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Factors influencing user acceptance of a mature and embedded computer system

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Abstract

Productivity gains associated with investments in information technology (IT) have generally not been forthcoming. One construct that is seen as influencing the extent of individual productivity gains associated with utilising IT is user acceptance. Studies have identified a range of factors that influence acceptance in contexts where use is voluntary. However, in many modern workplaces systems are mature and embedded, affording users limited discretion over use. The current study, therefore, identified factors that influenced acceptance of a mature and embedded computer system, and identified 'number of applications' and 'perceived usefulness' as appropriate measures of acceptance for such systems.

Keywords

User acceptance, mature computer system, embedded, system usage, user satisfaction, perceived usefulness.

INTRODUCTION

Organisations have spent enormous sums of money on IT. It has been estimated that in the year 2000 US $1 trillion was spent on IT worldwide (Davidson 2001). Despite such expenditure, the productivity gains have generally not been forthcoming. This has come to be known as the IT-productivity paradox (Attewell 1994, Gordon 1999). The challenge for researchers and those involved in the development, implementation, and management of systems is to better understand the basis of the productivity paradox so that they can increase the likelihood of achieving performance gains resulting from investments in IT.

One construct that is seen as influencing the extent of individual productivity gains associated with utilising IT is user acceptance. By assessing user acceptance and identifying those factors that influence acceptance, researchers can provide guidance to organisations about how to improve the outcomes from IT investments. However, such guidance needs to be sensitive to particular organisational contexts.

A number of studies have explored user acceptance of technology where use is voluntary (Davis 1989, Davis 1993, Mathieson 1991, Taylor and Todd 1995). However, many of the behaviours in organisations, such as system use, are not volitional (Brown et al. 2002). Researchers have therefore been interested in exploring user acceptance of mandated technologies (Ibid., Roberts and Henderson 2000). There is an assumption that users of mandated technologies have little discretion over the use of a technology. However, a mandate is "an authoritative command" (Merriam-Webster 2003*).* There is sense of being ordered to perform an action, but this does not mean that the action will be performed. If a mandate is to lead to users having limited discretion over system use two conditions need to hold. First, the system needs to be reasonably mature, that is, systems which are generally quite reliable and have gone through a period of iterative development. If a system is immature, such as a first generation bespoke system, there is a chance that even with a mandate to use the technology the system may not function properly and fall into disuse. Second, the system would need to be embedded in the organisation, indicated by the system being well established and employed extensively to support the organisation's business. If the system had been recently implemented, the diffusion or embedding of this technology would only occur if people come to adopt or appropriate the technology (Carroll et al. 2002). The use of the term mandated technology, may therefore not usefully convey the nature of systems in many modern organisations. Instead, it might be more useful to describe such systems as mature and embedded technologies.

The primary aim of this paper is to identify those factors that influence user acceptance of a mature and embedded computer system in an Australian government organisation. The secondary aim is to explore the utility of different measures of user acceptance in such a context.

In the following section, user acceptance measures and factors thought to influence acceptance are reviewed. The study context and methodology are then described. Following this, factors that are related to user acceptance are identified. Finally, the implications of the findings for the selection of acceptance measures, and for system developers, implementers and managers, are considered.

LITERATURE REVIEW

User acceptance of IT

An area that has received considerable attention in the IT research literature is user acceptance of IT. The assumption is that the degree of user acceptance of IT influences the individual and organisational productivity gains that can be achieved by implementing IT (Davis 1989, Goodhue and Thompson 1995, Gelderman 1998). Several measures of user acceptance have been employed including: system usage (Davis 1989, Igbaria et al. 1997, Roberts and Henderson 2000), behavioural intention (Davis 1989, Mathieson 1991, Taylor and Todd 1995) user commitment to a system (Clegg et al. 1997), user's sense of ownership (Clegg et al. 1997), user dependence on the system, or the necessity of the system for effective organisational functioning (Sanders and Courtney 1985, Goodhue and Thompson 1995), user satisfaction (Ives et al. 1983, Doll and Torkzadeh 1988, Clegg et al. 1997, Igbaria and Tan 1997, Al-Gahtani and King 1999, Mahmood et al. 2000), decision-making satisfaction (Sanders and Courtney 1985, Guimaraes et al. 1992), and impact on effectiveness (Igbaria 1990).

There are a wide variety of measures that can be employed to assess user acceptance. An important consideration in deciding which measure to employ is the system context. For example, concerns have been raised about the utility of system usage measures in contexts where users have limited discretion (Ives et al. 1983, Thong and Yap 1996, Roberts and Henderson 2000). Commonly employed system usage measures address the frequency of system use or duration of use. Given the wide uptake and utilisation of computer it is possible that such measures would fail to discriminate effectively between users, since many users would employ systems frequently or for long periods of time, leading to highly skewed data. An alternative approach is to identify the number of applications used (Igbaria and Tan 1997). This might represent a more effective usage measure in limited discretion environments, since in many workplaces employees utilise multiple applications to assist with performing their jobs. While the use of certain applications may be non-discretionary, such as e-mail, the use of other applications may be voluntary, such as using the organisation's Intranet. However, in non-discretionary contexts the measure of choice for researchers is user satisfaction (Thong and Yap, 1996). This is because user satisfaction addresses users' beliefs, which are viewed as being much more variable than their self-reported usage behaviour.

The theoretical grounding for much of the research into user acceptance comes from the technology acceptance model developed by Davis et al. (1989). This model is an adaptation of the theory of reasoned action, which sees beliefs and attitudes as antecedents of future behavioural responses, such as actual system use (Ajzen 1985, Davis 1993). This theoretical perspective is driven by a desire to predict human behaviour (Ajzen 1985). In situations where immature or recently implemented systems are being evaluated, or were use is voluntary, this perspective would appear to be appropriate. However, in many modern workplaces, where system use is well entrenched and non-discretionary then this theory would appear to no longer be applicable. This is because usage of the system is already manifested and largely beyond the control of users. It would seem appropriate to more directly assess the goal of user acceptance measures by assessing users' beliefs and attitudes regarding the impact of IT on their performance. A promising candidate is the measure of perceived usefulness developed by Davis (1989), which assesses "the degree to which a person believes that using a particular system would enhance his or her job performance" (Davis 1989, p. 320).

A number of studies have found perceived usefulness to be a strong and direct determinant of system usage (Davis 1989, 1993, Roberts and Henderson 2000) and user satisfaction (Igbaria et al. 1994, Al-Gahtani and King 1999, Roberts and Henderson 2000). In addition, some studies have employed measures assessing the impact of a system on effectiveness or performance, which are very similar to perceived usefulness, as consequents of system usage and user satisfaction in situations where system use is well established (Goodhue and Thompson 1995, Igbaria and Tan 1997, Gelderman 1998). These studies found that both satisfaction and system usage were direct determinants of performance. These findings suggest that perceived usefulness may be a useful means of assessing user acceptance of IT in contexts where the system of interest is well established.

Researchers assessing user acceptance have also been interested in exploring the extent to which various factors appear to influence users' perceptions of acceptance. The identification of these factors can then be used to facilitate the provision of informed guidance to system developers, implementers, post implementation reviewers, or management about how to gain greater benefits from IT (Davis 1989, Willcocks 1989, Mathieson 1991, Davis 1993).

Factors that influence user acceptance of IT

A range of measures has been employed by researchers interested in exploring factors that influence user acceptance of IT. Figure 1 provides an overview of the types of factors that previous researchers have considered. The factors identified fall into two broad categories: external factors, and beliefs and attitudes. The review of studies will largely be limited to those that have employed measures assessing system usage and user satisfaction, since these are the two most widely used measures of user acceptance (Igbaria et al. 1994).

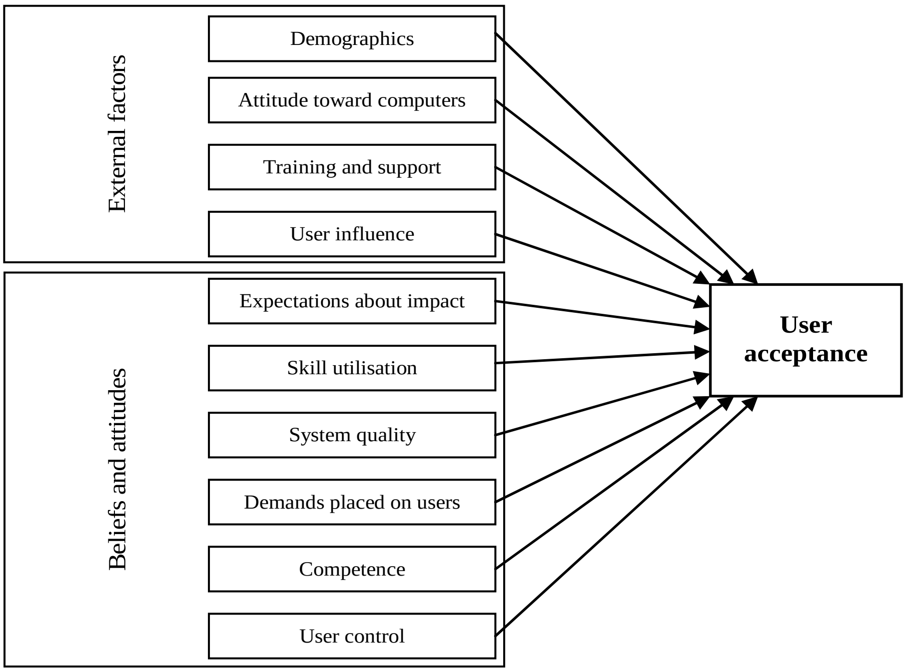

Figure 1: Factors influencing user acceptance of IT

External factors

External factors hypothesised as influencing user acceptance include demographics, attitudes toward computers in general, training and support, and user influence over system design.

Studies have considered the possible influence of demographic variables such as age, gender, length of service, length of time in job, and rank on user acceptance (Igbaria et al. 1989, Clegg et al 1997). The correlational results from these studies provide some support for the view that more senior employees tend to use computers less; but in terms of user satisfaction the results are more equivocal. The one study that used multiple regression analysis failed to find a significant relationship between demographic variables and user acceptance (Clegg et al. 1997).

Clegg et al. (1997) assessed the relationship between users' attitudes to computers in general and a range of user acceptance measures. They found a direct link between user attitudes and user satisfaction.

In terms of training, studies have found support for a positive and direct effect on system usage (Igbaria 1990, Igbaria et al. 1995, Al-Gahtani and King 1999) and user satisfaction (Mahmood et al. 2000). Other studies, however, have found either mixed (Igbaria et al. 1997) or non-significant (Ang and Koh 1997) results. In terms of system support, Igbaria et al. (1995) found evidence for a positive direct effect on usage, however Al-Gahtani and King (1999) failed to find support for this relationship. Studies have also employed measures that combine training and system support. Clegg et al. (1997) found that training and system support was significantly correlated with commitment and satisfaction, however, a multiple regression analysis failed to confirm this result. Thompson et al. (1991) employed a similar measure assessing training and system support, but failed to find a significant relationship with personal computer (PC) use. The inconsistencies in these findings could result from differences in the extent to which the technology was embedded in particular contexts. For example, Ang and Koh (1997) argued that the effect of user training was minimal because the system of interest was a vital part of the work environment.

Mahmood et al. (2000), in a meta-analysis, found that user satisfaction was strongly affected by user involvement in system development. However, Baroudi et al. (1986) only found support for this relationship in eight of the thirteen studies they reviewed. In addition, only four of the nine studies examining the relationship between user involvement and system usage reported significant findings. Clegg et al. (1997), using a measure assessing user influence over system development, failed to find significant correlations with frequency of use or hours of use, but did find a significant correlation with user satisfaction. The relationships between user involvement and both system usage and satisfaction are somewhat equivocal, although there is more consistent support for a relationship between user involvement and satisfaction. The failure to find consistent support for a relationship may result from the systems being assessed already having been implemented for some time, so that any effect of user involvement would have dissipated. It could also be due to low numbers of users being involved in the development process.

Consideration of the above research indicates that the relationship between the external factors and user acceptance was equivocal. In particular, none of the external factors were consistently related to user acceptance where multiple studies were considered.

Belief and attitudinal factors

Belief and attitudinal factors considered by previous researchers include future expectations, skill utilisation, system quality, demands placed on users, competence, and user control.

In terms of users' expectations, Mahmood et al. (2000) found moderate support for the hypothesis that users with higher expectations of the future performance outcomes associated with a system will be more satisfied than those users with more realistic expectations. Clegg et al. (1997) also found significant positive correlations between user satisfaction and two measures assessing users' expectations of the future impact of a computer system on themselves (1), and on their organisation (2). These expectation measures also had positive and significant correlations with hours of use, commitment, and ownership. Following multiple regression analysis, a direct relationship was found between expectations of the system's future impact on the organisation and three of the acceptance measures - commitment, satisfaction and ownership. Similarly, Compeau et al. (1999) found support for a direct positive relationship between performance outcome expectations and system usage, indicating that users who believed that using computers would lead to being better organised, more effective, and more productive also tended to use computers more. However, a negative relationship was found between personal outcome expectations and system usage, indicating that users who believed using computers would increase their chances of gaining promotion, a raise, and greater status tended to use computers less. Compeau et al. (1999) postulated that due to the pervasiveness of computers, the ability to use them is a necessary but not sufficient skill for gaining future rewards, such as a raise or a promotion.

Clegg et al. (1997) assessed the relationship between skill utilisation, the extent to which the system challenged users and provided them with the opportunity to utilise and develop their skills, and a range of user acceptance measures. Skill utilisation was directly related to user satisfaction and ownership, but there was no direct relationship between skill utilisation and the two measures of system usage, hours of use and frequency of use.

System quality measures address such issues as the functionality of a system, equipment performance, reliability, flexibility, usability and ease of use (Clegg et al. 1997, Igbaria et al. 1989). Igbaria et al. (1989) found positive correlations between system quality and all of their system usage measures. Clegg et al. (1997) found that usability was positively related to frequency of use and hours of use, however, a multiple regression analysis failed to provide support for a direct relationship. Igbaria et al. (1995), in a test of their microcomputer usage model, found that the influence of system quality on usage was largely mediated through other variables, with only a small direct effect on usage.

Clegg et al. (1997) assessed the attentional, effort, and error demands placed on users by a system, that is, the extent to which users had to exert mental effort, physical effort, and work hard to avoid or correct errors. They failed to find any significant relationships between these demand measures and a range of user acceptance measures. Thompson et al. (1991), however, did find support for a significant negative relationship between complexity of use and system utilisation, indicating that people who perceived the system to be more complex tended to use the system less. A measure developed by Davis (1989) to assess perceived ease of use is somewhat analogous to measures assessing demands or complexity of use. Studies have generally found that perceived ease of use has an indirect influence on system use, mediated by perceived usefulness, with little or no direct effect on usage (Davis 1989, 1993, Igbaria et al. 1995). This also indicates that ease of use was an antecedent of perceived usefulness. However, contrary to this indirect relationship, Igbaria et al. (1997) found ease of use to be a direct determinant of usage. The relationship between ease of use and user satisfaction has also been explored, with no significant direct effects found (Al-Gahtani and King 1999).

A number of studies have assessed users' feelings of self-efficacy or competence towards use of IT. Compeau et al. (1999) measured computer self-efficacy using such items as "I could complete the job using the software if there was no one around to tell me what to do as I go" (p. 151). The results of their analysis indicated a significant positive relationship between this measure and usage. Henry and Stone (1997) found support for a significant correlation between computer self-efficacy and behavioural intention. Employing a similar measure, but instead labelled as competence, Clegg et al. (1997) found competence to be significantly correlated with frequency of use, but not hours of use. In a meta-analysis, Mahmood et al. (2000) found support for a significant positive relationship between user skills, viewed as being somewhat analogous to self-efficacy, and user satisfaction. Similarly, Blili et al. (1998) found a significant relationship between user ability and information quality.

Clegg et al. (1997) assessed users' perceived method control, timing control, and overall control of a system. These three measures assessed the extent to which users felt they had control over how to use the system, when to use the system, and the extent to which they felt in control of the system overall. Overall control was positively related to frequency and hours of use, however, both method control and timing control failed to correlate significantly with either of these acceptance measures. Furthermore, using multiple regression, none of these control measures predicted hours of use or frequency of use.

Consideration of the above belief and attitudinal factors indicates that performance outcome expectations and competence were the only two factors that consistently predicted user acceptance. Skill utilisation was also directly related to acceptance, but this finding was based on a single study.

In summary, few of the external factors or belief and attitudinal factors were found to have a direct effect on user acceptance. This could have resulted from variations between studies in the measures used to address particular factors. It is also likely that many contextual issues, such as the length of time the system had been in place and the pervasiveness of computers in the work place, may have influenced the relative contribution of those factors thought to influence user acceptance. This suggests that careful attention needs to be given to identifying the nature of the research context and selecting appropriate measures.

METHODOLOGY

This research was undertaken to examine user acceptance of a mature and embedded computer system in an Australian government organisation, and to identify those factors that influence user acceptance. The computer system was mature in the sense that most of the applications on the system were commercial off-the-shelf applications with a long history of iterative development. It was embedded in the sense that the organisation employed computers extensively to support its business and the system in use was well established.

Sample and procedure

The data for this study were collected by means of a paper-based questionnaire disseminated to 346 employees. A total of 188 were returned representing a response rate of 54.3%. After exclusion of incomplete questionnaires, the final sample consisted of 182 respondents.

The age of the participants ranged from 20 to 59 years, with a mean of 39 years. The majority of the sample was male (84%). The length of service of participants ranged from 2 months to 39 years, with a mean of 17 years, and the length of time they had been in their current jobs ranged from 2 weeks to 14 years, with a mean of 20 months.

Measures

Respondents were asked to complete a self-report questionnaire, which was largely composed of measures employing response options anchored on a 5-point Likert-type scale. Three categories of factors were assessed: user acceptance, external factors, and belief and attitudinal factors.

System usage, user information satisfaction and perceived usefulness were used to assess user acceptance. Two measures of system usage were employed: frequency of use (Igbaria et al. 1997) and number of applications used (Igbaria and Tan, 1997). Frequency of use was included in order to test out concerns raised in the literature about the utility of usage measures in non-discretionary contexts (Ives et al. 1983, Thong and Yap 1996, Roberts and Henderson 2000). Number of applications used was included since it was felt that it might be an effective system usage measure in contexts where users have limited discretion. Similarly, a modified form of the user information satisfaction scale develop by Doll and Torkzadeh (1988) was included, because measures assessing user satisfaction are commonly employed when use of a system in non-discretionary (DeLone and McLean 1992, Thong and Yap 1996, Igbaria et al. 1997). Perceived usefulness was also used since it was argued that it could make an appropriate measure of acceptance in the context of an embedded system.

A range of external factors were measured including: demographics (age, sex, length of service, length in job, and rank), attitudes towards computers in general, training and system support, and user influence over system design. Respondents' attitudes to computers in general (eg. self-perceptions of computer literacy), and training and system support were assessed using modified forms of the measures developed by Clegg et al. (1997). The extent of user influence over system design was also assessed using a measure developed by Clegg et al. (1997).

Eight measures, based on those developed by Clegg et al. (1997), were used to assess users' beliefs and attitudes: expectations about the future impact of the system on oneself, expectations about the future impact of the system on the organisation, skill utilisation, two measures of system quality (satisfaction with system design, and usability), demands placed on users (in terms of their mental attention, physical effort and the avoidance and correction of errors), competence, and user control (which was composed of three clusters of items, method control, timing control, and overall control).

RESULTS

Prior to correlation and regression analysis, the variables were assessed in terms of missing values and fit between their distributions and the assumptions of multivariate analysis. The frequency of use measure was removed because more than 91% selected "several times per day" on the rating scale, indicating that this measure failed to effectively differentiate amongst the respondents. Two variables were transformed due to violating assumptions of normality: user influence exhibited an L-shaped distribution, so it was recoded as a bimodal variable; length of time spent in the job was logarithmically transformed due to substantial positive skewness and kurtosis.

Correlations

A correlation matrix using case-wise deletion of missing data was calculated. Table 1 shows the matrix of intercorrelations among the dependent variables, and Table 2 shows the intercorrelations among the dependent and independent variables. Internal consistency reliability coefficients for all the multi-item measures were also calculated and were above the minimum acceptable level for reliability of 0.70 (Nunally, 1978). Length of service was removed prior to conducting regression analysis due to its strong correlation with age ($r = .77$).

The correlations in Table 1 show that perceived usefulness was significantly correlated with the two other measures of user acceptance, number of applications and information satisfaction. However, information satisfaction and number of applications were not significantly correlated.

Variables	(Alpha coefficient)	1	2	3
Number of applications		1.00		
Information satisfaction	(0.95)	0.10	1.00	
Perceived usefulness	(0.92)	0.32**	0.44**	1.00

*p<0.05, **p<0.01

Table 1: Intercorrelations among the dependent variables.

The intercorrelations between the user acceptance variables (dependent) and possible influencing factors (independent) are shown in Table 2. The correlations reveal that the number of applications respondents employed was significantly correlated with their sex, attitudes toward computers, expectations (self, and organisation), user influence, user control, demands on users, skill utilisation, and strongly correlated with competence. Information satisfaction was significantly correlated with sex, job grade, expectations (organisation), competence, training and support, skill utilisation, and strongly correlated with system design and usability. Perceived usefulness was significantly correlated with expectations (self, and organisation), user control, training and support, system design, usability, skill utilisation, and competence.

Variables	(Alpha coefficient)	Number of applications	Information satisfaction	Perceived usefulness
Age		-0.13	0.01	-0.01
Sex		-0.22**	-0.17*	-0.13
Length of service		0.04	0.07	0.13
Length in job		0.08	-0.06	-0.14
Job grade/rank		-0.10	0.17*	0.04
Attitudes toward computers	(0.77)	0.26**	-0.12	0.10
Training and support	(0.75)	-0.02	0.30**	0.22**
User influence		0.44**	-0.12	0.05
Expectations (self)	(0.79)	0.27**	0.04	0.39**
Expectations (organisation)	(0.88)	0.24**	0.16*	0.39**
Skill utilisation	(0.71)	0.20**	0.27**	0.32**
System design	(0.86)	0.13	0.51**	0.46**
Usability	(0.89)	0.11	0.57**	0.46**
Demands on users	(0.81)	0.25**	-0.09	-0.05
Competence	(0.88)	0.56**	0.19*	0.29**
User control	(0.80)	0.34**	0.14	0.33**

*p<0.05, **p<0.01

Table 2: Intercorrelations between the dependent and independent variables.

Multiple regressions

The results of the standard multiple regression analyses for the three user acceptance variables are summarised in Table 3. The analyses show that the 15 independent variables explained 51% of the variance (Adjusted R^2) in number of applications employed by respondents, 43% of information satisfaction, and 40% of perceived usefulness. Competence explained 12% of the variance in number of applications, with user influence explaining 6%, demands on users 3%, and 1% each for age, job grade, and expectations (self). The two system quality measures, system design and usability, together explained 6% of the variance in information satisfaction. Sex explained 5% of the variance, attitudes toward computers 3%, and user influence, expectations (self), skill utilisation and user control each explained 2%. System design explained 4% of the variance in perceived usefulness, user control explained 3%, and expectations (self) contributed 2%.

Variables	Number of applications		Information satisfaction		Perceived usefulness	
	β values	Semi-partial r^2	β values	Semi-partial r^2	β values	Semi-partial r^2
Age	-0.15*	0.01	-0.00	--	0.05	--
Sex	-0.04	--	-0.25**	0.05	-0.07	--
Length in job	0.07	--	-0.05	--	-0.13	0.01
Job grade	-0.16*	0.01	0.12	0.01	0.03	--
Attitudes toward computers	-0.02	--	-0.21**	0.03	0.01	--
Training and support	-0.08	--	0.07	--	-0.07	--
User influence	0.26**	0.06	-0.15*	0.02	-0.05	--
Expectations (self)	0.15*	0.01	-0.17*	0.02	0.19*	0.02
Expectations (organisation)	-0.06	--	-0.01	--	0.10	0.01
Skill utilisation	0.03	--	0.16*	0.02	0.14	0.01
System design	0.06	--	0.27**	0.04	0.27**	0.04
Usability	0.01	--	0.23*	0.02	0.11	--
Demands on users	0.20**	0.03	-0.08	--	-0.12	0.01
Competence	0.48**	0.12	0.08	--	0.09	--
User control	0.09	--	0.15*	0.02	0.21**	0.03
Adjusted R^2	0.51		0.43		0.40	

*p<0.05, **p<0.01, -- = Semi-partial r^2 value <0.005

Table 3: Multiple regression analyses for the three user acceptance variables.

DISCUSSION AND CONCLUSIONS

This study identified factors that influenced user acceptance of a mature and embedded computer system in an Australian government organisation. In this context, it was important to identify measures that would effectively represent user acceptance and adequately differentiate between participants. The four measures employed to assess acceptance were: frequency of use, the number of applications used, user information satisfaction and perceived usefulness. The frequency of use measure failed to effectively differentiate between respondents. This is consistent with the view that system usage measures have limited utility in non-discretionary contexts. However, the other system usage measure, number of applications used, did effectively differentiate between respondents. This measure therefore appears to be appropriate for use in contexts where users have limited discretion. The information satisfaction measure was selected since it is commonly employed by researchers interested in assessing user acceptance when use of a system is non-discretionary (DeLone and McLean 1992, Thong and Yap 1996, Igbaria et al. 1997). Information satisfaction also effectively differentiated between respondents. Perceived usefulness has not previously been employed as a user acceptance variable. However, it was argued that it could make an appropriate measure of user acceptance. The significant correlations between perceived usefulness, and both number of applications and information satisfaction lends support to this view.

It is useful to identify the extent to which key stakeholders involved in the development, implementation and management of systems have control over the various factors (Thompson et al. 1991). It follows that those factors that are at least partially controllable should be the focus of attention for improving user acceptance. Whereas the demographic variables are largely not controllable, the remaining external factors and the various beliefs and attitudes about the system and its impact, appear to be partially controllable.

First, the results suggest that the number of applications employed by users might be increased by improving users' perceptions of competence and by giving more users influence over system development. User perceptions of competence in using the system explained 12% of the variance, that is, people who believed they were capable of using the system effectively also tended to use a greater number of applications. This is consistent with previous studies that have found a positive link between competence, or self-efficacy, and system usage (Compeau et al. 1999, Clegg et al. 1997, Roberts and Henderson 2000). User influence over system development accounted for 6% of the variance in usage. This lends support to the idea that users who are involved in the development process will exhibit greater levels of acceptance of the system (Baroudi et al. 1986).

One strategy for improving the overall level of competence of users would be to recruit personnel with significant experience in using computers. Improving the quality of system support and training could also enhance competence, however, training and system support was not significantly correlated with competence, nor with the number of applications used. It is perhaps the case that training and system support provides enough guidance and skills to allow basic users to adequately employ computers in their work, but it is not sufficient for them to feel competent using computers. Competence is more likely to be enhanced by the provision of training and support which is sensitive to the particular work context within which users find themselves.

Second, the two system quality variables, system design and usability, were significant determinants of user information satisfaction. These two variables together explained 6% of the variance. By improving the reliability, flexibility, functionality and ease of use of the system, developers and designers could increase users' satisfaction with the information provided by the system. However, improving the quality of information provided by a system requires more that just improving system quality. There is also a need to address the content and accuracy of information. These are not always under the control of the system. For example, the accuracy of information on websites or databases designed to support decision making is often dependent on the information provided by the author or database operator. Improving the content and accuracy of information will therefore require improvements in personnel performance and the supporting information management processes.

Third, users' perceptions of the usefulness of the system in enhancing their performance were significantly influenced by system design, expectations about the system's future impact on themselves, and their feelings of control over the system. System design accounted for 4% of the variance. This result is supported by a previous study, which found that system quality had a direct influence on perceived usefulness (Igbaria et al. 1995). User control explained 3% of the variability in perceived usefulness, which indicates that users who perceived they had control over how to employ the system tended to also believe that the system enhanced their job performance. Finally, users' expectations about the future impact of the system on themselves were a significant predictor of perceived usefulness.

The extent to which people believe that the system enhances their work performance could be increased through improving the design of the system. While aesthetics and user friendliness can be important, in order for a system to enhance work performance it must provide certain functionality. For bespoke applications, much effort needs to be expended on iterative identification, development and testing of functionality. However, many organisations rely heavily on commercial off-the-shelf applications. These applications are often designed to address the needs of a wide variety of users. Consequently, such applications tend to have considerable functionality, which is only partially employed by particular users, and much is beyond the awareness of users. 'Improving' the functionality of such applications therefore could involve facilitation of a discovery process between users, such as helping to establish an application 'hints and tips' discussion forum.

Enhancing perceived usefulness through improving or managing expectations presents a difficult challenge. The nature of the statements used, such as "In future, I expect that this system will lead to a more responsible job for me," suggests that users' expectations are likely to be influenced by non system factors. In particular, it is the nature of users' roles, supported by the system, which would influence their expectations. This suggests that positive expectations will result from improving the richness, variety, completeness and responsibility of users' jobs, and by ensuring that any changes to the system do not reduce these features of their work. The user control measure assessed the extent to which users felt they had control over how to use the system, when to use it, and the extent to which they felt in control. Such issues are also not just dependent on the system, but are influenced by the context within which it is used. Improving user control might involve increasing user competence, that is, improving their mastery over the system, increasing the flexibility of the system, or increasing the discretion of users over how and when they undertake work that is supported by the system.

A better understanding of those factors that influence user acceptance of IT promises to provide insights into some of the reasons underlying the IT - productivity paradox. This study has identified a variety of different factors that influenced user acceptance in the context of a mature and embedded computer system in an Australian government organisation. Strategies for improving user acceptance have also been identified. A significant contribution of this study is the identification of perceived usefulness and the number of applications used as appropriate measures of user acceptance in contexts where a computer system is mature and its use is embedded or largely non-discretionary. The views of previous researchers regarding the value of using user information satisfaction as a measure of user acceptance have also been reinforced.

REFERENCES

Ajzen, I. (1985) From intentions to actions: a theory of planned behavior, In J. Kuhl and J. Beckmann (Eds.), *Action control: from cognition to behavior* (pp. 11-39) New York: Springer Verlag.

Al-Gahtani, S. and King, M. (1999) Attitudes, satisfaction and usage: factors contributing to each in the acceptance of information technology, *Behaviour and Information Technology,* 18(4), 277-297.

Ang, J. and Koh, S. (1997) Exploring the relationships between user information satisfaction and job satisfaction, *International Journal of Information Management,* 17(3), 169-177.

Attewell, P. (1994) Information technology and the productivity paradox, In D. Harris (Ed.), *Organizational linkages: understanding the productivity paradox* (pp. 13-53) Washington, D.C.: National Academy Press.

Baroudi, J., Olson, M. and Ives, B. (1986) An empirical study of the impact of user involvement on system usage and information satisfaction, *Communications of the ACM,* 29(3), 232-238.

Blili, S., Raymond, L. and Rivard, S. (1998) Impact of task uncertainty, end-user involvement, and competence on the success of end-user computing, *Information and Management,* 33, 137-153.

Brown, S., Massey, A., Montoya-Weiss, M., and Burkman, J. (2002). Do I really have to? User acceptance of mandated technology. *European Journal of Information Systems*, 11, 283-295.

Carroll, J,. Howard, S., Vetere, F., Peck, J and Murphy, J. (2002) Just what do the youth of today want? Technology appropriation by young people, *Proceedings of the 35th Hawaii International Conference on Systems Sciences*, 1-9.

Clegg, C., Carey, N., Dean, G., Hornby, P. and Bolden, R. (1997) Users' reactions to information technology: some multivariate models and their implications, *Journal of Information Technology,* 12, 15-32.

Compeau, D., Higgins, C. and Huff, S. (1999) Social cognitive theory and individual reactions to computing technology: a longitudinal study, *MIS Quarterly,* 23(2), 145-158.

Davidson, J. (2001, 6-7 January) Surviving the tech stock debacle*, The Australian Financial Review - Weekend,* pp. 22-23.

Davis, F. (1989) Perceived usefulness, perceived ease of use, and user acceptance of information technology, *MIS Quarterly,* 13(3), 319-339.

Davis, F. (1993) User acceptance of information technology: system characteristics, user perceptions and behavioral impacts, *International Journal of Man-Machine Studies,* 38, 475-487.

Davis, F., Bagozzi, R. and Warshaw, P. (1989) User acceptance of computer technology: a comparison of two theoretical models, *Management Science,* 35(8), 982-1003.

DeLone, W. and McLean, E. (1992) Information systems success: the quest for the dependent variable, *Information Systems Research,* 3(1), 60-95.

Doll, W. and Torkzadeh, G. (1988) The measurement of end-user computing satisfaction, *MIS Quarterly,* 12(2), 259-274.

Gelderman, M. (1998) The relation between user satisfaction, usage of information systems and performance, *Information and Management,* 34, 11-18.

Goodhue, D. and Thompson, R. (1995) Task-technology fit and individual performance, *MIS Quarterly,* June, 213-236.

Gordon, R. (1999) Has the "new economy" rendered the productivity slowdown obsolete? Northwestern University, 14 June.

Guimaraes, T., Igbaria, M. and Lu, M. (1992) The determinants of DSS success: an integrated model, *Decision Sciences,* 23, 409-429.

Henry, J. and Stone, R. (1997) The development and validation of computer self-efficacy and outcome expectancy scales in a nonvolitional context, *Behavior Research Methods, Instruments, & Computers,* 29(4), 519-527.

Igbaria, M. (1990) End-user computing effectiveness: a structural equation model, *International Journal of Management Science,* 18(6), 637-652.

Igbaria, M., Guimaraes, T. and Davis, G. (1995) Testing the determinants of microcomputer usage via a structural equation model, *Journal of Management Information Systems,* 11(4), 87-114.

Igbaria, M., Pavri, F. and Huff, S. (1989) Microcomputer applications: an empirical look at usage, *Information and Management,* 16, 187-196.

Igbaria, M., Schiffman, S. and Wieckowski, T. (1994) The respective roles of perceived usefulness and perceived fun in the acceptance of microcomputer technology, *Behaviour and Information Technology,* 13(6), 349-361.

Igbaria, M. and Tan, M. (1997) The consequences of information technology acceptance on subsequent individual performance, *Information and Management,* 32, 113-121.

Igbaria, M., Zinatelli, N., Cragg, P. and Cavaye, A. (1997) Personal computing acceptance factors in small firms: a structural equation model, *MIS Quarterly,* 21(3), 279-305.

Ives, B., Olson, M. and Baroudi, J. (1983) The measurement of user information satisfaction, *Communications of the ACM,* 26(10), 785-793.

Mahmood, M., Burn, J., Gemoets, L. and Jacquez, C. (2000) Variables affecting information technology end-user satisfaction: a meta-analysis of the empirical literature, *International Journal of Human-Computer Studies,* 52, 751-771.

Mathieson, K. (1991) Predicting user intentions: comparing the technology acceptance model with the theory of planned behaviour, *Information Systems Research,* 2(3), 173-191.

Merriam-Webster's Collegiate Dictionary (2003) 11th Edition. Merriam Webster Inc. and Franklin Electronic Publishers Inc.

Nunally, J. (1978) *Psychometric theory (2nd Edition)* McGraw-Hill: New York.

Roberts, P. and Henderson, R. (2000) Information technology acceptance in a sample of government employees: a test of the technology acceptance model, *Interacting with Computers,* 12, 427-443.

Sanders, G. and Courtney, J. (1985) A field study of organisational factors influencing DSS success, *MIS Quarterly,* March, 77-89.

Taylor, S. and Todd, P. (1995) Understanding information technology usage: a test of competing models, *Information Systems Research,* 6(2), 144-176.

Thompson, R., Higgins, C. and Howell, J. (1991) Personal computing: toward a conceptual model of utilisation, *MIS Quarterly*, March, 125-143.

Thong, J. and Yap, C. (1996) Information systems effectiveness: a user satisfaction approach, *Information Processing and Management,* 32(5), 601-610.

Willcocks, L. (1989) Information technology in public sector settings: towards effective systems, *International Journal of Public Sector Management,* 2(3), 15-29.

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