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An extension of the technology acceptance model in an ERP implementation environment

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Abstract

This paper presents an extension to the technology acceptance model (TAM) and empirically examines it in an enterprise resource planning (ERP) implementation environment. The study evaluated the impact of one belief construct (shared beliefs in the benefits of a technology) and two widely recognized technology implementation success factors (training and communication) on the perceived usefulness and perceived ease of use during technology implementation. Shared beliefs refer to the beliefs that organizational participants share with their peers and superiors on the benefits of the ERP system.

Using data gathered from the implementation of an ERP system, we showed that both training and project communication influence the shared beliefs that users form about the benefits of the technology and that the shared beliefs influence the perceived usefulness and ease of use of the technology. Thus, we provided empirical and theoretical support for the use of managerial interventions, such as training and communication, to influence the acceptance of technology, since perceived usefulness and ease of use contribute to behavioral intention to use the technology.

Keywords: Technology acceptance model; Enterprise resource planning; Shared beliefs; Training; Communication

1. Introduction

There is a growing body of academic research examining the determinants of information technology acceptance and utilization among users [16,71]. The theoretical foundation primarily originates from a theory on the adoption and diffusion of innovation, where individuals' perceptions about using it are posited to influence adoption behaviors [57,64]. Also, there are theoretical models that attempt to explain the relationship between user attitudes, perceptions, beliefs, and eventual system use. These include the theory of reasoned action (TRA) [4], the theory of planned behavior (TPB) [5], and the technology acceptance model (TAM) [20]. Among these, TAM seems to be the most widely used by IS researchers, perhaps because of its parsimony and the wealth of recent empirical support [3].

TAM posits that perceived usefulness and perceived ease of use of IT are major determinants of its usage. Davis [21] argued that research on technology acceptance needs to address how other variables affect core TAM variables, such as usefulness, ease

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of use, attitude and user acceptance. In a similar vein, Karahanna and Straub [40] observed that little attention had been paid to understanding factors that influenced the belief constructs of perceived usefulness and ease of use. They argued in favor of investigating antecedent variables that can explain the core TAM variables and extend TAM in a way that enhances our ability to better understand the acceptance and usage of existing and new IT. Factors contributing to the acceptance of an IT are likely to vary with the technology, target users, and context [56].

Most of the prior studies have been carried out in traditional and relatively simple but important environments, such as personal computing, e-mail systems, word processing and spreadsheet software [34]. But with the advent and adoption of complex IT systems that cut across functional and organizational boundaries requiring business process reengineering during implementation, it was clear that there is an increased need for studies that examine and extend TAM in a complex IT setting [37,50].

In their conclusion to a meta analysis of TAM research, Legris et al. [48] found that most TAM studies examined the introduction of office automation software or systems development applications. They concluded that TAM research would benefit from examining the introduction of business process applications and pointed out that it would be better if it was performed in a business environment. Here, we provide specific contributions along these lines. We examine TAM within a real business environment and extended TAM by considering it in the implementation of an enterprise resource planning (ERP) system. Given its complexity, we believe an investigation of the extended TAM in this context furthers our understanding of the acceptance of complex IT.

ERP systems are programs that aim to provide integrated software to handle multiple corporate functions including finance, human resources, manufacturing, materials management, and sales and distribution [19]. The adoption of these systems by the business world has been touted as one of the most important developments in the corporate use of IT in the 1990s [18]. They require significant organizational resources and their implementation is inherently risky due to large investments required. Thus, ERP systems represent a completely different class of IT application compared with traditional and simple IT systems.

This study examined how shared beliefs in the benefits of the ERP system along with two IT implementation success factors, project communication and training, impact the core TAM variables in the context of an ERP implementation [49,60,74].

2. Literature review

2.1. ERP implementation research

Factors that have been identified for achieving ERP implementation success include top management support [14,24,76]; a strong business justification for the project [47]; training of employees [6,65]; project communication; properly defined roles for all employees including chief information officers and functional managers [77]; user involvement [8]. A good review of the above factors has been provided by Nah et al. [58].

ERP implementations almost always require business process reengineering, because of the need to adapt the organizational processes to match the capabilities of the software. This means there is the need to go beyond traditional project management principles [35]. In addition, ERP systems are organizational-wide systems and their implementation involves multiple stakeholders, often in geographically dispersed locations. It requires data standardization, integration of the system with other IS and the need to manage several consultants and vendors [67]. Traditional project management challenges are magnified in such environments, making the implementation more difficult, expensive and failure-prone [53]. This complexity suggests that we should not assume that the results obtained in other simpler technology implementation environments readily apply to ERP environments.

2.2. Technology acceptance model (TAM)

One of the key measures of implementation success is achieving the intended level of usage of the IT. System usage is a reflection of the acceptance of the technology by users [73]. The TAM has served as a basis for past research in IS dealing with behavioral intentions and usage of IT [1,22,30,38,39,54,70].

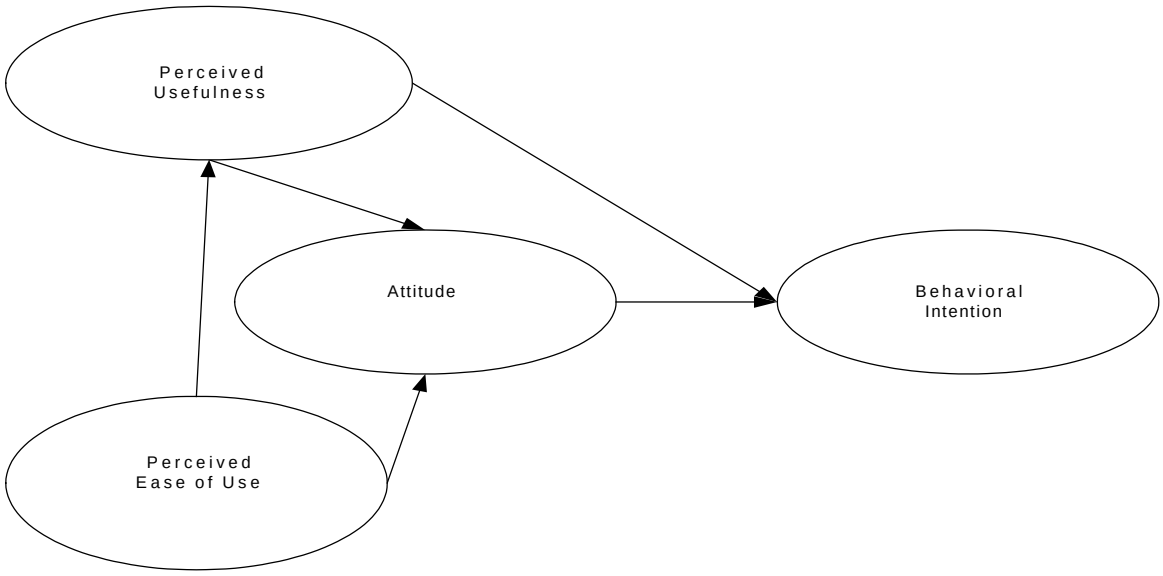

Fig. 1. The technology acceptance model (TAM).

A good review of some of the past research is provided by Lucas and Spitler.

The TAM is an adaptation of TRA developed by Fishbein and Ajzen [27]. TAM was specifically tailored for modeling user acceptance of IS with the aim of explaining the behavioral intention to use the system. TAM proposes that *perceived usefulness* (PU) and *perceived ease of use* (PEU) are of prime relevance in explaining the behavioral intention to use IS and hence, systems (Fig. 1). Davis defined perceived usefulness as "the degree to which a person believes that using a particular system would enhance his or her job performance" and defined perceived ease of use as "the degree to which a person believes that using a particular system would be free of effort." TAM postulated that computer usage is determined by a behavioral intention to use a system, where the intention to use the system is jointly determined by a person's attitude toward using the system and its perceived usefulness.

Research efforts have been devoted to extensions to the theory by examining the antecedents of those two belief constructs underlying TAM. As noted by Venkatesh and Davis [75], a better understanding of these would enable us to design effective organizational interventions that might lead to increased user acceptance and use of new IT systems.

3. Research model

A goal of our effort was to examine the influence of antecedent variables on the previously mentioned TAM constructs of PU and PEU. Studying the influence of external variables on the constructs not only contributes to theory development, but also helps in designing appropriate intervention programs, such as training, that might lead to improved technology acceptance. This is particularly true in an ERP implementation environment.

Our model is shown in Fig. 2. The model has as its core the TAM constructs and postulated relationships (enclosed in a box). We hypothesized that three external variables, beliefs in the benefits of ERP system, project communication, and training would influence PU and PEU and therefore behavioral intention to use an ERP system.

3.1. Beliefs in the benefits of ERP system

Beliefs about an object provide the basis for attitude formation toward the object and thus an understanding of beliefs and belief formation processes affords us the opportunity to understand how interventions, such as training and communication, can be used to shape

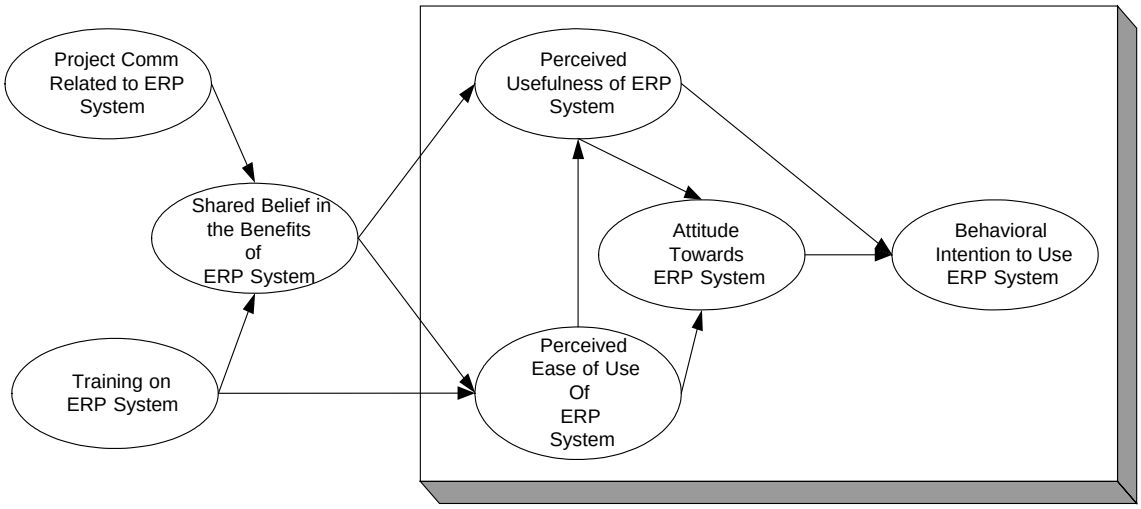

Fig. 2. The research model.

beliefs and therefore behavioral intention to use a technology.

Because ERP systems cut across functional boundaries and are organization-wide IS designed to provide a unified view of organizational processes, many users at different organizational levels are involved in their implementation. To achieve success a sense of mutual trust and commitment must develop between the various participants to ensure a *free exchange of beliefs and opinions* [61,79]. It is this shared sense of belief about IS project benefits that allows organizational participants to find common grounds and a shared sense of purpose. Since the benefits of IS operating at multiple levels are complex and subtle [25], it can be theorized that users form beliefs about these benefits at the individual level as well as form shared beliefs with peers and managers about these benefits.

This implies that managers may be able to influence belief about the ERP system through training, the use of project champions as opinion leaders, and appropriate information dissemination. It is our view that a shared belief about the overall benefit of the system on the organization plays a role in shaping the usage intentions. This assertion therefore differs from the PU belief found in TAM. It deals with the belief that relates to the performance of the individual and how a particular system would enhance his or her job performance. In contrast, shared beliefs are shared with peers and managers about the value of the ERP system. Since they form a shared belief, it is theorized that it will have a positive effect on the PU of the ERP system.

Additionally, the shared beliefs in the benefits of the ERP system will have an impact on its perceived ease of use. This is primarily due to the complex nature of the ERP technology. Compared to traditional technologies, ERP systems not only require that users understand it and find its interface to be easy to use but also that they understand the business implications of changes made through the user interface. Past research has argued that the perceived ease of use of a technology might be influenced by the actions and statements of significant supervisors and peers. Thus, we are proposing that the perceived ease of using an ERP system might be influenced by the extent to which a user believes that there is a strong shared belief in the organization that the system will be beneficial.

3.2. Training, belief in benefits of ERP system and ease of use

Venkatesh and Davis modeled and empirically tested the determinants of PEU and found that an individual's computer self-efficacy is a strong determinant of PEU, whereas objective usability affects ease of use only after direct experience with the system. The implication of this finding was that training mechanisms aimed at improving the computer self-efficacy of

users is more likely to be effective in gaining user acceptance.

Igbaria, Zinatelli, Cragg and Cavaye examined the impact of internal and external training, internal and external support, and top management support on PU and PEU. They concluded that while internal training had no significant effect on perceived ease of use, it did have a significant effect on perceived usefulness. On the other hand, they observed that external training had no significant effect on PU but it did have an effect on PEU. Thus, the impact of training on PEU and PU might be dependent on its nature and source.

Past research suggests that training influences user attitudes, behavior, and performance and further that the impact of training on behavioral intention is mediated by belief mechanisms [29,78]. We are suggesting that any effect that training has on attitude and behavioral intention is mediated by beliefs, and more specifically the shared belief in the benefits of the ERP system and PEU of the system. An implication of this is that, due to the mediation assumption and centrality of beliefs, managers may proactively influence beliefs directly through such strategic managerial action as broad-based information dissemination and the use of opinion leaders. Training provides managers with a mechanism to disseminate useful and pertinent information about the ERP system and how it fits in with the existing and proposed system. Training allows users to interact with the ERP system (or a closely approximated prototype). It provides a means for users to develop and test varieties of inferences about the ERP system and its effect on business processes. Thus, we proposed that the training provided as part of the implementation process will affect the shared beliefs about the benefits of the ERP system.

In our discussions with managers, one concern of employees is the ''new learning'' that occurs with the implementation of the system. Employees at all levels were expected to accept different responsibilities and almost invariably had to learn a new set of skills [66]. Then, the relationship between training and PEU is of significant interest, since research indicated that perceptions of ease are affected by training during the early stages of learning. To the extent that PEU affected intended usage and acceptance, a model that incorporated a relationship between training and PEU was appropriate. Also research suggested that the impact of training on a construct such as PEU might depend on the specificity of the technology and thus we proposed that, in an ERP implementation environment, the training provided would affect perceptions about the PEU of the technology.

3.3. Communication, shared beliefs in the benefits of the ERP system and perceived usefulness

The importance of communication in achieving project management success has been well noted [23,28,52,80]. In fact, lack of communication has been linked to many project failures. Communication provides the avenue through which personnel from different functional areas share information critical to the successful implementation of projects. Kydd [46] notes that effective communication is needed to reduce uncertainty (absence of information) and equivocality (existence of conflicting interpretations) present in IT development and implementation environments. In an ERP implementation the importance of effective communication has been well noted [26].

The decision to adopt an ERP is very likely to arise from senior managers. Communication becomes the means through which information about the benefits of the technology flows from these individuals to others, leading to an increase in the shared beliefs about the benefits of the system [15,44]. Since the ability to influence behavior is dependent on factors such as the frequency and accuracy of information, it is expected that perceptions about the usefulness of the technology (PU) will also be dependent on the amount and quality of communication provided.

Effective communication will lead to the development of trust and exchange of information needed for those process changes and ultimately the acceptance of the technology. One of the goals of communication is to influence attitude and behavior [32]. Specifically, since the influencing goal of communication attempts to change behavior through a change in attitude, it is dependent on the interpersonal dispositions between senders and receivers of the communication [72]. This goal of communication also assumes that the receiver's behavior cannot be determined in advance, and thus it provides one of the means through which managers can influence behavior: in the case of ERP implementation, this is the intention to use the technology. Therefore, our model suggests that communication will impact the shared belief about the

benefits of the system and subsequently influence attitude and behavioral intention through the impact that shared belief has on PU and PEU.

3.4. Behavioral intention to use an ERP system

Questions could be raised as to whether behavioral intention is appropriate in this context, since ERP systems are basically transaction processing systems and implemented to replace legacy systems making expected usage mandatory. The usage of ERP system incorporates both mandatory and discretionary usage. The mandatory usage represents a base level needed to perform minimal job functions and usage beyond that might become voluntary. In fact this has been observed to be true for large multifunctional information technologies. Prior research alluded to perceived voluntariness as being important in the acceptance and use of technology [2]. In addition, even if usage were mandatory, effective usage leads to organizational benefits, not just selective usage. The value of an ERP system might lie in its effective and efficient usage [45]. Even in situations where usage is mandatory, the participation of the users can be effective if the users believe that they have some control over the outcome of the effort [36]. Last, even for systems where use is mandated, variations exist in the intentions of individuals [33]. Thus, it is appropriate to examine behavioral intention to use the technology even when usage might be mandatory.

4. Methodology

A field survey was employed to test our research propositions.

4.1. Sample and procedure

The study was carried out in a large global organization that was implementing an ERP system. The ERP software that had been chosen by the company was SAP. The study of the implementation using SAP R/3 was of particular interest because it was considered the leading software and has been implemented by such companies as Allied Signal, Coca-Cola, Dow Chemical, DuPont, Eastman, General Electric, Hoechst, IBM, etc. [7].

The name of the company is withheld due to our non-disclosure agreement with the executives. The company was implementing several modules of SAP software and several functional units were involved in the process. The company is a healthcare products organization with over 20,000 employees worldwide and multiple research and development, manufacturing and distribution facilities in different locations throughout the United States. The company intended to implement order management, billing, purchasing, financial, inventory and logistics, pricing, and production planning modules. An 18-month implementation was planned, with a total budget of about US$ 70 million. Following preliminary discussions with the chief information officer of the company, permission was granted for conducting the study with a sample representative of the employees at different levels and locations.

Data obtained from a single source controls numerous exogenous variables that may confound results from a multi-company survey. Organizational culture is not likely to vary significantly from division to division. Since ERP systems make significant changes, not only to the IT infrastructure of the company but also to the business processes, single source data controls for exogenous variables that may confound results in a multi-firm survey.

4.2. Measures

The items used in the operationalization of the constructs were adopted from relevant prior research. The adopted items were validated and wording changes were made to tailor the instrument for our use. Specifically, items measuring perceived ease of use and perceived usefulness were adapted from Davis and modified to fit the ERP context. Similarly, the items for attitude and behavioral intention were adapted from Davis and Taylor and Todd. The items for measuring ERP project communication were developed based on previous research on project management, product innovation management [31], management and organizational communication [41,42] and in consultation with industry executives involved with ERP implementation. Similarly, items used in measuring ERP training were based on the literature on training and information systems [62]. These items were discussed with industry executives

in terms of content and meaningfulness as they relate to measuring ERP training. The items for shared beliefs in the benefits of the ERP project were taken from the literature on organizational benefits of IS projects [55]. Again these items were discussed with industry executives for relevance, wording, and meaningfulness in the ERP context.

4.3. Pre-tests

Although many items had been validated by past research, the adopted instrument, along with new items, was examined to ensure content, construct validity, and reliability within the ERP context. Instrument validation or re-validation was necessary because the validity of the instrument may not have been persistent across different technologies and user groups.

The research instrument was discussed with five executives experienced with ERP implementation from three different organizations from three different industries. The organizations were from the health services, semi-conductor, and textile industries. The purpose of these discussions was to refine the constructs and the items measuring each construct. Likert scales were used for measuring each independent and dependent variable in the research model. Based on feedback, minor changes were made in the instructions and wording of some of the items to reflect ERP implementation. The instrument was then pilot

Table 1
Question items used in the study

Construct	Item	Measure	Source
ERP project communication	PJC1	I was well-informed about the project through the company newsletters	Developed validated by Pinto [60]
	PJC2	I was informed about the project through presentations, demonstrations or road shows	
ERP training	TR1	The kind of training provided to me was complete	Developed and validated by Venkatesh and Davis [74]
	TR2	My level of understanding was substantially improved after going through the training program	
	TR3	The training gave me confidence in the NEW system	
	TR4	The training was of adequate length and detail	
	TR5	The trainers were knowledgeable and aided me in my understanding of the system	
Belief in the benefits of ERP project	BENB1	I believe in the benefits of the NEW system	Developed and Validated by Mirani and Lederer [55]
	BENB2	My peers believe in the benefits of the new system	
	BENB3	My management team believes in the project benefits	
Attitude towards ERP system	ATT1	The NEW system will provide access to more data	Taylor and Todd [71], Davis [20]
	ATT2	The NEW system will make data analysis easier	
	ATT3	The NEW system will be better than the OLD system	
	ATT4	The NEW system will provide accurate information	
	ATT5	The NEW system will provide integrated, timely and reliable information	
Perceived usefulness	PU1	Using the NEW system will increase my productivity	Davis [20]
	PU2	The NEW system will be useful in my job	
Ease of use	PEU1	Learning to operate the NEW system will be easy for me	Davis [20], Taylor and Todd [71]
	PEU2	It will be easy to get the NEW system to do what I want it to do	
Behavioral intention	BI1	I expect to use the NEW system	Davis [20], Taylor and Todd [71]
	BI2	I expect the information from the NEW system to be used	

tested with a different group of 40 users. The instrument's reliability was evaluated; the Cronbach's alpha values ranged from 0.58 to 0.87 indicating a satisfactory level of reliability exceeding that commonly required for exploratory research [59]. As part of the pre-test, comments and suggestions on question items, item wording, item sequence, and directions in completing the instrument were also solicited. Based on this, several minor modifications were made to directions for completing the instrument and on how the Likert-type scales appeared. The final items are listed in Table 1 along with their sources. The subjects who had participated in the pre-test were excluded from the final data collection and subsequent study.

4.4. Data collection

A mail survey was distributed to 1562 employees of the organization. The participants were located in different regions of the United States and worked for different units of the organization. A total of 571 responses were obtained, representing a response rate of 37%. This is comparable to response rates obtained in research using similar field settings. Of these 571 respondents, 409 were end-users who had completed training on the ERP system.

The respondents represent a diverse sample with regard to educational background, job function and age distribution. About 46% had a high school education and over 49% had at least a bachelor's degree; the rest had advanced education. About 34% of the respondents worked in the customer service department; other functional units represented were finance (25%), operations/distribution (35%), and pricing (6%). The respondents ranged in age from 18 to over 60 years. There was a large variation in the number of years that the respondents had worked at the organization with the average being slightly over 9 years. Respondents had spent slightly over 4 years on average in their current position. The average respondent had been involved in two previous IT implementations. An investigation was carried out to ascertain non-response bias. Based on *t*-test among both demographic characteristics and independent and dependent variable measures between early respondents and late respondents, no significant difference was exhibited [69].

5. Results and analysis

5.1. Reliability and validity analysis

The reliability and validity of the measurement instrument was carried out using reliability and factor analysis (Tables 2 and 3, respectively). The tables show that the reliabilities of the items ranged from 0.62 for behavioral intention to 0.88 for training. The reliabilities for each construct were within acceptable range for this type of research.

Factor analysis was carried out to examine measurement convergent and discriminant validity. Typically convergent validity is considered to be satisfactory when items load high on their respective constructs (factors). As shown in Table 3, all items had high loading on their respective factors. Most exhibited loading higher than 0.60 on their respective

Table 2
Summary of measurement scales ($N = 449$)

Construct	Mean[a]	Standard deviation	Reliability (alpha)
ATT1	2.73	1.41	0.86
ATT2	3.22	1.44	
ATT3	3.27	1.42	
ATT4	3.35	1.45	
ATT5	3.08	1.27	
TR1	3.66	1.46	0.88
TR2	3.66	1.46	
TR3	3.65	1.32	
TR4	3.70	1.42	
TR5	3.17	1.52	
BENB1	4.71	2.11	0.80
BENB2	5.58	2.12	
BENB3	3.71	2.06	
PEU1	3.31	1.45	0.76
PEU2	3.87	1.29	
PJC1	4.31	2.12	0.67
PJC2	4.71	2.37	
BI1	2.03	1.33	0.62
BI2	2.49	1.34	
PU1	3.69	1.33	0.67
PU2	3.51	1.28	

[a] Likert-type scale ranging from 1 to 7 with 1 being strongly agree and 7 being strongly disagree, except for PJC1, PJC2, and BENB1, BENB2 and BENB3 where the scale ranged from 1 to 10 with 1 being strongly agree and 10 being strongly disagree.

Table 3
Results of factor analyses[a]

	Factor						
	1	2	3	4	5	6	7
ATT1	0.809						
ATT2	0.797						
ATT3	0.772						
ATT4	0.725						
ATT5	0.651						
TR1		0.851					
TR2		0.834					
TR3		0.830					
TR4		0.777					
TR5		0.748					
BENB1			0.826				
BENB2			0.787				
BENB3			0.730				
PEU1				0.837			
PEU2				0.753			
PJC1					0.867		
PJC2					0.814		
BI1						0.906	
BI2						0.671	
PU1							0.783
PU2							0.611

[a] Only loadings of 0.6 or above are shown.

factors, signifying desirable measurement convergent validity. Factor 1 represents attitude toward the ERP system, factor 2 is ERP training, factor 3 is shared beliefs in the benefits of the ERP system, while factor 4 is the ease of use, factor 5 is project communications, factor 6 is behavioral intention to use the system and factor 7 is the perceived usefulness of the system. Discriminant validity was assessed by examining whether each item loaded higher on the construct it measured than on any other construct. The overall results indicated that the measurement exhibited reasonable discriminant validity.

5.2. Analysis using structural equation modeling (SEM)

The research model (Fig. 2) was tested using structural equation modeling (SEM) software EQS [13]. The modeling analysis allows researchers a comprehensive means of assessing and modifying theoretical models on a substantive basis, thus offering a great potential for furthering theory development and testing. This method allows the testing of a theoretical model as a whole, as well as comparisons among competing or alternate theoretical specifications [51]. Anderson and Gerbing [9] recommended assessing the theoretical model of interest by estimating a series of five-nested models that represent plausible alternate specifications. A model M_2 is said to be nested within model M_1 if its set of freely estimated parameters are a subset of those estimated in M_1. This is usually denoted by $M_2 < M_1$.

The constrained parameters in M_2 are fixed at zero. The five nested models are as follows:

1. The saturated model (M_s) in which all the parameters linking the constructs to one another in the model are estimated.
2. The null model (M_n) in which all the parameters linking the constructs to one another are fixed at zero which means there are no posited relationships among the constructs.
3. The theoretical model (M_t) which is the research model of interest.
4. The constrained model (M_c) in which one or more parameters estimated in M_t are constrained. This represents the next most likely constrained alternative model from a theoretical perspective.
5. The unconstrained model (M_u) in which one or more parameters constrained in M_t are estimated. This typically represents the next most likely unconstrained alternative model from a theoretical perspective.

These five nested models can be represented in the following sequence:

$$M_n < M_c < M_t < M_u < M_s$$

The comparisons with null and saturated models are typically satisfied by statistical rather than theoretical criteria. It is sufficient to compare the constrained, theoretical and unconstrained models. The testing of these nested models are accomplished by using a set of sequential Chi-squared difference tests (SCDTs), which are asymptotically independent [68], each testing the null hypothesis of no significant difference between two nested structural models. The difference between the Chi-squares for two nested models is itself asymptotically distributed as Chi-square, with

degrees of freedom equal to the difference in the degrees of freedom for the two models. Since the SCDTs are dependent on sample size, a normed fit index 'delta' has been proposed by Bentler and Bonnet [12] to be used in conjunction with the SCDTs. The delta index provides information about practical significance so that a statistically significant effect can be evaluated according to its practical usefulness in

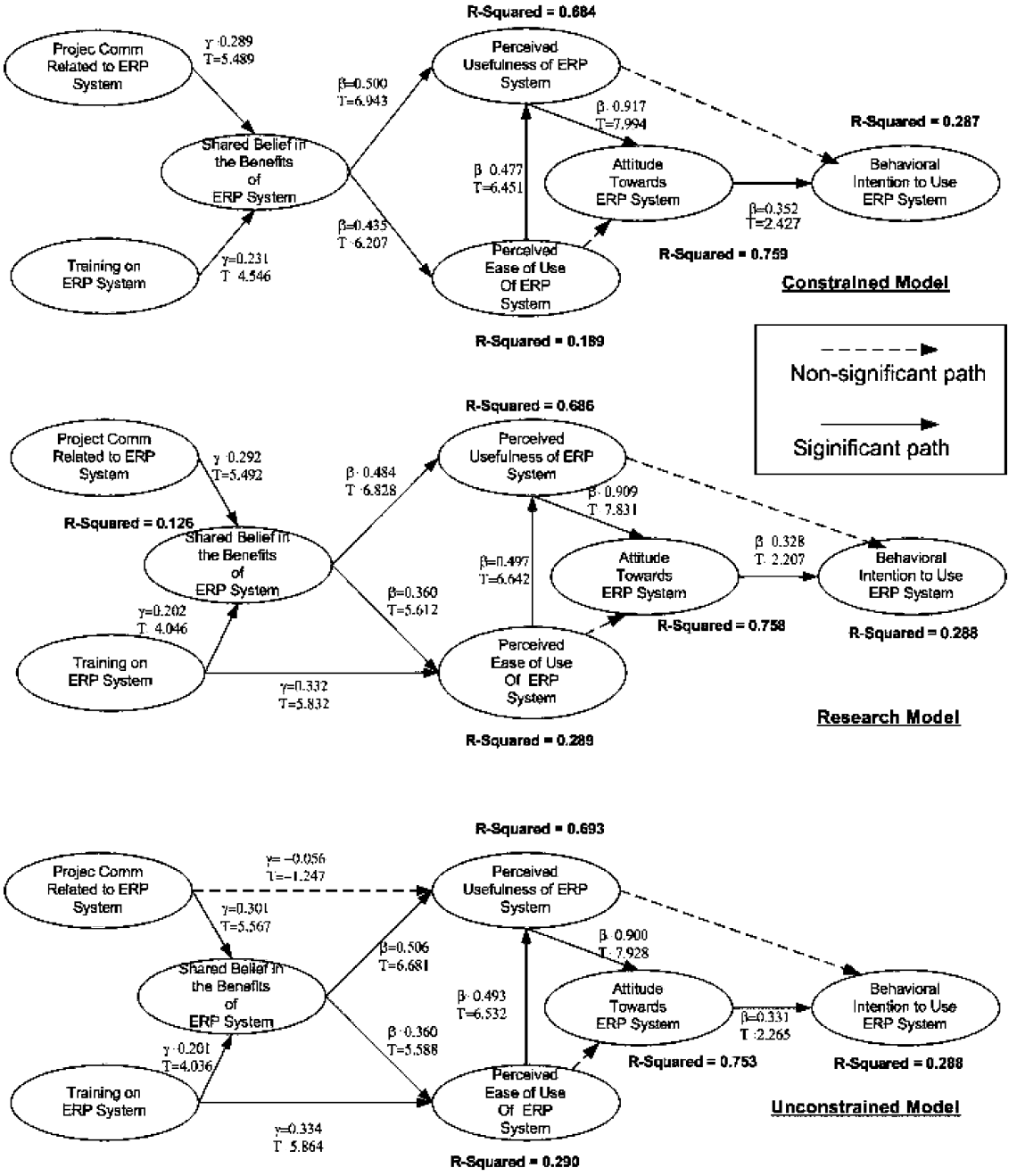

Fig. 3. Results of testing nested models.

Table 4
Overall fits of models

Fit index	Recommended value	Constrained model (M_c)	Theoretical model (M_t)	Unconstrained model (M_u)
Chi-square/d.f.	≤3.0			
CFI	≥0.9	0.910	0.919	0.918
CFI (robust)	≥0.9	0.928	0.936	0.934
GFI	≥0.9	0.890	0.901	0.892
AGFI	≥0.8	0.859	0.863	0.861
NNFI	≥0.9	0.895	0.905	0.904
SRMSR	≤0.10	0.086	0.065	0.066

explaining the data. The research model along with the constrained and unconstrained model is presented in Fig. 3. The constrained model has been derived on the theoretical basis that external variables, such as ERP training and ERP project communication, will affect the TAM variables only through the psychological variable-shared beliefs in the perceived benefits of the ERP system.

The unconstrained model has been derived on the basis that external variable, such as ERP training and project communication, will affect both the TAM variables as well as belief in ERP benefits variable. Table 4 show the fits of the constrained, theoretical (research), and unconstrained models. Table 5 shows that the robust comparative fit index, the GFI and AGFI are 0.936, 0.901 and 0.863, respectively for the theoretical model and 0.928, 0.890 and 0.859, respectively for the constrained model. We obtain a statistically significant support for the theoretical model when compared with the constrained model (see Table 6) where we find a Chi-square difference of 40.0 with 1 degree of freedom ($P < 0.001$). This implies that there is significant change in terms of Chi-square value as well as in the goodness-of-fit statistics.

The difference between the theoretical model and the constrained model also makes sense in that in the theoretical model the training on ERP system is allowed to affect the perceived ease of use construct. As shown in Fig. 3, the path between training on ERP system and PEU is statistically significant. This path is also supported ($\gamma = 0.332$, $T = 5.83$) substantially by prior research. Hence, the theoretical model makes both statistical and substantive sense especially in the ERP context when compared with the constrained model.

Although the unconstrained model has a similar fit to the data as the research model, the path from project communication to PU variable is statistically non-significant and has a very low path loading ($\gamma = -0.056$, $T = -1.25$). Additionally, the Chi-square difference between the theoretical model and the unconstrained model is 2.15 with 1 degree of freedom ($P < 0.10$) and hence also non-significant. Given this evidence, as well as the non-significant value of the delta index, it is clear that the theoretical model is a more reasonable choice over the unconstrained model and that it is more parsimonious. Therefore, it is reasonable to conclude that the theoretical model provides a much more compelling sense both statistically and substantively when compared with the alternate constrained and unconstrained models.

All the specified paths in the research model have been supported (see Fig. 3) except for the path

Table 5
EQS tests of alternative nested theoretical models

Model	Chi-square	d.f.	CFI (robust)	GFI	AGFI
Null (M_n)	4474.0	210	–	–	–
Constrained (M_c)	564.5	180	0.928	0.890	0.859
Theoretical (M_t)	524.4	179	0.936	0.901	0.863
Unconstrained (M_u)	523.6	178	0.934	0.892	0.861

Table 6
Nested model comparison

Model comparison	Chi-square	d.f.	Delta
M_n–M_c	3910	30	0.87
M_c–M_t	40	1	0.0089
M_t–M_u	2.1	1	0.00048
M_n–M_t	3950	31	0.88
M_n–M_u	3951	32	0.88
M_c–M_u	41.9	2	0.0093

between PEU and attitude and the path between PU and behavioral intention to use ERP system. The theoretical model has been able to explain 28.8% of the variance of the behavioral intention to use the ERP system. It has been able to explain 75.8, 68.6, 28.9 and 12.6% of the variance of attitude towards ERP system, PU of ERP system, PEU of ERP system, and shared beliefs in the benefits of ERP system respectively.

6. Discussion, conclusion and limitations

In this study, we extended the TAM model through the addition of one belief construct, shared beliefs in the benefits of an ERP system, and two external variables, training and project communication. We tested the extended TAM model in the context of an ERP implementation. This study contributed by considering a new belief construct that reflects on the shared understanding of the benefits of the ERP system among the organizational users of the system. Second, the study considered two important and recognized factors in IS research, training and project communication, as two external factors that affect the core TAM constructs through the shared belief in the benefits of ERP system. Third, it contributed by investigating and testing existing IS theory in a new IT context: the implementation of ERP systems. Unlike many IT systems, ERP systems by their very nature require simultaneous changes in business processes and information sharing and use that make it very challenging to implement.

In our analysis, we have found significant support that both project communication and training affect beliefs in the benefits of the ERP system. The key roles that communication plays include providing and obtaining information and creating understanding among organizational participants that leads to the formation of shared beliefs among organizational participants, especially those that are the targeted users of the innovation.

Training provides the hands-on mechanism that allows users of the ERP system to explore the system both from a technical standpoint as well as from a functional perspective. It allows the users to obtain first hand information and experience. It also allows them to explore the PEU of the system. Thus, training helps in the formation of the shared beliefs in the benefits of the ERP system as well as affects the PEU of the system. Hence, our study confirms that managers may undertake strong and effective communication initiatives coupled with effective training on ERP systems to affect the core TAM variables.

We found significant support that shared beliefs in the benefits of ERP system affect both PU and PEU of ERP system. A shared belief in the benefits of ERP system allows users to understand the various ways that the ERP system will make them productive. Additionally, the shared belief in the benefits allows them to perceive the system to be easy to use and the use becomes more meaningful in day to day routines. We have found no support that PEU affects the formation of attitude towards ERP system. This finding is consistent with others that show that PEU does not have a significant on attitude in a field setting [43]. In an ERP environment users are more concerned with the larger goal of how an ERP system supports business processes rather than the technology itself.

We found that the beliefs formed regarding the usefulness of the ERP system are important in the formation of positive attitudes towards the system. If management can take appropriate steps to positively influence the belief structures that bring about positive attitude formation that will then lead to more acceptance of the technology by the organization's members. One mechanism for influencing belief structures is through training provided as part of the ERP implementation. We found that training positively influences the formation of shared beliefs in the benefits of the system and shared beliefs influence both the PU of the system and the PEU of the system. This is important and significant; it provides managers with a tool (training) to positively influence the formation of beliefs that affect attitude, which in turn affects behavioral intention. By providing an appropriate training environment where users have the ability to interact with the ERP system or a prototype, managers should be able to influence the formation of beliefs regarding the perceived usefulness and benefits of the ERP system. Thus, although managers have recognized the importance of training in ERP implementation [17], our research provides both theoretical and empirical support for why training is important and should help encourage managers in their training efforts.

Another mechanism for influencing belief structures is project communication. Communication is

considered a critical element in enabling people to change their attitudes and behavior [10,11]. The key roles that communication plays include providing and obtaining information and creating understanding among organizational participants that leads to the formation of shared beliefs among organizational participants. Our results indicate that if managers put in place communication mechanisms, then the communication is likely to have a positive effect on the shared beliefs about the benefits of the project, which will eventually lead to an increase in the acceptance of the technology.

ERP implementations have been plagued by numerous problems and there is the need therefore to conduct more work to provide guidance to practitioners on how to achieve implementation success. We found encouraging results on the role of external factors such as training and communication and the influence of beliefs on attitude and the mediation effect of attitude on the behavioral intention to use an ERP system. Some limitations need to be considered. Although this study was conducted in a large organization that was implementing several modules of an ERP system, it is only prudent that caution be exercised in generalizing the findings. Obviously, there are other factors besides training, project communication, and shared beliefs, such as the nature of the technology itself, that affect behavioral intention. When an ERP package is started, organizational members must acquire complex new knowledge, must learn to overcome the knowledge barriers and organizational changes that implementation carries with it and simultaneously unlearn what they already know [63].

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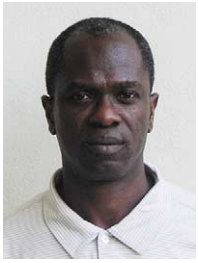

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