The Effect of Industrial Differences on ERP Implementation

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Abstract

This research examines the structural effects of business process gap, vendor assistance and training across different industries in the performance improvement of ERP system in Taiwan's companies. Evidence is found that the gap between existing business process and ERP system process will reduce the implementation performance of ERP system from industrial perspective. Education/training effect in higher gap industry is more obvious. When the business process gap attains certain high level, vendor assistance effect replaces education/training effect, offsets business process gap effect and raises the industrial performance of ERP system. In conclusion, the findings suggest that reinforcing education and training is still critical for ERP implementation success, especially for the industries under intrinsic business process gap weakness and insufficient vendor assistance. In our sample, electronics industry is of this kind.

1. Introduction

Enterprise Resource Planning (ERP) system, which becomes a popular tool in current business administration, is an information System (IS) that integrates all aspects of a business including production planning, purchasing, manufacturing, sales, distribution, finance and customer service [19]. However, ERP systems are different from general software, their uniqueness and integration feature account for many reported implementation failures. These failures of ERP implementation even led to organizational bankruptcy [7,14].

Critical success factors for ERP implementation are widely discussed by many antecedent researches [e.g. 11, 16, 15]. Major ERP package vendors also have employed the concept of Best Practice (BP), which transfers the past successful experience to the new ERP projects, to make the implementation effective and efficient [11]. Since standard ERP implementation process is gradually established, more sophisticated issues about implementation practice are needed to be taken into consideration. These issues involve the customization of standardized ERP system in various cultures, countries and industries. A group of researches pay attention to strategic and cultural issues involving the alignment of ERP implementation with products and processes [7, 9, 14, 22]. Sheu et al. [21] puts emphasis on national differences. They argue that national differences affect multinational ERP implementation with regard to the type and amount of ERP adaptation, centralization of implementation decisions, information sharing, project duration, project approach and training program. Furthermore, the categories of national difference that affect implementation practices are language, culture, politics, regulations, and management style. Realizing the potential effects of national differences on multinational ERP implementation practices is necessary to enable managers to be more proactive in planning and implementation. Although industrial difference is also a salient factor that makes businesses different, few studies clarify the profiles of ERP implementation under different industries so far. By the questionnaire survey conducted in Taiwan's representative companies in 2003, this study examines the structural effects of business process gap, training and vendor assistance in the context of industrial differences on the performance improvement of ERP system in Taiwan's companies.

We extend the above line of research by focusing on industrial differences. This study differs from the existing researches on this topic in two important aspects. First, among various industrial differences, we select business process gap as an industrial difference factor. In this way, we can describe the structural relationship of ERP implementation under different industries more precisely. Second, after classifying industries by the degree of business process gap, we examine the effects of education/training and vendor assistance. To put it shortly, this paper attempts to explain how and why factors of industrial differences affect multi-industrial ERP implementation practices by the structural effects of business process gap, training and vendor assistance.

For a sample of companies in Taiwan, the empirical results show that the gap between existing business process and ERP system process will reduce the implementation performance of ERP system from industrial perspective. Education/training effect in higher gap industry is more obvious. While the business process gap attains certain high level, vendor assistance effect replaces education/training effect, offsets business process gap effect and raises the industrial performance of ERP system. In conclusion, the findings suggest that reinforcing education and training is still critical for ERP implementation success, especially for the industries under intrinsic business process gap weakness and insufficient vendor assistance. In our sample, electronics industry is of this kind.

The remainder of this paper is organized as follows. The hypotheses of this study are first set up. The data and methodology are detailed in the next section followed by a discussion of the empirical results and the overall conclusions.

2. Hypotheses

Industrial differences can be observed by a variety of dimensions. In Taiwan, electronics industry is very export-oriented, but construction industry is not. Average ages of employees are younger in emerging industries. In terms of R&D, high-tech industries such as electronics and biotechnology are more R&D intensive than traditional industries such as paper products. Moreover, other dimensions for industrial differences include: business process, value chain, industry concentration, advertising intensity, capital intensity, growth rate…and so on [6]. Castanias and Helfat [5] discuss "industry-specific-skills" as those skills that have value in particular industries but that are not easily transferable across industries. Industry characteristics naturally attract their fit workers and thus shape industry culture.

Organizational learning has increasingly attracted the interest of practitioners and scholars for their competitive advantage in the rapidly changing business environment. Argyris and Schon [1] defined organizational learning as "the detection and correction of error". Huber [12] regards organizational learning as changes in an organization's behaviour through its process of information. Argyris and Schon [1] pose three levels of organizational learning that are briefly discussed below. Single-loop learning (SLL) happens when errors, problems and mistakes are detected and eventually corrected. In this first stage, Argyris and Schon [1] state that prevailing goals, policies, processes and routines remained unchallenged and unquestioned. An organization continues to maintain the status quo of the fundamental activities. Double-loop learning (DLL) is needed when, in addition to single-loop learning, fundamental issues are questioned, challenged, and reviewed. Routines and norms are examined for underlying causes of the problems and factors that are related to the error detection and rectification. Assumptions are reevaluated for changes, adding to knowledge-base competencies. It is a generative learning, which enhances organizational capabilities and organizational strategic understanding in order to adapt the organization to the environment it faces, and leading organization to higher-level of learning. In this level of learning, organizations seem flexible, deviating from their old routines to innovative ways in order to sustain such capabilities. Deutero-learning (DL): Highest among all, this type of learning is a reflective cognition of the organizations [1]. In the first two stages, firms are aware of the necessity of learning, eventually reflecting on why or why not learning is taking place. Organizations at the DL stage are conscious of the disadvantages of ignorance that eventually motivates them to learning. Organizations that have achieved this level are open to positive feedback, proactive coordination and communication in order to avoid failure in the learning process.

Although ERP implementation success may be related to some individual parts (or non-systematic variance) such as leader intelligence, opportunity, accident…and so on, it still may also be caused by some common parts (or systematic variance). The investigation of these common parts is useful to those businesses trying to implementing ERP system. Since ERP implementation can be viewed as an organizational learning behavior [16], implementation outcomes may be affected by industry culture, process and other industry characteristics. According to the learning theory of schema, learners have to construct meaning based on their own previous experiences and knowledge structures. These previous knowledge structures are called "schema". If new learning material is closer to a learner's schema, he/she will learn it faster [3, 18]. Appling schema concept to our ERP implementation problem, when an industry's schema is closer to the ERP system, this industry will implement it more smoothly. To put it shortly, the schema gap may affect the probability of implementation success. In order to describe the structural relationship of ERP implementation more precisely, we use "the gap between existing business process and ERP system process" (i.e. business process gap) to represent the schema gap. Business process gap is widely regarded as a significant negative factor for ERP implementation success [e.g. 11, 25]. Tsai et al. [25] even points out that business process gap is one of the most significant factors in this problem (the other significant factors are education/training and vendor assistance). They find that business process gap, education/training problem and insufficient vendor assistance have negative impact on ERP implementation performance. If we view ERP implementation as an organizational learning behavior, business process gap represents the "inherent attribute", education/training represents the "acquired attribute" and vendor assistance represents the "environmental attribute". It seems reasonable that ERP implementation success consists in these three aspects.

As for the education/training factor, in order to help users understand how the ERP system will improve their jobs, formal education and training in the ERP implementation is recommended by many scholars [e.g. 4, 10, 17]. Training, re-skilling, and professional development are also critical [23], especially in ERP software design and implementation methodology. Many researches mention that education and training is a critical success factor for ERP implementation [e.g. 11, 16, 15, 4, 10, 23, 13], but few studies put education/training in the framework of industrial differences. Based on above discussion, we want to test the following hypothesis:

Hypotheses: When the industrial gap between existing business process and ERP system process is higher, the industrial performance of ERP system will be lower and vendor assistance will be higher. Education/training effect in higher gap industry is more obvious.

3. Data and Methodology

The initial sample is formed based on the questionnaire survey regarding ERP implementation in Taiwan during 2003. In this survey, 3597 questionnaires were sent to manufacturers and service companies on the 2001 list of Top 5000 Largest Corporations in Taiwan. Of the 3597 questionnaires mailed, 657(18.27% of 3597) usable responses were returned. Only the ERP package adopted companies can enter our sample, so the sample size is 212. Likert Scale is used as a measurement method. Sample data were obtained with a certain level of reliability and validity.

DeLone and McLean [8] developed six dimensions of information system(IS) success measures, which included system quality, information quality, system use, user satisfaction, individual impact and organizational impact. Following DeLone and McLean [8], we measure the performance improvement of ERP system by the following expressions:

$$P_{ij} = \sum_{k=1}^{l_j} (P_{ijk} \times \overline{W}_{jk} / \sum_{k=1}^{l_j} \overline{W}_{jk}),\ i = 1\ to\ N,\ and\ j = 1\ to\ 6 \tag{1}$$

$$\overline{W}_{jk} = (\sum_{i=1}^{N} W_{ijk}) / N \tag{2}$$

$$P_i = \sum_{j=1}^{6} (P_{ij} \times \sum_{k=1}^{l_j} \overline{W}_{jk} / \sum_{j=1}^{6}\sum_{k=1}^{l_j} \overline{W}_{jk}),\ i = 1\ to\ N \tag{3}$$

where P_{ij} is the performance improvement level of the j^{th} dimension for the i^{th} respondent's company. P_i is composite performance improvement level for the i^{th} respondent's company. $\overline{W}_{jk}$ is the average importance level score of the k^{th} measure of the j^{th} dimension as perceived by N respondents, P_{ijk} is the performance improvement level score of the k^{th} measure of the j^{th} dimension for the i^{th} respondent's company, and l_j is the number of chosen measure of the j^{th} dimension. W_{ijk} is the importance level score of the of the k^{th} measure of the j^{th} dimension as perceived by the i^{th} respondent.

As for business process gap, the questionnaire asked our sample companies if they feel a high gap between existing business process and ERP system process. Variable equals to 1 if they have the business process gap problem and 0 otherwise. It is similar for vendor assistance. Variable equals to 1 if they have sufficient vendor assistance and 0 otherwise. As modeled by Tsai et al.[24], we use "Inadequate well-educated IT members", "Lack of IT knowledge for organization members", "Employee resistance", "Organization members inadequately prepared to use the ERP system as tools for assisting their work", and "Not enough understanding of the ERP functions by organization members" to measure the degree of the problem of education and training. The means of industrial performance and business process gap are listed in table 1. Table 2 shows the classification of industries by the degree of business process gap. Table 3 shows the descriptive statistics (means and standard deviation) of industrial performance, business process gap, education/training problem and vendor assistance. In order to make sure the relationship between implementation performance and business process gap, we regress the composite performance improvement level of ERP system on business process gap,

$$P_i = \alpha_1 + \alpha_2 GAPBP_i + u_i \tag{4}$$

where P_i is defined as above. $GAPBP_i$ is a dummy variable equal to 1 if they have the business process gap problem, and 0 otherwise. When the improvement is higher, P_i will be higher; and u_i is the random error term.

Finally, the classified regression analysis of the composite performance improvement level of ERP system and the degree of the problem of education and training is employed.

$$P_i = \beta_1 + \beta_2 DPEDUT_i + e_i \tag{5}$$

where P_i is defined as above. $DPEDUT_i$ is the degree of the problem of education and training. When the improvement is higher, Pi will be higher, and so is $DPEDUT_i$; e_i is the random error term.

4. Empirical Results

Table 1 shows the means of industrial performance and business process gap. As seen in this table, Electric Machinery is the industry that has the highest business process gap (0.750), and Banking /Insurance is the industry that has the lowest business process gap (or no gap). Because some industries' sample sizes are too small, we classify the industries into four classes: Lower Gap (N=42), Middle Gap (N=65), Higher Gap (N=55), and Highest Gap (N=50).

Table 2 shows the classification of industries by the degree of business process gap. In general, service industries have lower business process gap, and traditional manufacture industries have higher gap. This result is rather consistent with our expectation. The descriptive statistics of industrial performance, business process gap, education/training problem and vendor assistance are listed in Table 3. As seen in this table, when business process gap increases, the implementation performance of ERP declines in the former three classes. However, the highest gap is an exception. When we turn to the vendor assistance variable, the highest gap also has relative high vendor assistance. This fact suggests that although the highest gap class is weaker in process gap, but vendor assistance compensate for this disadvantage.

The estimation results of equation (4) are showed in Table 4. When the sample comprises the highest gap class, the effect of business process gap is insignificant statistically. However, when the sample excludes the highest gap class, the effect of business process gap becomes insignificant statistically. This result is consistent with the observation in Table 3.

The estimation results of equation (5) are showed in Table 5. In consideration of between-group effect, we divide equation (5) into four parts according to our business process gap classification. The results indicate that education/training effect is not significant statistically in the two extreme classes, the lower gap and the highest gap. When neglecting the highest gap class, the results show that when business process gap increases, education/training effect also increases, ranging from 0 to -0.260, -0.339. For the highest gap class, education/training effect is not so obvious because vendor assistance is sufficient to compensate for its disadvantage in process gap.

These results illustrate the structural relationship of ERP implementation. The relationship of business process gap and ERP implementation performance seems to be nonlinear. One important factor is vendor assistance. When industrial business process gap attains certain high level, vendor assistance will be higher to compensate for this disadvantage. For Lower Gap class, education/training effect is not obvious in nature. On the other hand, for Highest Gap class, the problem is so great that their effort in education and training has no obvious attainment. Education/training effect is the most influential in those industries that have not-too-high level of business process gap and whose vendor assistance is not very large (the shaded area). In our sample, this kind of industry belongs to Higher Gap class, which is Electronics/Appliance industries. When industrial inherent attribute (business process gap), and environmental attribute (vendor assistance) are not sufficient for a company, its best strategy is to reinforce education/training effect, an acquired attribute in our model.

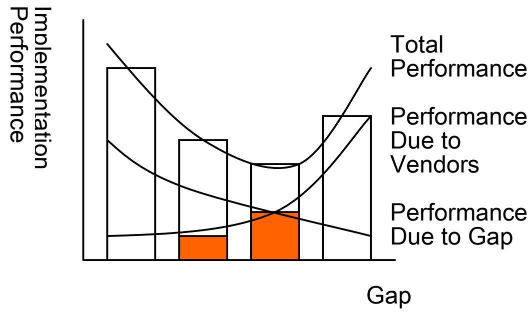

Figure 1 Implementation performance structural relationship

Table 1 Means of industrial implementation performance and business process gap

Industry	Number of Companies	Perfor-mance	Business Process Gap	Industry	Number of Companies	Perfor-mance	Business Process Gap
Food	6	5.030	0.500	Steel/Iron	25	5.240	0.160
Textiles	6	5.667	0.500	Vehicles/Parts	17	4.706	0.412
clothes	2	5.021	0.500	Transportation	4	5.750	0.000
Plastics/ Rubber	6	5.333	0.167	Department Stores	5	5.400	0.200
Chemical	5	5.200	0.400	International Trades	10	5.600	0.400
Electronics/ Appliance	55	4.982	0.382	Banking /Insurance	2	5.000	0.000
Electric Machinery	4	5.250	0.750	Construction	6	4.667	0.333
Information Product	30	5.067	0.267	other Services	29	5.034	0.276

Table 2 Classification of industries by the degree of business process gap

Level of Gap	Industry Grouping
Lower Gap (N=42)	Plastics/ Rubber, Steel/Iron, Transportation, Department Stores, Banking /Insurance
Middle Gap (N=65)	Information Products, Construction, Other Services
Higher Gap (N=55)	Electronics/ Appliance
Highest Gap (N=50)	Food, Textiles, Clothes, Chemicals, Electric Machinery, Vehicles/Parts, International Trading

Table 3 Descriptive statistics of industrial implementation performance, business process gap, education/training problem and vendor assistance

Level of Gap	Performance	Business Process Gap	Education/Training Problem	Vendor Assistance
Lower Gap (N=42)	5.310	0.143	1.357	0.560
	(0.749)	(0.354)	(1.265)	(0.468)
Middle Gap (N=65)	5.015	0.277	1.138	0.631
	(1.023)	(0.451)	(1.368)	(0.425)
Higher Gap (N=55)	4.982	0.382	1.164	0.673
	(0.991)	(0.490)	(1.067)	(0.474)
Highest Gap (N=50)	5.140	0.460	1.460	0.740
	(0.980)	(0.498)	(1.170)	(0.439)

Note: Total sample size is 212. The numbers in parentheses are the standard deviations of corresponding means.

Table 4 Regressions of implementation performance on business process gap

$$P_i = \alpha_1 + \alpha_2 GAPBP_i + u_i$$

Equation	Intercept	*GAPBP*	Adj. R^2	F-Value	D.W.
A1	5.406	-0.157	0.042	2.810*	1.855
	(25.203***)	(-1.653*)			
A2	5.208	-0.045	-0.002	0.521	1.932
	(30.409***)	(-0.721)			

Note: Equation (A1) uses the sample excluding the Highest Business Process Gap class, and Equation (A2) uses the whole sample." t-statistics" are reported in parentheses below each parameter estimate. *, **, ***indicate significant at the 10%, 5%, and 1% levels, respectively.

Table 5 Regressions of implementation performance on the degree of the problem of education and training

$$P_i = \beta_1 + \beta_2 DPEDUT_i + e_i$$

Equation	Intercept	*DPEDUT*	Adj. R^2	F-Value	D.W.
Lower Gap	5.281	0.021	-0.024	0.049	1.999
	(30.617***)	(0.221)			
Middle Gap	5.311	-0.260	0.107	8.662***	1.839
	(33.935***)	(-2.943***)			
Higher Gap	5.376	-0.339	0.117	8.143***	2.217
	(28.808***)	(-2.854***)			
Highest Gap	5.187	-0.032	-0.019	0.072	2.234
	(22.948***)	(-0.269)			

" t-statistics" are reported in parentheses below each parameter estimate. *, **, ***indicate significant at the 10%, 5%, and 1% levels, respectively.

5. Conclusion

The implementation of an ERP system is a radical logistical innovation for a company and needs explorative learning [16]. Many researches devote to the investigation of the critical success factors of ERP implementation, while few studies pay attention to industrial differences in this problem. We begin our study from the perspective that ERP implementation can be viewed as an organizational learning behavior. In this way, this research examines the structural effects of business process gap, vendor assistance and training across different industries in the performance improvement of ERP system in Taiwan's companies. Evidence is found that the gap between existing business process and ERP system process will reduce the implementation performance of ERP system from industrial perspective. Education/training effect in higher gap industry is more obvious. While the business process gap attains certain high level, vendor assistance effect replaces education/training effect, offsets business process gap effect and raises the industrial performance of ERP system. In conclusion, the findings suggest that reinforcing education and training is still critical for ERP implementation success, especially for the industries under intrinsic business process gap weakness and insufficient vendor assistance. In our sample, electronics industry is of this kind.

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