in this study. Most of the measurement scales demonstrated adequate internal consistency. The exceptions were the measures subjective norms and norms relating to peers. However, given the number of items in these scales the reliabilities are deemed acceptable for the purposes of further analyses.

	SN	SN1	SN2	IM	OQ	JR	RD	PEOU	PU	US
SN	*.57*	.87*	.62*	.12	.29*	.10	.18	.11	.24*	.09
SN1		*.59*	.18	.15	.31*	.22*	.35*	.20	.39*	.13
SN2			*.85*	.00	.05	-.10	-.19	-.09	-.11	-.03
IM				*.85*	.20	.29*	.15	.09	.31*	.08
OQ					*.70*	.39*	.33*	.48*	.52*	.40*
JR						*.86*	.59*	.36*	.59*	.31*
RD							*.67*	.43*	.52*	.25*

	SN	SN1	SN2	IM	OQ	JR	RD	PEOU	PU	US
PEOU								*.73*	.35*	.44*
PU									*.79*	.45*
US										*.88*

* $p < 0.05$

SN = Subjective Norm, SN1 = Subjective Norm Peers, SN2 = Subjective Norm Management, IM = Image, OQ = Output Quality, JR = Job Relevance, RD = Results Demonstrability, PEOU = Perceived Ease of Use, PU = Perceived Usefulness, US = User Satisfaction

Table 1: Correlation matrix for the measurement scales (Internal consistency coefficients are presented along the main diagonal and in italics)

As anticipated by the proposed model there are significant positive relationships between usefulness and satisfaction and ease of use and satisfaction. There is also a weak correlation between usefulness and ease of use. The extended TAM also predicts significant relationships between norms, image, output quality, relevance, demonstrability and usefulness. These predicted relationships were observed in the data. One exception is the relationship between norms relating to management and usefulness.

Path Analysis results.

Two models based on the extended TAM (Venkatesh and Davis, 2000) were tested using path analysis via AMOS. The first model, Model 1, is presented in Figure 1.

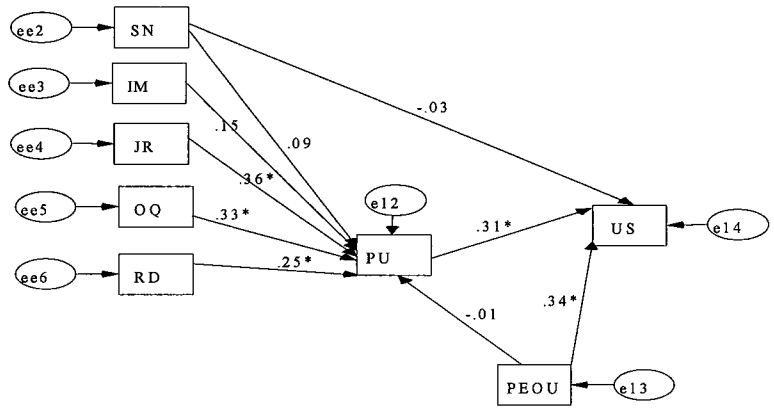

Figure 1: The extended TAM – Model 1 (An asterisk indicates that the coefficient is significant, $p < .05$)

The analysis showed that both usefulness and ease of use predicted user satisfaction (b = .31 and b = .34 respectively), thus failing to provide support for Hypothesis 1. Interestingly, ease of use did not predict usefulness (b=-.01). In addition, norms and image did not predict usefulness, but as predicted relevance, output quality and demonstrability were positively related to usefulness. Notably, there was no direct link between norms and user satisfaction providing some support for the mediational role of usefulness.

When subjective norm (SN) was broken into Peer SN and Management SN components, the relationship in Model 1 change markedly. The results of this modification, referred to as Model 2, are presented in Figure 2.

Figure 2 shows that the path coefficients for the antecedents of usefulness have changed. Most notably we find that both Peers SN and Management SN now predict usefulness. However, output quality and demonstrability are no longer significantly related to usefulness, thus contradicting Hypothesis 4. The path coefficients for output quality and demonstrability have also become non-significant. Furthermore, the path coefficient from usefulness to satisfaction has changed from b = .31 to b = .56, thus providing some support for Hypothesis 1. Again we find that the direct links between the subjective norm measures and satisfaction are non-significant.

Table 2 presents a comparison of goodness of fit indices for Models 1 and 2. Given that the data set had missing values, AMOS does not calculate some of the absolute fit indices. With the exception of the NCS and RMSEA indices, both models fit the data. The NCS for model 1 is close to the more liberal cut-off of 5.0.

DISCUSSION

Our first objective was to test the external validity of the TAM in a mandatory setting. In contrast to other studies we used specific items related to the domain of interest, the incident reporting system, to develop the scales for perceived usefulness, ease of use and user satisfaction (a surrogate for system usage). Factor analysis and reliabilities provided support for the construct validity of the constructs used in this study. Two models based on the extended TAM were tested using path analysis. The first model, Model 1, was supported, providing reasonable goodness of fit indices (Hair *et al.*, 1998). All three determinants of usefulness (relevance, output quality and demonstrability) were significant. However, image was not significant in this setting. This latter finding may be a feature of the subjects used, namely, blue-collar workers. Unlike professionals who may perceive that projecting their image is an important part of their work, supervisory staff in blue-collar settings may not use it among their peers.

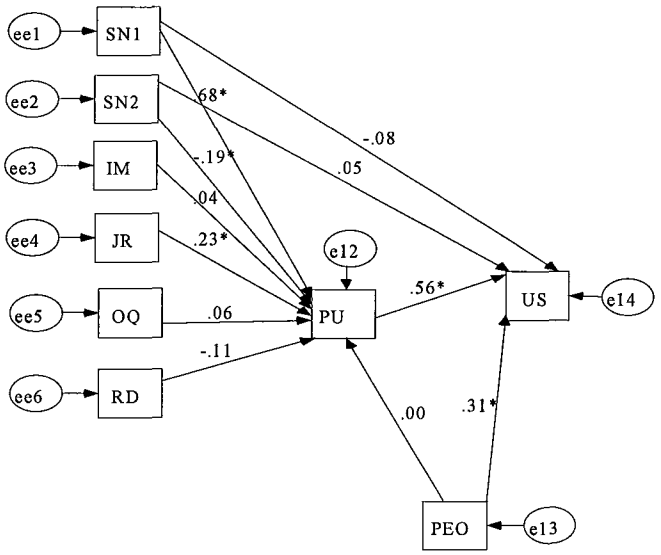

Figure 2: The extended TAM - Model 2 (An asterisk indicates that the coefficient is significant, $p < .05$)

Model	NCS	NFI	IFI	CFI	RMSEA
1	5.356	.948	.958	.957	.229
2	7.171	.918	.929	.928	.273

NCS = Normed chi-squared, NFI = Normed Fit Index, IFI = Incremental fit index, CFI = Comparative fit index, RMSEA = Root mean square error of approximation.

Table 2: Fit indices for Models 1 and 2

This study did confirm that the extended TAM constructs were suitable to partially predict user satisfaction. In the Venkatesh and Davis (2000) study 39% of variation in predicting usage was achieved in their mandatory setting three months after implementation. In addition usefulness and ease of use very equally important in predicting satisfaction (Hypothesis 1), thus providing support for the position posited by Igbaria *et al.* (1997) and Agarwal and Prasad (1997). The current findings suggest that some key factors are missing from the TAM and the extended TAM. Alternatively, these findings may suggest that the applicability of the model is not universal.

We expected a significant direct and indirect (mediated through perceived usefulness) effect of subjective norm on user acceptance (Hypotheses 2 and 3). There was only partial support

for these hypotheses further fuelling the debate regarding the explanatory power of subjective norm (Mathieson, 1991; Hartwick and Barki, 1995; Taylor and Todd, 1995). Venkatesh and Davis (2000) used the theory of internalisation of social influence to argue that even when a system is mandated by the organisation, perceptions of usefulness will respond to social pressure (subjective norm). They argued that the direct compliance effect of subjective norm operates whenever an individual perceives that the important referents have the ability to reward or punish the behaviour.

The items comprising subjective norm in our study included three levels of referents, their peers, their superiors and personnel they were in charge of. As using all three levels may have complicated the construct, we undertook an analysis to separate subjective norm into two variables, Peer SN and Management SN. The creation of two SN variables had a significant effect on our first model. Although Model 2 was less parsimonious, it still provides reasonable goodness of fit indices. The most important difference was that Peer SN was a very significant determinant of usefulness (b=0.68). It also resulted in usefulness becoming a more significant factor in predicting user satisfaction than ease of use as postulated in our first hypothesis.

In addition, there were significant changes to all other determinants of perceived usefulness, with the exception of Job Relevance. Output quality and results demonstrability were no longer significant predictors of usefulness. This finding suggests the type of subjective norm may be context dependent in influencing usefulness. In this study, in which use of the safety management system was mandated, influence from peers had more impact on perceived usefulness than perceived influence from management. It is difficult to discern from this study in influence of organisational culture on variables such as peer SN, but the results do suggest that factors other than individual difference variables may be influential. Future research may consider additional extensions of the TAM to include organisational factors.

In summary, while our study in a mandatory setting supports the extended TAM, it seems that the determinants of usefulness are domain dependant. Not all the antecedents of perceived usefulness were significantly related to usefulness. Job relevance, however, was one variable that consistently predicted usefulness. Participants perceived the safety management system to be useful if it was deemed to job or task relevant. Given that usefulness in turn is a predictor of end user satisfaction, it follows that, at a practical level, in the pre-implementation and implementation phases, management should ensure that users of the system "see" the relevance of system being adopted. Similarly, some attention should be given to the role of peer social pressure in perceived usefulness of a system. The findings in the current study suggest that peer rather than management social pressure influences perceived usefulness. The recognition of this influence in the implementation phase of a system may assist in the acceptability of that system. It follows that there is a need for further studies in different settings to unravel these variations.

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APPENDIX

Measurement scales used in this study

<the reporting system> replaces the name of the reporting system in order to maintain anonymity of the site. Also the site is referred to as "the site" rather than it's company name.

Perceived Usefulness:

1. <the reporting system> helps me find out about safety issues across the plant.
2. <the reporting system> provides a standard way of reporting incidents across the plant.
3. Reporting incidents in <the reporting system> assists me in making safety improvements in my department.
4. <the reporting system> is able to store safety history for future use.
5. <the reporting system> provides a way of sharing my experiences of safety incidents across the plant.

Ease of use:

1. I find it easy to enter incidents into <the reporting system>.
2. I find it takes too long to enter incident details into <the reporting system>.
3. I find that too much detail is required to be entered for each incident.
4. I find that incident reporting in <the reporting system> is user friendly.

Overall satisfaction:

1. How well does the information accuracy of Incidents in<the reporting system> fit what you want?
2. How well does the information format of Incidents in <the reporting system> fit what you want?
3. How well does the ease of use of the incidents system in <the reporting system> fit what you want?
4. How well does the speed of <the reporting system> fit what you want?
5. All things considered how well does the incident system in <the reporting system> fit what you want?

6. Are you satisfied with using the incident system in <the reporting system>?

Job Relevance

1. Reporting the incidents in <the reporting system> helps me take care of the safety of the people for whom I am responsible.
2. Reporting the incidents in <the reporting system> helps me plan corrective actions to prevent safety incident
3. Reporting the incidents in <the reporting system> reassures people that their concerns are being followed up.
4. Reporting the incidents in <the reporting system> is important to me as it helps me to reduce accidents.

Results Demonstrability

1. I believe I could communicate to others the consequences of reporting safety incidents in <the reporting system>.
2. The results of reporting safety incidents in <the reporting system> are apparent to me.
3. I would have difficulty explaining why reporting safety incidents in <the reporting system> may or may not be beneficial.
4. I would be able to show outputs (printouts/screen displays) from <the reporting system> that safety performance has improved by reporting incidents.

Output Quality

1. I find that reporting incidents in <the reporting system> is better than the mainframe system it replaced.
2. I am able to easily print out reports of any of my incidents in <the reporting system>
3. I am always notified by <the reporting system> of all my outstanding corrective actions arising from incidents.
4. The quality of the output I get from <the reporting system> incident system is high.

Image

1. People at <the site> who report incidents in <the reporting system> have more prestige than those who do not.
2. Being able to enter incidents into <the reporting system> is seen by others as a sought after skill
3. Entering incidents into <the reporting system> is not seen by others as productive works
4. People in my organization who report incidents in <the reporting system> have a high profile.

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