Impact of Environmental Uncertainty and Organizational Context on ERP Overall Benefits

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Abstract

Today, ERP is used to help most of firms processing volumes of information under more uncertainty and more competitive environments. This study aims to investigate how ERP performance is affected under the environmental uncertainty. Using organizational information processing theory (OIPT), we propose that environmental uncertainty affects organizational context, which in turn influence ERP overall benefits. A subunit (such as manufacturing plant or different functional department) level survey is used to collect data. The partial least squares technique indicates that environmental uncertainty has a positive impact on organizational context. Organizational context has a direct and mediating impact on ERP overall benefits. The paper concludes with discussions and Implications for both researchers and practitioners.

Keywords: Environmental uncertainty; Organizational context; ERP all benefits

Introduction

Managers in every industry have faced difficult challenges in the sense that their firms encounter increasingly environmental uncertainty (Pagell and Krause, 1999; Castrogiovanni, 2002). Short product life cycle, short product design cycle, rapid technological change, diverse range of customers' tastes, scare resources, and frequent entry by unexpected outsiders are a few factors that influence firms' external environments. In high uncertainty environments, organizational decision may make mistakes simply because managers cannot determine or predict which alternative will solve a problem (Daft, 2001; Schoemaker, 1993). In order to cope with environmental uncertainty and to assist manager's decision, many firms implement powerful information systems such as ERP (enterprise resource planning) systems to increase their information processing capacity, and their flexibility to adapt to environmental changes (Watson and Fenner, 2000). This is so because implementing ERP seeks to improve operational efficiency and business efficacy (Castrogiovanni, 2002; Chou and Chang, 2008; Rajagopal, 2002). ERP systems can improve operational efficiency by integrating business processes and providing better access to integrated data across the entire enterprise (i.e. information processing capacity). As to enhance efficacy, an enterprise may redesign its business processes according to the templates (or best practices) embedded in the ERP systems via parameters setting (Davenport, 1998; Lucas et al., 1988). This can improve enterprise's flexibility to adapt to environmental changes. For example, when enterprise builds a new manufacture plant due to the strong market demands, ERP users may only need to set the new plant code in the ERP systems. The others such as vendors' information, product specifications, inventory level, material code, cost allocation, may share current information from other plants. But, can the connectivity of ERP's function and process be influenced by the environmental uncertainty? And, how the environmental uncertainty impacts ERP performance? Our study intends to explore those causes and effects.

According to the research of Daft and Lengel (1986), Daft and Macintosh (1981), Galbraith (1977), Milliken (1987), Tushman and Nadler (1978), and Weick (1979), technology, organizational context (interdepartmental relations), and external environments are three sources of uncertainty. Regarding the organizational context, following Gattiker and Goodhue (2004, 2005), interdependence and differentiation between subunits of an organization are used in this study. Interdependence is the degree to which sub-units must exchange information or material in order to complete their tasks (McCann and Ferry, 1979; Gattiker and Goodhue, 2004). Differentiation means that the products produced and markets served are different between subunits (Gattiker and Goodhue, 2004).

Regarding the external environments, three characteristics of external environments-dynamism, heterogeneity, and hostility are identified (Dess and Beard, 1984; Karimi et al., 2004). Dynamism is characterized by the rate of change and innovation in production and service technologies, as well as the uncertainty or unpredictability of customer taste and actions by the firm's principle industries (Karimi et al., 2004). Heterogeneity is characterized by the degree or similarity or differentiation within the organization task environments (Hall, 1999). It also refers to the degree of concentration-dispersal of scarce material and financial resources, the need to ensure the availability of resources, and the degree of competition for these resources (Karimi et al., 2004). Hostility is characterized by severe regulatory restrictions, a harsh and overwhelming business climate, a shortage of labor or raw materials, and a relative lack of exploitable opportunities and resources, as well as intense competition in price, product, technology, and distribution (Miller and Friesen, 1983; Mintzberg, 1979).

In this study, we attempt to investigate the relationships of external environments, organizational context, and ERP technology via organizational information processing theory (OIPT). Because OIPT states that organizations process information to reduce uncertainty, and their effectiveness depends on their capacity to process information and match their information process capacities with the uncertainty they faced (Daft and Lengel, 1986; Galbraith, 1974; Tushman and Nadler, 1978). A lot of prior researches study the impact of environmental uncertainty, such as on vertical integration in the cattle industries (Charlebois and Camp II, 2007); on task characteristics (nonroutineness and interdependence) (Karimi et al., 2004); on manufacturing flexibility (Pagell and Krause, 1999); on strategic supply management initiatives (Paulraj and Chen, 2007); on economic satisfaction and relationship commitment in distribution channels (Sahadev, 2008), on organizational buyer's satisfaction with service providers (Wood, 2008), but there is no similar research regarding the impact of environmental uncertainty on interdependence and differentiation between plants, and then on ERP benefits. Our research fills this gap.

Research Model and Hypothesis Development

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 (Gattiker and Goodhue, 2005; Chou and Chang, 2008). On the other hand, integration aims to connect information and processes of distinct sub-units of the organization (Gattiker and Goodhue, 2005; 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.

Organizational Information Processing Theory (OIPT)

This theory identifies three important concepts: information processing needs, information processing capability, and the fit between the two to obtain optimal performance (Premkumar et al., 2005). OIPT posits that resolving uncertainty is the central task in organizational design (Gattiker and Goodhue, 2004). The theory conceptualizes uncertainty as a lack of information about statuses of tasks, environments, and so on (Galbraith, 1973; Galbraith, 1977). In addition, many information processing theorists have suggested various sources or types of uncertainty, including: the characteristics of the self-contained tasks that sub-units must execute, instability of the external environments, interdependence with other sub-units (Tushman and Nadler, 1978) and differentiation among sub-units (Daft and Lengel, 1986). The amount and types of uncertainty vary across organizations and among individual sub-units within organizations. Typically, organizations have two strategies in dealing with uncertainty to increase information needs: (1) developing buffers to reduce the effect of uncertainty, and (2) implementing structural mechanisms and information processing capability to enhance the information flow and thereby reduce uncertainty. A classic example of the first strategy is to build inventory buffers to reduce the influence of uncertainty in demand or supply. An example of the second strategy is the redesign of business processes in organizations and the implementation of integrated IS that improves information flow to reduce uncertainty. The adoption and implementation of ERP belongs to the scope of second strategy.

ERP systems can be viewed as a particular class of information processing mechanism (Gattiker and Goodhue, 2005). Thus OIPT suggests the impact of ERP depends, at lease in part, on the amount and types of uncertainty at hand. Because integration and standardization are two major characteristics of ERP systems (Gattiker and Goodhue, 2004; 2005), their performance will be influenced by the two major sources of uncertainty: external environment (dynamism, heterogeneity, and hostility) and organizational context (interdependence and differentiation). Figure 1 illustrates our research model. In this model, we propose that an increase in dynamism, heterogeneity, and hostility are related to more interdependence and differentiation. High interdependence contributes to the positive ERP benefits, while high differentiation will incur ERP-related compromise or design costs which decrease ERP benefits. Further, organizational context mediates the impact of environmental uncertainty on ERP benefits.

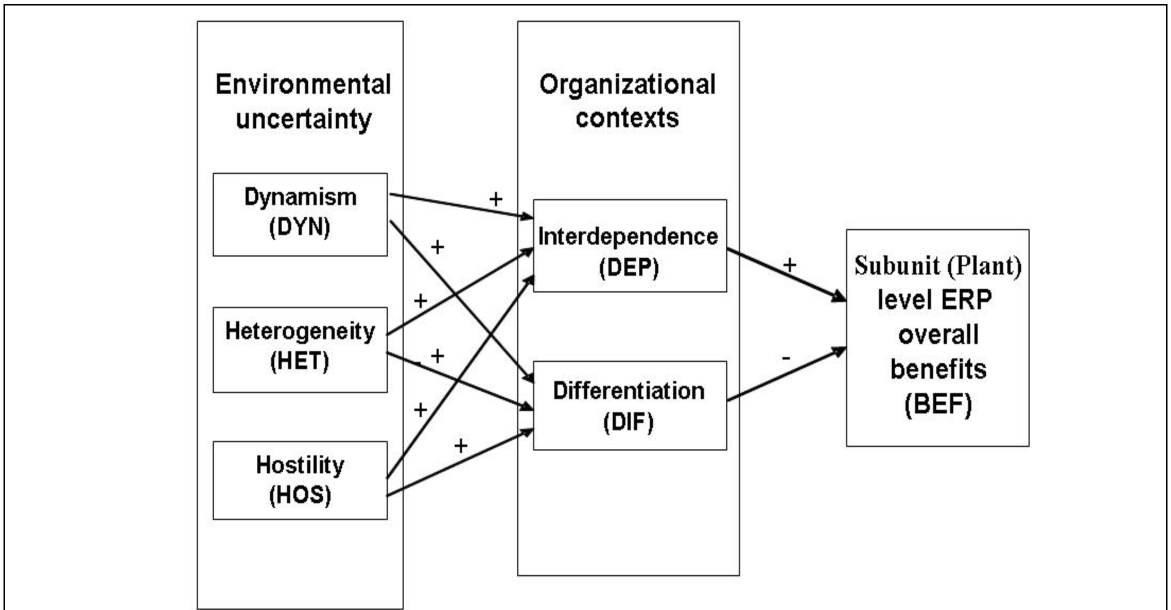

Figure 1 - Research Model

Environmental uncertainty influences interdependence and differentiation

Environmental uncertainty has been described as the degree to which an environment is stable-unstable, simple-complex, and concentrated-dispersed (Aldrich, 1979). Using industrial classification data, these dimensions of environmental uncertainty are measured by dynamism (stable-unstable, turbulence), homogeneity-heterogeneity (simple-complex, concentration-dispersion), and hostility (Capacity, munificence) (Dess and Beard, 1984). Castrogiovanni (2002) and Karimi et al. (2004) states these dimensions as dynamism, heterogeneity, and hostility. Charlebois and Camp II (2007) also address that these dimensions are environmental capacity, environmental dynamism, and complexity. Following Karimi et al. (2004), we will use dynamism, heterogeneity, and hostility as the dimensions of environmental uncertainty in this study.

In a highly dynamic environment, products and services quickly become obsolete, the rate of innovation in products/services and in process is high, and as well as the uncertainty of customers' taste and preferences (Agbejule and Burrowes, 2007; Karimi et al., 2004). This makes managerial planning and control difficult due to low task predictability. For example, subunits that faced unpredictable change may find that static budgets become ineffective control devices because initial standards rapidly become outdated (Chenhall and Morris, 1986). Another example is the fast change or vaporization of customer's taste in IC

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consumer products, subunits in Taiwan may need to dynamically adjust the manufacturing plans to avoid over production.

In dynamic task environments, decision makers must cope with unpredictable external events and must seek to integrate and continuously improve operating processes (Daft et al., 1988). To be successful, decision makers need detailed, timely information that allows them to coordinate the flow of activities and provides them, at all levels in the organization, with a thorough understanding of process dynamics and their relationship to both local and organization-wide performance. This is particularly important for the IC foundry manufacturers in Taiwan. In order to satisfy many customers, the physical fabrication must provide customized service and mixed products by dynamically changing operation and capacity configuration.

As environmental uncertainty increases, interdependent between plants of an organization become more important due to the increased need for coordination, information sharing, and material exchange to resolve uncertainty. At the same time, higher interdependence allows organizations to more easily detect, bring, and send information about the change of task environments (Maier et al., 1997; Schwab et al., 1985). Therefore, under the higher dynamism, one can expect a higher frequency of communication between plants.

On the other hand, under the higher dynamism, in order to sustain competitive advantage, organizations need continuous innovation and change in products and services, and seize customer's taste. Each plant may be assigned special missions in providing privileged products or services in order to catch customer's taste or fit marketing needs, which incur different from other plants. Based on the above discussion, we propose following two hypotheses.

> *H1a: The greater the environmental dynamism, the greater the interdependence between plants.*

> *H1b: The greater the environmental dynamism, the greater the differentiation between plants.*

In a highly heterogeneous environment, organizations face numerous distinctive elements that remain the same or change slowly and require very different marketing, production, and administration practices (Daft et al., 1988; Miller and Friesen, 1983). According to the research of Chidambaram and Jones (1993), and Karimi et al. (2004), under more heterogeneous environments, organizations will likely face many non-routine and interdependent tasks in building coalitions, exchanging information, and establishing goals and priorities. In order to effectively exchange output, build coalitions, and establish priorities, one plant could be closer to another plant to set a coordination mechanism and to design the common language or format, such as same product name, same part number or same material code number. Hence, the interdependence of one plant with another plant will increase. This can be seen in the IC testing and assembly manufacturers in Taiwan. When wafers probing test are done, those wafers are sent to different assembly plants for IC packing. After finishing ICs packing, those ICs are sent back to testing plant for final test. It is very important for different assembly plants to use the same product name, part number or material code for IC packing. Otherwise, testing plant will not know if those packed ICs coming from which wafer lot.

On the other hand, non-routine tasks, marketing needs and competitions that one plant face may be different with another plant. Each plant may need to implement its marketing tactics, management strategy and production methods to cater customers' taste, thus, incurring different from other plants. For example, many Taiwan's enterprises have world-wide plants. The marketing environments that one plant faced may be different from other plants. Hence, each plant may implement its own marketing tactics and management strategy to fit local environments. Based on above discussion, we propose the following two hypotheses.

H2a: The greater the environmental heterogeneity, the greater the interdependence between plants.

H2b: The greater the environmental heterogeneity, the greater the differentiation between plants.

The dimension of hostility concerns the relative insufficiency of input and output resources to which an organization has accessed in its environment (Achrol and Stern, 1988; Achrol et al., 1983). Hostile environments are considered as lack of exploitable opportunities, intensity of competition overwhelming business climates, and lack of capacity to manage the environment (Charlebois and Camp II, 2007). Under more hostile environments, organizations will face a greater frequency of change and the need for greater environmental scanning for more data (Maier et al., 1997), exploration (ex. search, variation, risk taking, innovation, discovery) and exploitation (ex. refinement, choice, efficiency, selection, implementation, execution) (March, 1991). According to the research of Karimi et al. (2004), when hostility creates a threat to an organization's primary goals, in order to better understand its task environments, reduce uncertainty, and ensure access to scare resources, the organization's responses can be in the forms of greater integration and coordination and establishing favorable linkages with key elements of its task environments. For example, in order to ensure access to scare resources and get better buying power, subunits in Taiwan are joined together to bargain with suppliers. Some enterprises even establish a joint procurement center to process all the low materials and spare parts that subunits need for production. Therefore, one can expect that the greater the magnitude of hostility in the environments, the greater the interdependence of organizational plants.

On the other hand, the business climates (ex. government policy, accounting principle, and tax regulations…) that one organizational plant faced may be different from other plants. Plant may need to build particular structure or information system to fit environmental needs. Thus, the differentiation between plants will increase. Based on the above discussion, we propose following two hypotheses.

H3a: The greater the environmental hostility, the greater the interdependence between plants.

H3b: The greater the environmental hostility, the greater the differentiation between plants.

Organizational context influences ERP overall benefits

A substantial amount of works have discussed the organizational context in ERP implementation success such as by organization culture and political structures (Allen et al., 2002), by technology adaption level and organizational resistance (Hong and Kim, 2002), by culture (Davison, 2002; Soh et al., 2000), by organizational stages of growth (Liang and Xue, 2004), by organization size (Mabert et al., 2003), by nationality differences (Sheu et al., 2004), by task characteristics (karimi et al., 2004), by interdepartmental relationship (Gattiker and Goodhue, 2005), by organizational structure (Morton and Hu, 2008), by intra-organizational standardization (Benders et al.,2006), and by organizational interventions (Chou and Chang, 2008). In our study, following Gattiker and Goodhue (2004; 2005), we use OIPT to examine the influence of interdepartmental relationship (interdependence and differentiation) on ERP benefits. OIPT states that the level of interdependence between organizational subunits will influence the benefits of a highly integrated, standardized system, such as ERP (Wybo and Goodhue, 1995). Tushman and Nadler (1978) posit that the impact of an integrative coordination mechanism on a subunit, such as a plant, may depend on the level of interdependence between that plant and other plants in the organization. When the interdependence that one subunit shares with another is high, changes in one plant may require some adjustment in the other, we can expect greater information sharing between them. For example, when one plant provided input to another plant (such as IC

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testing plant supplying wafers to IC assembly plant), the level of interdependence between these two plants were high. Changes in the master production schedule or inventories of one plant may necessitate adjustments by the other plant, and an information system that integrated the data of both plants may thus improve coordination.

The major reason that many organizations have implemented ERP is to manage interdependence and improved the flow of information across subunits (Cooke and Peterson, 1998). If an organizational subunit needs to exchange information and materials with other subunits, the ERP should facilitate this flow. After all, data standards eliminate the burden of reconciling or translating information that is inconsistently defined across two or more subunits (Huber, 1982). Data standards also do away with the potential for translation or reconciliation errors as well as ambiguity about a field's true meaning (Sheth and Larson, 1990). Finally, ERP improves the seamless integration and timeliness of information and brings the benefits to the organization. Based on the above discussion, we propose the following hypothesis.

H4: For a plant that has implemented ERP, the greater the interdependence of one plant with another plant in the organization, the greater the ERP overall benefits accrued by that plant.

On the other hand, when an individual subunit's local task characteristics or its local external environments differ from other organizational subunits, that subunit may well require unique, nonstandard systems in order to cope with its particular circumstances (Tushman and Nadler, 1978). Since our study focuses on the plant level, the products produced, technologies employed, and the markets served by each plant may differ significantly within an organization, in particular, when external environments change frequently and unpredictably (Gattiker and Goodhue, 2004). For example, a plant produces PVC (Polyvinyl Chloride) films and cuts them to unique lengths for each customer order (i.e. not to stock). In advance of customer orders, the plant produces films by a few lengths, such as 50 feet. When a customer's order arrives, films are then cut to the customer-specified length. Those films are cut from either a new film or from remnants which are left over from when earlier orders were cut. Because the length of each remnant is random, there is no part number for them. Thus, this plant has a relatively uncommon inventory tracking problem and needs a system to "know" the individual length of each remnant in stock. Therefore, if the plant is part of an ERP implementation that includes mostly plants that produce standard-length discrete films and thus do not have the same inventory challenge, it may well experience difficulty.

OIPT predicts that the costs of a standardized system, such as ERP, increase in proportion to the degree of sub-unit differentiation, which is the uniqueness of tasks, technologies, environment, goals, etc. across sub-units (Lawrence and Lorsch, 1986). According to the research of Goodhue et al. (1992) and Gattiker and Goodhue (2004), when an integrated information system such as ERP is implemented across a number of differentiated subunits, design and compromise costs will arise. Those costs will decrease ERP performance (Gattiker and Goodhue, 2004; 2005).

In general, when differentiation (process, product and market-related difference) between plants is greater, it is less likely that a system that standardizes data and processes among plants will meet all plants' needs equally well. Thus, differentiation influences the overall benefits of ERP which has implemented. Based on the above discussion, we propose the following hypothesis.

H5: For a plant that has implemented ERP, the greater the differentiation of a plant from another plant in an organization, the lower the ERP overall benefits accrued by that plant.

Research Method and Data

The operation of latent variables (constructs)

We used the survey method to test our model in this paper. A survey instrument such as construct variables, definition, and questionnaire was developed by identifying appropriate and verified measurements from a compressive literature review. Three constructs (i.e. dynamism, heterogeneity, and hostility) in the environmental uncertainty came from the research results of Karimi et al. (2004), Hall (1999), and Miller and Friesen (1983). Two major constructs (interdependence and differentiation) in the organizational context were adapted from the research results of Gattiker and Goodhue (2005). The definitions and questionnaires of data quality and ERP overall benefits mainly came from the research results of Gattiker and Goodhue (2005). The Five-point Likert Scale was used for each manifest variable (1 meant strongly disagree, 2 meant disagree, 3 meant no comment, 4 meant agree, 5 meant strongly agree). Table A1 and Table A2 in Appendix contain the summary of constructs, categories, definition and measurement items.

Although we borrowed the questions from existing scales where possible, as an additional means of ensuring that questionnaire items matched 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.

Data collection

The survey was administered to managers in Taiwan's manufacturing companies which had implemented ERP systems. Questionnaires with return envelopes were sent to 60 enterprises of Taiwan. The initial version of the survey instrument was refined through a pre-test with 33 completed questionnaires returned. 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), one item from quality was dropped.

The refined instrument, in the form of a self-administration questionnaire, 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* 2007. One hundred sixty-nine questionnaires were returned with three uncompleted responses and two responses employed custom-built IS. One hundred sixty-four questionnaires were completed and usable for data analysis, showing an effective response rate of 16.4 percent. Table 1 showed the characteristics of respondents according to industry types and demographics.

Data Analysis and Results

We used partial least squares (PLS) to assess validation and test linkages in the theoretical model. The reflective way was constructed for the relationship between manifest variables and latent variables. In general, PLS was better suited to explain complex relationships as it avoided two serious problems: inadmissible solutions and factor indeterminacy (Fornell and Bookstein, 1982). Unlike a covariance-based structural equation modelling method such as LISREL, PLS employed a component-based approach for estimation purposes (Lohmoller, 1989), and could handle formative constructs (Chin et al., 1996). This study employed SmartPLS 2.0 (Ringle et al., 2005).

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

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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, most of the constructs had a Cronbach α greater than 0.7 except for dynamism (0.673) and hostility (0.678), showing high and acceptable level of reliability. In general, the entirety of our questionnaires had high and acceptable 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 interviewing senior managers and 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, which suggested the acceptability of the construct reliability. Regarding the AVE, a score of 0.5 indicated acceptability (Fornell and Larcker, 1981). As shown in Table 2, all of the AVE values of constructs were greater than 0.5. In addition, as shown in Table A3 in Appendix, the loadings of the measures in our research model were significant on their path loadings at the level of 0.01. Those results confirmed the converged validity. Finally, we verified the discriminant validity of our instrument by looking at the square root of the AVE 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.

Table 1. Profile of companies and respondents

		# of Companies or Respondents	Percent (%)	Accumulated %
Education	University/College	85	51.8	51.8
	Graduate School	79	48.2	100.0
Industries	Traditional MFG	83	50.6	50.6
	High Tech MFG	81	49.4	100.0
Position	Plant Manager	98	59.8	59.8
	Material Manager	20	12.2	72.0
	Operation Manager	15	9.1	81.1
	Purchase Manager	26	15.9	97.0
	Senior Staff	5	3.0	100.0
Time elapsed since ERP implementation	1~2 years	26	15.8	15.8
	2~3 years	13	7.9	23.7
	3~4 years	28	17.1	40.8
	4~5 years	28	17.1	57.9
	Over 5 years	69	42.1	100.0
ERP vendors	Domestic Vendor	66	40.2	40.2
	Foreign Vendor	98	59.8	100.0

Table 2 - Reliability of constructs

Measures	Items	Composite Reliability	AVE	Cronbach's alpha
Dynamism (DYN)	4	0.801	0.501	0.673
Heterogeneity (HET)	1	1.000	1.000	1.000
Hostility (HOS)	2	0.855	0.748	0.678
Interdependence (DEP)	7	0.875	0.505	0.837
Differentiation (DIF)	9	0.900	0.505	0.877
ERP overall benefits (BEF)	3	0.905	0.763	0.842
Data quality (QTY)	5	0.839	0.519	0.769

Table 3 - Correlation between constructs

	DYN	HET	HOS	DEP	DIF	BEF
DYN	0.708					
HET	0.248	1.000				
HOS	0.284	0.461	0.865			
DEP	0.447	0.381	0.473	0.711		
DIF	0.321	0.297	0.246	0.154	0.711	
BEF	-0.115	0.165	0.080	0.229	-0.184	0.873

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

Hypotheses testing

Because of the acceptable level of validity, the proposed hypotheses were tested by PLS. The results of the PLS analyses were illustrated in Figure 2 and summarized in Table 4. As shown in Figure 2, the model explained a substantial amount of variance for ERP overall benefits (R^2=0.102), interdependence (R^2=0.349), and differentiation (R^2=0.159), which were greater than the recommended 0.10 (Falk and Miller, 1992). All of the hypotheses were supported as expected. In addition, the influence of environmental uncertainty on interdependence by the numbers were dynamism (β=0.320), hostility (β=0.308), and heterogeneity (β=0.160). The influence of dynamism (β=0.248) on differentiation was higher than heterogeneity (β=0.196) and hostility (β=0.084), and heterogeneity was higher than hostility. As a whole, dynamism had the most impact on organizational context. Regarding the impact of organizational contexts on ERP overall benefits, interdependence exerted a positive effect on overall benefits, while differentiation generated a negative influence. Those results conformed to the research of Gattiker and Goodhue (2005).

To further examine the intermediate effect of both interdependence and differentiation, we first tested the direct relationships, including a model of dynamism, heterogeneity, and hostility predicting ERP over benefits. The βs of dynamism, heterogeneity, and hostility were -0.307 ($p<0.001$), 0.154 ($p<0.001$), and 0.144 ($p<0.001$) respectively, according to 12.9% variance. We then proceeded to see if

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there is a mediation effect by adding the intervening constructs (interdependence and differentiation). From figure 2, the foregoing constructs partially mediated relationship between dynamism and ERP overall benefits because the indirect paths and the direct path were both significant. In a similar vein, the foregoing constructs were also a partially mediator between heterogeneity and ERP overall benefits. On the other hand, these intervening constructs completely mediated the relationship between hostility and overall benefits since the indirect paths were significant and the direct path was completed eliminated. Besides, the increase in R^2 (i.e. from 0.129 to 0.164) perhaps showed that dynamism, heterogeneity, and hostility were not the only variables that predicted the organizational context.

Table 4 - Results of hypotheses testing

Results	Hypothesis		Path Coefficient	t-value for path
Supported	H1a	Dynamism->Interdependence	0.320	11.008
Supported	H1b	Dynamism->Differentiation	0.248	8.328
Supported	H2a	Heterogeneity->Interdependence	0.160	3.813
Supported	H2b	Heterogeneity->Differentiation	0.196	4.388
Supported	H3a	Hostility->Interdependence	0.308	7.475
Supported	H3b	Hostility->Differentiation	0.084	1.931
Supported	H4	Interdependence->ERP Overall Benefits	0.264	12.140
Supported	H5	Differentiation->ERP Overall Benefits	-0.225	8.388

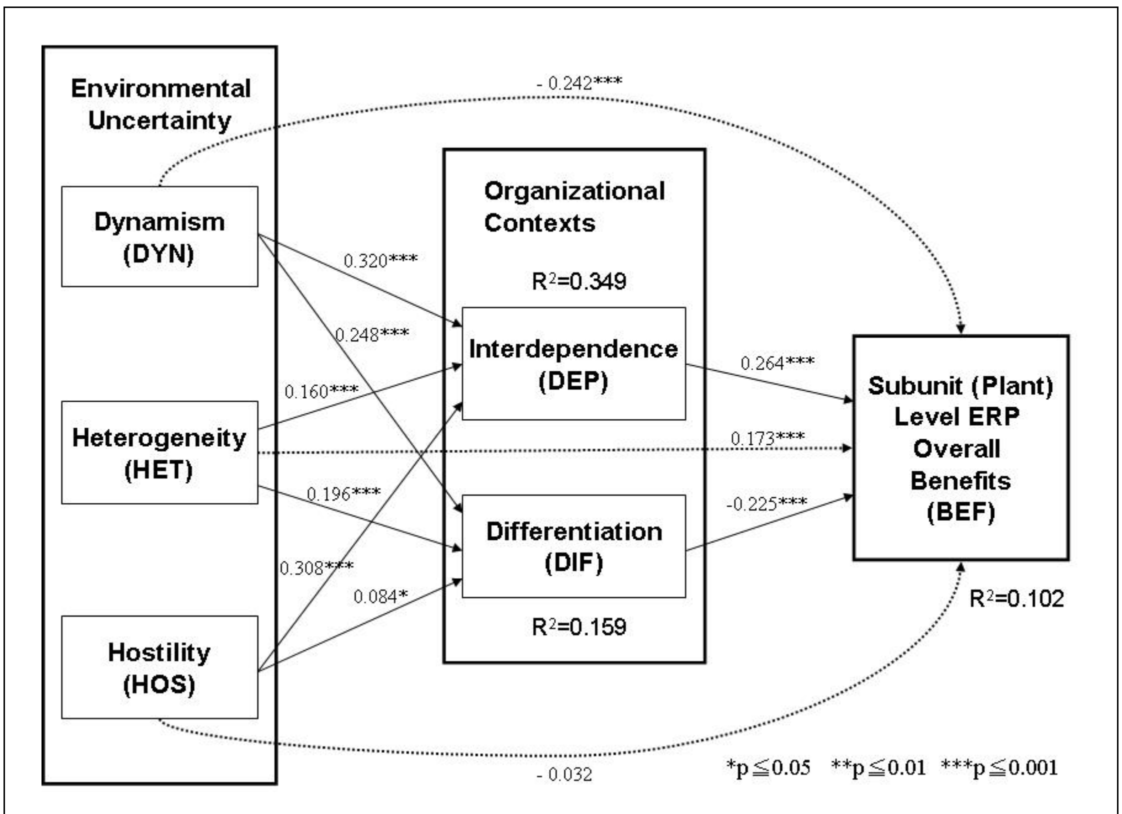

Figure 2 - Results of PLS Analysis Model

Post Hoc Analysis

Three control variables were included in our study: data quality (Gattiker and Goodhue, 2005), time elapsed since ERP implementation (Gattiker and Goodhue, 2005), and ERP vendor (Wang et al., 2006). The reason for choosing these variables was that they played an important role in affecting ERP performance, although these variables did not relate directly to our theoretical model. We employed ANOVA to test the effects of these control variables on ERP overall benefits. Data quality (F=38.990, p<0.001) and time elapsed since ERP implementation (F=62.466, p<0.001) were significant. But the ERP vendor (F=2.505, p=0.115) was insignificant. Regarding the impact of elapsed time on ERP overall benefit, as show in Table 5, the observations were segmented into five categories based on the number of years elapsed since ERP implementation. These results indicated that time elapsed since ERP implementation had a positive effect on ERP overall benefit. For the first four years, the ERP overall benefit increased steadily, yet it decreased for the fifth year. After that, ERP overall benefit increased again but at a decreasing rate.

Table 5. ERP overall benefits for time elapsed since implementation

Time elapsed (years)	# of companies	ERP Overall Benefit (Mead (S.D.))
1~2	26	2.78(0.85)
2~3	13	3.46 (0.52)
3~4	28	3.93(0.60)
4~5	28	3.81 (0.54)
More than 5	69	3.91 (0.30)

Note: S.D.: Standard Deviation

Discussion and Implication

In the research of Karimi et al. (2004), they used OIPT to investigate the impact of environmental uncertainty on task characteristics, while our research used the same characteristics of environmental uncertainty (i.e. dynamism, heterogeneity, and hostility) to explore the effects on organizational context. Gattiker and Goodhue (2005) also used OIPT to study the influence of organizational context on ERP's benefits. Based on the research of Karimi et al. (2004) and Gattiker and Goodhue (2005), our study extends previous findings on ERP benefits by linking environmental uncertainty dimensions to OIPT. We develop and test a theoretical model to investigate the effects of environmental uncertainty and organizational context on ERP overall benefits in the post-implementation stage. Our study contributes to the theory building of relationships between environmental uncertainty and organizational context, which in turn influence ERP overall benefits. The results indicate that ERP benefits are affected not only by the original feature of a firm (such as interdependence and differentiation of one plant) (Gattiker and Goodhie, 2004; 2005), but also by environmental uncertainty. By elaborating our model in terms of three dimension of environmental uncertainty and two dimension of organizational context, we offer a rich set of results and implications.

First, in the study of Gattiker and Goodhue (2005), interdependence and differentiation between subunits were used as independent variables in measuring ERP performance. However, interdependence and differentiation work as intermediate variables in our model. Dynamism, heterogeneity and hostility are the independent variables in our study, because our research model is based on the premise that those salient antecedents may affect the standardization and integration of ERP systems via organizational context. In addition, Gattiker and Goodhue (2005) measured ERP performance in terms of a

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two-stage model—i.e. intermediate ERP benefits (coordination improvement and task efficiency) and overall ERP benefits. Due to focusing on how environmental uncertainty influences organizational context that in turn affects ERP overall benefits, and the role of intermediate ERP benefits already well discussed in Gattiker and Goodhue's (2005) research, our study uses one-stage methodology to measure ERP performance.

Second, our study indicates that environmental uncertainty has the two-sided influences on ERP overall benefits. Hypotheses 1a, 2a and 3a state the positive influence of environmental uncertainty on interdependence, and higher interdependence results in higher ERP benefits (hypothesis 4). In facing dynamism, heterogeneity and hostility environments, our results indicate higher frequency of communication, sharing of information integration and coordination among subunits or plants. The integration and standardization of ERP's functions can effectively and efficiently help organization in information processing, proving the prompt and accurate data, and lead to higher benefits. Hypotheses 1b, 2b and 3b also state the positive influence on differentiation, and higher differentiation reduces ERP benefits (hypothesis 5). Under the higher dynamism, heterogeneous and hostility environments, in order to sustain competitive advantage, plants need continuous innovation and change in products and services, seize customer taste, establish goals and priorities, and effectively exploit scare resources. Those foregoing actions will result in higher differentiation among subunits or plants (Gattiker and Goodhie, 2005). While integration and standardization are the two characteristics of ERP, differentiation will bring alignment costs such as compromise costs and design costs (Gattiker and Goodhie, 2004), and misfits between an ERP and an individual plant's business conditions which drop ERP overall benefits (Gattiker and Goodhie, 2005). In addition, facing higher environmental uncertainty, enterprises may perform organizational restructuring, such as implementing flat structure, constructing taskforce teams, or aligning business processes to meet external environmental changes. Those activities will bring the internal coordination effort and external information process cost which lower the performance of organization. Continuously, due to organization restructuring, the processes and functions of the ERP system may need to readjust or customize in order to meet new organizational structures and new business process flow. Those actions may bring the efforts of organizational interventions (Chou and Chang, 2008) and costs of mutual adaptation (Hong and Kim, 2002; Leonard-Barton, 1997) such as revising existing organizational procedures, developing new organizational procedures, and training end-users to accommodate both new procedures and new ERP applications, and thus cut down the benefits of ERP.

Third, as the results indicated, dynamism and heterogeneity affect ERP overall benefits either directly or indirectly through organizational context, while hostility influences ERP overall benefits is partially mediated by organizational context. This implies that ERP overall benefits are not fully affected by organizational context. Rather, dynamism and heterogeneity also impact ERP overall benefits. Because in dynamic task environments, subunit or plant within an organization must deal with unpredictable external events and must seek to integrate and continuously improve operating processes (Daft at al., 1988), which may require unique and non standard systems to cope with its particular circumstances, thus that directly impacts the integration and standardization of ERP functions. In heterogeneity task environments, subunit or plant within an organization has a greater need for information processing to reduce uncertainty (Daft and Lengel, 1986). In order to effectively share information, build coalitions, and establish priorities, one plant would be closer with another plant to set a coordination mechanism and to design the common language or format, such as same product name, same part number or same material code number, which reinforces the integration and standardization of ERP functions. On the other hand, the effect of hostility on overall benefits is fully mediated by organizational context. As the hostility is related to severe regulatory restrictions, lack of exploitable opportunities, and harsh and overwhelming business climates. Organization may implement marketing strategy or strategy alliance to overcome such problems. Thus, the impact of hostility on ERP overall benefits (such as integration and standardization) may not be so obvious compared with those of dynamism and heterogeneity.

Environmental uncertainty increases information processing within organizations because managers must identify opportunities, detect and interpret problem areas, and implement strategic (such as implement IS) or structure adaptations (Daft et al., 1988). By implementing ERP, organization expects that the integration and standardization of ERP functions can effectively process information and improve decision making. However, in high variety and rapid changes of external environments, the benefits of ERP technology after implementation still remain uncertain. Our research tests and verifies that ERP benefits rely on the level of fit between ERP information processing mechanisms and organizational task environments. For practitioners, we suggest that both organizational context and ERP systems need to be evaluated and adjusted to fit the change of external environments.

Although ERP diffusion agencies including ERP vendors and consulting firms strongly recommend that ERP project embody the universally applicable 'best practice' and should be implemented without extensive adaptation of the packaged software (Bancroft and Seip, 1998), some academics maintain that the notion of 'best practice' is illusory and potentially disruptive because ERP does not provide models for every process of every industry and most firms usually reconfigure or add new functionality to ERP systems for optimal use within their unique context (Swan et al, 1999). That is why Hong and Kim (2002) proposed the organizational fit perspective and ERP implementation contingency variables to examine those impacts on ERP successful implementation. They stated that the mutual adaptation between ERP software package and user environment is very important for ERP implementation success. Such mutual adaptation process brings the organization's existing operating processes and the packaged software's embedded functionality into alignment through combination of software configuration and organizational change (Volkoff, 1999). In the software configuration, ERP adaptation can increase the feature-function fit between ERP and the adopting organization, which is likely to result in lower resistance, reduce training needs, less organizational adaptation (Bingi et al., 1999). In the organizational change, it involves adapting the existing business processes to the standard business process of ERP. When external environments change, organizational structure, measurement compensation, organizational culture, and business process flow may need to be adjusted together to fit those environmental changes (Hammer and Stanton, 1999). If ERP functions can align with those business process flow changes and organizational components changes, company can just implement organizational adaptation. Otherwise, ERP adaptation is always indispensable.

Our findings highlight the needs to pay close attention to both organizational task environments and ERP systems for better data to further support decision making. Practitioners need to consider the environmental uncertainty whether to redesign tasks, organizational structure, or tune ERP systems in order to take better advantage of ERP potential. After understanding the changing nature of organizational task environments, organizations can apply task-oriented analysis techniques (such as a strategic ERP team and advanced technology groups, or mission-oriented project teams) to improve

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the fit between organizational task environments and ERP systems, which may result in better integrated and accurate data quality, and thus reduce uncertainty.

Conclusion and Limitations

Organizations in every industry have faced rapid changes in their external environments (Castrogiovanni, 2002). We first investigate what is the impact of environmental uncertainty on organizational context, and how it is mediated by organizational context to affect ERP benefits. This study contributes to a deeper understanding of the relationships between organizational task environments and ERP benefits. In addition, our research contributes to the IT innovation literature by focusing on the much neglected post-implementation stage, extending and enriching the extant literature on IT innovation.

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 culture, organizational size, and organizational structure may also influence interdependence and differentiation, and thereby ERP performance. Also, we did not have an avenue to collect data from a random sample of companies. All of our data was collected from top 1000 manufacturing companies of CommonWealth magazine 2007 in Taiwan. Therefore, we are limited in generalizing our findings widely. Follow-up studies could collect data from a random sample of firms that implemented ERP. In addition, we focus at the subunit (plant) level. Our analysis does not include global costs and benefits, such as the ability to quickly answer corporate-wide questions involving multiple plants. We also don't consider how the organizational structural aligns with organizational task environments. In measuring heterogeneity, we refer to the research of Karimi et al. (2004), which only use one item to measure heterogeneity. This may limit the reliability and validity of construct variable. Follow-up studies could improve this weakness by adding more items from existing literature or developing on their own for this construct. Finally, about the control variables, we only consider data quality and time elapsed since ERP implementation. The capabilities of top managers' environmental scanning (Daft et al., 1988) and IT staffs may also affect ERP performance. Follow-up studies could consider those factors.

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Appendix

Table A1 - Definition of the constructs

Constructs	Definition	Key Reference	Items*
Dynamism	The rate of change and innovation in production and service technologies, as well as the uncertainty or unpredictability of customer taste and actions by the firm's principle industries.	Karimi et al. (2004)	4(4)
Heterogeneity	The degree or similarity or differentiation within the organization task environments.	Hall (1999) Karimi et al. (2004)	1(1)
Hostility	Severe regulatory restrictions; a harsh and overwhelming business climate; intense competition in price, product, technology, and distribution; a shortage of labor or raw materials; and relative lack of exploitable opportunities and resources.	Miller and Friesen (1983) Karimi et al. (2004)	2(2)
Interdependence	The degree of exchange information or material among plants.	Gattiker & Goodhue (2004, 2005)	7(7)
Differentiation	The degree of different products, service, and process flow among plants.	Gattiker & Goodhue (2004, 2005)	9(9)
ERP overall benefits	Overall business impact of ERP on organizational subunit.	Gattiker & Goodhue (2005)	3(3)
Data quality	Accurate and relevant data to generate better information.	Gattiker & Goodhue (2005)	5(6)

Note: *Final item numbers (Initial item numbers). One item in data quality is dropped.

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Table A2 - Questionnaire items: definitions provided to survey respondents

Construct	Item	Description
Dynamism	Envdyn1	The market activities of company's key competitors are difficultly predictable.
	Envdyn2	The tastes and preferences of company's customers in principle industry are difficultly predictable.
	Envdyn3	The rate of innovation of new operating processes and new products or services in company's principle industry have dramatically increased.
	Envdyn4	Company's principle industry's downswings and upswings are difficultly predictable.
Heterogeneity	Envhet1	The diversity in company's production methods and marketing tactics to cater to different customers have dramatically increased.
Hostility	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.)
Interdependence	Deptdep1	To be successful, this plant must be in constant contact with these other departments.
	Deptdep2	If this plant's communication links to these other plants were disrupted things would quickly get very difficult.
	Deptdep3	Frequent information exchanges with these other plants are essential for this plant to do its job.
	Deptdep4	Close coordination with these other plants is essential for this plant to successfully do its job.
	Deptdep5	Information provided by these other plants is critical to the performance of this plant.
	Deptdep6R	This plant works independently of these other plants.
	Deptdep7	The actions or decisions of these other plants have important implications for the operations of this plant.
Differentiation	Deptdif1	The model numbers, or products' name or configurations or formulations used in plants are different.
	Deptdif2	The active part numbers or material code numbers or finished goods part numbers or finished goods code numbers used in different plants are different.
	Deptdif3	Number of levels in the typical bill of materials is different between plants.
	Deptdif4	The degree to which products are made to customer specifications, instead of to stock is different between plants.
	Deptdif5	The average number of design changes per month is different between plants.
	Deptdif6	The number of new design introductions per month is different between plants.
	Deptdif7	The average amount of time that passes between the time an order to production, and the time an order to completion is different between plants.
	Deptdif8	The need to identify or segregate material by individual piece or lot rather than merely by part number is different between plants.
	Deptdif9	Amount of production activity dedicated to processing as opposed to assembly or fabrication is different between plants.
ERP overall benefits	Benf1	In terms of its business impacts on the plant, the ERP system has been a success.
	Benf2	ERP has seriously improved this plant's overall business performance.
	Benf3	ERP has had a significant positive effect on this plant.
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 plant is accurate.
	Qty3	The data that employees receive from the ERP system is true.
	Qty4	The ERP data that plant 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 plant employees. (Dropped)
Note: 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 above.		

Table A3 - Loadings of the measure

Construct	Items	Mean	S.D.	Loading	t-value	Items Dropped
DYN	envdyn1	2.927	0.848	0.678	24.160	
	envdyn2	2.976	0.886	0.706	29.259	
	envdyn3	2.902	0.867	0.721	26.540	
	envdyn4	3.006	0.903	0.727	28.454	
HET	envhet1	3.030	0.896	1.000		
HOS	envhos1	3.085	0.875	0.801	35.556	
	envhos2	3.030	0.896	0.925	171.893	
DEP	deptdep1	3.098	0.895	0.820	98.304	
	deptdep2	3.085	0.955	0.824	94.287	
	deptdep3	3.030	0.949	0.738	43.243	
	deptdep4	3.171	0.988	0.703	30.097	
	deptdep5	3.122	0.951	0.610	20.920	
	deptdep6	3.110	0.865	0.655	27.169	
	deptdep7	3.152	0.976	0.584	18.980	
DIF	deptdif1	3.122	0.919	0.667	32.994	
	deptdif2	3.098	0.888	0.673	26.801	
	deptdif3	3.061	0.970	0.547	16.568	
	deptdif5	3.482	0.739	0.685	26.466	
	deptdif6	3.524	0.696	0.852	70.158	
	deptdif7	3.530	0.678	0.838	68.607	
	deptdif8	3.713	0.724	0.760	48.789	
	deptdif9	3.360	0.864	0.709	29.699	
BEF	benf1	3.524	0.705	0.722	19.412	
	benf2	3.695	0.778	0.927	115.055	
	benf3	3.622	0.809	0.953	187.744	
QTY	qty1	3.732	0.710	0.580	15.318807	
	qty2	3.640	0.806	0.831	52.051141	
	qty3	3.799	0.728	0.862	87.045732	
	qty4	3.921	0.646	0.699	29.302319	
	qty5	3.683	0.781	0.583	19.059625	
	qty6	3.671	0.822	0.349	9.06463	Dropped

Note: S.D. indicates Standard Deviation.

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