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Enterprise resource planning survey of Korean manufacturing firms

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Abstract: Enterprise Resource Planning (ERP) systems are packaged software designed to integrate and optimise the business processes of an enterprise. The ERP systems have been embraced by industry as a de facto solution to integrate their business functions. The adoption of the ERP concept is a truly global phenomenon. This paper reports a recently completed survey study on Korean manufacturing firms. The study used the same survey questionnaires used in two previous surveys done on US and Swedish manufacturing firms. Our objective is to determine the extent of adoption of the ERP system in the Korean manufacturing firms, their motivations, implementation strategies and benefits obtained, and to provide useful data to draw similarities and differences between different countries' practices.

Keywords: Enterprise Resource Planning (ERP); Korean manufacturing firms; US manufacturing firms; Swedish manufacturing firms; survey study.

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1 Introduction

The Enterprise Resource Planning (ERP) system is a software package designed to integrate and optimise the business processes of an enterprise (Davenport, 1998; Brady *et al.*, 2001; Gullledge *et al.*, 2005). Functions covered by the ERP system include manufacturing, distribution, accounting, financial, human resource management, project management, inventory management, service and maintenance, and transportation, providing accessibility, visibility and consistency across the enterprise. The ERP systems identify and plan the enterprise-wide resources needed to take, make, distribute, deliver and account for customer orders. Corporate computing with ERP allows companies to implement a single integrated system by replacing or reengineering their mostly incompatible legacy information systems.

The implementation and maintenance cost of the ERP systems is very high, typically ranging from 15 to 50 million US dollars (Hunton and McEwen, 2002). Therefore, the project of implementing an ERP system is usually the largest single project that an enterprise would ever launch in its lifetime. Despite its high implementation and maintenance cost, the ERP system has become the *de facto* solution in industry to realise an enterprise-wide information system (Hitt *et al.*, 2002). The importance and implementation cost of ERP systems have naturally created interest in investigating critical factors involved in the implementation and operation process (Holland and Light, 1999; Soh *et al.*, 2000).

Even though many case studies have been reported, there are only two comprehensive survey studies reported in academic journals – one on US manufacturing firms and the other on Swedish manufacturing firms (Mabert *et al.*, 2000; Olhager and Selldin, 2003). Mabert *et al.* mailed their survey to American Production and Inventory Control Society (APICS) members while Olhager *et al.* mailed their survey to the Swedish Production and Inventory Management Society (PLAN) members. The collected results were analysed and presented in terms of enterprise characteristics, pre-implementation process, implementation experience, ERP system configuration, benefits and future direction.

We have conducted an equivalent survey study on Korean manufacturing firms. The exact same kind of data has been collected from Korean manufacturing firms using the same survey questionnaires used in the two previous surveys done on US and Swedish manufacturing firms. Our objective was to determine the extent of adoption of the ERP system in Korean manufacturing firms, their motivations, implementation strategies and

benefits obtained, and to provide useful data to draw similarities and differences between different countries' practices.

In this paper, we present a survey study of the implementation of ERP systems in South Korean¹ manufacturing firms. We adopted exactly the same survey form – translated into Korean – used for both US and Swedish studies. Even though we present the findings on Korean manufacturing firms in the same manner as the US and Swedish studies, the use of the same survey form will render further comparative study possible. The paper is organised as follows: first, we discuss the research methodology and the characteristics of the responding enterprises; then we present and analyse the results of the Korean study. We also provide several comparative remarks relative to the US and Swedish studies.

2 Research methodology

Data collection was achieved in two phases in October and November 2004. During Phase 1, between 1 October and 11 November, the data was collected directly using personal interviews, the survey being conducted through phone contact or e-mail correspondence. During Phase 2, between 28 October and 30 November, the survey results were collected through surface mail. From the direct data collection channel, we obtained 45 usable responses. For the mail survey, the authors mailed 1500 surveys to the randomly chosen manufacturing firms who were registered in Korean Securities Dealers Automated Quotations (KOSDAQ). Out of 1500 requests, we obtained 86 usable responses, which correspond to 5.8%. Considering the length and comprehensive nature of the survey and the near 100% response rate from the direct survey, this response rate is considered reasonable. In fact, if we incorporate the direct response rate, the final response rate is 8.3%. Note that the response rates for the USA and Sweden are 9.6% and 37.2%, respectively.

The US survey study used 479 responses and the Swedish study used 190 responses while the Korean study used 131 responses. Considering the total population of each country (USA – 280 million, 1999; Sweden – 9 million, South Korea – 48 million, 2004), the relative number of responses used in the Korean study falls between the USA and Sweden.

3 Enterprise characteristics

The characteristics of the respondents and the enterprises are summarised in Table 1. Eighty-nine percent of the total respondents represented the entire enterprise while 11% represented a business unit or a division. Sixty-three percent of the respondents are at the managerial level or above in their organisation. It is interesting to note that Korean respondents indicated their ranks, such as 'president', 'senior manager' and 'general manager', but not their functional areas. This may illustrate a cultural difference between countries in terms of what kind of identity the employees prefer to use.

Table 1 Enterprise characteristics

Table 1.1 Respondent's position

<i>Respondent's position</i>	<i>Percentage (%)</i>
Executives	6.1
Senior managers	6.9
General managers	11.5
Managers	38.9
Deputy managers	22.1
Staffs	13.0
Others	1.5

Table 1.2 Firm's annual revenue (\$ Million)

<i>Annual revenue</i>	<i>Percentage (%)</i>
50 or less	47.1
51–250	27.3
251–750	9.1
751 and up	16.5

Table 1.3 Number of employees

<i>Number of employees</i>	<i>Percentage (%)</i>
< 500	47.1
500–1000	20.7
1001–5000	12.4
> 5000	19.8

Table 1.4 Portion of items produced

<i>MTS (%)</i>	<i>versus</i>	<i>MTO (%)</i>	<i>Percentage (%)</i>
0–5		100–95	35.0
6–35		94–65	17.9
36–65		64–35	12.8
66–94		34–6	19.7
95–100		5–0	14.5

Table 1.5 ERP package saturation

<i>ERP package saturation</i>	<i>Percentage (%)</i>
Company has installed a package ERP system	65.6
Company is currently installing a package ERP system	6.9
Company plans to install a package ERP system within the next 18 months	13.0
No package ERP system is planned	14.5

About half of the responding firms have annual revenues of \$50 million or less, and fewer than 500 employees. The distribution of company sizes as measured by revenue and number of employees is similar to that for Sweden. However, there were more large corporations in the Korean study, as 16.5% of the firms have more than \$750 million in annual revenue and 19.8% have more than 5000 employees.

Like in the Swedish case, Make-To-Order (MTO) dominates (65% more) in 52.9% of the firms, whereas 34.2% of the firms are dominated by Make-To-Stock (MTS) (65% more). The remaining 12.8% have a more or less equal split between MTO and MTS. Thirty-five percent of the firms use MTS almost exclusively (95% or more).

The distribution of process choice takes into account that a manufacturing firm may have a mix of processes. Each firm was classified as one of the five fundamental process choices: project, job shop, flow shop, line, and continuous process. 25.7% of them are flow shop, 23.0% project manufacturing, 22.7% line, 18.2% job shop and 10.4% continuous process in the Korean firms studied here.

ERP package saturation in Korean manufacturing firms indicates that a majority of respondents are familiar with the concept of ERP systems. Seventy-two point five percent have implemented or are in the process of implementing an ERP system. If we include those who are planning to implement an ERP system within the next 18 months, 85.5% of the firms will have implemented ERP systems in 18 months.

4 Survey results

The results presented in this section are based on the firms that have implemented or are implementing an ERP system. Thus, firms that plan to install a package ERP system within the next 18 months (13%) as well as those firms with no plans for ERP systems (14.5%) are not included in the results.

4.1 Pre-implementation process

Table 2 summarises respondents' answers to questions concerning activities that led to the implementation of a packaged ERP system. Based on a number of identified factors from our pretest, a 5-point Likert scale was employed to measure the importance of various motivational factors. The motivation section lists the average, median and mode responses. The most commonly quoted motivational factor was 'simplify and standardise system', followed by 'replace legacy systems', 'gain strategic advantage', and 'restructure company organisation'. Reflecting the timing of this study – year 2004 – 'solve the Y2K problem' ranked the lowest.

Most firms are pursuing a single packaged ERP approach. For 35.3% of the respondents, a single system is expected to provide complete functionality for all expected business needs. For 40.2% of the respondents, a single package will be employed as the backbone of support, with some supplemental systems handling special requirements. It is worth noting that 15.7% of the Korean respondents indicated they have developed in-house systems as compared with only 1.5% of the US firms and 4% of the Swedish firms.

Table 2 Pre-implementation activities

Table 2.1 Company motivation to implement ERP

<i>Company motivation to implement</i>	<i>Average</i>
Simplify and standardise systems	3.82
Replace legacy systems	3.67
Gain strategic advantage	3.55
Restructure company organisation	3.49
Ease of upgrading systems	3.22
Improve interactions and communications with suppliers and customers	3.16
Pressure to keep up with competitors	3.06
Link to global activities	2.60
Solve the Y2K problem	1.84

Table 2.2 Estimated ERP system life

<i>Estimated life</i>	<i>Percentage (%)</i>
Less than 3 years	5.9
3 to 5 years	38.2
5 to 7 years	30.4
7 to 10 years	14.7
Above 10 years	10.8

Table 2.3 Formal evaluation analysis for ERP

<i>Formal analysis</i>	<i>Percentage (%)</i>
Yes	37.3
No	58.8
No response	3.9

Table 2.4 Analysis approach

<i>Analysis approach</i>	<i>Percentage (%)</i>
ROI	100.0
EVA	6.1
Payback	21.2
Other	0
<i>Total</i>	127.3*

Note: *Total greater than 100% because some firms used more than one method

Table 2.5 Strategic approach

<i>Strategic approach</i>	<i>Percentage (%)</i>
Single ERP Package	35.3
Best-of-breed from several ERP packages	3.9
Single ERP package with other systems (home-grown, legacy, specialised functionality, <i>etc.</i>)	40.2
Multiple ERP packages with other systems (home-grown, legacy, specialised functionality, <i>etc.</i>)	4.9
Totally in-house developed	8.8
In-house plus some specialised package functionality	6.9

Table 2.6 Estimated return

<i>Estimated return (%)</i>	<i>Percentage (%)</i>
Less than 5	2.8
5–15	30.6
16–25	27.8
26–50	22.2
Above 50	16.7

The answers to the estimated ERP system life indicate that the expected useful life of the system exceeds five years for 55.9% of the firms. Thirty-eight point two percent of the respondents expected between three and five years of ERP system life. Fifty-eight point eight percent of the firms did not conduct a formal evaluation analysis. Every firm in the Korean study that conducted a formal analysis used the ROI tool. The estimated return was higher than 15% in 66.7% of the firms and 38.9% of the firms quoted a return of 25% or more.

4.2 Implementation experience

The implementation time and implementation cost differ substantially between enterprises, as shown in Table 3. Twenty-eight point six percent of the firms finished their implementation in less than six months while there was no firm which executed the implementation for more than 37 months. It is notable that Korean firms were able to implement the ERP system at a much lower cost, as 77.2% of the firms spent less than \$5 million, while 42.3% of the US firms and 37.7% of the Swedish firms spent less than \$5 million.

Seventy-two point seven percent of the firms adopted the 'Big Bang' or 'Mini Big Bang' implementation strategies and deployed the ERP system throughout the organisation at one time. The implementation time for 'Big Bang' was shorter by almost four months than those for 'Mini Big Bang' or 'Phased-in' approaches. The strategies adopted were similar among the three countries. However, it is notable that Korean firms seldom used 'Phase-in Site' strategies, while between 20% and 25% of the US and Swedish firms used them.

The software cost accounted for 30.7%, followed by the hardware cost at 24.4% and the consulting cost at 23.2%. The training and implementation team cost the least among the three countries.

Table 3 Implementation experience and configuration

Table 3.1 Implementation duration

<i>Implementation duration</i>	<i>Percentage (%)</i>
6 months or less	28.6
7 to 12 months	27.3
13 to 18 months	18.2
19 to 24 months	19.5
25 to 36 months	6.5

Table 3.2 Implementation strategy and duration

<i>Implementation strategy</i>	<i>Korea</i>	
	<i>Percentage (%)</i>	<i>Average time</i>
Big bang	59.1	12.6
Mini big bang	13.6	16.0
Phased-in module	26.4	15.4
Phased-in site	0.9	16
Phased-in module + site	–	–

Table 3.3 ERP system cost

<i>System cost (\$M)</i>	<i>Percentage (%)</i>
Less than 5	77.2
5–25	15.8
26–50	4.0
51–100	1.0
Above 100	2.0

Table 3.4 ERP cost components

<i>Cost components</i>	<i>Percentage (%)</i>
Software	30.7
Hardware	24.4
Consulting	23.2
Training	9.4
Implementation team	11.2
Other	1.1

Table 3.5 Single ERP package implemented

<i>Order</i>	<i>Korea</i>	
	<i>Package</i>	<i>Percentage (%)</i>
1	SAP	28.7
2	Oracle	21.8
3	Uni-ERP	15.8
4	K-systems	4.0
5	The Zone	3.0
	Other	26.7

Table 3.6 Amount of ERP customisation required

<i>Amount</i>	<i>Percentage (%)</i>
Major	20.0
Significant	52.2
Minor	27.8

Table 3.7 ERP module implemented

<i>Module</i>	<i>Implementation sequence/average</i>	<i>Implementation frequency (%)</i>	<i>SAP (%)</i>	<i>Oracle (%)</i>	<i>Uni-ERP (%)</i>	<i>Others (%)</i>
Materials management	1/2.93	93.7	93.1	86.4	93.8	97.7
Financial accounting	2/3.37	92.8	100	86.4	93.8	90.9
Production planning	3/3.59	83.8	82.8	68.2	93.8	88.6
Order entry	4/3.68	86.5	89.7	77.3	81.3	90.9
Personnel/ Human resources	5/4.08	82.9	51.7	77.3	100	100
Financial control	6/4.63	85.6	93.1	81.8	87.5	81.8
Distribution/ Logistics	7/5.04	73.0	82.8	54.5	68.8	77.3
Quality management	8/5.88	69.4	58.6	59.1	81.3	77.3
Asset management	9/6.37	82.9	93.1	72.7	93.8	77.3
Purchasing	10/6.57	91.9	93.1	86.4	87.5	95.5
R&D management	11/6.68	50.5	31.0	31.8	68.8	65.9
Maintenance	12/8.82	61.3	44.8	40.9	75.0	77.3

4.3 ERP system configuration

Table 3.5 presents company-based data for packaged ERP implementation experiences. We started by looking at the software packages in use. The SAP software represented 28.7% of the single-package implementations. The second in the list was Oracle with 21.8%. Uni-ERP software by Samsung SDS Co. was the third with 15.8%. It is worth noting that the made-in-Korea packages were implemented by at least a quarter of the firms.

All the firms indicated that they did some sort of customisation, with 20% of the firms reporting major customisation.

Table 3.7 specifies the implementation frequency per module for a few ERP products.

4.4 Benefits and future directions

Companies that have implemented an ERP system are experiencing performance changes mainly from the information perspective. Information is more easily accessible and the transaction across the enterprise has improved, as indicated in Table 4.1. The first four on the list of the ERP performance outcomes are almost identical to those in the US and Swedish firms. Quickened information response time was first on the list, followed by improved order management/order cycle, decreased financial close cycle and increased interaction across the enterprise.

The areas that have benefited the most from ERP implementation are the integration of business operations/processes, financial management and the quality of information (Table 4.2). On the other hand, information technology costs have not decreased. These findings are quite similar to those experienced in the cases of the USA and Sweden.

Most companies that have implemented an ERP system are implementing, planning or considering various extensions to the system, as shown in Table 4.3.

Table 4 Benefits and future direction

Table 4.1 ERP performance outcomes

<i>Performance outcomes</i>	<i>Average</i>
Quickened information response time	4.17
Increased interaction across the enterprise	3.95
Decreased financial close cycle	3.90
Improved order management/order cycle	3.61
Lowered inventory levels	3.24
Improved cash management	3.18
Improved interaction with customers	3.13
Improved interaction with suppliers	3.03
Improved on-time delivery	2.99
Reduced direct operating cost	2.97

Table 4.2 Areas benefiting from ERP

<i>Benefited areas</i>	<i>Average</i>
Integration of business operations/processes	3.81
Financial management	3.71
Quality of information	3.61
Inventory management	3.53
Availability of information	3.50
Personnel management	3.41
Supplier management/procurement	3.39
Customer responsiveness/flexibility	3.13
Decreased information technology costs	2.95

Table 4.3 Extensions to ERP system

<i>Extensions</i>	<i>Implementing/ Implemented</i>	<i>Planned for future</i>	<i>Considering</i>	<i>No plans</i>
Data warehouse	23.5	13.2	29.4	33.8
Supply chain system	23.4	17.2	29.7	29.7
CRM system	17.4	18.8	27.5	36.2
Advanced planning and scheduling system	20.6	8.8	33.8	36.8
Business intelligence capabilities	21.0	14.5	19.4	45.2
e-Business or e-Commerce enabled	18.0	14.8	39.3	27.9
Tying your suppliers to your ERP system	20.3	18.8	23.4	37.5
Tying your customers to your ERP system	19.0	19.0	22.2	39.7

5 Summary and conclusions

First, among the respondents in the three survey studies, the US firms were the largest in terms of annual revenue and number of employees, followed by Korean and then Swedish firms. In the Swedish study, most of the respondents were small- and medium-sized firms. Despite such differences in enterprise characteristics, many answers were quite similar across the three countries. Second, all three countries' firms indicated that the most important motivations for implementing ERP systems were 'simplify and standardise systems' and 'replace legacy systems'. Third, the expected life of an ERP system was between three and seven years in all three countries. But the US firms expected a longer life for an ERP system while the Swedish firms expected a shorter life for an ERP system. Fourth, the Korean and US firms preferred a single package with other systems while the Swedish firms preferred only a single package. Fifth, most

US firms did formal evaluation analyses, while many Korean firms implemented an ERP system without a formal evaluation analysis. Those Korean firms that did a formal evaluation analysis adopted the ROI method, while the Swedish firms used a variety of evaluation methods. Reflecting this practice, the Swedish firms estimated higher returns than other countries. Sixth, the Korean firms implemented the ERP system in the shortest time possible, regardless of the implementation strategy adopted. They also reported a higher level of customisation. It is not clear whether this indicates an improved implementation procedure over the years or is characteristic of Korean practice. Seventh, all three countries' firms' experiences were mostly in the areas of 'quickened information response time' and 'increased interaction across the enterprise' and least in the area of 'reduced direct operating cost'. Only the Korean firms rated 'decreased financial close cycle' highly. Eighth, all three countries' firms were interested in e-Business and tying customers and suppliers to the ERP system in the future. Ninth, the larger the size of an enterprise, the more the ERP system contributed to the overall improvement of enterprise operations.

There are numerous contributions from this study. First, we provided some raw data on the ERP implementation process for other researchers. Second, we provided an indirect comparative study among the three representative countries from three continents so that similarities and differences in the ERP implementation practices could be analysed. Also, the findings presented in this paper could be useful for small to medium-sized enterprises. Except for a few conglomerates, the majority of manufacturing firms in Korea are small to medium sized. Especially compared to the US data, in which more large enterprises are represented, the Korean and Swedish practices can be more relevant for the analysis and planning purposes of the small- to medium-sized firms (Huin, 2004; Piturro, 1999; Wong and Lu, 2005).

There are also several limitations in this study. These limitations may be addressed in subsequent research. First, for objective comparison purposes, the timing and extent of the study is not always comparable with the US and Swedish studies. For example, the item on the Y2K problem was completely irrelevant for the Korean study. A concurrent international survey study may be conducted in the future to eliminate such discrepancies (Soh *et al.*, 2000; Krumbholz *et al.*, 2000; Adam and O'Doherty, 2000; Booth *et al.*, 2000). Second, more in-depth analyses on the relationships between individual parameters may be useful in the future. Third, the industry sector can be expanded beyond manufacturing. Fourth, it might be worthwhile attempting similar comparative studies between different types of industries and between different types of information systems.

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Note

- 1 In this paper, 'Korea' is used to refer to 'South Korea'.