ERP IMPLEMENTATION AMONG MANUFACTURING BASED SMEs AND MNCs: A MALAYSIAN CASE STUDY

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ABSTRACT

Given the significant impact of implementing enterprise resource planning (ERP), many small and medium sized enterprises (SMEs) have started adopting the ERP system for their manufacturing processes. This paper is aimed at making a comparative analysis on enterprise resource planning (ERP) system implementation among manufacturing based multinational corporations (MNCs) operating in Malaysia and small and medium sized enterprises (SMEs). The partial least squares (PLS) modeling technique was used to assess the cause-effect associations between technological, organizational and environmental (TOE) factors and successful ERP adoption in these two manufacturing sectors. The empirical result suggests that the causal relationship between technological factor and successful ERP adoption is statistically significant for SMEs. This implies that successful ERP system adoption in the sample SMEs seems to be facilitated by the existence of adequate technological and environmental factors exclusively. The findings show that Malaysian government has been very supportive in equipping the SMEs with ERP system. The analysis further revealed significant associations between organizational and environmental factors with successful ERP adoption for MNCs. This suggests that MNCs with distinctive size and operational complexity leverages extensively on their organizational and environmental factors to experience successful ERP adoption as opposed to smaller sized SMEs. Based on the empirical findings, several theoretical and practical implications are highlighted in this study.

Keywords : Enterprise Resource Planning (ERP) system, Small and Medium sized enterprises (SMEs), Multinational Corporations (MNCs), Technology-Organization-Environment (TOE), Partial Least Square (PLS), adoption.

Introduction

Most manufacturing companies involved in manufacturing, inventory, sales and distribution activities have been using information system to improve productivity, profitability and information flow across their organizations. The ERP system is an extension of Material Resource Planning (MRP) system which is used to integrate the business processes, thus improving the vertical and horizontal information flows in adopting firms (Bingi et al. 1999). Adoption of ERP system by enterprises across the world has been spectacular. Jacobson et al. (2007) for example showcased 14 percent growth in ERP sales revenue across the world in 2005. These authors also pointed that manufacturing based small and medium sized enterprises (SMEs) outclassed large enterprises ERP adoption rate by 27% in the same year.

Although the ERP system have enormous advantages towards improving the productivity of manufacturing plants and reducing the production costs, there has been many challenges involved in adopting these complex system such as inadequate technical infrastructure, poor project management, lack of employee cooperation and impromptu users training contributing towards ERP implementation failure (Nah et al. 2001; Kanjanasanpetch and Igel, 2003). There are a number of prominent organizations such as Aerogroup, Boeing, Dell and Foxmeyer which have failed in their ERP implementation (Ragoswsky and Somers, 2002). While various factors have been cited in the literature, strategic analysis on the factors that influence ERP adoption success in both MNCs and SMEs which have different organizational and production size as well as complexity are scarce. Such analysis can guide both potential ERP adopting enterprises as well as ERP vendors/consultants on how factors available both within and outside an enterprise should be leveraged so as to experience cost-effective ERP project. This study aims to examine the importance of technological, organizational and environmental (TOE) factors toward successful ERP system adoption in manufacturing based multinational corporations (MNCs) operating in Malaysia and SMEs.

Theoretical Background and Hypotheses

The theoretical basis for this study stems from research on IS adoption. Various theoretical frameworks have been established over the years to evaluate the reasons or driving factors that facilitate successful Information System (IS) adoption such as the Theory of Reasoned Action (TRA) (Ajzen & Fishbein, 1975), the Technology Acceptance Model (TAM) (Davis, 1989) and the Diffusion of Innovations (DOI) model (Rogers, 1962). In this study, we relied on Tornatzky and Fleischer's (1990) Technology-Organization-Environment (TOE) theoretical lens to examine ERP system adoption across two manufacturing based organizations with different size structure.

The TOE framework argues that IS adoption is strongly influenced by three factors:

- technological - describes both the internal and external technology relevant to the organizations, which includes existing technologies inside the firm, as well as the pool of available technologies in the market.
- organizational - often defined in terms of the centralization, formalization and complexity of firms' managerial structure, the quality of its human resources and the amount of slack resources available internally.
- environmental context is the arena in which a firm conducts its business, its industry, competitors, access to resources supplied by others and dealings with government.

Since its establishment, many studies have used the TOE framework to identify the factors influencing adoption of technology in organizations (e.g. Lacovou et al., 1995; Kuan & Chau, 2001; Gibbs and Kraemer, 2004). Some studies have modified the TOE framework to suit their research needs (e.g. Zhu et al., 2004; Zhu et al., 2003). In the next sub-section, a discussion on the TOE components and its related hypotheses are presented.

Technological factors

Various studies have demonstrated that successful technology adoption is a key enabler in the process of manufacturing modernization (e.g. Crook & Kumar, 1998; Ageshin, 2001; Zhu et al., 2003; Al-Mashari, 2002). Technology competences constitute not only physical assets but also intangible assets since expertise and know-how are complementary to physical assets (Chin, 1998). The technological aspect in this study can be viewed from two perspectives i.e. technology infrastructure and skilled human capital (Stratman and Roth, 2002).

It is the combination of hardware and software available in the organization that will enable the employees to use technology for work purposes. Note that technology infrastructure in this study refers to availability of appropriate networks and hardware that supports ERP system usage. Croom & Jones (2005) argued that greater investment in technology infrastructure positively affects the adoption of technology within the organization. Studies investigating the role of human capital capability towards technology implementation are growing in recent times. Studies by Stratman & Roth (2002) and Ravichandran & Lertwongsatien (2005) for instance argued that skilled human capital is particularly important in the context of ERP implementation due to the heavy technology and knowledge transfer elements. Several empirical studies (e.g. Bancroft et al., 1998; Davenport, 1998) followed a similar line of argument – skilled human capital is vital in the successful completion of ERP.

Based on the above arguments, we hypothesize that:

H_{1a}: *Technological context (i.e. IT infrastructure and skilled human capital) has a positive and significant effect toward successful ERP system adoption in manufacturing based MNCs*

H_{1b}: *Technological context (i.e. IT infrastructure and skilled human capital) has a positive and significant effect toward successful ERP system adoption in manufacturing based SMEs*

Organizational factors

Manufacturing based organizations have to constantly adopt new technological innovations in order to improve their competitive advantage. Organizational factors represent variables that are internal to the organization, which influences the adoption of new technological applications (Robey et al., 2002). Certain features of organizations like organization structure, climates, size, leadership and culture will influence the adoption of technology (Hitt, 2002; Harrison et al;, 2002). In this study, two variables within organizational context are used, namely: top leadership and organization perceived ease of use.

Top leadership involvement is regarded as an important factor in determining the success of the acceptance of technology because they are involved in the planning, organizing, staffing and leading of the ERP systems implementation. Stratman & Roth (2002) showed that transformational leaders i.e. visionary, willing to take risk and highly adaptable to change people, are more adoptive to new technology than transactional leaders. Gibbs et al (1998) and Wu & Wang (2007) suggested that top management support and enthusiasm is critical for successful implementation of technology in organizations.

Perceived ease of use is defined as "the degree to which a person believes that using a particular system would be free of effort" (Davis, 1989, p. 320). In terms of ERP systems adoption, the perceived ease of use (PEOU) can be evaluated by conducting a survey of the end users perception on the ERP systems (i.e. in terms of its user friendliness, complexity level, etc.). However many researchers have studied the perceived usefulness more from an individual rather than organizational perspective (e.g. Adams et al., 1992; Harrison et al., 2002; Anandarajan et al., 2000; Wu & Wang., 2007).

We therefore hypothesize:

H_{2a}: *Organizational context (i.e. top leadership involvement and perceived ease of use) has a positive and significant effect toward successful ERP system adoption in manufacturing based MNCs*

H_{2b}: *Organizational context (i.e. top leadership involvement and perceived ease of use) has a positive and significant effect toward successful ERP system adoption in manufacturing based SMEs*

Environmental Context

In addition to technological and organizational characteristics, the external environment in which a firm conducts its business will also influence its innovative capability (King & Anderson, 1995). Miles and Snow (1978) found that organizations would pay more attention to adopt innovative technologies when they face uncertain environments. Damanpour (1991) suggest that environments with high uncertainties would have positive influences on successful IS adoption.

Governmental support is another important environmental characteristic for technological innovation. Government through regulation can both encourage and discourage the adoption of innovative technologies (Ageshin, 2001). Government can provide financial incentives, pilot projects, and tax breaks to stimulate technological innovation adoption by enterprises. Therefore we would expect that environmental uncertainty and governmental support might influence the adoption of ERP system.

The following hypotheses are consequently proposed:

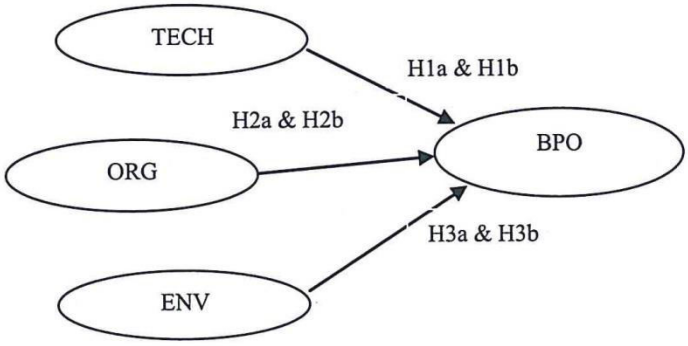
H_{3a}: *Environmental context (i.e. environmental uncertainty and government support) has a positive and significant effect toward successful ERP system adoption in manufacturing based MNCs*

H_{3b}: *Environmental context (i.e. environmental uncertainty and government support) has a positive and significant effect toward successful ERP system adoption in manufacturing based SMEs*

Research model

The above proposed research hypotheses depicts path analyses of a direct causal-effect model. The causal-effects between technological factors (TECH), organizational factors (ORG) and environmental (ENV) factors with successful ERP adoption (as proxied by business process outcomes (BPO)) in both manufacturing based MNCs and SMEs is graphically represented in Figure 1.

Figure 1: Research framework model



Methodology

We collected our data from July - Dec 2010 (6 months) using a self-complete questionnaire. The questionnaire comprised of three sections: Section A probed demographic information, Section B enquired on the importance of the independent construct measurement items (i.e. Technological, Organizational and Environmental) toward ERP adoption. Section C explored the sample firms' perception toward ERP adoption success that is proxied by positive business process outcomes (the dependent variable) experienced post adoption. The items used in the operationalization of the

constructs were adopted from relevant prior research. Technological measures were adapted from Stratman and Roth (2002) (human capital) and Ravichandran & Lertwongsatien (2005) (IT infrastructure), while organizational measures was referenced from Karimi et al. (2007) (top leadership support) and Cheng et al. (2008) (PEOU). The environmental measures were taken from Damanpour (1991). These scales were measured using a 7 point *Likert scale* with 1 = '*Not at all important*' through to 7 = '*Very important*'. The dependent variable was referenced from Karimi et al. (2007) and was also scaled using a 7 point Likert with 1 = Strongly disagree through 7 = Strongly agree. The content validity of the questionnaire was determined through a pilot survey that helps in minimising research design errors and maximise response rates, question applicability and question performance (Sarantakos, 1993).

Sample Size and Survey Administration

The target respondents in this study are Malaysian based manufacturing based SMEs and MNCs that has completed ERP system implementation in the past two years or so. Based on the database provided by the Malaysian Industries Development Authority (MIDA), Federation of Malaysian Manufacturers (FMM) and Multimedia Development Corporation Malaysia (MDeC), we successfully compiled the details of 220, which comprised of 110 MNCs and 110 SMEs. The administration of the survey involved the following steps.

First, each of the 220 firms was contacted in order to validate the identity of the contact person available in the sample list. Second following the initial contact process, the questionnaire package that consisted of the questionnaire, participant information sheet with concise explanation of the survey, and a self-addressed return envelope, was posted to the sample firms. In order to increase the response rate, several important design issues as proposed by Dillman (1978) was followed. A total of 87 firms responded to the survey. After a second round of follow-up emails was

made, another 25 firms returned the completed questionnaire. This represented a total of 112 responses or a response rate of 50.9 percent (n = 112/ n = 220).

Common method variance

In this study, we relied upon single respondents from each sample firm to inform on the sought information. Such an approach often constitutes risk of common method variance biasness (Ganster, Hennessey & Luthans, 1983). To test for existence of such risk, the Harman single factor evaluation method developed by Podsakoff and Organ (1986) was used. This technique specifies that the individual measures for each construct be loaded into an exploratory factor analysis (EFA) to identify if the first extracted factor accounts for the majority of the variance amongst all measures. If all measures converge into one single dimension, common method bias will be a concern in this study. The EFA test outcome indicates formation of a total of 16 factors with eigen values 1 or more. This result suggests that common method variance bias risk is not a big threat in this research.

Partial Least Squares (PLS) Estimation

The Structural Equation Modeling (SEM) approach was used to validate our research model. In order to evaluate the appropriateness of the measurement models for the latent constructs, we leveraged on the recommendations provided by Fornell and Bookstein (1982) and employed the Partial Least Square (PLS) modeling approach. PLS was chosen over other structural modeling procedures due to the following reasons. First, the ordinary least squares characteristics inherent within PLS suits well to an exploratory research such as the present study. Second, PLS conducts simultaneous analysis for both the measurement model and the structural or theoretical model. Third, PLS estimation is well suited for a small sample sized research such as the current study.

In line with PLS protocols (Chin, 1998), the robustness of the reflective measurement scales was evaluated in the following context: (1) assessment of the convergence of the scales where items with factor loadings higher than 0.707 is accepted; (2) measurement of the reflective scales internal consistency which is determined by the composite reliability value higher than 0.60; (3) examining the average variance extracted (AVE) which should be higher than 0.50 threshold, (4) examining the discriminant validity of the model. This is done by computing the square-root of the AVE value. If the computed value (AVE^2) is above the correlation values, then the latent variables are statistically valid.

Once the appropriateness of the measurement model has been established the next step is to provide evidence supporting the theoretical model as demonstrated by the structural (inner) component of the model. The structural model in the study is examined using two criterions: (1) the R^2 of the model. Chin (1998: 323) suggested that R^2 of 0.67, 0.33 and 0.19 represents substantial, moderate and weak structural model, respectively and (2) the estimates of the path coefficients need to be statistically significant and done using the bootstrapping procedure.

Findings and Analysis

The demographic profile of the participating firms suggests that out of 112 respondents, 63 are MNCs whilst 49 are SMEs. Both MNCs and SMEs are involved in manufacturing industry, with annual sales of over RM10 million (MNCs) and between RM1 to RM5 million (SMEs). In this survey, 35 percent of informants were general managers, with another 25 percent of them being in managing director position. About 20 percent of the informants were project managers followed by 10 percent of IT manager job title and another 10 percent with 'other job titles'. The average organizational tenure of the informants was 7.5 years. Collectively, these measures indicate that the informants were highly competent to answer the questions of this study, thus implying reasonable and quality centric responses.

PLS Estimation for MNCs

The research model for MNCs was tested with three reflective independent constructs, i.e. technological (TECH), organizational (ORG) and environmental (ENV) factors, and a dependent reflective construct: business process outcomes (BPO). The measurement model assessment shows the followings. In the context of convergence of scales, 12 items of TECH, 4 items of ORG, 3 items of ENV and 8 items of BPO constructs returned factor loading lower than 0.707. These items were removed and the model was retested with refined items. The internal consistency of the three constructs as denoted by the composite reliability which is higher than 0.60, is stable. The average variance extracted (AVE) for these scales are more than 0.50 while the discriminant validity is also satisfactory as the squared correlation values are greater than the correlation values. These results are shown in Table 1 and 2.

Table 1: Convergence of scales for MNCs

Construct	Original items	Final items	Valid Scales	Factor loading
TECH	17	5	1. Technology infrastructure supporting electronic linkages	0.76
			2. Sharable corporate data across business units	0.77
			3. IT staff(s) with ability to analyze the impact of changes	0.75
			4. IT staff(s) with ability to implement ERP system upgrades	0.74
			5. Expert ERP database management system administrator	0.78
ORG	7	3	1. Senior executives with consistent interest in ERP project	0.78
			2. Top level managers' personal involvement in ERP project	0.80
			3. Top management's consistent support for ERP project	0.82
ENV	8	5	1. Government provides financial support for ERP project	0.78
			2. Government encourages companies to use ERP technology	0.84
			3. Government helps to train manpower	0.77
			4. Customer requirements are diversified	0.76
			5. Customer requirements vary quickly	0.81
BPO	13	5	1. ERP usage has improved our efficiency of operations	0.77
			2. Data provided by ERP adds value to our operation	0.87
			3. ERP system provides a high level of enterprise integration	0.86
			4. ERP usage has improved our quality of operations	0.89
			5. ERP usage has made our company more responsive	0.79

Table 2: Inter-construct correlations, squared correlations and reliability measures (MNCs)

		Correlations and squared correlations				
Composite Reliability	**AVE**		**TECH**	**ORG**	**ENV**	**BPO**
0.84	0.68	**TECH**	**0.75**	0.53	0.35	0.43
0.81	0.65	**ORG**	0.53	**0.76**	0.45	0.34
0.78	0.59	**ENV**	0.35	0.45	**0.78**	0.35
0.82	0.71	**BPO**	0.43	0.34	0.35	**0.80**

In the context of structural model evaluation, the R^2 of the MNCs model is 0.41, representing a moderate structural model. The bootstrapping procedure for this model (refer to Table 3) implies that the structural link emerging from TECH → BPO is statistically significant ($\beta = 0.34$; $t = 4.18$). The result suggests that the hypothesis of technological factor having a positive and significant role in ERP adoption is supported (H1a). The path relationships between ORG → BPO ($\beta = 0.42$; $t = 4.29$) is also significant, so H2a is supported. The path between ENV → BPO ($\beta = 0.19$; $t = 1.71$) is significant, indicating accepted of H3a and significance value 95 percent.

Table 3: The structural path model results (MNCs)

Paths hypothesized relationships:	**Direct model**
	R^2 = 0.41
TECH → BPO (H1a)	0.34 (4.18)***
ORG →BPO (H2a)	0.42 (4.29)***
ENV → BPO (H3a)	0.19 (1.71)**

Note: *** significance value $p < 0.01$ and ** significant at $p < 0.05$

PLS Estimation for SMEs

The measurement model assessment for SMEs shows deletion of 14 items for TECH, 5 items for ORG, 6 items for ENV and 10 items for BPO constructs (refer to Table 4). These items were removed and the model was reassessed. The internal consistency, AVE and discriminant validity (squared correlation) requirements are statistically fulfilled (refer to Table 5).

Table 4: Convergence of scales for SMEs

Construct	Original items	Final items	Valid Scales	Factor loading
TECH	17	3	1. Technology infrastructure supporting business operations 2. High capacity network infrastructure supporting business 3. High speed network infrastructure supporting business	0.81 0.88 0.76
ORG	7	2	1. Senior executives with consistent interest in ERP project 2. Top level managers' personal involvement in ERP project	0.73 0.71
ENV	8	2	1. Government provides financial support for ERP project 2. Government encourages companies to use ERP technology	0.74 0.75
BPO	13	3	1. ERP usage has lowered our costs of operation 2. The functionalities of ERP meets our job requirements 3. ERP usage has improved our efficiency of operations	0.88 0.74 0.89

Table 5: Inter-construct correlations, squared correlations and reliability measures (SMEs)

		Correlations and squared correlations				
Composite Reliability	**AVE**		**TECH**	**ORG**	**ENV**	**BPO**
0.92	0.58	**TECH**	**0.74**	0.66	0.33	0.33
0.91	0.55	**ORG**	0.66	**0.76**	0.25	0.44
0.88	0.69	**ENV**	0.33	0.25	**0.80**	0.45
0.81	0.57	**BPO**	0.33	0.44	0.45	**0.81**

The structural model evaluation, the R^2 of the SMEs model is 0.36, representing again a moderate structural model. The structural link from TECH → BPO is statistically significant ($\beta = 0.43$; $t = 4.78$), thus H1b is accepted. The paths between ENV → BPO ($\beta = 0.39$; $t = 3.31$) is also significant, indicating acceptance of H2b. Finally, the path emerging from ORG → BPO ($\beta = 0.12$; $t = 1.59$) is significant, thus H3b is accepted at significance value 90 percent.

Table 6: The structural path model results

Paths hypothesized relationships:	Direct model
	$R^2 = 0.36$
TECH → BPO (H1b)	0.43 (4.78)***
ORG → BPO (H2b)	0.12 (1.59)**
ENV → BPO (H3b)	0.39 (3.31)***

Note: *** $p < 0.01$ and ** $p < 0.10$

Discussions

In this study, we examined the importance of technological, organizational and environmental factors toward successful ERP adoption in manufacturing based MNCs and SMEs which have implemented ERP. Using the TOE framework, we found that technological and organizational factors to have played a greater role in ERP adoption for MNCs, while technological and environmental factors are important for SMEs.

The empirical finding for MNCs suggests that being a matured and complex business entity, acquisition of basic and advanced IT infrastructure may not be an issue. MNCs however perceive their organizational and environment factors to play significant role in their ERP adoption project success. The Malaysian government has been encouraging MNCs to aggressive on attracting a Foreign Direct Investment (FDI) and take opportunities on the initiatives provided by Malaysian government since 1980s. The establishment of various foreign investment friendly policies has spurred the inflow capital of various MNCs to setup their plant in various states of Malaysia. Being corporations with larger capital strength, MNCs are able to implement advanced IT infrastructure as well as hire the best brains. These 'strengths' translates into capabilities to experience successful ERP adoption as advanced infrastructure and skilled human capital facilitates good absorptive capacity of ERP related business process knowledge. Apart from this, consistent support from top leadership in MNCs has also hindered limited disturbance to ERP project continuity.

The result is evidence that Malaysian government recognizes the critical role of SMEs towards the contribution of economic growth. In the last 9th Malaysian plan (2005-2009), the government made provision of USD$2 billion to help SMEs in achieving sustained business competitiveness, primarily using advanced technologies (SMIDEC, 2010). Agencies such as the Small and Medium Industries Development Corporations (SMIDEC) are given responsibilities to assist SMEs in adoption of new technologies by providing soft loans, grants and venture capital funding. The government support component of the environmental factor seem to have had a favorable role in enriching SMEs with IT infrastructure such as hardware, software and networking platforms which are necessary throughout a ERP project lifecycle. This result shows an encouraging success of government's policies for SMEs. While the current initiatives are commendable, perhaps extended efforts should be taken to increase ERP system uptake by SMEs across the nation. For instance, perhaps SMIDEC should provide a complete guidance on the type of IT infrastructure that is needed to implement ERP system with continuous updates on latest technological requirements for manufacturing activities. In addition, an ERP system can provide a powerful opportunity for many manufacturers to gain critical insight and competitive advantage by taking them beyond simply managing internal business processes.

Conclusion

The findings in this study have both theoretical and practical implications. In theoretical context, this study extends TOE framework to compare manufacturing based MNCs and SMEs ERP adoption process. In practical sense, the findings highlight that ERP implementation success in organizations of different size structure requires diligent management of various factors. As with any studies, there are limitations in our study. We used the key respondent approach to capture the relevant information. We targeted a key person from senior management position to answer our questions. The responses could differ if they were answered by other personnel such as IT executives or users.

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