User Acceptance of ERP Systems in the United States

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ABSTRACT

Enterprise Resource Planning (ERP) systems are widely used in most industries today because of the benefits they offer: improved integration of business processes, improved cost control, improved decision making, improved customer service, and improved profitability. Although much IS research has been published concerning acceptance of enterprise systems, adoption issues, or critical success factors in implementing an ERP system, little research has been presented that focuses on the ERP usage behavior. The purpose of this research is to attempt to extend the unified theory of acceptance and use of technology model in order to predict the acceptance of ERP systems among its users in the United States.

INTRODUCTION

Enterprise Resource Planning (ERP) systems and other corporate-wide systems, such as Supply Chain Management and Customer Relationship Management, are widely used in most industries today. These systems have become very popular because they integrate all of a company's business processes and share a common database (Topi, Lucas, and Babaian, 2005). Additional applications such as sales force automation, call centers, knowledge management, and data warehousing have emerged in recent years (Boudreau, 2002). As of 2005, U.S. firms have spent more than $165 billion on enterprise applications (Laudon, 2006).

Enterprise systems are increasingly used because of their potential to increase organizational and individual users' productivity, along with providing many other benefits (Hwang, 2005; Gefen, 2004; Ash and Burn, 2003, Mahowald and Levitt, 2005; Avalone, 1999). Because these enterprise systems are usually complex, they are both difficult and costly to implement successfully and numerous research studies indicate that the final benefits are often uncertain (Edwards, 2005). When businesses implement an ERP system, these complex systems usually create a burden on the employees to use them effectively (Topi, et.al., 2005).

User acceptance of information technology, specifically complex enterprise systems, has received much attention in MIS research journals during the past several years. Several models, such as the Technology Acceptance Model, Theory of Reasoned Action, and the Theory of Planned Behavior Cognitive, propose several constructs to explain end-users' acceptance behavior and IT usage (Davis, 1989; Ajzen and Fishbein, 1980; Ajzen, 1985).

Recently, the Technology Acceptance Model has been applied to ERP systems to explain the complex implementation and adoption issues by stakeholders and end users (Amoako-Gyampah & Salam, 2004; Gefen, 2004). Amoako-Gyampah & Salam (2004) found that the use of managerial interventions, such as training and communication, to influence the acceptance of ERP systems are supported, since perceived usefulness and ease of use contribute to usage ERP systems. Gefen (2004) also found that the perceived usefulness of ERP contributes to client assessment that their business relationship with the vendor is worthwhile.

The Unified Theory of Acceptance and Use of Technology (Venkatesh et al., 2003) is the most recent work in the area of explaining and predicting user acceptance and use of technology. This theory examined eight different models and integrated the components of those models into a single, unified model that is more predictive than any of the individual models alone. UTAUT considered and integrated the theory of reasoned action, the technology acceptance model, the motivational model, the theory of planned behavior, a model that combined the technology acceptance model and the theory of planned behavior (resulted in the decomposed theory of planned behavior), the model of PC utilization, the innovation diffusion theory, and the social cognitive theory.

Prior research in ERP has almost ignored the acceptance of the software from the perspective of individual user behavior regarding the use of the system. This paper attempts to address this gap in the research by incorporating ERP acceptance in the framework of technology acceptance. From a pool of diverse attributes of a typical ERP software, we attempt to identify those attributes that are critical in facilitating the acceptance of ERP systems in the US. In doing so, we rely on the rich body of research on technology acceptance (Chau and HU, 2001; Taylor and Todd, 1995; Venkatesh et al., 2003).

Although the direct influence of enterprise systems on a firm’s productivity has been debated in the IS literature for several years (Ash and Burn, 2003), the importance of systems adoption by the end users is consistently emphasized for the successful implementation of enterprise systems (Joshi, 2005; Delone and McLean, 1992; Boonstra, 2003). Enterprise systems are usually large and complex systems involving different types of end users in the organization, which makes this understanding difficult and complex (Hwang, 2005).

Furthermore, when implementing an enterprise system in a global environment, the complexity of adoption issues takes on even greater importance. Additionally, if companies want to accomplish the goals of becoming more streamlined in carrying out their processes and more productive in their operations, they should want to avoid what other companies in many industries have experienced: ERP implementation project failure. This failure rate is currently estimated to be 85% (Hoffman, 1999).

Specifically, the purpose of this research is to examine the external factors which influence user acceptance of ERP systems in a variety of industries in the US. The current paper begins with a discussion of the theoretical background of the study and develops the conceptual framework. The following sections present, successively, the research model, research design, survey, results, implications, and the conclusion.

THEORETICAL BACKGROUND

Several models have been used in the research of user acceptance and usage behavior that provide explanation and justification for the variables under consideration. Each model will be examined briefly as to its relevance to the present study.

The TAM model, based on the theory of reasoned action by Fishbein and Ajzen (1975), was developed by Davis (1989) and expanded in Davis et al. (1989). According to Davis et al.

(1989, p.985), the goal of the TAM model is “to provide an explanation of the determinants of computer acceptance that is general, capable of explaining user behavior across a broad range of end-user computing technologies and user populations, while at the same time being both parsimonious and theoretically justified.”

The TAM model does not include the variable of subjective norm that is used in the Theory of Reasoned Action (TRA). TRA is a mathematical formula that is used to predict behavioral intentions. It suggests that behavioral intentions are determined by a consumer’s attitude toward some behavior or performance of some act as well as a subjective norm, which is based on the expectations of others concerning the consumer’s performance of the act or behavior. The theory of planned behavior is based on Fishbein and Ajzen’s theory of reasoned action (1975). The theory of planned behavior proposes that the perceived control the consumer has over the situation can also influence consumers’ intentions.

The latest model to be developed from this body of research is a synthesis and unification of eight different models called the unified theory of acceptance and use of technology (UTAUT) by Venkatesh et al. (2003). This model examined the determinants of user acceptance and usage behavior—performance expectancy, effort expectancy, social influence, and facilitating conditions and found that all contribute to the usage behavior either directly (facilitating conditions) or through behavioral intentions (performance expectancy, effort expectancy, and social influence).

Although acceptances of various types of information technologies have been studied in the past, there is a paucity of research on the acceptance ERP systems in general and. The model is based primarily on UTAUT and is shown in figure 1. We propose that performance expectancy and effort expectancy along with social influence will affect the use of an ERP system. The moderating variables are gender, income, age, experience and voluntariness of use of an ERP system.

RESEARCH MODEL

The structural equation model relating performance expectancy, effort expectancy, social influence, and facilitating factors with usage behavior is illustrated in Figure 1. In the figure, performance expectancy ($\xi 1$), effort expectancy ($\xi 2$), and social influence ($\xi 3$) are three independent latent variables measured through the four observed variables X1, X2, and X3, respectively. Thus, each independent variable is measured by one observed variable which is the average score from a multi-item scale intended to measure that dimension. The moderating variables are gender ($\xi 4$), income ($\xi 5$), age ($\xi 6$), experience ($\xi 7$), and voluntariness of use ($\xi 8$). The dependent variable, usage behavior ($\eta 1$), is measured by one observed variable, Y1.

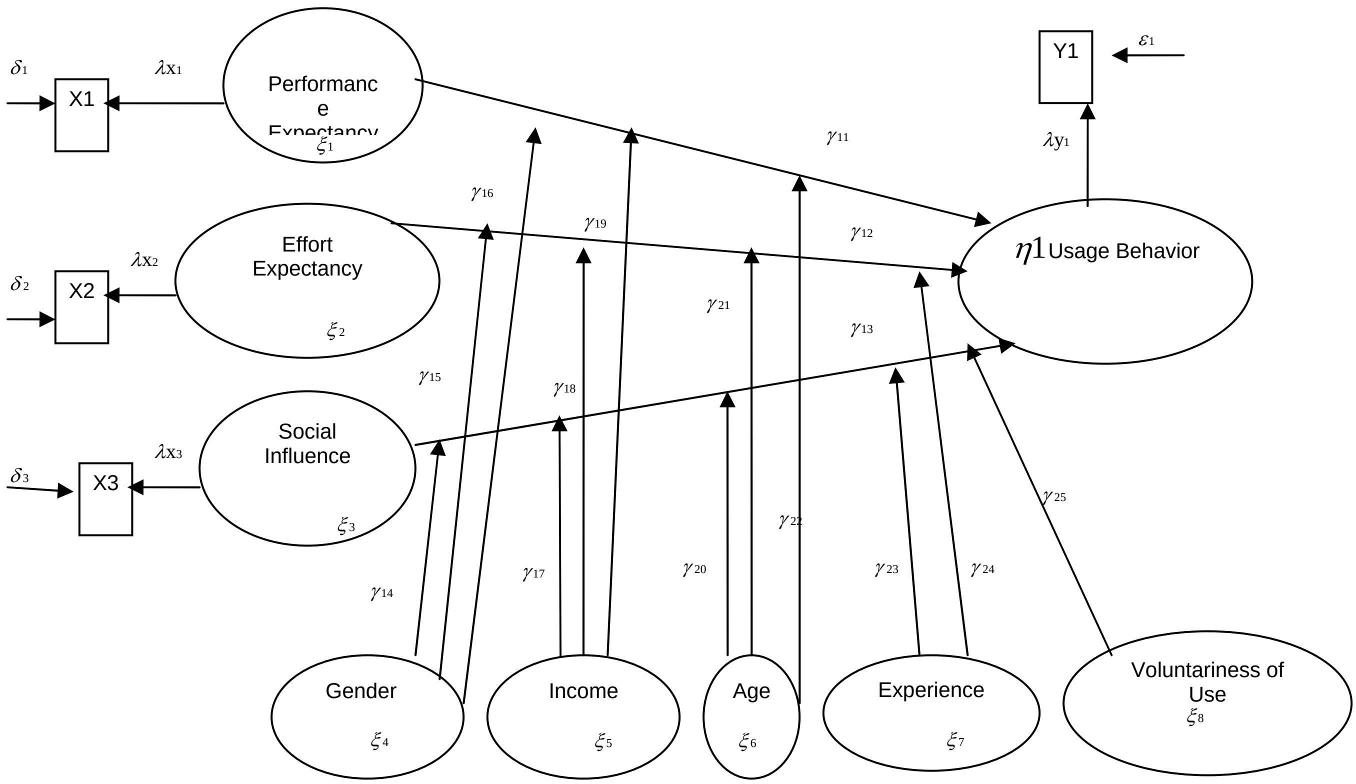

Figure 1: The Research Model

The relationship between performance expectancy and usage behavior is moderated by gender, income, and age. Prior research has shown that the effect of performance expectancy on usage behavior is stronger for younger men. In our context, the use of ERP systems depend on the usefulness of the technology to allow users to integrate business processes and control cost. Hence, we propose that young men with less income will be more interested in the usefulness of the technology.

The relationship between effort expectancy and usage behavior is also moderated by gender, income, age, and experience. Prior research has shown that the effect of effort expectancy on usage behavior is stronger for older women with limited experience. We propose that effort expectancy is also moderated by income. We believe that those professionals who earn more are busy individuals and would not be willing to spend much time learning a new technology.

The effect of social influence on usage behavior is moderated by gender, income, age, experience, and voluntariness of use of technology. Prior research has shown that the effect of social influence on usage behavior is stronger for older women with limited experience and under conditions of mandatory use. We propose that income will also have a moderating effect on social influence. We theorize that people who earn more are less sensitive to what others think about the use of a new technology.

RESEARCH DESIGN

Operationalization of Constructs

The measures used to operationalize the constructs were taken from relevant prior studies. A thorough review of technology acceptance literature was conducted to identify studies in which constructs similar to the ones used in our study were operationalized. Adapting existing measures isomorphically to the context of the study, metrics for the study variables were generated. Table 1 summarizes the relevant prior research that served as the basis for construct operationalization.

Performance Expectancy (PE)	Davis (1989), Chau and Hu (2001), Venkatesh et al. (2003)
Effort Expectancy (EE)	Davis (1989), Chau and Hu (2001) Venkatesh et al. (2003)
Social Influence (SI)	Chau and Hu (2001), Venkatesh et al. (2003), Taylor and Todd (1995)
Usage Behavior (U)	Davis (1989), Chau and Hu (2001), Venkatesh et al. (2003)

Table 1: Relevant References for Research Model Constructs

SURVEY

Local Pilot Survey

The petrochemical industry in southeast Texas relies heavily on its investment in ERP software. Companies in this industry find, produce, refine, and market fuels and hydrocarbons. The main reasons these plants and refineries invested heavily in acquiring and implementing ERP systems was to become more efficient, more streamlined in carrying out their processes, and, of course, more profitable. Because these systems were designed to improve overall corporate productivity, performance, and the competitive position of the business, we feel that it is important for managers in the petrochemical industry to know which behavioral factors facilitate the acceptance of ERP systems by the users. Too much is at stake for management to ignore the factors that will increase and improve the use of the ERP system by the end users.

We wanted to focus the pilot study of our research on the petrochemical industry of Southeast Texas because it is a major industry here. We did not know at the time which ERP system was being used, but we suspected most, if not all, of these plants were using some enterprise system. We contacted a representative from each plant or refinery via email and explained the purpose of our research. In many instances, the contact person was a former student who was happy to participate in the survey. We asked for the names and email addresses of ERP end users who would possibly want to participate in this survey. We asked for a broad representation of users, which would represent all departments or divisions that used the ERP system. Once approval was given by the corporate attorney at most of these plants, the names of the ERP users were sent to us, along with their email address. We received about 100 names from approximately 10 major plants or refineries.

Once we had the names and addresses, we emailed a cover letter explaining the purpose and nature of our project. In the cover letter, we included the link to our survey on the Web. We put our survey on the Web (surveymonkey.com) to facilitate receiving the responses and for conducting the data analysis. Approximately 73 people responded. We conducted a pilot test with 73 returned responses. The pilot study revealed no problems or confusion about the survey instrument, confirming the suitability of the instrument.

National Survey

A national survey was conducted next. The purposive sampling method was used for this study. The purposive sampling method searches for a specific profile based on target respondent definition for the concerned survey. The target respondents for this study were ERP users from any industry. A total of 502 usable responses were obtained from the national survey.

Characteristics of Respondents

The relevant demographics and other characteristics of the respondents are presented in the tables that follow:

Age	Frequency	Percent	Cumulative Percent
Below 25 years	2	.8	.8
25-34 years	49	10.5	11.3
35-44 years	104	22.9	34.2
45-54 years	164	33.3	67.5
55-64 years	141	28.6	96.1
65 years and above	19	3.9	100.0
Total	493	100.0	

Table 2: Age

Gender	Frequency	Percent	Cumulative Percent
Male	413	73.8	73.8
Female	147	26.2	100.0
Total	560	100.0	

Table 3: Gender

Educational Qualification	Frequency	Percent	Cumulative Percent
High School	139	28.4	28.4
Bachelors	231	47.2	75.6
Masters	90	18.5	94.1
Doctorate	29	5.9	100.0
Total	489	100.0	

Table 4: Qualifications

Annual Income	Frequency	Percent	Cumulative Percent
Below $25,000	37	7.6	7.6
$25,000-$50,00	116	23.9	31.5
$50,001-$100,000	199	40.9	72.4
$100,001-150,000	80	16.5	88.9
Above $150,000	54	11.1	100.0
Total	486	100.0	

Table 5: Annual Income

Characteristics of Companies

The industries and sizes of companies surveyed are given in tables 6 and 7. Table 8 presents the different types of ERP systems being used by the companies surveyed. Table 9 lists the length of time during which different companies have been using the ERP system.

Industry	Frequency	Percent	Cumulative Percent
Aerospace and Defense	29	5.2	5.2

Apparel and Footwear Solution	1	.2	5.4
Automotive	11	2	7.4
Chemical	47	8.3	15.7
Consumer Products	18	3.2	18.9
Healthcare	77	13.8	32.7
High Tech	45	8.1	40.8
Media	4	.7	41.5
Mining	2	.4	41.9
Oil and Gas	36	6.5	48.4
Pharmaceuticals	6	1.1	49.5
Professional Services Providers	42	7.5	57.0
Public Sector	44	7.9	64.9
Retail	14	2.5	67.4
Telecommunications	27	4.8	72.2
Utilities Industry	11	2.0	74.2
Wholesale Distribution	11	2.0	76.2
Others	133	23.8	100.0
Total	557	100.0	

Table 6: Participating Industry

Company Size	Frequency	Percent	Cumulative Percent
Very Small (less than100 employees)	85	17.4	17.4
Small (between 100 and 250)	35	7.2	24.6
Medium (between 250 and 500)	64	13.1	37.7
Large (between 500 and 1000)	61	12.5	50.2
Very Large (more than 1000)	243	49.8	100.0
Total	488	100.0	

Table 7: Company Size

Type of ERP Systems	Frequency	Percent	Cumulative Percent
BEA	10	2.1	2.1
Horizon - MRP Plus	5	1.0	3.1
In-House Developed system	112	23.4	26.5
JD Edwards	20	4.2	30.7
NetERP	4	.8	31.5
Oracle (PeopleSoft)	102	21.3	52.8
SAP	149	31.2	84.0
Siebel	15	3.1	87.1
Teklynx – Sentinel	3	.6	87.7
Others	58	12.3	100.0
Total	478	100.0	

Table 8: Types of ERP Systems in Use

Number of Years of ERP Usage	Frequency	Percent	Cumulative Percent
Less than one year	38	7.8	7.8
1-3 Years	94	19.3	27.1
4-6 Years	156	32.0	59.1
7-9 Years	66	13.6	72.7
10-15 Years	69	14.2	86.9
More than 15 Years	64	13.1	100
Total	487	100.0	

Table 9: Duration of ERP Usage

RESULTS

The parameters for the structural equation model illustrated in Figure 1 were estimated by the maximum likelihood method using AMOS 5.0. In the model, performance expectancy, effort expectancy, and social influence are three independent latent variables measured through the three observed variables X1, X2, and X3, respectively. Thus, each of the independent variables is measured by one observed variable which is the average score from a multi-item scale. The dependent variable, usage behavior (η_1), is measured by one observed variable, Y1 which is also the average score from a multi-item scale. The model fit indices for the structural equation model are listed below:

	Recommended Value:
Chi-square/Degree of freedom: 2.25	<= 3.0
Goodness-of-fit index: 0.902	>= 0.9
Adjusted goodness-of-fit index: 0.867	>= 0.8
Normal fit index: 0.931	>= 0.9
Comparative fit index: 0.960	>= 0.9
Standardized root mean square residual: 0.065	<=.10

All measures of the causal model exceeded the acceptable levels thereby exhibiting that the Structural Equation Model presented a good fit with the data. Table 10 shows the detailed model test results.

Parameter	Estimate
$R^2 \eta_1$	.64
$R^2 \xi_1$	.312
$R^2 \xi_2$	.105
$R^2 \xi_3$	.469
γ_{11}	.312 **
γ_{12}	.105 **
γ_{13}	.469 **
γ_{14}	.139
γ_{15}	.169
γ_{16}	-.277
γ_{17}	.106
γ_{18}	-.133
γ_{19}	.029
γ_{20}	-.020
γ_{21}	-.178
γ_{22}	.165
γ_{23}	.118
γ_{24}	.103
γ_{25}	.280**

** p-value < .001

Table 10: Standardized Parameter Estimates for the Structural Model

The explanatory power of the model is examined using the R^2 value for Usage Behavior. The combination of Performance Expectancy (PE), Effort Expectancy (EE), and Social Influence (SI) accounted for 64% of the variances observed in consumers' usage behavior regarding the

ERP system. The path coefficients from PE, EE, and SI are all significant at $p < .001$ level. Even though PE, EE, and SI are all significant determinants of Usage Behavior (UB), SI exhibited the strongest direct and total effects on BI.

As expected, the effects of PE, EE, and SI are moderated by gender, age, experience, income, and voluntariness to use the technology. In particular, the effect of PE was moderated by gender, age and income. The effect of EE was moderated by gender, age, income, and experience. The effect of SI was moderated by gender, age, experience, income, and voluntariness to use the technology.

Assessment of the psychometric properties of the final model

Table 11 displays the items used to measure each construct, estimated error variances, item reliability, and factor loadings. Based on these numbers, the convergent and discriminant validity of the final model was assessed and presented in Tables 12 and 13.

Convergent Validity

The convergent validity of the instrument was assessed by three measures: item reliability, construct reliability, and average variance extracted (Chau 1997). An item reliability of at least .70 for each item is considered to be evidence of convergent validity (Nunnally and Berstein 1994). None of the item reliabilities was less than .70. Construct reliability was calculated as follows: (square of summation of factor loadings)/{(square of summation of factor loadings) + (summation of error variances)}. Construct reliability for all the factors in the final model were above .80, a suggested minimum for evidence of convergent validity (Nunnally and Bernstein 1994). Lastly, the average variance extracted measures were calculates as follows: (summation of squared factor loadings)/{(summation of squared factor loadings) + (summation of error variances)}. If the average variance extracted is less than .50, the convergent validity of the construct is weak. The average variance extracted for each construct is greater than .70 for the final model. Thus, there is strong empirical support for the convergent validity of the research variables on all three measures.

Discriminant Validity

The discriminant validity was evaluated by comparing the squared correlation between two constructs with their respective average variance extracted. Discriminant validity is demonstrated if the average variance extracted of both constructs are greater than the squared correlation (Chau 1997). The squared correlations between constructs PE and SI, EE and SI, and EE and PE are .71, .61, and .68 respectively. As the average variance extracted for each of the three constructs PE, SI, and EE are .71, .77, and .69 respectively, there is evidence that the construct SI exhibited high discriminant validity of itself from constructs PE and EE. The discriminant validity between EE and PE is also adequate.

Construct	Error variances	Item reliability	Factor loadings
Performance expectancy (PE)			
PE1	.54	.77	.88

PE2	.20	.91	.95
PE3	.28	.87	.93
PE4	.35	.85	.92
Effort expectancy (EE)			
EE1	.66	.70	.81
EE2	.31	.84	.92
EE3	.27	.87	.93
EE4	.31	.84	.92
Social influence (SI)			
SI1	.22	.81	.90
SI2	.23	.73	.82
SI3	.20	.74	.85
Usage Behavior (UB)			
UI1	.25	.89	.94
UI2	.20	.91	.96
UI3	.66	.70	.82

Table 11: Psychometric Properties of the Final Model

Construct	Construct reliability	Average variance extracted
Performance Expectancy (PE)	.91	.71
Effort Expectancy (EE)	.89	.69
Social Influence (SI)	.80	.77
Usage Behavior (UB)	.87	.69

Table 12 : Convergent Validity

Constructs	Squared correlation
EE <-> PE	.68
PE <-> SI	.71
EE <-> SI	.61

Table 13: Discriminant Validity

On the basis of the total effects on usage behavior, all three (performance expectancy, effort expectancy, and social influence) determinants of acceptance of the ERP system were found to be significant. The moderating influences of gender, age, income, experience and voluntariness of users were also observed. The model accounted for 65% of the variance in usage behavior.

IMPLICATIONS

The purpose of developing the research model in the paper is to explain the factors that may influence the acceptance of ERP systems by users in the United States. This research has much potential. First, it fills a void in the ERP literature by addressing the factors that may facilitate the acceptance of ERP in different industries. There are various types of ERP systems available (such as SAP, BEA, Horizon - MRP Plus, In-House Developed system, JD Edwards, NetERP, Oracle (PeopleSoft), TEKLYNX – SENTINEL, etc.) and knowing which factors (for example, ease of use or improvement in performance) contribute to its acceptance gives the industries the knowledge to choose a particular one over others. Second, the findings of this study will provide the different industries a better understanding of user acceptance of ERP systems. ERP systems will enable managers to make better decisions by providing company-wide information. Third, from an academic standpoint, this study will enable us to test the modified UTAUT model in an entirely different context.

CONCLUSION

In this paper, we attempt to extend the unified theory of acceptance and use of technology (UTAUT) model proposed by Venkatesh et al. to predict the acceptance of ERP systems among its users in the United States. We have relied on prior research in ERP and Technology Adoption. In addition to proposing a model for ERP acceptance, we identified the underlying dimensions that would measure each construct of the model. We tested the model by conducting surveys among the users in different industries. The model accounted for 65% of the variance in usage behavior.

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