Determinants of professionally autonomous end user acceptance in an enterprise resource planning system environment

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A B S T R A C T
To fully exploit the capabilities of complex technologies, businesses must deliberately foster technology acceptance by end users. This deliberate activity must recognize the complexity of factors that influence individuals’ perceptions, intentions, and usage of information technology. This study surveyed 66 professionally autonomous end users and gathered information on their perceptions related to several technology acceptance factors for a newly installed enterprise resource planning (ERP) system component. Study analyses focused on end user perceptions of ERP component usefulness, their intention to use the system, and self-reported usage of a system component. Valuable insights into the perceptions of professional end users toward a component of a complex technology were gained. Recommendations based upon the results of this study include: (a) clearly describe, early in the implementation process, an overall picture of the ERP system flow and visually show end users how the components they use “fit” into the whole system; (b) convert ERP-related “tech talk” to common end user language by either clear explanation of unique terms or associations of new terms to ones commonly understood by end users, and (c) provide adequate resources (financial, physical, human, etc.) to ensure that end users have access to timely support.

1. Introduction

Technology’s ever-present grasp continues to influence individuals’ and societies’ interactions, just as it has for decades. For businesses, the ever-expanding amount of information that has to be managed leads to an increase in system integration and complexity. This leads ultimately to a redefinition of skills required of proficient end users and the variables that influence user acceptance of information systems.

One of the issues in information management is getting the right information to the right person at the right time and in a usable form (Robertson, 2005). Without technology acceptance users might only use the system superficially to enter/store data but not to explore its full potential; i.e. to analyse the information to gain a competitive advantage.

The pervasive use of technology, particularly in business contexts, and the need for individuals to accept and use it, continues to fuel research of technology acceptance. Moon and Kim (2001, p. 1) posits that technology acceptance varies with technology, target users, and context. Prediction of system use in mandatory adoption contexts of complex systems that span multiple functional units and organizations, such as enterprise resource planning (ERP) system implementations, is an important issue in technology acceptance. Equally important to the prediction of technology usage is the question of can we discover what perceptions end users have about the usefulness of specific systems and their components. Professionally autonomous (Lin, 2004, p. 14) end users, i.e. individuals possessing considerable latitude in both how they allocate their work time and what technology they use to complete work assignments, represent a significant number of complex business technology end users. Specifically, academic end users have significant professional autonomy which translates to a spectrum of technology usage levels and unique perspectives regarding acceptance of complex technology.

For decades, information technology (IT) researchers have studied human–computer interactions and the measurement of technology acceptance, the result of which has been the extensive testing of Davis’s (1989) technology acceptance model (TAM). TAM and other technology acceptance models and theories measure technology acceptance as use of the system; consequently acceptance and usage terms are used interchangeably (Davis, 1989; Davis, Bagozzi, & Warshaw, 1989; Mathieson, 1991; Morris & Venkatesh, 2000).
This study examines technology acceptance variables for highly educated, professionally autonomous end users of an ERP component to understand significant variables’ correlation and predictive effects on perceived usefulness and usage constructs. The rest of the paper is structured as follows: Section 2 gives a brief literature review of ERP and TAM papers related to our study. Section 3 describes the research model and hypotheses, followed by details of the methodology in Section 4. Section 5 shows the results of the study, and finally, Section 6 provides a discussion of the findings and conclusions.

2. Literature review

The review is divided into three parts. The first part gives a short overview of ERP and literature related to ERP implementation, the second part reviews the original technology acceptance model and discusses TAM extensions, and the third part discusses TAM studies applied to ERP system implementations.

2.1. Enterprise resource planning

The term ERP refers to popular business management systems that (a) integrate multiple business facets; (b) use client/server applications; and (c) allow the sharing of organizational information across departmental, subsidiary, and corporate delineations to achieve enterprises’ competitive goals (Axam & Jerome, 2003; Dunlap, 2005; Nah, Tan, & Teh, 2004). According to Axam and Jerome (2003), ERP is “the de facto backbone of business intelligence” (p. 1); yet in 2004, the Gartner Group indicated that enterprises deploying ERP solutions not only significantly exceeded implementation cost and time estimates but also failed spectacularly “due to unplanned or underplanned implementation projects” (Axam & Jerome, 2003, p. 1). ERP systems “require significant organizational resources and their implementation is inherently risky due to large investments required. Thus, ERP systems represent a completely different class of IT application compared with traditional and simple IT systems” (Amaoko-Gyampah & Salam, 2004, p. 732) examined by previous research.

Contemporary research has chronicled global advances in technological innovations, such as ERP, across many disciplines. IS research, while dominated by the topic of information technology usage/operation, is also focused on technology transfer, which includes innovation, acceptance, adoption, and diffusion (Glass, Ramesh, & Vessey, 2004). Given the fact that ERP implementations’ failure rates exceed 50 percent (Barker & Frolick, 2003; Brown, 2004; Scheer & Habermann, 2000) and that this innovative technology has received little academic IS research attention (Amaoko-Gyampah & Salam, 2004; Brown & Vessey, 1999; Gallivan, 2001; Nah et al., 2004), researchinto variables that influence why ERP implementations succeed or fail is of great interest to a wide variety of stakeholders.

2.2. Technology acceptance models

Researchers in the IS field are said to “consider TAM one of the information systems fields’ own theories” (Lee, Kozar, & Larsen, 2003, p. 753) and have incorporated and extended TAM’s original constructs to research covering a variety of systems and contexts (Davis, 1989; Davis et al., 1989; Mathieson, 1991; Taylor & Todd, 1995; Venkatesh et al., 2003). However, Hwang (2005) states that, “there is an increased need for studies that examine and extend TAM in a complex IT setting” (p. 152). Lee et al. (2003) also note that several leading IS researchers (Taylor & Todd, 1995; Venkatesh, 2000; Venkatesh & Davis, 2000) call for further studies in mandatory settings. The following paragraph will briefly discuss the original TAM, and an extension of TAM by Venkatesh and Davis (2000) called TAM2.

Since the original development of TAM by Davis (1989), a wide variety of studies were conducted that used that instrument and meta-analysis studies on TAM research. Since 1990, researchers have studied several combinations of TAM with other well-tested models, attempting to extend this robust technology acceptance model. Venkatesh et al. (2003) posit a new Unified Theory of Acceptance and Use of Technology (UTAUT) model which integrates elements from eight previously validated models into a “Unified” causal model. Venkatesh et al. (2003) hypothesize and empirically support UTAUT, a model which includes “three direct determinants of intention to use (performance expectancy, effort expectancy, and social influence) and two direct determinants of usage behavior (intention and facilitating conditions)” (p. 466). To date, empirical testing of this new UTAUT model is limited.

Venkatesh and Davis (2000) extend the original TAM by incorporating three social influence processes (subjective norm, voluntariness, and image) and four cognitive instrumental processes (job relevance, output quality, result demonstrability, and perceived ease of use) relative to the original TAM perceived usefulness construct. A second article by Venkatesh (2000) also extends TAM for the perceived ease of use construct; however, the usefulness construct is the focus of the current study. Thus, references to TAM2 in this study represent the Venkatesh and Davis (2000) model extending the perceived usefulness exclusively. Venkatesh and Davis’ TAM2 model research not only extended the model but also resulted in the validation of an expanded instrument to measure technology acceptance.

2.3. TAM and enterprise resource planning systems

Gallivan (2001) establishes the theoretical framework for his longitudinal study by combining organizational-level knowledge gained from technology implementation research and conceptual-level insight of constructs related to Rogers (1976), and Prescott and Conger’s (1995) traditional innovation adoption models. The author melds the implementation events and the factors that influence them from his study’s IT department participants into a complex process/variace model divided into two stages of assimilation, early and later. Ultimately, the primary result of Gallivan’s (2001) longitudinal study was the creation of themes and cause-and-effect relationships of factors on assimilation. Gallivan offers these contributions, the culmination of his case study, and summarizes his study “as propositions for future examination and empirical validation” (Gallivan, 2001, p. 78).

Another ERP related cross-sectional study, which used a TAM2-based survey, was conducted in an on-line analytical processing (OLAP) environment. Hart and Porter (2004) surveyed 65 companies in South Africa licensed to use an industry top-ranked OLAP product. The TAM2 model used in Hart and Porter’s study included only the independent variables collectively referred to as cognitive instrumental processes (CIP) (Venkatesh & Davis, 2000). Hart and Porter (2004) found that the variables perceived ease of use, result demonstrability, output quality, and job relevance are positively associated to the dependent variable, perceived usefulness. Therefore they conclude, “the TAM2 extension improves understanding of the effect of users’ cognitive processes on perceived usefulness of a technology” (p. 54).

Nah et al. (2004) conducted a single-site survey of 229 end users of a Midwestern U.S. public institution approximately 1-year post SAP R/3 implementation. The research model used for the study incorporated the original TAM constructs, perceived usefulness
Failure more research in the area of technology acceptance, especially of complex systems is needed. The original TAM model is well established and tested. In addition, a variety of extensions have emerged to further investigate the different constructs and adapt the model to a variety of IT environments. Very few studies have been conducted regarding technology acceptance of ERP systems especially those dealing with autonomous end users. Our study will contribute to the body of knowledge in that specific area.

3. Research model and hypotheses

The current study is a quantitative, one-group, correlational study that utilizes two survey instruments: a minimally adapted TAM2 questionnaire and usage self-report scales. The constructs investigated in this study were perceived ease of use and perceived usefulness from the original TAM and result demonstrability and subjective norm from the extended TAM2. The research model including the hypotheses tested is shown in Fig. 1.

The four hypotheses studied were:

H1. Participant’s perceived ease of use regarding the Banner ERP system will be significantly related to the perceived usefulness they report.

Perceived ease of use is defined as “the extent to which a person believes that using a particular system will be free of effort” (Davis, 1989, p. 320). Perceived usefulness is defined as “the extent to which a person believes that using a particular system will enhance his or her job performance” (Davis, 1989, p. 320). In our study the “particular system” is the Banner ERP system. Earlier research (e.g., Amoako-Gyampah & Salam, 2004; Davis, 1989) showed that perceived ease of use is positively correlated with perceived usefulness. For our study, we hypothesize that if users consider the Banner ERP system easy to use they will also find it more useful.

H2. Participant’s acknowledgement of the Banner ERP system results, as measured by TAM2 result demonstrability scales, will be significantly related to the perceived usefulness they report.

Result demonstrability is defined as “tangibility of the results of using the innovation” (Moore & Benbasat, 1991, p. 203), i.e., users credit gain in their job performance to system usage. Users who can relate increases in their job performance should perceive the system as more useful than users that do not experience that connection.

H3. Participant’s perceptions of social influence, as measured by TAM2 subjective norm scales, will be significantly related to the perceived usefulness they report.
Subjective norm is defined as “a person’s perception that most people who are important to him think he should or should not perform the behavior in question” (Fishbein & Ajzen, 1975, p. 302). This construct is of particular interest for this study. On the one hand, professionally autonomous end users might not be as susceptible to subjective norms as other users because of their autonomy. On the other hand, since the system under study is mandatory and performance evaluations might be influenced by the use of the system, e.g., faculty members who refuse to use the systems might be reprimanded by their department heads.

H4. Participant’s perceived usefulness of the Banner ERP system will be significantly related to the amount of usage they report.

Consistent with TAM and TAM2 we expect a positive relationship between perceived usefulness and usage behavior.

4. Methodology

4.1. Sample

Rural 2-year Utah colleges were selected as a purposive sample for this study for their ERP implementation timing, faculty’s autonomous end user characteristics, and government-funded institution classifications. Faculty members have broad professional autonomy in completing their job responsibilities, as do other professional employees in many government-funded industries.

To facilitate high response rates for the study, several strategies were used to encourage participation by the targeted individuals. The response strategies included: a pre-study descriptive letter requesting their participation in the study; personal, face-to-face requests to groups of potential participants to individualize the request; and the option of completing the survey on-line or in a paper form to give participants a choice of how they participated in the study survey. Electronic surveys were accessed via a WebCT (now Blackboard, http://www.blackboard.com) based site. WebCT is a web-based system that supports e-Learning and information sharing and is used as the course management system throughout the Utah educational network. Participants could alternatively complete a paper survey version accessible on-line as an email attachment.

4.2. Survey instrument

In addition to demographic items the current study utilizes two survey instruments, TAM2 and Davis’ (1989) original self-reported usage questions. The TAM2 questionnaire (Venkatesh & Davis, 2000), with some minor wording adaptations to reflect the specific university environment, was used to assess user’s perceived usefulness, perceived ease of use, and behavioral intention to use the Web Self-Service component. All TAM2 survey items used a 7-point Likert scale to measure responses. The scale ranged from 1 = “strongly disagree” to 7 = “strongly agree.”

At the end of the demographic section of the survey, respondents were asked three average usage and open-ended questions about perceived positive/negative aspects of the system.

4.3. Pretest

A focus group and pilot study group of educational administrators, faculty members, and staff employees reviewed the instruments prior to data collection to ensure appropriate adaptation of measurement items. The primary objectives of conducting the pilot study were to (a) test the study instrument, (b) test the WebCT electronic data gathering site, and (c) elicit feedback on both the instrument and the site. Only minor changes to the instruments’ instructions were requested; there were no problems reported with the WebCT site.

4.4. Data collection and demographics

The study included 204 potential participants from four Utah, 2-year college sites. A total of 74 individuals completed the survey; however, only 66 surveys (32%) were usable. Of the participants completing the survey, 62 were classified as faculty, 8 were staff, and 4 were administrators. The 74 participants of the sample included 51 males and 23 females; this distribution equaled the potential participant-pool gender mix. The participants’ age ranged from 30 to 74, with an average age of 49. The education level of over 85% of participants was a master’s degree or higher. The respondents reported an average of 18 total years working in education, ranging from 1 to 46 years, and an average of almost 12 years in their current position.

Participants were representative of all academic areas with the most responses from the business/economics and science areas. The average time respondents used the system weekly was 85 min.

5. Analysis and results

5.1. Instrument reliability and validity

The scales used in this study contain previously validated items from prior research (Davis, 1989; Taylor & Todd, 1995; Venkatesh & Davis, 2000). However, reliability and construct validity of the instrument were assessed using the data from the present study.

Reliability of the current study data was addressed from two perspectives: (a) for the entire instrument, and (b) for each individual subscale. SPSS was used to calculate statistics for internal consistency reliability tests. The overall Cronbach’s alpha coefficient for the data gathered from the TAM2 instrument was .88 (based on the theoretical model consisting of all nine constructs), suggesting that the 28 scales are internally consistent and result in a high degree of reliability. Further item analysis by construct resulted in Cronbach’s alpha ranging from .68 to .93. These levels are similar to other TAM/TAM2 survey studies.

Construct validity of the survey instrument was addressed using a confirmatory factor analysis. Factor loadings were significant (p < .01) without exception. All items loaded onto their nine respective factors and exceeded .60, with the exception of three manifest variables. The result demonstrability items one and four plus subjective norm item three, however, had factor loadings of .42, .53, and .42, respectively. These lower-strength factor loadings, while of concern, represented accurate measures of their respective constructs and were retained. Overall, the scales accurately measured the constructs they were designed to measure. Discriminant validity was established by assessing that each item loaded higher on the construct it measured than on any other construct.

5.2. Path analysis of original model

Based on the literature reviewed, the primary constructs of interest in this study were perceived ease of use, result demonstrability, subjective norm, perceived usefulness, and intention. The research model was tested using structural equation modeling software LISREL.

As illustrated in Fig. 2 three of the four paths showed a statistically significant relationship.
5.3. Path analysis of alternative model

Since data had been collected on all TAM2 constructs, multiple path analyses were performed to investigate the acceptability of an alternative path model (Fig. 3) and to determine whether other TAM2 variables more closely predicted the usage variable for these data. Due to sample size constraints, a structural equation model using all items was not possible. Therefore, the results of the CFA were used to guide the data reduction approach where items within each construct were averaged. Two additional constructs show a statistically significant relationship with perceived usefulness: output quality and job relevance.

Output quality goes beyond looking at what tasks a system is capable of performing and the degree to which those tasks match the user’s job description. Output quality looks at how well a system performs those tasks. (Venkatesh & Davis, 2000, p. 191). Job

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<tr>
<th>Table 1</th>
<th>Path analyses results and model fit indices.</th>
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<td>Model: predictor</td>
<td>Usefulness</td>
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<td>$R^2$</td>
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* $p < .05$, ** $p < .01$, *** $p < .001$.

a Borderline significant at $p = .057$.
b Borderline significant at $p = .055$.c
relevance is defined as “an individual’s perception regarding the degree to which the target system is applicable to his or her job” (Venkatesh & Davis, 2000, p. 191).

Tests of the alternative model resulted in the indication of moderate model fit coupled with the possibility of improved variance prediction for all three paths. Table 1 includes the fit indices for the original and alternative models.

The first path in Fig. 3 was revised by adding the predictors of output quality and job relevance to perceived ease of use, and omitting result demonstrability and subjective norm since they were non-significant in the original model. The coefficient for the perceived ease of use construct in the final model was considered a borderline-significant predictor (p = .057). Accordingly, the perceived ease of use construct was retained for the final path model and the first null hypothesis was clearly rejected (p < .01) in support of the alternative, a direct correlation between perceived ease of use and usefulness.

Next, the second path was tested using intention as the criterion variable. This analysis included the previously supported path variables plus other possible predictor variables. Results of the second path regressions estimated perceived usefulness as the only statistically significant predictor variable for intention to use (p < .001).

An additional test was conducted at this point to determine if perceived usefulness was a direct predictor of usage for these data, in other words to test the possibility of a two-path versus a three-path model. The results of this test supported the theoretical-based (Davis et al., 1989; Venkatesh & Davis, 2000; Venkatesh et al., 2003); full moderation of usefulness on usage by intention. The result of the third and final path analysis estimated intention to use as the only borderline-significant predictor (p = .055) for usage. The fourth study hypothesis, therefore, cannot be rejected; however, considering the borderline-significant result, it is possible that different sample data may cause this null hypothesis to be rejected and a clear correlation between usefulness and usage may be supported. There were no significant interactions or moderating relationships found in the path model. The parameter estimates and fit indices are presented in Table 1.

Fig. 3 represents the final path model with the standardized beta coefficients for each relationship. The explanation of the variance in usefulness increased from .48 to .60 in the final model. Overall, the fit indices for the current data declined slightly with the final path model over the alternative model; however, the increase in the variance of usefulness explained was considered a more accurate indicator of model fit for the data.

Tests for linearity and normality assumptions, and potential multicollinearity, were performed and revealed no problems.

6. Discussion and conclusion

Christensen (1998) investigated the connection between positive attitudes toward IT as precursors to effective technology use, concluding that additional verification of this relationship could significantly impact the way individuals are trained to use technology. To fully exploit the capabilities of complex technologies, businesses must deliberately foster technology acceptance by end users. This encouragement activity must recognize the complexity of factors that influence individuals’ intentions to use IT. In this study, a survey of rural-Utah higher education faculty perceptions of the usefulness of an ERP component and their reported intention and usage of this system were presented. By analyzing the user perceptions in the current study, knowledge of correlations between latent and manifest variables and their predictive strengths provided valuable insights into the perceptions of professionally autonomous end users toward complex technology. Better understanding of determinants of user acceptance and usage will help design organizational strategies to increase system usage.

The research reported in this article reaffirmed previously validated measurement instruments for technology acceptance, as well as considered a spectrum of models relevant to mandatory implementation settings. Specifically, the results of this study empirically support most of the constructs of the extended technology acceptance model, TAM2, focusing on perceived usefulness (Venkatesh & Davis, 2000).

An ERP system provides a means to collect, store and disseminate information more efficiently and effectively, but more and more of today’s companies discover that to gain a competitive advantage managing information is not enough; the information needs to be accurate and easily accessible to managers for analysis. Our study supported that view by showing that information quality and job relevance of the information provided has a direct influence on the perceived usefulness of the overall information system.

State and federally funded public institutions providing education services can benefit from the research by noting the factors that influence participants’ perceptions of technology usefulness, which ultimately foster use of complex systems. In this study, the variables that significantly influenced participants’ perceptions of system usefulness were (a) job relevance, (b) output quality, and (c) perceived ease of use. System usage, however, appears to be driven by factors other than those included in the current research or may be more appropriately measured by scales other than time.

From a corporate practitioners’ perspective, relevant business contexts reflective of the highly educated, autonomous end users of this study include mid- to high-level managers of corporations with similar demographics and individual discretion in accomplishing their work using complex IT systems. Demographic factors influencing technology acceptance within corporate settings may include rural location of a “corporate” site, average age of team members, or education level of group members. Practitioners may find this research helpful when specifically dealing with highly educated, professionally autonomous individuals.

The ultimate implication of this research to educators and employers regarding end users is the need to educate and hire individuals who meet redefined proficiency parameters as end users. This revised definition of proficient end user includes not only a more detailed understanding of database systems and how to query them, but also the inclusion of an arsenal of communication skills. Increased system complexity comes with equally complex communications demands (Beltamo, 2005). Successful complex technology acceptance appears inextricably linked with skill in both system and communication realms.

Limitations of the current study included several areas. First, there were several constructs measured by only two items. This issue limited the availability to perform statistical reduction of scales and, consequently, more sophisticated item reduction techniques were not possible. Second, factor analysis conducted on small sample sizes (less than 300) can produce mixed results. After data collection and preliminary review, the usable sample for the current study included 66 participants. Additional statistical measures were reviewed, as discussed previously, in attempts to minimize this limitation. However, researchers are strongly cautioned when generalizing the results of the current study.

Our future is in examining our past; that is, thoroughly examining IT. Several IS researchers have suggested that future research of technology acceptance should integrate multiple robust models and frameworks to progressively advance this area of research (Benbasat & Zmud, 1999; Gallivan, 2001; Glass et al., 2004; Lee et al., 2003; Pozzebon, 2004). In their multi-theoretical technology acceptance research, Venkatesh et al. (2003) suggest focusing future investigations on public and government institutions to
expands the research scope to this specialized business segment. Venkatesh et al. (2003) state, “one of the most important directions for future research is to tie this mature stream of research [technology acceptance] into other established streams of work. For example, little to no research has addressed the link between user acceptance and individual or organizational usage outcomes” (p. 470).

Working from Lee et al.’s (2003) research plan, a multi-pronged analysis of the histories of Rogers’ Innovation Diffusion (1976), Ajzen’s Theory of Planned Behavior (1991), DeLone and McLean’s D&M IS Success Model (2003), and Schwarz’ Core-Outcome and Acceptance-Outcome Model (2004) research may inform the IS community of the social, cognitive, cultural, and contextual antecedents for a future parsimonious “Unified” (Venkatesh et al., 2003) technology acceptance model. Thus, an “amalgamation” (Glass et al., 2004) of models may better inform and direct future IS researchers by facilitating the linkage of user acceptance to individual and organizational outcomes.

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