



# Modeling use of enterprise resource planning systems: a path analytic study

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**Abstract**

In this research, we evaluated user participation and involvement in the context of enterprise resource planning (ERP) systems. Since ERP systems are enterprise-wide in scope, these systems have a high level of complexity, and require a different implementation methodology. While most studies analyze implementation at an organization or industry level, there is a dearth in research in ERP system adoption at the individual or user level. In our study, we examine ERP system acceptance at the individual level. In this research, we expected to find differences in the nature of user participation and involvement in ERP compared to other information systems. Using Barki and Hartwick's extension of the theory of reasoned action, a revised model was developed and tested empirically. While Barki and Hartwick's model explains user behavior *vis-à-vis* user participation and involvement, a more parsimonious model demonstrates that usage dynamics in ERP implementation are different. We complemented our statistical analysis by three case studies. Based on our results we believe that, given the nature of ERP and its implementation, traditionally formalized links between influencers of users' attitude and involvement may need to be revised. We have discussed why we need to seek alternate forms of influencers. In doing so, we suggest that investments be made in preparatory work practices and employee development prior to ERP decisions. Such investments are complementary to information technology and are widespread throughout the firm. We believe that such investments will play a significant role in influencing the attitude of users toward any system and also their involvement. *European Journal of Information Systems* (2003) 12, 142–158. doi:10.1057/palgrave.ejis.3000453

**Keywords:** information system (IS) use; enterprise resource planning (ERP); theory of reasoned action (TRA)

**Introduction**

Enterprise resource planning (ERP) represents a broad set of activities supported by a multi-module application software that helps an organization manage its business, including production or service planning, purchasing, maintaining inventories, interacting with suppliers (or customers), providing customer service, and tracking orders. Markus *et al.* (2000) state that ERP systems integrate inventory data with financial, sales, and human resources data, allowing organizations to price their products, produce financial statements, and manage resources. An ERP system, as a software package, provides an information structure that is isomorphic to the business processes of the entire organization. Some researchers have even called the ERP system a 'total solution' to an organization's information system (IS) needs (Brown & Vessey, 2000). While the concept of the ERP is very attractive for organizations, most organizations have realized that while the potential benefits of ERP implementation are significant, the costs of failure are high. Davenport

(1998) reports that one of the reasons for the failure of ERP is that organizations tend to falter in the absence of an alignment between its human and business systems and the new technological system. In this paper, the terms ERP and ERP systems are used interchangeably.

In the past decade, companies have allocated substantial resources for ERP implementation, maintenance, and training. The ERP revolution generated over \$20 billion in annual revenues for suppliers, and an additional \$20 billion for consulting firms (Willcocks & Sykes, 2000). Companies that have implemented these systems plan to add e-commerce capabilities, upgrade software, and add new functionality within the first 18 months of their installation (Peterson *et al.*, 2001). Although this study was done using US companies, studies from Europe also report increasing ERP implementation that leads us to believe that the trend towards ERP adoption is global. According to Van Everdingen *et al.* (2000), most large companies in Europe have already implemented ERP systems, and the next wave of ERP adoption will be in mid-size companies with 50–1000 employees. According to them, the total mid-market (market for mid-size companies) was estimated to be around \$5 billion for both 1999 and 2000, and this will continue to rise. In short, significant amounts of money are being invested in the adoption of ERP systems all over the world. As this trend continues, it is imperative that we study the organizational, individual, and technology-based issues that enable successful adoption of this technology.

Past studies have concentrated on the role of, and interactions between, top management in ERP imple-

mentation (Sarker & Lee, 2000; Willcocks & Sykes, 2000), the fit between the organization and ERP (Van Everdingen *et al.*, 2000), general issues on ERP implementation (Chang *et al.*, 2000), imputed roles in an ERP implementation (Askenäs & Westelius, 2000), and a contingency framework for ERP implementation (Brown & Vessey, 2000). While many such works are theoretical and exploratory in nature, none of them focuses on the user. We have attempted to refocus on the user of ERP and, in doing so, have attempted to identify success factors associated with ERP. We use Barki & Hartwick's (1994) extension of the theory of reasoned action (TRA) model to examine user participation and involvement in ERP adoption.

Our paper is organized as follows. First, we provide a theoretical framework for our study of ERP implementation. Here we review the existing literature on ERP adoption and provide the theoretical basis for studying individual-level adoption of ERP technology. Next, we provide a methodology for our research. Then, we provide a detailed analysis of our results. We present three cases of ERP implementation and conduct a qualitative analysis to complement our quantitative results. Finally, we present a discussion and conclusion.

### Theoretical framework

In recent years, a number of studies have investigated antecedents and consequences of ERP adoption. These studies have involved companies in the USA, as well as Europe and Australia. Table 1 summarizes studies on ERP implementation.

**Table 1 Studies in ERP systems**

<i>Study</i>	<i>Method</i>	<i>Major findings</i>
Brown & Vessey (2000)	Multiple case studies	<ul style="list-style-type: none"> <li>● Objective was to determine important predictors for initial and ongoing ERP implementation success.</li> <li>● Preliminary findings show that there are differences between the value-chain and support activity implementations</li> </ul>
Askenäs & Westelius (2000)	Case study	<ul style="list-style-type: none"> <li>● Used the actor-network theory to analyze the use of ERP systems.</li> <li>● Considered ERP systems to be actors, and explored the way in which ERP systems are perceived by their direct and indirect users.</li> </ul>
Chang <i>et al.</i> (2000)	Case study	<ul style="list-style-type: none"> <li>● Conducted a Delphi study to identify issues in ERP life cycle management.</li> <li>● Identified 10 major issues and 38 subcategories in ERP implementation.</li> </ul>
Sarker & Lee (2000)	Case study	<ul style="list-style-type: none"> <li>● Studied three key social enablers for successful ERP implementation</li> <li>● Proposed that while all three enablers may contribute to ERP implementation success, only strong and committed leadership is a necessary condition.</li> </ul>
Scott & Kaindl (2000)	Action research	<ul style="list-style-type: none"> <li>● Studied seven organizations that contributed to the enhancement of the Treasury module of the SAP ERP software.</li> <li>● Identified organizational factors that enabled the functionality enhancement process.</li> </ul>
Van Everdingen <i>et al.</i> (2000)	Survey	<ul style="list-style-type: none"> <li>● Examined adoption of ERP by European firms.</li> <li>● Evaluated the present state of ERP adoption mainly in mid-size manufacturing firms</li> <li>● Predicted that this market will constitute a large portion of new ERP implementations within the next 5 years.</li> </ul>
Willcocks & Sykes (2000)	Theoretical	<ul style="list-style-type: none"> <li>● Identified several situations where IS personnel and CIOs failed to successfully implement ERP solutions.</li> <li>● Provided recommendation for IT personnel for successful installation.</li> </ul>

Chang *et al.* (2000) identified 10 important categories of issues in ERP life cycle management. They identified issues that were related to (in order of importance) knowledge management, systems development, operational deficiencies, organizational context, system performance, cost/benefit, support, data conversion, lack of consultation, indeterminateness, and reluctance to accept dissenting view. Research on ERP adoption has broadly divided determinants of adoption into two major categories: the first category of studies looks at organizational factors as an important determinant of ERP adoption, and the second considers technological factors to be antecedents to implementation. Markus *et al.* (2000) investigated multisite implementations of ERP software and proposed that there are multiple inter-dependent layers within an organization that influence adoption. They proposed business strategies to manage the implementation better and they included organization and technology-based strategies. In the paragraphs that follow, we survey existing literature to identify studies that have looked at organizational and technological factors.

Selected studies have looked at the organizational aspects of ERP adoption within organizations. Scott & Kaindl (2000) studied seven firms that were involved in enhancing the functionality of one of the modules of an ERP package. Using a grounded theory approach, they found that 'swift trust' from the occupational community that included 'collaborators with common professional interests and social similarities' (Scott & Kaindl, 2000), conflict resolution, reciprocity, and informal networks impact functionality or module enhancement. And, a deeper understanding of the process of enhancing functionality of an ERP module benefits team members and collaborators.

Researchers have identified culture as an important issue in ERP implementation and success. Some studies have looked at organizational culture as an antecedent to ERP implementation and success (Davenport, 1998; Scott & Kaindl, 2000; Willcocks & Sykes, 2000), while others have cited that national culture also plays a role (Van Everdingen *et al.*, 2000). Organizational culture affects ERP adoption, and is in turn affected by it. According to Davenport, the enterprise system imposes its own logic on the company's culture.

The role of personnel is another variable that was studied. Sarker & Lee (2000) found that a strong and committed leadership is a necessary condition to successful ERP implementation. Willcocks & Sykes (2000) looked at the role of the CIO and IT function in adoption. They identified different scenarios where either the IT personnel were not consulted in ERP adoption because this was not considered to be an IT decision, and cases where the IT department was asked to take the lead but did not have the expertise or experience to implement such a large system. Willcocks & Sykes recommend that the CIO and IT function should devise strategy, structures, and processes for successful implementation. The studies we

considered looked at single implementations; one research that looked at multisite implementation found that autonomy/centralization and coordination of transactions between the headquarters and divisions are strategic alternatives available to organizations (Markus *et al.*, 2000).

Technological issues in ERP adoption go hand-in-hand with organizational factors. Markus *et al.* (2000) stated that choice of technology, or software configuration in particular, should be aligned to the organization's structure and operations. This is especially important in multisite implementations where an organization may have centralized or decentralized operations. In their Delphi study of issues important in ERP life cycle management, Chang *et al.* (2000) identified technology-based factors that are crucial for ERP adoption. Other studies have focused on enhancing the actual technology to be implemented, for example, a steering committee of seven organizations helped augment the US Treasury module of SAP software (Scott & Kaindl, 2000). Willcocks & Sykes (2000) proposed that one of the problems that may have contributed to failure of some ERP implementations is that organizations considered IT to be a cost rather than a strategic resource. They emphasized the need for IT architecture planning before implementing an ERP system. The technology platform within an organization should be considered carefully in any ERP implementation, whether single or multi-site (Markus *et al.*, 2000).

In our review of literature we identified many studies that have considered an organizational unit of analysis, but we failed to find any that has looked at ERP adoption from the user's or individual's perspective. A number of studies have investigated the determinants of IS use by individuals. Theories proposed include the TRA (Fishbein & Ajzen, 1975), the technology acceptance model, referred to as TAM (Davis *et al.*, 1989), and the theory of planned behavior (Ajzen, 1991). In this research, we considered the TRA as our baseline model and used a variation of TRA proposed by Barki & Hartwick (1994) as the basis for our study. We briefly describe the TRA below. We chose TRA to model ERP use since TAM, which was originally conceptualized by Davis *et al.* (1989) to understand why people accept or reject IS, does not incorporate subjective norms. Moreover, the Barki & Hartwick (1994) adaptation of the TRA framework formalizes user participation and involvement and these are constructs that assume far greater importance in ERP implementations. For a review of studies using TAM and TRA, see Venkatesh (2000) and Barki & Hartwick (1994), respectively.

### TRA

Fishbein & Ajzen (1975) introduced the TRA as a result of their work on persuasion theory and determinants of volitional behavior. The theory identifies two unique factors that contribute to intended behavior: individual attitude and subjective norm. Attitudes are 'enduring, learned predispositions toward responses directed at

some object, person, or group (Zimbardo, 1969).’ Subjective norm is the perception of an individual regarding how people who are important in that individual’s life would feel about certain behavior (Fishbein & Ajzen, 1975). An individual’s attitude and subjective norm influence intended behavior. Barki & Hartwick (1994) used TRA to study the use of mail software. For the external variables that affect attitude towards the system use and subjective norm of use, they operationalized constructs like user participation and user involvement. While participation can be considered to influence user involvement, involvement has little effect on participation. Barki & Hartwick (1989) have suggested that the term ‘participation’ refers to the behavioral engagement of users in IS development activities, and the term ‘involvement’ refers to the psychological engagement of users with the resultant IS product of that development process.

Differences in the nature and role of user participation, due to differences in the nature and type of systems, have been documented in prior research. Lu & Wang (1997) identified differences in user participation levels based on the maturity of IS. Garrity (1994) studied participation in a traditional SDLC context, and found that the type of IS moderates the relationship between user participation and the user’s perceived usefulness of the system. According to Choe (1998), user participation is greater in IS that have high task uncertainty. In this case, since ERP projects tend to decrease task uncertainty (and the associated user’s degrees of freedom) we should expect reduced user participation. Additionally, the findings of Hunton & Beeler (1997) indicate that the effect of user participation is dependent on the extent to which users perceive a noticeable degree of instrumental control over the decision outcome, pointing to less use of ERP systems. Since these studies identify effectiveness of user participation based on task and system complexity (McKeen & Guimaraes, 1997), it is imperative that we understand the nature of user participation in the ERP life cycle. This study is motivated by the fact that implementation and usage contexts of ERP systems are different (high expectations, highly compressed project schedules, intensive activities, high visibility, formalized stakeholder roles, etc.). Therefore, the nature of user participation, and consequently user involvement, in the implementation and subsequent use of these systems may be different and need to be studied.

## Methodology

### Sample and data collection

The sample for our study consisted of ERP users in nine organizations. The organizations chosen belonged to diverse industries; this was necessary to prevent industry bias. We selected organizations where at least five major modules of ERP were implemented and the systems were ‘live’ or operational. Since our research method is based on Barki & Hartwick (1994), we used the same instrument

as employed by them. The instrument is described in Appendix A. Questionnaires were distributed among *all* ERP users in the nine organizations in our sample. These organizations and their respective contribution to sample size are described in Table 2. Table 2 also provides a description of the organization, the ERP system in use, the number of questionnaires distributed, and the response rate. The ERP project leader was chosen as the organizational contact person. A total of 355 questionnaires were distributed in the organizations. Project leaders were requested to distribute the questionnaires to all the users (we defined users as those who had a login ID and password for the ERP that formally recognized their role in the organizational process) of ERP in their organization. In all, 123 valid and usable responses were received from individuals in various functional areas. This usable response set included responses from 89 non-managers (non-management respondents included purchasing officers, store superintendents, inventory clerks, order entry clerks, accountants, project coordinators, quality supervisors, etc.) (or operational staff), 20 deputy managers, eight senior managers, and six general managers.

Figure 1 provides descriptive sample statistics.

The questionnaire data were analyzed using path analysis of latent and manifest variables. We also collected qualitative data for three organizations. These cases are used in this paper to provide examples of some of the external factors or influences that have been found to be important in our quantitative analysis and to understand some of the linkages that have been proposed.

### Analysis

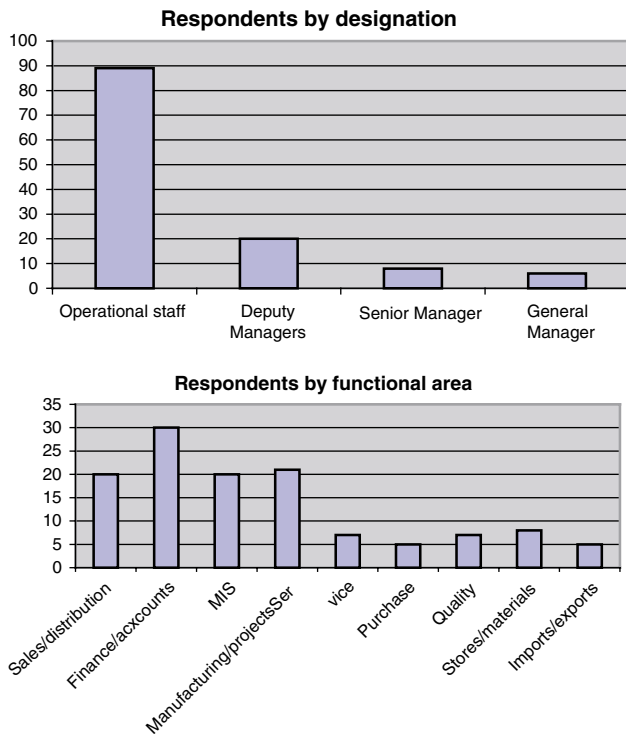
There were 15 manifest variables and nine latent variables in this study. These variables are described in Table 3. These variables were used to analyze the structural equations based on the research model shown in Figure 2 (the standard model). Before conducting structural equation modeling our descriptive analysis showed that, in terms of attitude toward the system and attitude toward system use, almost all respondents reported positive scores toward ERP. For the *subjective norm of use*, users (in supervisory roles) expected respondents to be frequent as well as heavy users of the system. This was not wholly unexpected since ERP is expensive to acquire and implement, and its effectiveness is of prime concern for top management and those formally charged with ensuring its success. This also points to an expectation among top management that intended users use the system extensively. Supervisors (who were themselves users) had not advocated ‘heavy usage’ but had recommended ‘frequent usage’ in only 10 cases out of 123.

We followed a two-step procedure based in part on an approach recommended by Anderson & Gerbing (1988). In step 1, a confirmatory factor analysis was carried out between the manifest variables and constructs in the model before we tested the path model. The PROC CALIS

**Table 2 Details of organizations surveyed**

Organization	ERP	Number of concurrent user licenses <sup>a</sup>	Questionnaires sent, responses received (response rate)
Manufactures and markets health drinks and in addition promotes and distributes a number of products in diverse categories, which include prominent household medicines for common ailments.	J D Edwards & BPCS	60	60, 12 (25%)
Manufacturer of products ranging from precision equipments, office equipment, furniture, heavy engineering, among others.	BaaN	500	100, 24 (30%)
Manufactures tractors having capacities of 50 and 70 hp	BaaN	50	50, 12 (30%)
Designs and manufactures color television, power inverters, UPS, electronic ballast, plastic molded components, deflection components, etc.	SAP	40	40, 13 (43%)
Speciality, performance, and fine chemicals that catered to the growing base of customers across a wide-ranging spectrum of industries.	BaaN	48	48, 15 (43%)
Pharmaceutical company that has built more recent ones in emerging therapeutic areas like cardiovasculars, central nervous system and nutritionals that reflect lifestyle transitions.	SAP	50	50, 11 (33%)
Manufactures multi-product company manufacturing chemicals, industrial raw materials and other related products.	BaaN	50	50, 14 (47%)
Manufactures and markets a wide range of air-conditioning and refrigeration systems and products.	BaaN	56	56, 11 (37%)
Manufacturers of commercial vehicles. Also manufactures special vehicles and engines for industrial, generator sets and marine requirements.	BaaN	70	50, 17 (42%)

<sup>a</sup>At the time of data collection.



**Figure 1** Descriptive sample distributions.

**Table 3 Variables and constructs**

Manifest variable	Associated construct	Name
V1	Overall responsibility	OVRR
V2		
V3	User-IS relationship	UISR
V4		
V5	Hands on activity	HOAC
V6	User involvement	USIN
V7	Attitude towards the system	ATTS
V8	Attitude concerning system use	ACSU
V9		
V10	Subjective norm concerning system usage	SNSU
V11		
V12	Intention to use the system	INUS
V13		
V14	System usage	SUSE
V15		

Note: Constructs bearing the same name as the associated manifest variables are the manifest structural constructs. See Appendix A for a detailed explanation of manifest variables. Actual questions are shown in Appendix B.

module of SAS was used for this analysis. In step 2, the measurement model was modified so that it represented the theoretical (causal) model of interest. This theoretical model was then tested and revised until a theoretically

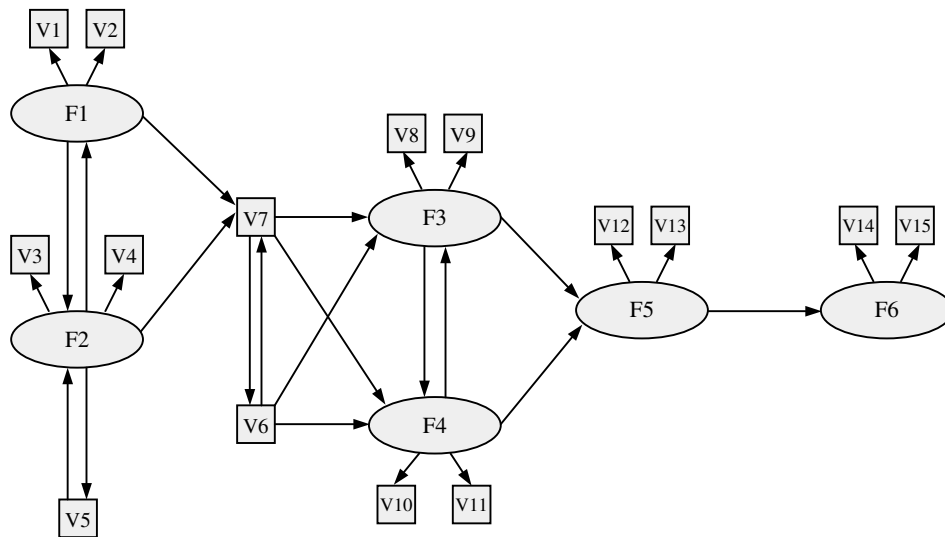


Figure 2 Standard research model (from Hartwick & Barki, 1994) – Model 1.

Table 4 Covariances of manifest variables

	V1	V2	V3	V4	V5	V6	V7	V8	V9	V10	V11	V12	V13	V14	V15
V1	0.070														
V2	0.138	0.619													
V3	0.120	0.280	0.403												
V4	0.055	0.080	0.141	0.114											
V5	0.054	0.120	0.144	0.079	0.113										
V6	0.060	0.160	0.112	0.040	0.055	0.345									
V7	-0.118	-0.292	-0.410	-0.179	-0.239	-0.163	1.699								
V8	-0.119	-0.336	-0.359	-0.138	-0.198	-0.168	1.378	1.381							
V9	-0.114	-0.335	-0.357	-0.147	-0.189	-0.159	1.350	1.266	1.437						
V10	0.033	0.066	0.104	0.018	0.025	0.010	-0.010	-0.019	-0.021	0.516					
V11	-0.004	-0.044	0.015	0.011	0.016	-0.022	0.146	0.129	0.139	0.255	0.493				
V12	0.041	0.078	0.174	0.051	0.114	0.073	-0.360	-0.231	-0.247	0.200	0.099	1.249			
V13	0.077	0.249	0.203	0.074	0.190	0.170	-0.722	-0.574	-0.559	0.123	0.171	0.847	1.810		
V14	0.046	0.072	0.135	0.036	0.158	0.073	-0.193	-0.014	0.049	0.167	0.184	0.739	0.907	1.866	
V15	0.145	0.386	0.406	0.139	0.250	0.334	-1.182	-0.936	-0.962	0.227	0.052	0.815	1.293	1.200	2.603

$n=123$ .

meaningful and statistically acceptable model was found. Covariances for the study's 15 manifest variables are presented in Table 4.

*Step 1: The measurement model.* In path analysis with latent variables, a measurement model describes the nature of the relationship between (a) a number of latent variables, or factors, and (b) the manifest indicator variables that measure those latent variables. The model investigated in this study consisted of six latent variables corresponding to the six constructs of the Barki & Hartwick model: overall responsibility, user-IS relationship, attitude concerning system use, subjective norm concerning system usage, intention to use the system, and actual system usage. Each of the six latent variables was measured by at least two manifest indicator variables.

We follow Bentler's (1989) convention of identifying latent variables as 'F' and manifest variables as 'V' in Figure 2 and Table 5. The measurement model was estimated using the maximum likelihood method, and the  $\chi^2$  value for the model was statistically significant,  $\chi^2(57, N=48) = 77.1885, P=0.0387$ . The ratio of  $\chi^2$  and the corresponding degrees of freedom is equal to 1.354 ( $77.185/57$ ), and is less than 2.0 (which is one of the criteria of good fit between model and data). The other fit indices, comparative fit index (CFI by Bentler) and the non-normed fit index (NNFI), have values of 0.9415 and 0.8922, respectively. For a model with a good fit, CFI and NNFI should be close to 1.0 (generally a threshold of 0.85 or 0.9 is sufficient to assert a good fit of the model with the sample data). From these values, coupled with the  $\chi^2/$

Table 5 Properties of the measurement model

Construct and indicators	Standardized loading	<i>t</i>	Reliability	Variance extracted estimate <sup>a</sup>
Overall responsibility (F1)			0.8134	0.6902
V1	0.9439	12.4289	0.8909	
V2	0.6996	8.4452	0.4894	
User-IS relationship (F2)			0.7934	0.6578
V3	0.8371	10.9102	0.7007	
V4	0.7841	9.9818	0.6148	
Attitude concerning system use (F3)			0.9469	0.8991
V8	0.9685	14.5419	0.9380	
V9	0.9275	13.4617	0.8603	
Subjective norm concerning system usage (F4)			0.7424	0.6120
V10	0.5177	4.0719	0.2680	
V11	0.9777	5.1096	0.9559	
Intention to use system (F5)			0.7412	0.5954
V12	0.6344	7.085	0.4025	
V13	0.8879	10.0239	0.7884	
System usage (F6)			0.7578	0.6259
V14	0.563	6.2579	0.3170	
V15	0.9669	10.8837	0.9349	

<sup>a</sup>Assesses the amount of variance that is captured by an underlying factor in relation to the amount of variance due to measurement error.

Table 6 Goodness-of-fit and parsimony indices for ERP Use

Description	Combined model							Structural model		
	$\chi^2$	d.f.	NFI	NNFI	CFI	PR	PNFI	RNFI	RPR	RPFI
Null model	1222.5	105								
Measurement model	121.84	57								
Model 1 (standard model)	265.49	76	0.7437	0.7065	0.7876	0.7238	0.5383	0.5106	0.9048	0.4620
Model 2 (Barki's model)	199.79	79	0.8366	0.8563	0.8919	0.7525	0.6294	0.8190	1.0476	0.8580
Model 3 (Without external factors)	85.41	27	0.8840	0.8592	0.9155	0.6000	0.5304			

Note: *N*=123. NFI=normed-fit index; NNFI=non-normed-fit index; CFI= comparative fit index; PR=parsimony ratio; PNFI=parsimonious normed-fit index; RNFI=relative normed-fit index; RPR=relative parsimony ratio; RPFI=relative parsimonious-fit index.

d.f. ratio, it can be said that a good fit exists between the sample data and measurement model.

Standardized factor loadings for the indicator variables are presented in Table 5. The SAS system CALIS procedure provides approximate standard errors for these coefficients that allow large sample *t*-tests of the null hypothesis that the coefficients are equal to zero in the population. The *t*-scores obtained for the coefficients in Table 4 range from 5.06 to 7.19, indicating that all factor loadings were significant ( $P < 0.001$ ). This finding provides evidence supporting the convergent validity of the indicators. Table 5 also provides the reliabilities of the indicators (the square of the factor loadings) along with the composite reliability for each construct. Composite reliability is a measure of internal consistency comparable to coefficient  $\alpha$  (Fornell & Larcker, 1981). All six scales demonstrated acceptable levels of reliability with

coefficients in excess of 0.70. The final column of Table 5 provides the variance-extracted estimate for each scale. This is a measure of the amount of variance captured by a construct, relative to the variance due to random measurement error (Fornell & Larcker, 1981). All six constructs demonstrated variance extracted estimates in excess of 0.50, the level recommended by Fornell & Larcker (1981).

Considering all our results together from Tables 4 and 5, we found support for the reliability and validity of the constructs and their indicators. This measurement model was retained as the study's final measurement model.

*Step 2: The structural model.* The initial theoretical model tested in our study is shown in Figure 2. This model contains both latent and manifest variables.

Goodness-of-fit indices for the model appear in Table 6, in the row headed 'Model 1.' Values on the NNFI and CFI

Table 7 Standardized path coefficients

Dependent variable/independent variable	Theoretical model (1)	Barki & Hartwick (2)	Reduced external variables (3)
System usage (F6)			
Intention to use system (F5)	0.8888**	0.8977**	0.8978**
Intention to use system (F5)			
Subjective norm concerning system use (F4)	0.2985*	0.3419**	0.3418**
Attitude concerning system use (F3)	-0.5220**	-0.5518**	0.5318**
Subjective norm concerning system use (F4)			
Attitude concerning system use (F3)	0.0451	0.1103	NA
User involvement (V6)	0.0233	0.0054	NA
Attitude toward the system (V7)	0.1115	NA	NA
Attitude concerning system use (F3)			
Subjective norm concerning system use (F4)	0.0163	0.0295	NA
User involvement (V6)	-0.0705*	-0.0586*	NA
Attitude toward the system (V7)	0.9152**	0.9190**	0.9190**
Attitude toward the system (V7)			
Overall responsibility (F1)	1.4056	-0.4588**	NA
User-IS relationship (F2)	5.4360	NA	NA
User involvement (V6)	-1.9931	-0.0044	NA
User involvement (V6)			
Overall responsibility (F1)	8.6025	0.4061**	NA
Attitude toward the system (V7)	-7.0872	-0.0218	NA

Note: N=123

\* $P < 0.01$ ; \*\* $P < 0.001$ .

were acceptable for Model 1 (in excess of 0.9). Residuals are concentrated around the zero mark with few large residuals. However, the distribution of the residuals was asymmetrical, and 10 of the residuals were relatively large (more than 2.0); however, no residual was greater than 2.75. The nomological validity of the theoretical model was tested using the  $\chi^2$  difference test. The  $\chi^2$  value from the measurement model (121.84) was subtracted from the  $\chi^2$  from the structural model (265.49), resulting in a  $\chi^2$  difference value of 143.55. The difference in degrees of freedom was 19. Since the critical value of  $\chi^2$  was 22.36, the significant value of  $\chi^2$  shows the theoretical model was not successful for accounting for all the relationships between latent and manifest constructs. This can be verified by the many path coefficients that were non-significant (see Table 7).

While the next step could have been to conduct a specification search (adding or dropping paths) using data based on our sample, there was a danger that data-driven modifications would have capitalized on chance characteristics of the sample data and result in a final model that would not generalize to the population or to other samples (MacCallum *et al.*, 1992). Therefore, we dropped paths in Model 1 to make the model equivalent to Barki & Hartwick's (1994) model (shown in Figure 3). Dropping these paths (to get Model 2) would be

acceptable only if it did not result in a significant increase in model  $\chi^2$ . The resulting difference in  $\chi^2$  (Model 1–Model 2) was 65.70, with a difference in degrees of freedom of 3. This difference is significant (the critical  $\chi^2$  value is 11.071). Model 2 was also compared to the measurement model to determine whether it successfully accounted for the relationships between the latent constructs. The  $\chi^2$  difference was calculated as 67.85 (d.f. = 22); this was significant too. This implied that while Model 2 provided an acceptable fit, its shortcomings were the same as that of Model 1 – in that many paths were non-significant.

Our third model (Figure 4) was based on the finding that there was a disconnect between the upstream components of the 'external factors' identified by Barki & Hartwick and 'attitude toward system' and 'user involvement.' The implication of this for ERP use is that attitude and involvement are influenced by factors other than overall responsibility (F1), user-IS relationship (F2), and hands-on activity (V5). So, for our third model, we did not consider the F1, F2, and V5.

Goodness-of-fit indices for this model appear in Table 6, in the row headed 'Model 3.' Values on the NNFI and CFI were acceptable for Model 3 (in excess of 0.9). Residuals were concentrated around the zero mark with few large residuals. The distribution of the residuals was



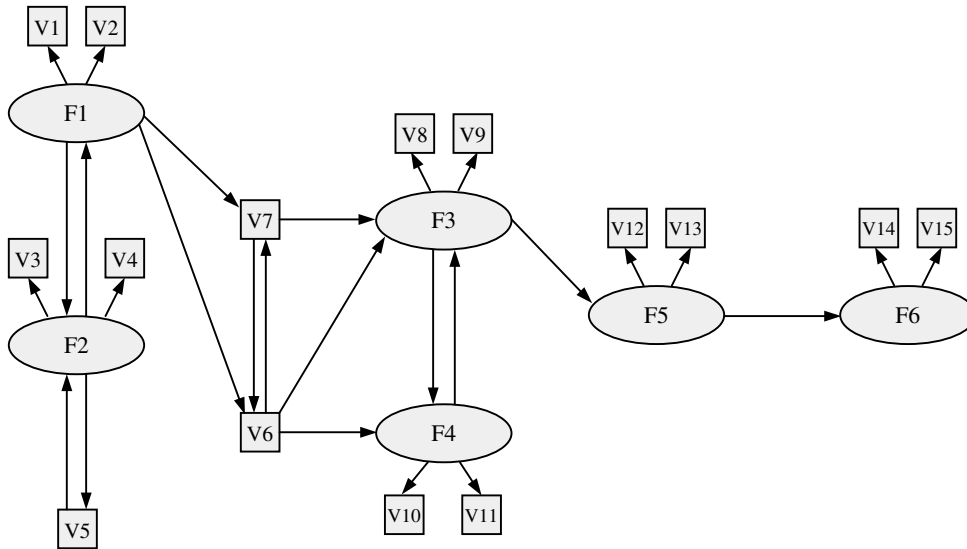


Figure 3 Modified research model (as proposed by Barki & Hartwick, 1994) – Model 2.

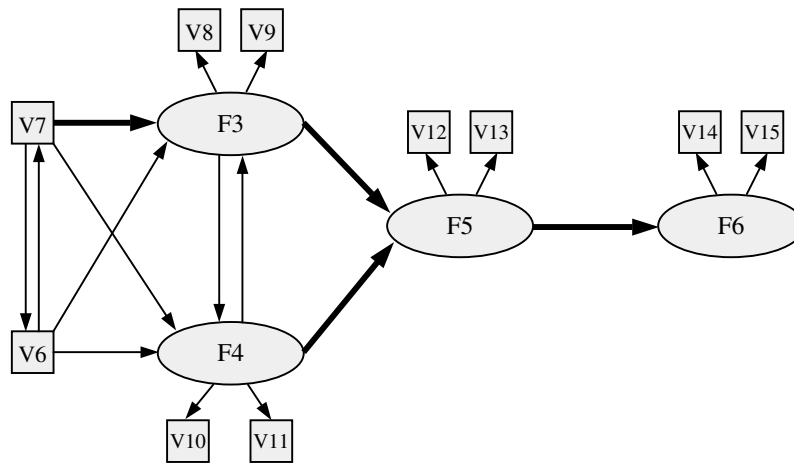


Figure 4 Final research model – Model 3; significant paths are highlighted.

symmetrical, and only one of the residuals was greater than 1.0 (Figure 5).

**Discussion**

The presence of a reasonable fit between sample data and TRA models in Models 1 and 2 (the standard TRA version and the version by Barki & Hartwick) shows that ERP usage in organizations is similar to the use of other IS deployed in organizations. In the past, models considered had been tested in non-ERP situations. The proposed models work well in the ERP context as well. However, there are differences in the significance of paths between constructs. For instance, the explained variance of *subjective norm concerning use* by other constructs is very small. In addition, many path coefficients are not statistically significant. This can be verified by examining the *t*-values and the *R*<sup>2</sup> values for Models 1 and 2. Of

significance, however, is the major deviation of our final model (Model 3) from Model 1 and Model 2. Possible explanations for this difference are discussed below.

Firstly, since an ERP project is expensive in terms of both hardware and software, it is imperative for the organization undertaking it to make it a success. Thus, senior managers tend to exert pressure on subordinates to use the software package for their daily office work (if the employee, on whom the pressure is being put, does a job that requires ERP package usage). Users who would benefit from using ERP are not given the option of choosing whether or not to use the ERP system. Bypassing ERP is not an available option regardless of any inadequacies in the ERP system. Given the high costs of changing software, most organizations use ‘work-arounds’ to customize the software.

-2.50000	-2.25000	1	1.82	*
-2.25000	-2.00000	0	0.00	
-2.00000	-1.75000	0	0.00	
-1.75000	-1.50000	2	3.64	**
-1.50000	-1.25000	0	0.00	
-1.25000	-1.00000	4	7.27	****
-1.00000	-0.75000	0	0.00	
-0.75000	-0.50000	0	0.00	
-0.50000	-0.25000	3	5.45	***
-0.25000	0	10	18.18	*****
0	0.25000	15	27.27	*****
0.25000	0.50000	8	14.55	*****
0.50000	0.75000	0	0.00	
0.75000	1.00000	1	1.82	*
1.00000	1.25000	5	9.09	****
1.25000	1.50000	1	1.82	*
1.50000	1.75000	1	1.82	*
1.75000	2.00000	1	1.82	*
2.00000	2.25000	0	0.00	
2.25000	2.50000	0	0.00	
2.50000	2.75000	0	0.00	
2.75000	3.00000	2	3.64	**
3.00000	3.25000	1	1.82	*

**Figure 5** Extract of SAS output – distribution of normalized residuals for Model 3 (each \* represents one residual).

Secondly, due to increasing demand for individuals with ERP experience, many volunteer to implement and use ERP systems. There continues to be an increasing demand for individuals with ‘ERP experience.’ Hence, usage of an ERP package can be perceived by ERP users to be beneficial to them in their careers. Hence, the prevailing market conditions and opportunities encourage individuals to use the ERP software. While the boom associated with ERP is certainly over, individuals with a strong combination of ‘domain knowledge’ (functional knowledge and expertise in finance, logistics, inventory control, etc.) and implementation and/or usage experience will continue to be in demand.

This difference in paths was in terms of the non-significance of the ‘external factors’ like overall responsibility, user–IS relationship, and hands-on activity. This difference can be attributed to the way in which the variables were conceptualized and operationalized. In essence, attitude toward the system and attitude toward system use tend to derive from influences that are external to the usage context. Moreover, the ERP, which is generally highly restrictive, does not necessarily lead to immediate individual users’ benefits. Hence, the case for factors affecting ERP use that are external to the application context is strengthened.

To understand the absence of the linkage between user involvement and subjective norm, it is useful to conceptualize *subjective norm* as the formalized and aggregated expectancy structure in an organization. Involvement is best conceptualized as intrinsic involvement, which refers to the association between objects, actions, or events and self-relevant goals and values

(Jackson *et al.*, 1997). Intrinsic involvement is a function of one’s goals and values and thus tends to endure throughout the development process. In the case of ERP, intrinsic involvement for key users may begin before the start of the ERP project, and may extend well beyond its completion. An individual is more involved in the project if the ERP experience provides opportunities for career advancement. Subjective norm refers to what is expected of an individual inside an organization. In the case of ERP, involvement tends to derive from extraorganizational aspects. Hence, there is an absence of a relationship between subjective norm and involvement.

The absence of statistically significant path coefficients can also be attributed to methodological aspects. The use of a pre-existing (albeit validated survey instrument) without refining and testing it for ERP-specific constructs could have also resulted in weaker than expected path coefficients. Items in the questionnaire we used were derived from constructs too closely associated with the traditional system development lifecycle. Some of the questionnaire items did not fit well into an ERP situation and could have been responsible for injecting noise into the data.

The changing nature of IS lifecycles (Sawyer, 2001) as a result of the increasing moves toward enterprise-wide commercial off-the-shelf systems dramatically alters the underlying dynamics associated with our established notions of user participation and user involvement. As a result, user participation, user–IS relationship, or hands-on activity does not seem to have any influence on either user attitude toward the system or user involvement. Based on our *measurement* model, these constructs are

valid. They were utilized and played out, much as we would expect in the traditional model of eliciting user participation. However, since we find a disconnect between users' roles, user-IS interaction and hands-on activities and user involvement, we would expect future implementations to use a different approach to eliciting user involvement. Additionally, successful ERP implementations do not generally tend to be IS-driven initiatives (Sarker & Lee, 2000; Willcocks & Sykes, 2000). The IS department tends to play a supporting role and is a partner in the entire process along with the key user group, the implementation partner, and the management committee. We believe that the role that is played by the IS department would further mitigate the linkage between user-IS relationship and attitude or user involvement. Lastly, the absence of the traditional form of hands-on activity would imply the absence of its influence on either user attitude or user involvement. In summary, it appears that the nature of ERP and its implementation heightens the distinction between involvement and participation. In the next section, we discuss our findings in the context of three cases. Following that, we provide a discussion of alternate constructs that can be identified in order to seek determinants of user involvement and attitude in the context of ERP use.

**Qualitative analysis**

In previous sections, we have used path analysis to study factors that affect ERP use in organizations. In this section, we employ case data to support and explain results obtained through structural equation modeling. We provide three cases of ERP use.

**Case A**

The engineering division of company A belongs to a European group and ranks among the leading companies in the field of mechanical engineering and plant construction. Company A has approximately 20,000 employees worldwide. The company follows similar well-documented processes worldwide. The firm focuses on quality of equipment supplies, service provided to the customer, innovation and also believes in nurturing an open working environment. An important belief is sharing the same information with clients, suppliers, and employees. As a result, vital information on the project schedules and cost are often shared with the customer as well as the supplier. The decision to implement ERP in the country operation was a part of a proposal aimed at having a uniform, IS worldwide. SAP was the vendor selected for the ERP package. SAP R/3 was to be implemented in various offices of company A. The IT department has gone through series of changes in a short span. At 2 years prior to ERP implementation, one EDP manager supervised two employees (who handled hardware and network administration/support and minor in-house software development) and reported to the General Manager (Finance). This three-person team managed systems that ran on three servers that were linked to 40 PCs connected over a LAN. This scenario had changed by the time the ERP went live. The company had an IT manager who headed a team of six, reported directly to management, and played a major role in decision making related to IT. The status of the organization at the time the study was carried out is shown as being in stage 4 of Nolan's model as shown in Figure 6. As the company was ISO 9000 certified prior to ERP

<b>IT infrastructure</b>	30-40 PC-s, 2-3 servers. LAN,	5 servers; few CAD stations. Internet / e-mail connectivity worldwide.	LAN/ WAN; regular back-ups. Annual AMC for all hardware.	SAP R/3. Intranets; radio towers.	Integrating customers/ vendors. E-commerce.	
<b>Application portfolio</b>	Accounting-FAP,K&E, Payroll,	AP movement to pinpoint status of vendor invoices. Project monitoring.	Modifications in existing packages. Integration of K&E and payroll system.	Proposal to do away with certain in-house packages.	Decision support systems??	
<b>Top management</b>	Approving IT budgets for the year.	Asking for improvements in various departments by means of IS?	Closer interaction of IT and management.	IT involved in key process modifications.	Expect returns on investment?	
<b>IS management</b>	Mainly managing data for management reporting to GM (finance),	EDP-Middle manager reporting to VP (finance). Two persons.	IT-Manager reporting to management; team of six. Outsourcing AMC-IT & T.	IT-head reporting to management; team of six.	Profit center?	
<b>Users</b>	Not much knowledge and no desire for new systems/ products,	250+ users at offices and remote sites	Increased demands from users-Pentium-III, latest software, Internet??	Internal SAP team for inputs on implementation.	Reduced employees more users. More knowledgeable. Involve customers/vendors??	
<b>Stage</b>	<b>I Initiation</b>	<b>II Contagion</b>	<b>III Control</b>	<b>IV Integration</b>	<b>V Data administration</b>	<b>VI Maturity</b>
	1992	1998	1999	2001	2002	2004

Figure 6 Stages of IT growth at company A.

implementation, all processes and functions of various departments are well documented. Prior to the ERP, the finance department utilized MIS effectively using independent financial packages. The projects department furnished summary time schedules to management using project management tools. An earlier attempt (that preceded the ERP by 2 years) to integrate data using Fox Pro two had failed owing to weaknesses in architecture (primarily in terms of lack of scalability) and inadequate security features. Moreover, the system was not user friendly. Change management was compounded because users and the IT department continued to blame each other and project cost escalated. Facing such problems the company management had decided to implement ERP. The company had retained a consulting firm for design and customization of SAP R/3 modules.

Training formed a critical component of ERP implementation. Training was conducted with the objective of improving the chances of the system meeting users' needs and allowing the users to articulate their viewpoints. Training was also conducted to elicit users' buy-in to the proposed changes. This process was intended to build consensus and to minimize surprises when the new system would be implemented and used. Training also generated confidence that ERP would be successful in bringing about desired change. Users were prepared to develop a better understanding of the importance of data accuracy and were sensitized to a rough ride ahead.

In-house training sessions were held continuously for a fortnight with a mix of department heads and users. This allowed the department heads to comprehend the complexity of the ERP product and allowed users to share some of their concerns upfront in the presence of their functional heads. This, in many ways, calibrated the expectations of both management and the user community in terms of what to expect when leading up to the eventual steady state of ERP usage. Users insisted and ensured that both old and new systems were kept running in parallel. However, the workload required to keep both systems afloat created immense pressure on both the implementation team as well as the users to iron out remaining problems. The old systems were phased out sooner than planned because users and the implementation team felt compelled to learn at a faster rate. The company policy regarding the ERP implementation and subsequent improvement expectations had been clearly communicated. One of the stated policy decisions was cutting down on manpower by 10% as a result of better productivity of existing staff after ERP implementation in a phased manner. The explication of this policy was a clear communication of management commitment to organizational improvement. The CEO chaired regular meetings for removing mental blocks and apprehensions in the mind of employees about the system. At the same time, it was amply clear that the ERP implementation effort was a serious organizational attempt at – be they

process-related, organizational design-related or focused on specific individual roles and performance.

In this case, the subjective norm regarding ERP use was fashioned not by user involvement but by the implementation context (moving from a consolidation to the integration stage) and management policies (clearly enunciated policy of head count reduction). There was a premium on making the ERP succeed and users quickly recognized the relevance of many of the issues that had been raised during their training. They also understood that issues beyond simple usage would be necessary to demonstrate ERP enabled benefits. The combined pressure of high management visibility and involvement and the presumed inevitability of steady-state ERP usage pattern in a short timeframe created normative pressures on users to assimilate ERP into their work. In other words, the primary influencer of subjective norm appears to be direct management involvement and oversight in ERP implementations. While user involvement is diminished in ERP projects, user engagement (in this case by management) is heightened in ERP implementations.

#### Case B

In accelerated implementation schedules, where end-user participation is not feasible, system usage is often turned into a last line of defense against ERP failure. In one organization, ERP usage was used as an end as well as a means to demonstrate ERP success. The logic employed was that if ERP usage continued in spite of high response times (this was a common problem during the first few months of ERP use due to improper server sizing) and technical and functional glitches, then emergent and persistent problems would be sorted out over time. In other words, the burden of success had shifted to the users. This was an instance of negative intrinsic motivation to use the ERP. In other words, the normative expectation of the ERP implementation team was for users to 'bear with the system' while they sorted out the problems. This approach was undertaken with the mistaken notion that once on-time implementation could be demonstrated to management, subsequent funding (to 'fine tune the system') could then be justified. Needless to say, the organization ended up commissioning significant rework and functional modification of software to *make the ERP work*. Such usage dynamics had been preceded by negative implementation dynamics. In any organization the idea is to, almost always, nominate the best individuals to be key users – whose participation and actions would accord legitimacy to the entire process. Key users are designated users who represent a specific functional area (marketing or finance) and are involved in the entire ERP lifecycle. They tend to be the users' primary voice in the process mapping stage and in negotiations having to do with the extent of process reengineering. They are handpicked because of their functional area expertise, technical skills and learning ability and are deemed ERP champions. They

act as the organization's primary interface with implementation partners and are expected to coordinate closely with the IS group and their own functional heads. However, in this case many key users developed hostility toward ERP use when their suggestions or recommendations were either ignored or bypassed – in the interest of adhering to the tight and non-negotiable implementation schedule. In such instances, the key users' involvement allowed them to experience the software-centric nature of the implementation framework. In addition, when key users also experienced the 'aggressive schedules' that were supported by both management and the implementation partner, they recognized their reduced roles (The need to adhere to aggressive schedules can be understood because management treated the ERP implementation differently from a 'normal' IT project where delays had been assumed and tolerated.). This tended to diminish their intrinsic desire to support aggressive use of the ERP because they could foresee many of the pitfalls. Given their legitimacy, they were successful in transferring their negative perceptions to their user groups. Such negative perceptions about the ERP itself transferred to the nature of use of the ERP also. Specifically, most legitimate and straightforward use tended to be disinterested and half-hearted. This ERP use scenario posits that attitude toward ERP use tends to be influenced by key users. Attitude toward the system appears to be influenced more by key users and less by overall responsibility (which a user does not tend to have) or user-IS relationship (which is minimized in the case of ERP because of the enhanced role of ERP implementation partners and direct management involvement and oversight).

A separate set of dynamics was played out by a different set of key users who clearly articulated and supported the fast-track to ERP use. The key users' close interaction with implementation partners allowed them to experience the 'consultant' mode of work and they viewed the organizational ERP project as a training ground to prepare for a career change. These key users displayed and generated a high level of enthusiasm and motivation and proved to be highly productive because of the combination of their strong domain/functional knowledge and their freshly acquired technical expertise. Such key users were often instrumental in seeking and working toward resolutions when other key users (as mentioned above) chose to criticize ERP dynamics. In a rather unusual way, their goal of quitting the organization was contingent on enabling and demonstrating successful ERP use. Many implementation partners also see high-performing key users as potential recruits. This is because it is not easy to find individuals with the right blend of technical skills and functional knowledge *and* the requisite ERP implementation and use experience. Such interaction dynamics between stakeholders inside and outside the organization create normative pressures for ERP use, which are sometimes more than even those that can be attributed to top management.

### Case C

In organization C, the new CIO had recommended the implementation of an ERP as a 'last resort' after having tried to keep the existing MIS alive with 'life support' for 3 months. While the ERP was implemented successfully because of unstinted support by top management, top management functioning and the dynamics of decision-making did not change. For instance, a major organizational ritual was the 'Wednesday meeting' for which functional heads had to have their weekly status reports ready. A significant percentage of the functional heads' staff time was spent on collecting, collating, verifying and presenting the required information (targets, variances, exceptions, management and operational responses, etc). While ERP use held the promise of streamlining process, the ERP had been justified primarily on the promise of consolidation and integration of IS to radically improve operational efficiency. It was this goal of *operational efficiency* that had been used to justify major process changes to avoid any software customization to accelerate the implementation schedule and to incorporate undiluted 'best practices.' However, actual ERP use was driven by the information needs for the weekly meetings. This gap between the espoused and actual philosophy of ERP use created a high level of dissonance among users. Users saw the ERP as an information-logging device with the pre-ERP management decision-making structure incompatible with the changed processes. From the users' standpoint, there were no perceived or real benefits. Users viewed the ERP as a powerful data logging and control system in the hands of management.

One way to view ERP implementations is as a responsive and convenient fix to the IS department's struggle with diverse IT systems. In that context subsequent ERP use is often subordinate to tight schedules. While this leads to normative pressure to use the ERP (i.e. attain cutover from the previous system to the ERP), this pressure does not emanate from involvement (as expected from Barki & Hartwilk's model). Such pressure is often applied blatantly. For instance, when sales transactions took more than 20 min to complete (because of server sizing and configuration problems), users had to continue to work in that mode for at least 3 months before the server was upgraded. Even after the system attained steady state, users were unable to reschedule or reprioritize deliveries or payments (which had to be done in response to events outside the organization, for example, transportation delays, emergent orders from an important customer, etc.). Often such revisions were the outcome of the 'Wednesday meeting.' The ERP had forced a rigid discipline of ERP use in an undisciplined operational context. Users have had to constantly struggle with 'workarounds' and their own creativity.

In the preceding paragraphs we have illustrated alternative influencers of users' attitude toward ERP use and the influencers of subjective norm concerning use. From a theoretical standpoint, the confluence of many inter-

acting variables that include management visibility and involvement, the role of external organizations (implementation partners) and the pivotal role of key users creates a unique structure that determines ERP user behavior. Structure denotes a pattern of interdependency that is enacted by various participants that include ERP decision makers, the IS group, the external participants (ERP vendor and implementation partners), key users, and users. In most cases, ERP vendors determine the normative expectations when they influence top management to invest in an ERP. These normative expectations translate into usage patterns for users and implementation guidelines for the implementation team. We conclude this paper by highlighting selected aspects of conflict and sources of complementarity as ERP use is enacted in organizations.

### Conclusion

The present study shows that the model of theory of reasoned action, as specified by Barki & Hartwick (1994), has to be modified to be relevant for ERP systems. The main finding of this study was that while a theoretical model does explain user behavior *vis-à-vis* user participation and involvement, a more parsimonious model demonstrates that the dynamics in ERP implementation are different.

This finding has significant implications for organizations. Large investments are being made by organizations to implement enterprise-wide IS. The motivation for such systems may be varied but their utility to organizations cannot be underestimated. Yet, if organizations are not able to elicit meaningful and appropriate user involvement, user participation (which could be superficial) will tend to dilute the potential impact of the ERP project. The source of such inadequate participation could well be the nature of the ERP implementation process itself wherein users are involved only after a decision to implement a certain package has already been taken. When Jenson & Johnson (1999) conclude that 'most problems seem to result from users trying to map a previously ill-behaved system to work within the structure of the ERP system,' they are describing a framework where users tend to perceive the situation as – here is the software, make sure it works. User involvement has been linked to IS success (Yoon *et al.*, 1995; Hwang & Thorn, 1999). The least controversial measure of IS success has emerged to be user satisfaction with IS (Tait & Vessey, 1988; Tan & Lo, 1990; Glorfeld & Cronan, 1993). IS success has been linked with IS use (Downing, 1999). Hence, the extent and nature of ERP use does determine ERP success.

Newman & Noble (1990) have found that conflict in user involvement may result from the development of complex systems in which analysts and users have semantic differences, users have conflicting information requirements, and where users may not have sufficient influence or power to control the design process. While

the traditional notions of design might be absent in ERP projects, the very nature of user participation without much choice provides ample scope for users to perceive lack of influence or power to determine a solution framework that they seem to be designing for themselves. Robey & Farrow (1982) have reported that participation without influence may not lead to the successful resolution of a conflict between analysts and users. The ERP analogy to the Robey and Farrow study is the conflict between implementation partners and users. Users tend to retain most of the existing processes while implementation partners encourage organizational process changes by incorporating world-class business practices into the organization. Management tends to minimize the implementation cycle time by accepting an ERP system with minimal customization. This situation tends to strip users of their influence in determining the degree of customization of an ERP. This leads to inappropriate involvement and consequently suboptimal use. In the long run, the much-anticipated ERP benefits tend to be diminished.

The search for the determinants of user involvement and attitude can be better understood using the work of Dewan & Kraemer (1998). Dewan & Kraemer conclude that, 'the estimated returns from IT investment reflect other changes in the economies ... that are complementary to IT investments such as infrastructure, human capital, and informatization of business processes (p. 62).' An organization has to prepare itself for ERP implementation much before the actual ERP decision is taken. It may take years of build-up and requisite preparation with IT diffusion and infusion to determine, in large part, whether users demonstrate a combination of a positive predisposition to a new system when they view it from the standpoint of their work. Additional support for such requisite build-up comes from Bresnahan & Brynjolfsson (2000), who use the phrase 'complementary investment.' Just as Bresnahan & Brynjolfsson offer a theory of causation in that 'more firms with skilled workers find computers more productive and buy more of them,' we have reason to believe that organizations that are better prepared to absorb information technology will be able to leverage the benefits of information technology. Brynjolfsson & Hitt (2000) provide an alternate explanation when they state 'firms must incur substantial adjustment costs before IT is effective.' We believe that these adjustment costs may tend to be prohibitively high for organizations that do not have users who are experienced with IS. One of the critical factors for influencing users' attitudes and involvement can be understood in terms of the 'tuition paid for the learning (Dewan & Kraemer, 1998)' that precedes any part of ERP implementations.

We suggest that future research in this area incorporates the nature and intensity of top management involvement and oversight as well as the role of key users and their interaction with implementation partners.

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## Appendix A. Description of the questionnaire

'User participation' is composed of three constructs: *overall responsibility*, *user-IS relationship* and *hands on activity*. 'overall responsibility' is measured by six questions. The responses are measured on a nominal scale. For the analysis process averages of the response values on each scale are taken. The responses of the first five questions are averaged (Yes=1 and No=0) into V1 and the response on the sixth question is used individually (each box in the question, if checked, is assigned the value) as V2.

'User-IS relationship' is measured using seven questions. All the responses were measured on a nominal scale. The average of the responses on each scale was taken for analysis. The responses on the first five questions are averaged to give the value of the first manifest variable (V3). The next two questions are averaged to arrive at the value of the second manifest variable measured user-IS relationship (V4).

'Hands-on-activity' is measured using five questions scored on a nominal scale. Responses on all the five questions are averaged to arrive at a measure for this construct. Thus, hands-on-activity acts as a manifest structural variable (V5) in the TRA model (a construct

being measured directly – using only one manifest variable).

'User involvement' is measured on nine dimensions. These are: important/unimportant, needed/not needed, essential/not essential, trivial/fundamental, significant/insignificant, means a lot to me/means nothing to me, of concern/of no concern, relevant/irrelevant, and matters to me/does not matter to me. Each dimension is measured on a 7-point interval scale. The positive affects (useful, means a lot to me, etc.) in each dimension is assigned a value +3 while the other extreme is assigned a value -3. Intervals are on increments of 1.0. Responses on all the nine dimensions are averaged to arrive at a single measure of the manifest structural variable (V6) – user involvement.

'Attitude towards the system' is measured on four dimensions using a 7-point interval scale. These are: good/bad, terrific/terrible, useful/useless and valuable/worthless. Responses are given numerical values similar to those in the case of measurements for user involvement. Attitude towards the system also acts as a manifest structural variable (V7) in the TRA model.

The TRA constructs are measured based on frequency of system use and extent of system (whether system use is heavy or light). 'Attitude concerning system use' is measured on the same dimensions as in 'Attitude towards the system'. Measurements are on a 7-point scale and measurements on frequent use of system (V8) and heavy usage of system (V9) are each averaged to yield measures of the two manifest variables.

'Subjective norm concerning system use' is measured using six questions. Responses are on whether the responder's superiors, peers and subordinates expect him/her to frequently/heavily use the ERP system. Responses are taken on a 7-point scale with 'should' and 'should not' being the extremes. The extremes have been given values -3 (for should not) (V10) and +3 (for should) (V11).

Intention to use the system (as reported by the respondent in the questionnaire) is measured on two dimensions. These are: 'Heavy usage/Light usage' (V12) and 'Frequent usage/Infrequent usage' (V13). Measurement is on a 7-point interval scale, with one extreme given the score 0 and the other extreme 6.

System usage (as reported by the respondent in the questionnaire) is measured on two dimensions. These are 'Heavy usage/Light usage' (V14) and 'frequent usage/infrequent usage' (V15). Measurement is on a 7-point interval scale, with one extreme given the score 0 and the other extreme 6.

## Appendix B.

This survey has been designed to assess user perceptions and beliefs regarding the ERP project that is currently in place. Respondents are requested to provide their responses to all the questions. There is no specific desirable answer or response. These data are going to be used in an aggregated manner and, consequently, the more complete the response from your side the better the utility of

this questionnaire. Please place a check mark wherever applicable.

### A. User participation: overall responsibility

- |   |                              |                             |
|---|------------------------------|-----------------------------|
| Were you a part of the project team?  | <input type="checkbox"/> Yes | <input type="checkbox"/> No |
| Did you have a responsibility for estimating development costs of the new system?                     | <input type="checkbox"/> Yes | <input type="checkbox"/> No |
| Did you have a responsibility for requesting additional funds to cover unforeseen time/cost overruns? | <input type="checkbox"/> Yes | <input type="checkbox"/> No |
| Did you have a responsibility for selecting the hardware and/or software needed for the new system?   | <input type="checkbox"/> Yes | <input type="checkbox"/> No |
| Did you have a responsibility for the success of the new system?                                      | <input type="checkbox"/> Yes | <input type="checkbox"/> No |

I had main responsibility for the development project during:

- System definition     Physical design     Implementation

### B. User-IS relationship

	System definition	Physical design	Implementation
IS/data processing staff drew up a formalized agreement of work to be done during			
I was able to make changes to the formalized agreement of work to be done during			
The IS/Data Processing staff kept me informed concerning process and/or problems during			
I formally reviewed work done by IS/data processing staff during			
I formally approved work done by IS/data processing staff during			

- |  |                              |                             |
|--|------------------------------|-----------------------------|
| I evaluated an information requirements analysis developed by IS/data processing staff | <input type="checkbox"/> Yes | <input type="checkbox"/> No |
| I approved an information requirements analysis developed by IS/data processing staff  | <input type="checkbox"/> Yes | <input type="checkbox"/> No |

### C. Hands-on activity

- |  |                              |                             |
|--|------------------------------|-----------------------------|
| For this system I defined/helped define input/output forms | <input type="checkbox"/> Yes | <input type="checkbox"/> No |
| For this system I defined/helped define screen layouts     | <input type="checkbox"/> Yes | <input type="checkbox"/> No |
| For this system I defined/helped define report formats     | <input type="checkbox"/> Yes | <input type="checkbox"/> No |
| For this system I designed the user training program       | <input type="checkbox"/> Yes | <input type="checkbox"/> No |
| For this system I created the user procedure manual        | <input type="checkbox"/> Yes | <input type="checkbox"/> No |



**D. User involvement**

Please indicate your thoughts concerning the new system. I consider the new system to be:

	Extremely	Very	Quite	Ambivalent	Quite	Very	Extremely	
Important	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Not important
Not needed	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Needed
Essential	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Not essential
Trivial	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Fundamental
Significant	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Insignificant
Means a lot to me	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Means nothing
Of no concern	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Of concern
Irrelevant	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Relevant
Matters to me	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Does not matter to me

**E. Attitude toward the system**

Please indicate your feelings concerning your use of the new system

	Extremely	Very	Quite	Ambivalent	Quite	Very	Extremely	
Good	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Bad
Terrible	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Terrific
Useful	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Useless
Worthless	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Valuable

**F. Attitude concerning system use**

Please indicate your feelings concerning your use of the new system

My frequently using the new system:

	Extremely	Very	Quite	Ambivalent	Quite	Very	Extremely	
Good	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Bad
Terrible	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Terrific
Useful	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Useless
Worthless	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Valuable

Being a heavy user of the system:

	Extremely	Very	Quite	Ambivalent	Quite	Very	Extremely	
Good	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Bad
Terrible	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Terrific
Useful	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Useless
Worthless	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Valuable

**G. Subjective norm concerning the system use**

What do other people think about your use of the new system?	Should	Should not	
At work, my superiors think that I	<input type="checkbox"/>	<input type="checkbox"/>	<i>frequently use the new system</i> <i>frequently use the new system</i> <i>frequently use the new system</i> <i>be a heavy user of the new system</i> <i>be a heavy user of the new system</i> <i>be a heavy user of the new system</i>
At work, my peers think that I	<input type="checkbox"/>	<input type="checkbox"/>	
At work, my subordinates think that I	<input type="checkbox"/>	<input type="checkbox"/>	
At work, my superiors think that I	<input type="checkbox"/>	<input type="checkbox"/>	
At work, my peers think that I	<input type="checkbox"/>	<input type="checkbox"/>	
At work, my subordinates think that I	<input type="checkbox"/>	<input type="checkbox"/>	

**H. Intention to use the system**

How often do you intend to personally use the new system?

I intend to use the system	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Do you intend to be a heavy or light user of this system?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

**I. System use**

The following questions are about your current level of usage of the new system

Are you currently a heavy or light user of the system?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
How often do you use the new system?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Designation: \_\_\_\_\_

Functional area: \_\_\_\_\_

Role / designation in the ERP project: \_\_\_\_\_

Thank you for your kind cooperation