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THE ENVIRONMENTAL FACTORS AND CONDUCTED FACTORS THAT INFLUENCE THE ERP (ENTERPRISE RESOURCE PLANNING) BENEFITS

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Abstract

This study aims to examine ERP performance at the post-implementation stage, particularly from the perspective of environmental factors and conducted factors. Specifically, we propose that both environmental factors (including external contexts and internal contexts) and conducted factors (including data quality and customization) affect ERP intermediated benefits (including coordination improvement and task efficiency), which in turn influence the overall benefits. A firm-level survey is used to collected data. Our findings support the proposed hypotheses. We also provide implications for both managers and researchers.

Keywords: Environmental factors, Conducted factors, ERP intermediate benefits, ERP overall benefits.

1 INTRODUCTION

Enterprise resource planning (ERP) systems are commercial software systems that promise to improve operational efficiency and enhance organizational performance. Sometime called enterprise systems, ERP systems have been embraced by most of the large and medium organizations worldwide. The reason ERP is so popular is that it can improve operational efficiency and business efficacy (Gattiker and Googhue 2005, Wang et al. 2006, Liang et al. 2007). ERP improves operational efficiency by integrating business processes and providing better access to integrated data across the entire enterprise, while to enhance efficacy, a company may redesign its business practices by using the templates (or best practices) embedded in the ERP (Davenport 1998). Despite ERP asserts that can efficiently integrate enterprise business process, many projects have failed and led companies to financial difficulties (Miller 2000), and the failure rate ranged from 40 percentage to 60 percentage (Liang et al. 2007).

The high failure rate of ERP implementation may be attributed to the difference in interest between customer organizations that aim to provide the optimum solutions for business problems and ERP vendors who prefer a generic solution applicable to a broader market (Hong and Kim 2002, Rajagopal 2002). In other words, how to bring organizational processes and functions into closer fit with the best practice of ERP become the major concerned subjects in industry and academic fields (Gattiker and Goodhue 2005). In this study, we use organizational information processing theory (OIPT) (Daft and Lengel 1986, Karimi et al. 2004), which servers as a theoretical base to discuss the factors that influence ERP's performance. OIPT identifies three important concepts: information processing needs, information processing capability, and the fit between the two to obtain optimal performance (Premkumar et al. 2005). Since ERP system including data and process integration, we address that the fit will be influenced by environmental factors and conducted factors. So many previously empirical studies already find a lot of factors may impede the connectivity of function and process and in turn lead to the uncertainty, such as organizational misfit (i.e. data, process, use) (Soh 2000), organizational resistance (Copper and Zmud 1990), adaptation problems (ERP adaptation, or process adaptation) (Hong and Kim 2002), differentiation among sub-units (Gattiker and Goodhue 2005), and organizational structure (Morton and Qing 2008). While antecedent works discuss the impact of uncertainty which caused by task characteristics, intra-organizational standardization, interdepartmental relationship, or organization mechanism, they don't address the effect on ERP benefits from the perspective of environmental factors, particularly in the post-implementation stage of ERP. This study aims to fill the foregoing gap.

We will focus on a post-implementation phase (or the acceptance stage of IS implementation) of ERP (Rajagopal 2002) because many firms have used ERP over a period of several years and the success of the initial stage (i.e. the ERP implementation phase) does not necessarily lead to the benefits for the post-implementation phase (Liang et al. 2007). Following Gattiker and Goodhue (2005), the performance of a post-implementation phase is measured by both intermediate benefits and overall benefits. While Gattiker and Goodhue (2005) argued that ERP performance, in terms of reducing information uncertainty, is affected by the original features possessed by sub-units of an organization such as interdependence and differentiation among sub-units, this study contends that ERP performance is also influenced by two salient interventions—environmental factors (EF) and conducted factors (CF). The latter refers to the organizational fit of ERP (Hong and Kim 2002; Soh et al. 2000). On the other hand, EF represents a contingency variable that may affect the standardization and integration of ERP, and the fits between organizational processes and the best practices of ERP.

To test the proposed model, we adopt a survey method of collecting data and assessing the hypotheses. The contributions of this study are two-fold. First, this study simultaneously identifies two salient antecedents, environmental factors in terms of external contexts and internal contexts and conducted factors in terms of customization and data quality, from which ERP performance can be affected. Second, this study conceptualizes ERP performance as intermediate benefits and overall benefits.

2 RESEARCH MODEL AND HYPOTHESES

2.1 Enterprise resource planning (ERP) systems

ERP refers to those ISs that aim for both standardization and integration of the business operations (Gattiker and Goodhue 2005). The latest generation of ERP commercial software packages often integrate information from finance, accounting, human resources, operations, supply chains, and customers (Wang et al. 2008). The main role of standardization is to enforce the data consistency and the connections of activities related to certain business processes that occur simultaneously in various functions (Chou and Chang 2008). On the other hand, integration aims to connect information and processes of distinct sub-units of the organization (Chou and Chang 2008). With the help of the above features, business can achieve "end-to end" connectivity, thus, bringing various diverse functions and divisions together, which in turn improve performance.

2.2 Intermediate and overall ERP benefits in a post-implementation phase of ERP

Following Gattiker and Goodhue (2005), our study measured ERP performance in terms of a two-stage model—i.e. intermediate ERP benefits and overall ERP benefits, because understanding the intermediate benefits helps us explain why certain overall effects do or do not occur. Several intermediate ERP benefits may affect the final firm-level ERP performance, such as coordination improvements, task efficiency (Gattiker and Goodhue 2005), and top management support (Liang et al. 2007), and knowledge transfer (Wang et al. 2007). Although the aggregate-level (or firm-level) trends and benefits can be observed and speculated about, quantitative empirical research has not yet to offer a well-accepted explanation regarding the intermediate benefits that in turn affect the overall performance following ERP implementation. Specifically, ERP intermediate benefits were measured in terms of coordination improvement and task efficiency in this study (Gattiker and Goodhue 2005).

Our research model is based on the premise that the salient antecedents that affect the standardization and integration should be carefully addressed, because they denote the main focus of ERP. Quite a few antecedents have been identified by prior work, including institutional isomorphism (Benders et al. 2006, Liang et al. 2007), organizational misfit/fit (Soh et al. 2000), adaptation mechanisms (Hong and Kim 2002), characteristics of sub-units (e.g. interdependence and differentiation) (Gattiker and Goodhue 2005), ongoing learning effects (Rajagopal 2002), organizational intervention (Chou and Chang 2008), and so on. In this study, conducted factors and environmental factors are chosen as the salient variables that may influence ERP benefits, because they may affect standardization and integration, which improve/impede business processes into alignment with the best practices of ERP. Figure 1 lists our research model.

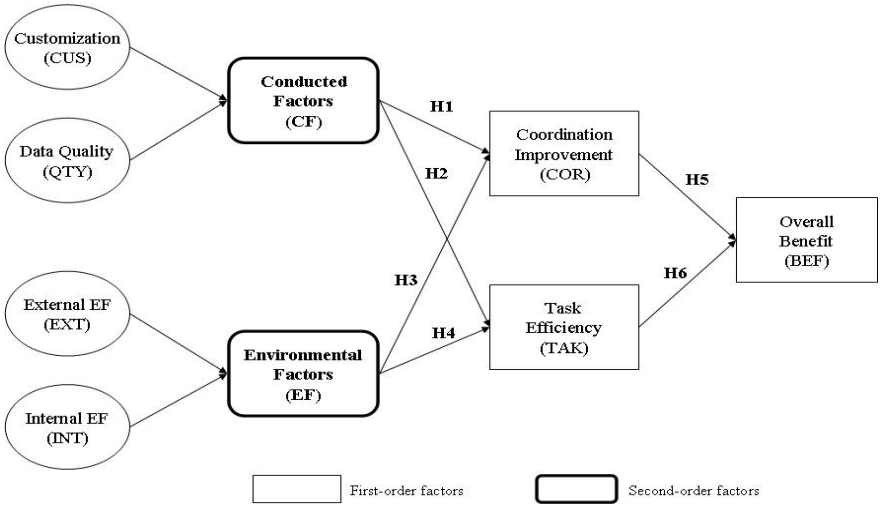

Figure 1. Research model

2.3 Conducted factors

So many prior studies research the factors that influence ERP implementation success such as top management support (Davenport 1998, Umble and Umble 2002, Wang et al. 2008), user support (Wang and Chen 2006, Wang et al. 2008), project team member competence (Somers and Nelson 2001, Remus 2007), project manager leadership (Sarker and Lee 2003, Soja 2006), Vendor support (Somers and Nelson 2001, Remus, 2007, Wang et al. 2008), Consultant competence (Somers and Nelson 2001, Finney and Corbett 2007, Wang et al. 2008). However, most of those critical success factors refer to the initial stage of ERP implementation. Since our study focuses on the post-implementation phase of ERP, the critical success factors should be different from the initial stage. In this study, we propose CF consisting of customization (Chou and Chang 2008, Soh et al. 2000) and data quality (Gattiker and Goodhue 2005, Vosburg and Kumar 2001) playing an important role in the post-implementation phase of ERP.

As the best practices provided by the ERP vendors and consulting firms may not supply models of every process to every industry (Swan et al. 1999), this implies that it is difficult to achieve the expected "connections" among the databases and activities related to a certain business process, unless ERP data items, ERP processes, and ERP input/output screens are either appended or altered (Hong and Kim 2002). In other words, function misfit is when ERP functionality does not fit with the organizational requirements. Using customization to solve function misfit has been suggested by prior work (Rajagopal 2002, Soh et al. 2000); misfit was addressed by using two different approaches—non-core and core customization. While the former includes the modification to the interface of an add-on module or a query/reporter writer facility, implementing the latter entails the revision of the base code (Soh et al. 2000). Suggested by prior work (Rajagopal 2002), customization led to integration because a well-designed ERP customization has the capability to integrate the vastly ignored manufacturing information with the popular administrative functions of an organization. This also implies that different sub-units of an organization will share the same information, which is available to those needed in real time, about various business functions in the organization. As a result, knowledge dissemination and sharing are rather smooth. Given that customization has the capability to address misfit and facilitate integration, we expect that customization positively affects both task efficiency and coordination improvements.

On the other hand, Vosburg and Kumar (2001) posit that without data quality, many other benefits from an ERP will likely not occur. ERP provides easy access to corporate-wide data, but if data is inaccurate or irrelevant to the business process in the organization, there will be few benefits (Gattiker and Goodhue 2005). Since this study focuses on the post-implementation phase of ERP, organizations already use ERP for a while. Data quality will play an important role that represents the fit between business processes and best practices of ERP. Foregoing discussion leads to hypotheses 1 and 2.

H1. For a firm that has implemented ERP, the greater the extent to which the CF is perceived to be characterized by customization and data quality, the greater the coordination improvement will be.

H2. For a firm that has implemented ERP, the greater the extent to which the CF is perceived to be characterized by customization and data quality, the greater the task efficiency will be.

2.4 Environmental factors

OIPT states that, in order to prosper, organizations must resolve uncertainty (Gattiker and Goodhue 2005). Environments are always the source of information uncertainty, which often impact the process of mission and influence the fit between organizational process and best practice of ERP (Chou and Chang 2008). Uncertainty is associated with an absence of information, which leads to acquisition of more data and results in the inability to confidently assign probabilities about how environments will affect the success or failure of a decision-making task (Milliken 1987, Karimi et al. 2004). According to the research of Galbraith (1977), Tushman and Nadler (1978), three sources of organizational uncertainty are technology, internal contexts, and external contexts. Hence, in this study, we propose EF that consists of internal EF and external EF affecting ERP performance.

In external EF, such as rapid technological change, global competitors, unpredictability of customer taste, severe regulatory restrictions, shortage of labors or raw materials, relative lack of exploitable opportunities and resources are a few of the factors that influence organizational task environments (Daft and Lengel 1986, Milliken 1987, Karimi et al. 2004). In order to cope with unpredictable external contexts, organization needs detailed and timely information to coordinate the flow of activities, which requires the information sharing and coordinated actions among the organizational units, and results in the coordination improvement. However, those coordinated activities requires organizational units to spend time for meetings setting, money for conference equipments, even design and coding costs for the customization of ERP software, which will decrease the task efficiency.

In internal contexts, following Gattiker and Goodhue (2005), we will focus on the interdependence and differentiation between units of the organization. Interdependence is the degree to which organizational units must exchange information or material in order to complete their tasks (McCann and Ferry 1979). Managing interdependence and improving the flow of information across organizational units is a major reason many firm have implemented ERP (Cooke 1998). The greater interdependence should lead to the greater data integration (Gattiker and Goodhue 2005). Differentiation means that the products produced and markets served are different between organizational units. When an ERP is not a good fit for an organizational unit's unique business processes, making do might compromise performance (Gattiker and Goodhue 2005). When differentiation between units is greater, it is less likely that a system standardizes data and processes between units will meet all units' needs equally well. In addition, OIPT predicts that the costs of a standardized system, such as ERP, increase in proportion to the degree of differentiation between organizational units which have the uniqueness of tasks, technologies, environment, and goals (Lawrence 1986). Since ERP provides integrated and standardized information for business operations, it forces organizational units using the same terminologies and measures, which can effectively improve coordination. While environmental change or differentiation increase that causes the compromise costs, design cost (Gattiker and Goodhue 2004), and mutual adaptation cost (Chou and Chang 2008) to ERP, this will degrease its task efficiency. Foregoing discussion leads to hypotheses 3 and 4.

H3. For a firm that has implemented ERP, the greater the extent to which the EF is perceived to be characterized by external EF and internal EF, the greater the coordination improvement will be.

H4. For a firm that has implemented ERP, the greater the extent to which the EF is perceived to be characterized by external EF and internal EF, the lower the task efficiency will be.

Finally, following prior work (Gattiker and Goodhue 2005), we believe that the overall benefits are positively associated with the intermediate benefits of ERP. Thus:

H5. For a firm that has implemented ERP, greater coordination improvement is associated with greater overall ERP benefits.

H6. For a firm that has implemented ERP, greater task efficiency is associated with greater overall ERP benefits.

3 RESEARCH METHOD AND DATA

3.1 The operation of latent variables (constructs)

This study used a cross-sectional firm-level survey to empirically assess our research model. To analyze the collected data and test the hypotheses, we adopted partial least square (PLS). The items in our questionnaire were adapted from measures that had been validated by prior research. Specifically, as shown in Appendix: Tables A1 and A2, the four antecedent variables (i.e. customization, data quality, external EF, and internal EF) came from prior studies and were adapted to suit ERP implementation context. The customization and data quality were then used as indictors to create the

superordinate CF construct. The two EF dimensions were then used as indicators to create the superordinate EF construct. The items concerning both the intermediate and overall ERP benefits were also adapted from previous literature (Gattiker and Goodhue 2005). To measure the constructs, this study employed a five-point Likert scale from "strongly disagree (1)" to "strongly agree (5)." While we borrowed the questions from existing scales where possible, as an additional means of ensuring that questionnaire items match the theoretical constructs, we conducted interviews with five managers of local manufacturing facilities; they answered the questions of the prototype questionnaire and were asked to explain their interpretations of the answers. We also extracted descriptions of business environments and ERP systems from these interviewees. The above information was then compared to their replies to the questionnaire items. The foregoing processes led to refinements of many questionnaire items.

3.2 Data collection

The initial version of the survey instrument was refined through a pre-test with 33 completed questionnaires returned from 60 enterprises of Taiwan. We then assessed the internal consistency and discriminated variability of the instruments. Cronbach's α values range from 0.680 (for hostility) to 1.000 (for heterogeneity). Because of low item-to-total correlation (less than 0.5), three items from internal EF were dropped (see Table A2 in Appendix).

In the formal version, refined instrument, in the form of self-administration, was then used to collect data from enterprises of Taiwan. One thousand questionnaires were sent to Taiwan's top 1000 manufacturing enterprises, as compiled by *CommonWealth Magazine*. One hundred and seventy-four questionnaires were returned with four uncompleted responses and one response employed custom-built IS. One hundred sixty-nine questionnaires were completed and usable for data analysis. Table 1 shows the characteristics of respondents according to industry types and demographics.

		# of Companies or Respondents	Percent (%)
Education	University/College	87	51.5
	Graduate School	82	48.5
Industries	Traditional MFG	85	50.3
	High Tech MFG	84	49.7
Position	Senior Manager	103	60.9
	Manager	22	13.0
	Senior Empoyee	17	10.1
	Empoyee	27	16.0
Time elapsed since ERP implementation	1~2 years	47	27.8
	2~3 years	14	8.3
	3~4 years	19	11.2
	4~5 years	15	8.9
	Over 5 years	74	43.8
ERP vendors	Domestic Vendor	68	40.2
	Foreign Vendor	101	59.8

Table 1. Profile of companies and respondents

4 DATA ANALYSIS AND RESULTS

We used partial least squares (PLS) to assess validation and test linkages in the theoretical model. In general, PLS could be used to not only asses the relationship among the salient constructs, including direct and indirect effects, but also allow latent constructs to be modeled as formative indicators as was the case with our data (Chin 1998). It is better suited to explain complex relationships as it avoided two serious problems: inadmissible solutions and factor indeterminacy (Fornell and

Bookstein 1982a). Unlike a covariance-based structural equation modelling method such as LISREL, PLS employs a component-based approach for estimation purposes (Lohmoller 1989). This study employed SmartPLS 2.0 (Ringle et al., 2005).

4.1 Measurement model

Cronbach α test was used to test the reliability of the questionnaires' construct variables. Suggesting by Cronbach (1951), the value of Cronbach's α that was greater than 0.7 could be judged as high reliability; that was less than 0.35 could be judged as low reliability. In practice, the reliability of questionnaires could be accepted when the value of Cronbach's α was greater then or equal to 0.6. As shown in Table 2, all of the constructs had a Cronbach α greater than 0.7, showing a high level of reliability. In general, the entirety of our questionnaires had a high level of construct reliability. Regarding the validity of our measurement model, three types of validity were assessed: content validity, convergent validity, and discriminant validity. Content validity was established by ensuring consistency between the measurement items and the extant literature. This was done by pilot-testing the instrument. The convergent validity was assessed by examining composite reliability and average variance extracted (AVE) from the measures (Hair et al. 1998). Although many studies employing PLS had used 0.5 as the threshold reliability of the measures, 0.7 was a recommended value for a reliable construct (Chin 1998). As shown in Table 2, all of the composite reliability values of constructs were greater than 0.7. For the AVE (average variance extracted) by a measure, a score of 0.5 indicated acceptability (Fornell and Larcker 1981). As shown in Table 2, all of the AVE value of constructs were greater than 0.5. Those results confirmed the converged validity.

Measures	Items	AVE	Composite Reliability	Cronbach's alpha
ERP overall benefits (BEF)	3	0.731	0.890	0.812
Coordination improvement (COR)	4	0.552	0.830	0.732
Customization (CUS)	3	0.635	0.839	0.712
External EF (EXT)	7	0.500	0.873	0.850
Internal EF (INT)	13	0.501	0.728	0.753
Data quality (QTY)	6	0.516	0.864	0.810
Task efficiency (TAK)	4	0.717	0.909	0.863

Table 2. Reliability of constructs

Finally, we verified the discriminant validity of our instrument by looking at the square root of the average variance extracted as recommended by Fornell and Larcker (1981). The result in Table 3 confirmed the sufficient discriminant validity: the square root of the AVE for each construct was greater than all of the inter-construct correlations involving the construct (Chin 1998). Thus discriminant validity was supported.

*The shaded numbers in the diagonal row are the square roots of the AVE (average variance extracted).

	BEF	COR	CUS	EXT	INT	QTY	TAK
BEF	0.855						
COR	0.483	0.743					
CUS	0.519	0.566	0.797				
EXT	-0.106	-0.062	-0.165	0.707			
INT	-0.034	0.115	-0.094	0.082	0.708		
QTY	0.377	0.326	0.470	-0.429	-0.071	0.748	
TAK	0.552	0.485	0.534	-0.149	-0.237	0.410	0.847

Table 3. Correlation between Constructs

According to the research of MacCallum and Michael (1993), a measurement perspective based on formative indicators reflects the notion that "in many cases, indicators could be viewed as causing rather than being caused by the latent variable measured by the indicators". A change in one of the first-order factors does not necessarily imply an equal change in the other. More specifically, when constructs are conceived as explanatory combinations of indicators that are determined by a combination of variables, their indicators should be formative (Fornell and Bookstein 1982b). A

typical example is socioeconomic status which is formed as a combination of education, income, occupation, and residence (Hauser 1973). Thus, in our study, CF was viewed as a second-order factor formed by the first-order dimensions of customization and data quality. We also constructed EF as a second-order factor formed by two first-order dimensions of external contexts and internal contexts. Finally, the result of content validity showed direction of causality is from items to construct and a change in one item is not necessarily associated with changes in the other items (Diamantopoulos and Winklhofer 2001). In shortly, given CF and EF were treated as a formative construct, we created a superordinate second-order construct using factors scores of the first-order constructs.

4.2 Hypotheses testing

The results of PLS analyses were illustrated in Figure 2 and summarized in Table 4. The model explained a substantial amount of variance for ERP overall benefits (R^2=0.365), coordination improvement (R^2=0.272), and task efficiency (R^2=0.318), which were greater than the recommended 0.10 (Falk and Miller 1992). As indicted in Figure 2, all of the hypotheses were supported. In addition, the influence of conducted factors (β=0.517) on coordination improvement was higher than that of environmental factors (β=0.179). In a similar vein, the impact of conducted factors (β=0.506) on task efficiency was also higher than that of environmental factors (β=-0.184). Regarding overall benefits, both coordination improvements and task efficiency had a positive effect on ERP overall benefits, the latter benefited more.

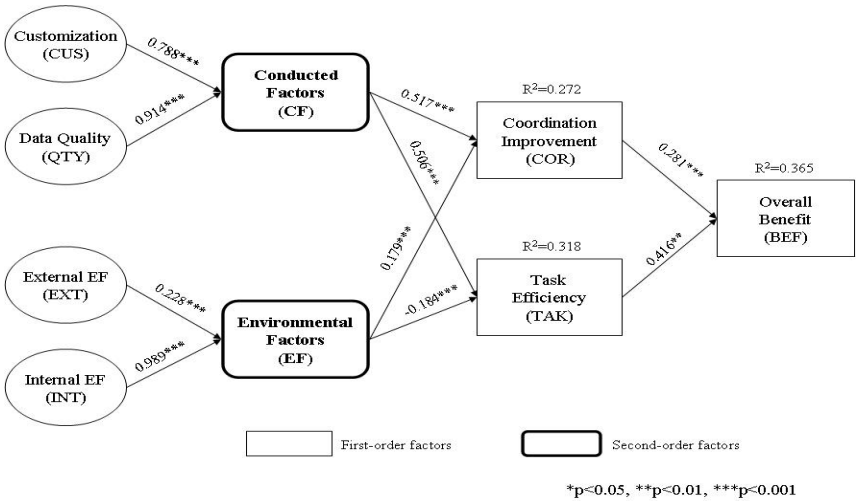

Figure 2. Results of PLS analysis

Hypothesis	Standardized path coefficient (direct effect)	t-value for path	Results
H1: CF→Coordination improvement	0.517	22.842	Supported
H2: CF→Task efficiency	0.506	18.540	Supported
H3: EF→Coordination improvement	0.179	5.185	Supported
H4: EF→Task efficiency	-0.184	7.136	Supported
H5: Coordination improvement→ERP overall benefits	0.281	6.757	Supported
H6: Task efficiency→ ERP overall benefits	0.416	12.522	Supported

Table 4. Results of hypotheses testing

5 DISCUSSION AND CONCLUSION

So many prior researches have discussed the ERP intermediate benefits and overall benefits in the post-implementation stage, such as by the original features of a firm (interdependence and differentiation of one plant) (Gattiker and Goodhue 2005), by organizational interventions (Chou and Chang 2008). Using OIPT, we develop and test a theoretical model to investigate the effect of EF and

CF on ERP's benefits in the post-implementation stage. Based on Gattiker and Goodhue's (2005) and Chou and Chang's (2008) research, including customization, intermediate benefits, and overall benefits, we propose an alternative way of affecting ERP benefits—i.e. EF and CF. In other words, we contend that ERP benefits are affected not only by the original features of a firm and managerial interventions, but also by EF and CF. The former emphasizes the influence of contexts that organization stands on ERP's performance, whereas the latter focuses on the effects of fit and output of ERP software.

As in most studies, the research presented here is limited by the measures used. Because environments are comprised of numerous uncorrelated facets, such as politics, technology, organizational strategy, organizational culture, organizational size, and organizational structure may also influence ERP's performance. In addition, our data is collected from top 1000 manufacturing companies of CommonWealth magazine in Taiwan. Therefore, we are limited in generalizing our finding widely. Follow up studies can collect data from a random sample of firms that implemented ERP. Finally, we do not discuss the mediation effects of coordination improvement and task efficiency. Follow up studies can consider those factors.

Our research contributes to the IT innovation literature by focusing on the much neglected post-implementation stage and extending and enriching the extant literature on IT innovation. Using OIPT and results of empirical analysis, we concluded: CF had the positive influence on coordination improvement and task efficiency, EF had the positive influence on coordination improvement but negative influence on task efficiency, coordination improvement, and task efficiency had the positive influence on ERP overall benefits.

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APPENDIX

*Final item numbers (Initial item numbers). Three items in internal EF are dropped.

Constructs	**Definition**	**Key Reference**	**Items***
Customization	The capability of handling the lack of fit between the organization's business processes and those envisaged by the ERP package designers.	Gattiker & Goodhue (2005), Chou & Chang (2008)	3(3)
Data quality	Accurate and relevant data to generate better information.	Gattiker & Goodhue (2005)	6(6)
External EF	The overall degree of change and innovation, similarity or differentiation, and regulatory restrictions in business climate includes including industry, market, raw materials, human resources, opportunities, etc.	Karimi et al. (2004)	7(7)
Internal EF	The overall degree of exchange information or material, different products, service, and process flow among all units of an organization.	Gattiker & Goodhue (2005), Tushman & Nadler (1978)	13(16)
Coordination improvement	The capability of adapting to changing conditions, coordinating and synchronizing among different units of a firm.	Gattiker & Goodhue (2005), Chou & Chang (2008)	4(4)
Task efficiency	The efficiency and productivity of business processes.	Gattiker & Goodhue (2005), Chou & Chang (2008)	4(4)
ERP overall benefits	Overall business impact of ERP on the organization	Gattiker & Goodhue (2005)	3(3)

Table A1. Definition of the constructs

Each question used a Likert scale: 1=strongly disagree to 5=strongly agree. The postfix "R" indicates reverse scoring for the analysis. The items were intermixed on the actual questionnaire instead of being sorted by construct as shown below.

Construct	Item	Description
Customization	Cus1	Individuals from this organization had a great deal of influence on how the ERP system was set up.
	Cus2	A standard version of the ERP software was implemented without changes being made to fit the particular requirements of this firm.
	Cus3	When the ERP system was being implemented (or modified) in this firm, the package was changed to better meet the needs of this organization.
Data quality	Qty1R	The information from the ERP system has numerous accuracy problems that make it difficult for employees to do their jobs.
	Qty2	The information that the ERP system provides to employees in this unit is accurate.
	Qty3	The data that employees receive from the ERP system is true.
	Qty4	The ERP data that employees (planners, supervisors, etc) use or would like to use are accurate enough for their purposes.
	Qty5R	It is difficult for employees to do their jobs effectively because some of the data they need is missing from the ERP system.

	Qty6R	The data accessible from the ERP system lacks critical information that would be useful to employees.
External EF	Envdyn1	The market activities of company's key competitors are difficulty predictable.
	Envdyn2	The tastes and preferences of company's customers in principle industry are difficulty predictable.
	Envdyn3	The rate of innovation of new operating processes and new products or services in company's principle industry has dramatically increased.
	Envdyn4	Company's principle industry's downswings and upswings are difficulty predictable.
	Envhet1	The diversity in company's production methods and marketing tactics to cater to different customers has dramatically increased.
	Envhos1	The market activities of company's key competitors have become far more hostile.
	Envhos2	The market activities of company's key competitors have affected organization in many areas (ex. pricing, delivery, etc.)
Internal EF	Deptdep1	To be successful, this unit must be in constant contact with these other units. (item dropped)
	Deptdep2	If this unit's communication links to these other units were disrupted things would quickly get very difficult.
	Deptdep3	Frequent information exchanges with these other units are essential for this unit to do its job.
	Deptdep4	Close coordination with these other units is essential for this unit to successfully do its job.
	Deptdep5	Information provided by these other units is critical to the performance of this unit. (item dropped)
	Deptdep6R	This unit works independently of these other units. (item dropped)
	Deptdep7	The actions or decisions of these other units have important implications for the operations of this unit.
	Deptdif1	The products or services provided in different units are different.
	Deptdif2	The rules of cost accounting used in different units are different.
	Deptdif3	The model numbers, or products' name or configurations or formulations used in units are different.
	Deptdif4	The active part numbers or material code numbers or finished goods part numbers or finished goods code numbers used in different units are different.
	Deptdif5	Number of levels in the typical bill of materials is different between units.
	Deptdif6	The average number of engineering changes per month is different between units.
	Deptdif7	The procedure of procurement is different between units.
	Deptdif8	The need to identify or segregate material by individual piece or lot rather than merely by part number is different between units.
	Deptdif9	Amount of production activity dedicated to processing is different between units.
Coordination improvement	Cord1	ERP helps to adjust to changing conditions among different units of the firm
	Cord2	ERP has improved the coordination among different units of the firm
	Cord3	ERP facilitates the integration of important information among different units of the firm
	Cord4	ERP helps to synchronize among different units of the firm
Task efficiency	Task1	Due to the ERP implementation, employees such as buyers, planners, and production supervisors need less time to do their jobs.
	Task2	ERP saves time in jobs like production, material planning and production management.
	Task3R	Now we have ERP, it is more time-consuming to do work like purchasing, planning and production management.
	Task4	ERP helps employees like buyers, planners, and production supervisors to be more productive.
ERP overall benefits	Benf1	In terms of its business impacts on the unit, the ERP system has been a success.
	Benf2	ERP has seriously improved this organization's overall business performance.
	Benf3	ERP has had a significant positive effect on this organization.

Table A2. Questionnaire items: definitions provided to survey respondents