Pergamon

International Journal of Accounting Information Systems 4 (2003) 205–225

INTERNATIONAL JOURNAL OF ACCOUNTING INFORMATION SYSTEMS

Examining the role of innovation diffusion factors on the implementation success of enterprise resource planning systems

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Abstract

Enterprise resource planning (ERP) systems have been adopted by many organizations in the past decade. These systems have revolutionized organizational computing by facilitating integrated and real-time planning, production, and customer response. While some companies have achieved significant efficiencies through ERP, others have complained of failed implementations, budget overruns, and disappointing performance. This paper draws upon Diffusion of Innovation (DOI) theory and Information Systems Success (IS) theory to develop and test a model of ERP implementation success. Results reveal that top management support and training are positively related to user satisfaction, while perceived complexity of ERP and competitive pressure show a negative relationship. Consensus in organizational objectives and competitive pressure are positively associated with perceived organizational performance. Post hoc analysis identifies user satisfaction as a moderator between certain DOI characteristics and organizational performance. This leads to the proposal of a new model of ERP implementation for future research.

Keywords: Enterprise resource planning; Diffusion of innovation theory; Information systems success; Organizational performance; User satisfaction; Systems implementation

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1467-0895/03/$ – see front matter
doi:10.1016/S1467-0895(03)00026-5

1. Introduction

Enterprise resource planning (ERP) systems have been qualified as ''the most important development in the corporate use of information technology (IT) in the 1990s'' (Davenport, 1998, p. 122). However, implementing enterprise systems is a costly and complex undertaking. While some companies have achieved significant efficiencies through ERP, others have complained of failed implementations, budget overruns, and disappointing performance (Fryer, 1999; O'Leary, 2000; Jenson and Johnson, 1999).

Researchers have identified several key factors that may contribute to a successful ERP implementation (Bingi et al., 1999; Motwani et al., 2002). Most of this research has been in the form of case studies of individual companies and interviews with IT professionals, both of which have provided rich accounts of the implementation process. We extend this line of research with the theoretical development and empirical testing of a model derived from two related literature streams, Diffusion of Innovation (DOI) (Rogers, 1983) and Information Systems Success (IS) (Delone and McLean, 1992). Taking an organizational level perspective, we examine the relationship between innovative, organizational, and environmental characteristics and two dimensions of ERP systems implementation success: user satisfaction and perceived organizational performance.

To test these relationships, we use regression analysis with a sample of firms that have recently implemented ERP systems and find that different sets of antecedents affect user satisfaction and organizational performance. Further analysis shows that these two outcomes are not independent but interact with each other. Based on the findings from our exploratory study and post hoc analyses of interactions, we conclude with a proposed moderated model of ERP implementation success. The proposed model simply states that user satisfaction moderates the relationships between DOI antecedents and ERP organizational performance.

2. Exploratory model and theory development

The success of IT implementations has been the focal point of a substantial amount of research over the last two decades. Two theoretical streams, DOI (Rogers, 1983) and IS implementation (Delone and McLean, 1992), have emerged, and each has been the basis for studies examining systems success. These two literature streams have numerous parallels as suggested by Premkumar et al. (1994), Fichman (2000), and others. In DOI theory, ''an organizational effort directed toward diffusing appropriate IT within a user community'' is analogous to IS implementation (Cooper and Zmud, 1990, p. 124).

Since its inception, DOI research has evolved from a focus on variables affecting the adoption or nonadoption of IT (Tornatzky and Klein, 1982) to its diffusion (i.e., extent of implementation) within an organization (Premkumar et al., 1994) and more recently to the organizational learning (Fichman and Kemerer, 1997) and performance (Ramamurthy and Premkumar, 1995) that may result from IT initiatives. In its current form, DOI theory

states that the organization's innovation and organizational characteristics and the environment in which it operates can influence the diffusion and success of IT initiatives (Fichman, 2000; Rogers, 1983). Complementing this view, IS implementation research has set forth various measures of systems performance and contributes to this paper with its focus on user satisfaction as an alternative performance measure (Delone and McLean, 1992).

The model we propose in this study and presented in Fig. 1 states that DOI factors (i.e., innovation, organizational, and environmental characteristics) will influence ERP implementation success both from a firm performance perspective and from a user satisfaction perspective. In the following sections, we develop hypotheses to support the model within an ERP implementation environment.

2.1. Innovative characteristics

Since Roger's (1983) seminal work on innovation diffusion, researchers have studied many innovation characteristics and their relationships with implementation and performance. Among these, compatibility and complexity have shown consistent associations with information systems innovation behaviors (Tornatzky and Klein, 1982; Fichman, 2000). We contribute to this research by including the level of business process reengineering (BPR) as an important additional dimension of innovation that will influence successful ERP implementations (O'Leary, 2000; Davenport, 1998). These three components of a firm's innovative posture are discussed in turn.

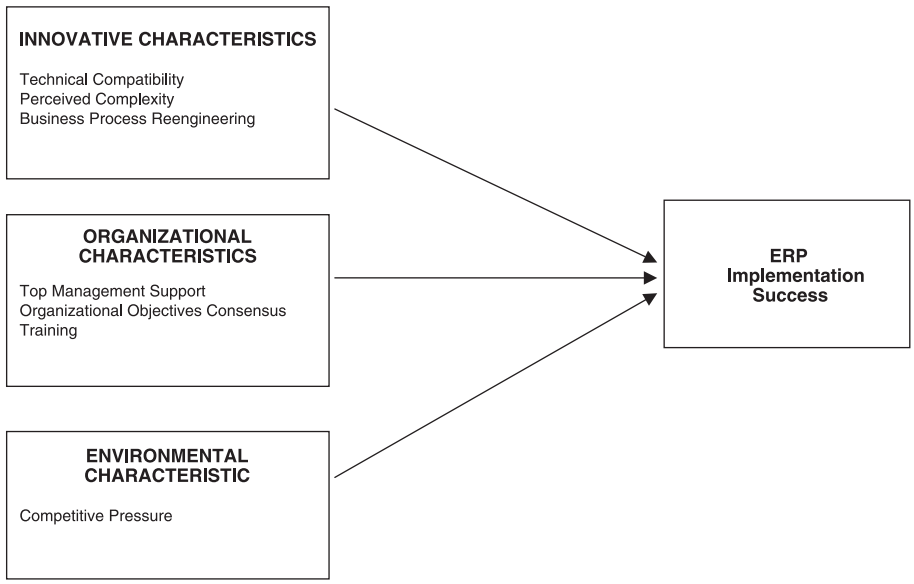

Fig. 1. ERP research model.

2.1.1. Technical compatibility

Technical compatibility refers to an innovation's compatibility with existing systems (in this case, retained systems), including hardware and software (Schultz and Slevin, 1975). In an ERP environment, it is likely that certain software will be retained and must be integrated with the ERP system. The easier it is to integrate new IT with retained systems, the greater the chances of realizing organizational benefits (Tornatzky and Klein, 1982). Additionally, the more compatible the new systems are with remaining software, the more satisfied users will be (Delone and McLean, 1992). Based on these arguments, the following hypothesis is postulated:

H1: The degree of compatibility of ERP systems with retained technical systems will have a positive relationship with implementation success.

2.1.2. Perceived complexity

A common theme in ERP literature is the inherent complexity of ERP systems (O'Leary, 2000; Bingi et al., 1999). Complexity is the degree to which a certain innovation is difficult to understand and use (Rogers, 1983). It is the opposite of ease of use or the degree to which a particular system is perceived to be relatively free from physical and mental effort (Davis, 1989). Companies that perceive their adopted ERP system to be a complex business solution will tend to diffuse it slowly and in limited capacity, thus not realizing its full benefits. It is also suggested that the perceived complexity of an innovation leads to resistance due to lack of skills and knowledge (Rogers, 1983). This resistance to new technologies leads to lower satisfaction and system performance. Based on these rationales, the following hypothesis is postulated:

H2: The perceived degree of complexity of ERP systems will have a negative relationship with implementation success.

2.1.3. Business process reengineering

ERP packages are built around best practices in specific industries (O'Leary, 2000). However, the software may not necessarily fit the operating practices of an adopting firm. In those cases, either the package is customized to better fit a company's needs or the company must change its business processes to conform to the package (Jenson and Johnson, 1999). Most experts agree that customization of the software results in higher implementation costs and longer implementations (Bingi et al., 1999; Davenport, 1998). Therefore, companies should keep the ERP package "as is" as much as possible and reengineer their business processes to conform to the package. Failure to do so will lead to a tardy implementation with most of the benefits left on the table (Bingi et al., 1999). Thus, an organization that reengineers processes to ERP best practices should better maximize the benefits from the implementation. Furthermore, a company that reengineers to best practices will most likely experience a smoother implementation, which will in turn increase stakeholder satisfaction. Thus, the following hypothesis is presented:

H3: The degree of reengineering to best practices of an ERP system will have a positive relationship with implementation success.

2.2. Organizational characteristics

DOI research posits that organizational characteristics influence the successful implementation of innovations (Rogers, 1983). In turn, IS implementation research suggests that the organization's culture is key to implementation success (Poston and Grabski, 2001). Specifically, top management support, training, and consensus with organizational objectives are important cultural dimensions influencing success (Bingi et al., 1999; O'Leary, 2000).

2.2.1. Top management support

According to Laughlin (1999), the first order of business in an ERP initiative is to gain full commitment from senior executives. The active involvement, vision, and direction of high-level executives provide the impetus needed to sustain the implementation of ERP (O'Leary, 2000). Top management must send clear signals to various parts of the organization about the importance of a project (McGowan and Madey, 1998). The support of top management will help focus efforts toward the realization of organizational benefits and lend credibility to functional managers responsible for its implementation and use. Based on these arguments, we postulate:

H4: The degree of top management support for the adoption of ERP systems will have a positive relationship with implementation success.

2.2.2. Organizational objectives consensus

Before embarking upon an ERP initiative, it is imperative that organizations develop a written business case (O'Leary, 2000). Contained therein should be the expected benefits that will result from the project and steps for achieving these benefits (Jeffery and Morrison, 2000). Management should also formally communicate the implementation objectives to employees and help everyone understand their contribution to the process as well as implications their decisions have on the value of the organization (Bradford and Roberts, 2001). Companies that embark upon an ERP project with clear and concise expectations of what the package will do for them will arguably realize greater organizational performance. Likewise, consensus among managers about the objectives of the ERP implementation, and how these objectives will be monitored and measured, will lead to higher user satisfaction. Based on these rationales, the following hypothesis is presented:

H5: Consensus with an organization's objectives regarding ERP adoption will have a positive relationship with implementation success.

2.2.3. Training

Because of the inherent complexity of ERP packages, training users is critical (Bingi et al., 1999). One of the greatest advantages of ERP, integration of data, can also be a double-edged sword when errors are introduced into the system. An error upstream can instantly impact what people do further down the line; therefore, employees should be aware of the problems their mistakes can cause (Stedman, 1998). Not only should training result in greater

achievement of organizational performance measures, but also allocation of the necessary resources for training will increase user satisfaction. Thus, the following hypothesis will be tested:

H6: The level of training an organization's employees undergo with respect to ERP systems will have a positive relationship with implementation success.

2.3. Environmental characteristics

An industry's competitive dynamics, and how a firm competes within it, has a great influence on the firm's strategic decisions (Porter, 1987). Although assertions regarding the influence of an organization's environment on IT decisions frequently appear in the literature (Kimberly and Evanisko, 1981; Kwon and Zmud, 1987; Thong, 1999), this relationship is the least researched in IS studies (Prescott and Conger, 1995). In particular, competitive pressure is one of the most widely cited reasons to implement an ERP system (Deloitte Consulting, 1999; O'Leary, 2000).

2.3.1. Competitive pressure

The need to develop and sustain a competitive advantage in the marketplace is what drives successful business strategies. The resource base view of the firm (Barney, 1996) posits that firms develop unique internal capabilities to gain competitive advantage. An ERP system is a capability that provides the infrastructure to manage information and coordinate activities within the firm to develop more efficient operations and to take advantage of new opportunities. Thus, when a firm embarks upon an ERP implementation, other industry players feel the pressure to eliminate their competitor's advantage as soon as possible (Poston and Grabski, 2001). Either the incentive of first mover advantage or the urgency to level the playing field will provide the focus and purpose to successfully overcome obstacles and resistance to innovation diffusion within the firm (Zaltman et al., 1973; O'Leary, 2000). Based on these arguments, the following hypothesis is postulated:

H7: Competitive pressure to adopt an ERP system will have a positive relationship with implementation success.

3. Research design

The current study measures implementation success in two ways, namely perceived organizational performance and user satisfaction. Measuring organizational performance of systems has been a daunting task for IS researchers (Delone and McLean, 1992). Studies have used both cost reductions (Chervany et al., 1972) and company profits (Hamilton and Chervany, 1981) as proxies for this measure. More comprehensive studies include both revenue and cost issues (Poston and Grabski, 2001) or include performance indicators unique to the particular technology studied (Ramamurthy and Premkumar, 1995). Still, other

researchers have used subjective estimates of business case attainment as a measure for organizational performance (Mabert et al., 2001). This latter approach, which is used in this study, is a well-documented method to ascertain an organizational level view of how IT projects benefit firms (Ramamurthy and Premkumar, 1995).

Likewise, the measurement of user satisfaction has been operationalized in different ways by IS research, but the definition remains consistent. According to the IS implementation literature, a system can be considered a success only if it is perceived to be satisfactory and willingly used by key stakeholders (Delone and McLean, 1992). User satisfaction is the most widely used single measure of IS research and has a high degree of face validity (Delone and McLean, 1992). Researchers have found that user satisfaction is especially appropriate when a specific information system is involved (Hamilton and Chervany, 1981).

To test the model presented in Fig. 1, we ran separate regressions on each of the dependent variables. This allowed us to test the model twice, from a DOI perspective and from an IS implementation perspective. While there is prior theoretical discussion for the potential relationship between user satisfaction and organizational performance (Delone and McLean, 1992), it is unclear which DOI characteristics might lead differently to these two success measures. Furthermore, there is no empirical evidence about the possible role that either of the success measures might have in an integrated model. Consequently, we first tested the effects of DOI variables on the success measures independently and then performed post hoc analyses of their potential interactions. Given the exploratory nature of these interactions, hypotheses were not developed prior to testing.

3.1. Data collection

A survey was administered to randomly selected members of America's SAP User Group (ASUG) following a key informant technique. The use of a single key informant in evaluating performance of information systems is consistent with previous studies (Goodman et al., 1995; Mohr and Spekman, 1994; Poppo and Zenger, 1998). Key informants were functional managers within their organizations, including materials management, marketing, finance, accounting, and operations.

Managers of functional areas are well placed to be aware of key organizational variables, such as organizational objectives and extent of reengineering within their areas, and are generally involved in the ERP implementation process (Premkumar et al., 1994). Respondents expressed being actively involved and at a high enough level to give accurate insight into their firm's ERP implementation process. Of approximately 65 managers contacted, 51 completed the survey (a response rate of 78%). A profile of the responding firms is shown in Table 1. The table reveals that responding firms span a wide range of industries, firm sizes, and experience with ERP.

3.2. Operationalization of variables

The items included in the survey are presented in Appendix A. Where possible, constructs were measured using previously developed instruments and multiple indicator items to

Table 1
Profile of survey respondents

	Frequency	Percentage
Industry		
Electrical	7	14
Chemical	6	12
Metal	3	6
Food/beverage	8	15
Consumer products	7	14
Plastic	3	6
Paper	4	8
Electronics	5	10
Other	8	15
Experience with ERP		
Less than 2 years	14	27
2–3 years	17	33
4–5 years	13	26
6–7 years	4	8
More than 7 years	3	6
Company employees		
Less than 1000	9	18
1000–1999	9	18
2000–4999	11	21
5000–9999	9	18
10,000–49,000	8	15
50,000 or more	5	10

strengthen validity. Items were measured with a seven-point Likert-type scale ranging from 1 = *strongly disagree* to 7 = *strongly agree*. The mean of scores over all questions provided the composite score for each variable.

Technical compatibility was adapted from Ramamurthy and Premkumar (1995). In that study, technical compatibility was measured with one item ascertaining the compatibility of a system with retained hardware and software. Because of the apparent dual dimensionality of this question, the item was separated into two questions in the current study: one measuring compatibility of hardware required to run ERP with retained hardware and one measuring compatibility of ERP with retained legacy software. The four-item *perceived complexity* scale was adapted from Moore and Benbasat (1991). The measures for strategic *objectives consensus*, *top management support*, *BPR*, and *training* were developed by the author. All four scales were based on a review of the current ERP and IS literature. *Competitive pressure* was measured using two questions developed by the author based on earlier work by Thong (1999). As described below, all scales were extensively pretested and validated and exhibit high reliabilities.

Perceived organizational performance was measured using a five-item scale reflecting ERP benefits. These benefits were those found by Deloitte Consulting (1999) and other

sources (Laughlin, 1999; Stenbeck, 1998) to be the most significant and relevant with respect to ERP. These benefits are inventory reductions, personnel reductions, improved order management and cycle times, reduced costs in procurement, and improved cash management. *User satisfaction* was measured with one question ascertaining whether functional managers are satisfied with the ERP package adopted by the organization.

3.3. Control variables

Elapsed time is employed as a control variable as suggested by Fichman (2000). This variable is calculated as the number of months since implementation of the ERP package and is included in the models to capture the variation due to timing issues (Foster and Swenson, 1997). Most DOI studies essentially take a snapshot in time of organizations' implementation of innovations. However, the earlier firms begin implementation, the more organizational learning that takes place and the greater the chance of realization of benefits. Additionally, the more time that has elapsed, the more comfortable employees are with the package and thus the greater the satisfaction.

Firm size is operationalized as the log of the number of employees (Kimberly and Evanisko, 1981). In DOI studies, the size of a firm has been used as a proxy for organizational complexity, slack resources, specialization, and scale (Tornatzky et al., 1983).

3.4. Validity and reliability

To establish readability and face and content validity, the questionnaire was pilot tested with SAP project managers in several different organizations prior to administration (Straub, 1989). Additionally, the instrument was discussed in depth with several ERP consultants using detailed structured interviews. Feedback from pilot testing was used to refine the format of the questionnaire items by addition, removal, or rephrasing of items as necessary. All scales were tested for various validity and reliability properties. Construct validity was assessed by both convergent and discriminant validity using confirmatory factor analytic techniques. Principal Components Analysis with varimax rotation was used. In addition, to provide further evidence, two other factor analytic techniques, Maximum Likelihood and Image, were employed, and the same factors emerged. Convergent validity was evaluated by examining if the questions loaded on the theorized factors. Discriminant validity was assessed by examining the rotated component matrix to ensure that items did not cross load on multiple factors.

Results of confirmatory factor analysis indicated that a priori assumptions were substantiated with a seven-factor solution: Technical compatibility, Perceived complexity, Reengineering, Top management support, Training, Objectives consensus, and Competitive pressure. Table 2 presents the test of convergent validity including standardized Cronbach α's, eigenvalues, variances, and cumulative variances explained by each construct. All variables have high factor loadings on their respective constructs (>.60), secondary loadings were negligible, and the reliabilities for each construct are above generally accepted guidelines (Nunnally, 1978). Based on the extensive examination of the psychometric

Table 2
Validity and reliability analysis

	Item	Factor loading	Mean	S.D.	Cronbach α	Eigenvalue	Variance explained	Cumulative variance
Independent variables								
Technical compatibility			6.56	3.49	.73	0.81	4.23	79.99
	Compat1	.60						
	Compat2	.78						
Perceived complexity			16.51	5.21	.88	5.51	29.00	29.00
	Complex1	.74						
	Complex2	.70						
	Complex3	.91						
	Complex4	.91						
BPR			7.67	3.01	.73	1.13	5.97	75.72
	BPR1	.68						
	BPR2	.92						
Top management support			21.18	4.78	.85	2.84	14.93	43.94
	Top1	.87						
	Top2	.72						
	Top3	.80						
	Top4	.82						
Organizational objectives consensus			9.67	2.97	.89	2.02	10.67	54.62
	Objective1	.87						
	Objective2	.82						
Training			10.37	2.35	.74	1.57	8.26	62.88
	Training1	.85						
	Training2	.60						
Competitive pressure			8.31	3.25	.60	1.31	6.88	69.75
	Pressure1	.70						
	Pressure2	.79						
Dependent variable								
Benefits of ERP (Perceived organizational performance)			22.12	6.69	.81	2.87	57.45	57.45
	RelAdv1	.83						
	RelAdv2	.65						
	RelAdv3	.74						
	RelAdv4	.82						
	RelAdv5	.75						

properties of the scales, we conclude that each variable represents a reliable and valid construct.

4. Results

Table 3 reports descriptive statistics of independent and dependent variables, and Table 4 presents the correlation matrix. None of the correlations approach .80, which would suggest a problem with multicollinearity among the research variables (Hair et al., 1995). Additional

Table 3
Descriptive statistics

	Range	Minimum	Maximum	Mean	S.D.
Independent variables					
Technical compatibility	6.00	1.00	7.00	4.3152	1.74598
Perceived complexity	5.00	1.40	6.40	4.1837	1.27072
BPR	6.00	1.00	7.00	3.8370	1.50575
Top management support	4.67	2.33	7.00	5.3878	1.16139
Organizational objectives consensus	6.00	1.00	7.00	4.8333	1.48515
Training	5.50	1.50	7.00	5.1848	1.17548
Competitive pressure	6.00	1.00	7.00	3.2857	1.4652
Time	9.00	1.00	10.00	4.02	2.19
Size (number of employees)	199,810	190	200,000	18,707	40,039
Dependent variables					
Perceived organizational performance	6.00	1.00	7.00	4.4245	1.33893
User satisfaction	4.00	2.00	6.00	4.6444	1.20897

tests reveal that all of the variance inflation factors were close to one, which rules out multicollinearity problems (Stevens, 1996).

The study employs stepwise linear regression models to test the relationship of the seven independent variables with each of the two success measures. Prior research lends support to this methodology for exploratory analysis with relatively small sample sizes. Results of the first model, a regression of perceived organizational performance on the independent variables, are shown in Table 5. The results reveal an R^2 of 0.344, suggesting a good fit for the model. Three variables are significant in the model: TIME, OBJECTIVES, and PRESSURE. Results of the second model, a regression of user satisfaction on the independent variables, are shown in Table 6. The results reveal an R^2 of 0.738, suggesting a very good fit. Four variables were found to be significant for this model: COMPLEX, TRAIN, PRESSURE, and TOPMGMT. Table 7 summarizes the results for all hypothesized relationships.

It is interesting to note that only competitive pressure was significant in both models, albeit with different signs. While pressure from competitors can increase ERP organizational performance, this pressure to perform can negatively affect user satisfaction. We speculate that the urgency and anxiety of implementing an ERP system to match a competitor's move may cause a great amount of stress to users that are also responsible for a successful implementation. Further studies could explore this issue by differentiating companies responding to a competitive threat from those that are first movers in their industries. Also noteworthy, training and top management support showed no relationship to perceived organizational performance. It appears these implementation-related variables work to enhance user satisfaction. This speculation is supported by post hoc analyses that follow. On the other hand, consensus toward organizational objectives leads to effective implementation and monitoring of the system's success and ultimately to perceived performance. We discuss these findings further in the final section.

Table 4
Correlation matrix

	SATISF	PERF	COMPAT	COMPLEX	TOPMGMT	BPR	OBJECTIVES	TRAIN	PRESSURE	TIME	SIZE
SATISF	1.000										
PERF	.299 *	1.000									
COMPAT	.294	− .102	1.000								
COMPLEX	− .693* *	− .291 *	− .322 *	1.000							
TOPMGMT	.471* *	.272	− .014	− .291 *	1.000						
BPR	.217	.129	.142	− .198	.258	1.000					
OBJECTIVES	.477* *	.304 *	.279	− .403* *	.488* *	.144	1.000				
TRAIN	.575* *	.250	− .005	− .332 *	.462* *	.105	.379* *	1.000			
PRESSURE	− .119	.368* *	− .046	− .064	.116	.114	− .017	− .197	1.000		
TIME	.070	.280	− .233	− .159	.119	.125	− .137	.001	− .008	1.000	
SIZE	.052	.224	.042	− .140	− .102	− .003	.091	.112	.133	.251	1.000

SATISF = satisfaction, PERF = perceived organizational performance, COMPAT = compatibility, COMPLEX =technical complexity, TOPMGMT = top management support, BPR = business process reengineering, OBJECTIVES = organizational objectives consensus, TRAIN = training, PRESSURE = competitive pressure, TIME = elapsed time, and SIZE = firm size.

* Correlation is significant at the .05 level (two-tailed).

** Correlation is significant at the .01 level (two-tailed).

Table 5
Stepwise linear regression results: perceived organizational performance

Multiple R	0.587				
R^2	0.344				
	df	Sum of squares	Mean square	*F*	Significance of *F*
Regression	3	26.644	8.881	6.652	.001
Residual	38	50.735	1.335		
Model					
Variable	*B*	S.E. of *B*	β	*t*	Significance of *t*
Constant	0.844	0.864		0.976	.335
TIME	0.239	0.081	0.390	2.953	.005
OBJECTIVES	0.324	0.127	0.337	2.548	.015
PRESSURE	0.318	0.123	0.340	2.584	.014

4.1. Post hoc analysis of performance variables

The correlation between satisfaction and perceived performance was .299, significant at the .05 level. This motivated further tests to determine if the dependent variables in the two models were associated in any way. Perceived performance was entered into the satisfaction regression and vice versa. The outcome of these tests was that while performance was not significant in the satisfaction model (β=.255, P=.122), user satisfaction was significant in the performance model (β=.444, P=.007) and significantly improved R^2. Other variables remained in the models with some loss of significance due to the inclusion of the new

Table 6
Stepwise linear regression results: satisfaction

Multiple R	0.859				
R^2	0.738				
	df	Sum of squares	Mean square	*F*	Significance of *F*
Regression	4	42.712	10.678	26.005	.000
Residual	37	15.193	0.411		
Model					
Variable	*B*	S.E. of *B*	β	*t*	Significance of *t*
Constant	0.598	0.610		0.981	.333
COMPLEX	− 0.553	0.084	− 0.603	− 6.582	.000
TRAIN	0.216	0.103	0.219	2.104	.042
PRESSURE	− 0.190	0.072	− 0.235	− 2.624	.013
TOPMGMT	0.229	0.097	0.229	2.375	.023

Table 7
Hypothesis testing results

Variables	Implementation success satisfaction of users hypotheses		Implementation success perceived organizational performance hypotheses	
	Number	Support	Number	Support
Technical compatibility	H1	No	H1	No
Perceived complexity	H2	Yes	H2	No
BPR	H3	No	H3	No
Top management support	H4	Yes	H4	No
Organizational objectives consensus	H5	No	H5	Yes
Training	H6	Yes	H6	No
Competitive pressure	H7	Yes (−)	H7	Yes

variable (regression tables available from the authors). These results suggested that user satisfaction might be an antecedent to perceived organizational performance.

To explore this possibility, a new regression was run on organizational performance that included user satisfaction as an independent variable. All possible interactions between independent variables and user satisfaction were entered at a second step into the regression equation. The results of the model are presented in Table 8. Although satisfaction was entered as an independent variable into the model, its significance was lost once the interactions were included in Step 2. Table 8 shows only those variables and interactions that remained in the model after successive iterations. It is important to note that once interactions are entered, the main effects of those variables cannot be interpreted and the analysis must focus on the

Table 8
Post hoc regression results: perceived organizational performance

Multiple R	0.686				
R^2	0.470				
Increase in R^2	0.126, $P < .05$				
	df	Sum of squares	Mean square	F	Significance of F
Regression	5	36.36	7.27	6.38	.000
Residual	36	41.01	1.14		
Model					
Variable	B	S.E. of B	β	t	Significance of t
Constant	1.302	0.855		1.522	.137
TIME	0.240	0.075	0.392	3.198	.003
PRESSURE	0.219	0.119	0.234	1.846	.073
OBJECTIVES	0.310	0.122	0.323	2.554	.015
SATISF × OBJECTIVES	− 0.288	0.105	− 0.380	− 2.745	.009
SATISF × TOPMGMT	0.250	0.124	0.277	2.018	.051

significant interactions themselves. Results show that satisfaction indeed moderates the relationship between two DOI variables and performance, namely objectives consensus and top management support. The interactions introduced in the second step significantly increase the model's R^2 from 0.344 to 0.470.

Moderator analysis plotting using Cohen and Cohen's (1975) technique further clarify these interactions (Fig. 2). For the first relationship (Fig. 2a), the plot shows a positive relationship between objectives consensus and perceived performance at low levels of user satisfaction but almost no variability at high levels of user satisfaction. This finding points to

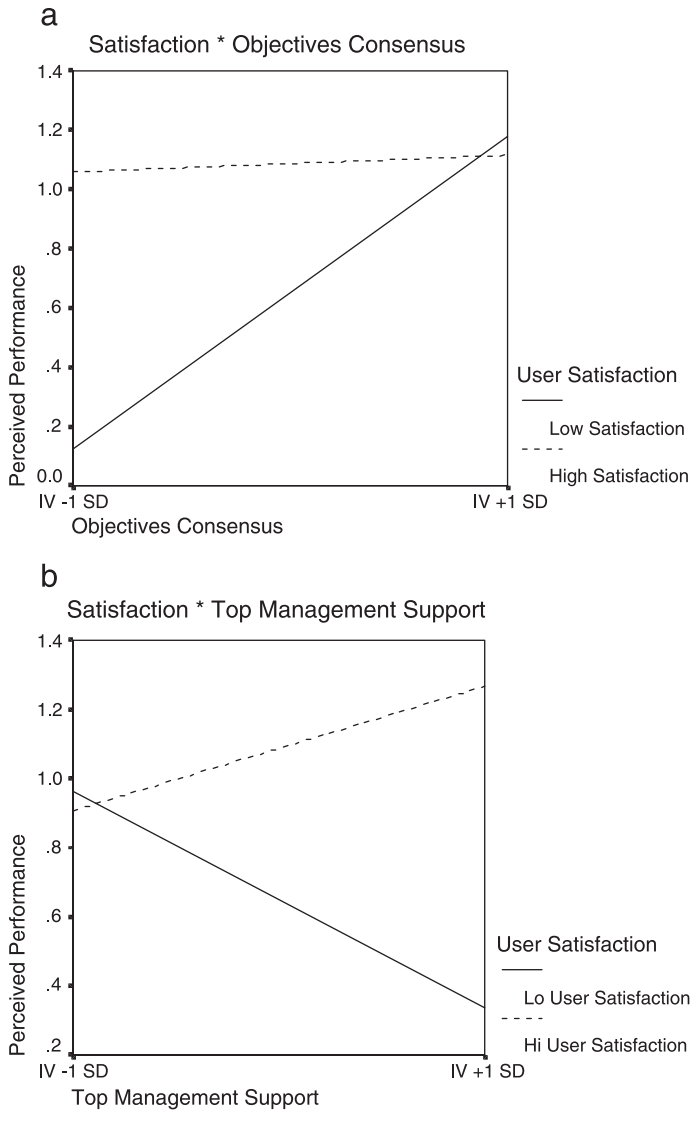

Fig. 2. (a and b) Moderator analysis plotting using Cohen and Cohen's (1975) technique.

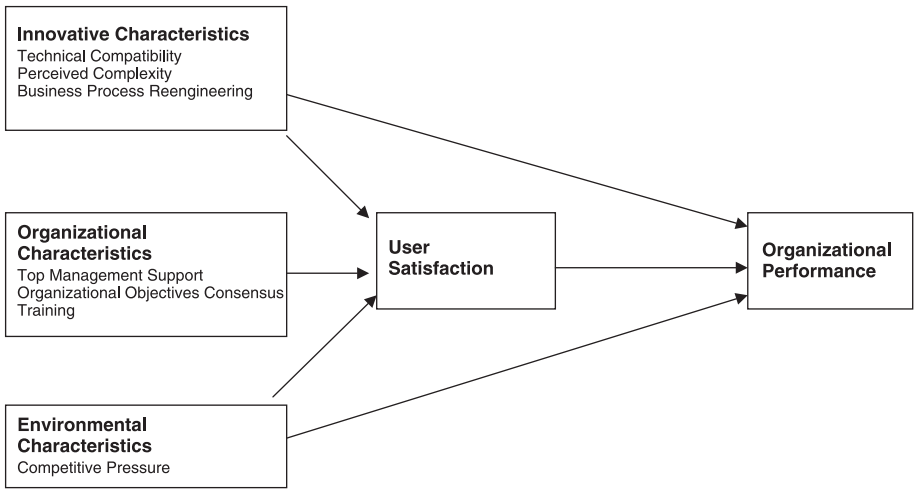

Fig. 3. Moderated model of ERP successful implementation.

the importance of paying attention to consensus building during the implementation process, especially when user satisfaction is negatively affected by other factors such as complexity and competitive pressure. For the second interaction of interest (Fig. 2b), the plot shows a positive relationship between top management support and perceived performance at high levels of user satisfaction but a negative relationship for low levels of satisfaction. This interesting finding seems to point to the fact that unsatisfied users will explain performance failure as a function of too much intervention from top management, whereas satisfied users will give credit to top management support for implementation success.

Based on these new findings, we propose a moderated model of implementation success that integrates DOI and IS implementation theories (Fig. 3). This model proposes that user satisfaction (an IS theory variable) moderates the relationships between DOI antecedents and perceived organizational performance from ERP implementation.

5. Discussion, contributions, limitations, and future research

In this study, we develop a model that draws upon DOI theory and IS implementation literature to examine the success factors of ERP systems. We test the relationships between innovation, organizational, and environmental characteristics and two measures of systems success: perceived organizational performance and user satisfaction. Results show that degree of consensus in organizational objectives and competitive pressure are significantly related to perceived performance. On the other hand, complexity of the system, training, competitive pressure, and top management support are significantly related to the satisfaction of functional managers using the new systems.

It is intriguing that different characteristics are significant in each of the models. Specifically, while strategic level issues are significantly related to overall perceived

performance, implementation issues are related to satisfaction. Most importantly, post hoc analyses reveal interesting interactions between DOI antecedents and user satisfaction. In

of an ERP application on the corporate structure would be decentralization due to more information being in the hands of users. The corporate culture may also change due to increased system openness and interdepartmental communication. Yet, another area of research inquiry could be the impact of ERP on information quality and the comparison of system quality of various ERP products (Delone and McLean, 1992).

Most IS success studies have concentrated on technological innovations with limited organizational scope; however, an ERP package is perhaps one of the most inclusive technologies in organizations thus far. Using comprehensive models that integrate literature streams from different fields such as organizational theory and strategic management can provide interesting insights into the adoption of emerging technologies with broad organizational impact. Following this approach, the study contributes to the DOI literature and poses new questions about the role of user satisfaction on implementation success.

Acknowledgements

This research was funded by a grant from the Scholarly Research Grant Program of the College of Business Administration at the University of Tennessee.

Appendix A. Survey instrument

Independent variables

Innovative characteristics

Technical compatibility

The ERP application was compatible with legacy system software that was retained (minimal interfacing).

The ERP application was compatible with existing hardware.

Perceived complexity (reverse code)

Our firm's interaction with the ERP system is clear and understandable.

It is easy for firm employees to get the ERP system to do what they want it to do.

Learning to use the ERP system has been easy for employees.

Overall, the ERP system is easy to use.

Business process reengineering

Our firm spent much time in redesigning business processes before configuring software.

Our firm tried to fit the ERP package to our business processes with a minimal amount of BPR (reverse coded).

Organizational characteristics

Organizational objectives consensus

When the ERP initiative began, there was consensus about its specific objectives.

When the ERP initiative began, its purpose was clear and concise.

Training

Our firm provided extensive training with the ERP system.

Our firm is dedicated to making sure employees are very familiar with the ERP system.

Top management support

SAP receives strong active support from top management.

Upper management has provided adequate financial and other resources to the SAP implementation effort.

Appendix A (*continued*)

Top management support
SAP has been closely tied to the competitive strategies of the firm.
The success of SAP implementation efforts was due to the active championing by key senior management person(s).
Environmental characteristics
Competitive pressure
Our firm experienced competitive pressure to implement an ERP.
Our firm would have experienced a competitive disadvantage if ERP had not been adopted.

Dependent variables
ERP implementation success
User satisfaction
Functional managers are satisfied with the ERP package(s) adopted by our organization.
Perceived organizational performance (ERP benefits)
Reduction in inventory levels.
Reduction in the number of employees.
Improvements in order management and cycle times.
Reduced costs in procurement.
Improved cash management.

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