



Enterprise resource planning survey of Swedish manufacturing firms

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Abstract

Enterprise resource planning (ERP) systems are the new type of information systems for enterprise integration. By adding functionality to previous manufacturing resource planning systems, the aim is to integrate functions and processes within a manufacturing firm. In this paper, we present a survey of ERP implementation in Swedish manufacturing firms, concerned with ERP system penetration, the pre-implementation process, implementation experience, ERP system configuration, benefits, and future directions.

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1. Introduction

Enterprise resource planning (ERP) systems are computer-based information systems for enterprise integration. They supersede manufacturing resource planning (MRPII) systems and material requirements planning (MRP) before that, and the perspective is broader than manufacturing (Chung and Snyder, 2000). ERP systems specifically address the need for integration of application programs for various business functions or processes in a manufacturing firm, such as sales, accounting and manufacturing. Different business applications can all use a common database that serves as

the integrating mechanism. Software vendors have typically successively renamed their systems from MRPII to ERP during the 1990s, to some extent justified by expansions in terms of functional content and the level of information and communication technologies employed. The users of ERP systems, i.e. the manufacturing firms have adopted the new name. For example, the responding firms in the survey presented in this paper have had no problem associating the functionality of the systems with the name of ERP systems. Whilst the practical issues related to ERP systems have been commented upon in business journals, the research literature is sparse. Some literature is emerging; see e.g. Jacobs and Whybark (2000), Langenwalter (2000), and Ptak and Schragenheim (2000).

In this paper we present a survey of implementation of ERP systems in Swedish manufacturing firms. Sweden has for long been considered

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an early adopter of new information and communication technologies, and is the home country for some of the leading ERP software vendors, such as Intenia, IFS and IBS. Therefore, it would be of general interest to investigate the approaches and experience of Swedish manufacturing firms. The survey covers ERP system penetration, the pre-implementation process, implementation experience, ERP system configuration, benefits, and future directions. The design of the survey and the questionnaire follows the design of the study by Mabert et al. (2000). They mailed their survey to APICS members (APICS—the educational society for resource management), wherefore we directed our study to PLAN members within manufacturing firms; PLAN—the Swedish Production and Inventory Management Society is the Swedish counterpart to APICS. PLAN provided the mailing lists.

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 Swedish study. We also provide some comparative remarks relative the US study (Mabert et al., 2000).

2. Research methodology

The survey reported here was mailed to PLAN members employed within manufacturing firms in Sweden. The questionnaire focuses on six areas: characteristics of the firm and the respondent including ERP system penetration, pre-implementation process, ERP system configuration, implementation experience, benefits observed, and future directions planned.

In November 2000 the authors mailed the questionnaire to PLAN members in 511 different firms. This constituted the entire body of PLAN members in Swedish manufacturing firms. Postage-paid return envelopes were provided. The survey employed three question formats: Likert scales, multiple response, and open response types of questions.

By January 2001, 190 usable responses were received for a response rate of 37.2%, which must be considered to be very good for this type of survey.

3. Enterprise characteristics

The characteristics of respondent and the enterprise are summarised in Table 1. The respondents' position in the firm is typically related to manufacturing planning and control, either logistics/supply chain manager or production/inventory control manager. These two categories account for approximately half the respondents. If we add IT/systems manager and plant/operations manager, 75% of the respondents are accounted for. The other respondents hold other positions but are members of the Swedish Production and Inventory Management Society, wherefore most of, if not all, the respondents are professionally centrally involved in the implementation and running of ERP systems.

The majority of the responding firms have annual revenue of \$50 million or less, and fewer than 500 employees. However, the sample also includes large corporations and large divisions within corporations.

The order penetration point determines the point along the total production process where a customer is linked to a specific product being produced. Two distinct choices are contrasted, i.e. make-to-stock (MTS) vs. make-to-order (MTO). MTO includes engineer-to-order situations and assemble-to-order. Thus, the manufacturing environments where the finishing operations are carried out based on actual customer orders are collected in the MTO option. The percentages in Table 1 indicate the proportion of items being produced in a MTS or MTO fashion. MTO dominate (65% more) in 59.6% of the firms, whereas 31.4% of the firms are dominated by MTS (65% more). The remaining 9.0% have a more or less equal split between MTO and MTS.

The distribution of process choice takes into account that a manufacturing firm may have a mix of processes. Each firm divided 100% among the five fundamental process choices: project, job shop, flow shop, line, and continuous process. Discrete manufacturers dominate with almost equal distribution among job shop, flow shop, and line. There are 6.0% project manufacturing and 11.6% continuous process, wherefore all five basic process choices are represented.

Table 1
Enterprise characteristics

Respondent's position	Percent
Executive	4.4
Logistics/supply chain manager	32.0
Production/inventory control	17.3
Systems manager/IT manager	13.8
Plant/operations manager	12.9
Purchasing manager/buyer	6.2
Other	13.3
Firm's annual revenue (\$ M)	
<15	28.1
16–50	29.9
51–250	26.4
251–750	11.4
>750	4.2
Number of employees	
<150	29.0
150–500	34.1
501–1000	17.4
1001–5000	14.2
>5000	5.3
Order penetration point	
MTS (%) MTO (%)	
0–5 100–95	32.8
6–35 94–65	26.8
36–64 64–36	9.0
65–94 35–6	20.2
95–100 5–0	11.2
Process choice	
Project	6.0
Job shop	26.4
Flow shop	27.2
Line	28.9
Continuous process	11.6
Package ERP saturation in Swedish manufacturing firms	
Firm has installed a package ERP system	74.6
Firm is currently installing a package ERP system	9.0
Firm plans to install a package ERP system within the next 18 months	5.3
No package ERP system is planned	11.1

ERP package saturation in Swedish manufacturing firms indicates that most respondents are used to the concept of ERP systems. 83.6% have implemented or are in the process of implementing an ERP system. Thus, the experience of the

Swedish manufacturing firms is likely to be a viable benchmark for manufacturing firms in other countries.

When compared to the US study (Mabert et al., 2000) we find that the Swedish manufacturing companies are somewhat smaller in size (annual revenue and number of employees). The US survey had a higher number of executives responding to the survey; 22.2%. As for ERP saturation, 74.6% of the Swedish firms have installed a package ERP system compared with 44.1% in the US. The US study had 479 usable responses out of 5000 questionnaires for a response rate of 9.6%.

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 (5.2%) as well as those firms with no plans for ERP systems (11.1%) are not included in the results. This leaves 158 manufacturing firms, or 83.2% of the respondents. The results thus present the distribution among these 158 enterprises.

4.1. Pre-implementation process

Table 2 summarises the answers concerning the activities leading up to the implementation of an ERP package. The motivation of the firm to implement ERP was based on a 5-point Likert scale with preset factors. The results show the average, the median as well as the mode, to indicate the profile of the answers. The two most commonly quoted motivational factors are “replace legacy systems” and “simplify and standardise systems”, whereas “restructure company organisation”, “solve the Y2K problem” and “pressure to keep up with competitors” have had the lowest impact. Most firms are pursuing a single package (55.6%), or a single package linked with other systems (add 30.1%). Mixed solutions that include multiple ERP packages are found in 10.4% of the cases.

The answers to the estimated ERP system life and the estimated return were given in time buckets; see Table 2. In 75.1% of the firms the

Table 2
Pre-implementation activities

Company's motivation to implement ERP	Average ^a	Median ^a	Mode ^a
Replace legacy systems	4.11	4	5
Simplify and standardise systems	3.67	4	4
Gain strategic advantage	3.18	3	4
Improve interactions and communication with suppliers and customers	3.16	3	4
Ease of upgrading systems	2.96	3	3
Link to global activities	2.85	3	4
Restructure company organisation	2.70	3	1
Solve the Y2K problem	2.48	2	1
Pressure to keep up with competitors	2.48	2	1
Strategic approach	Percent		
Single ERP package	55.6		
Single ERP package with other systems	30.1		
Multiple ERP packages with other systems	6.5		
Best-of-breed from several ERP packages	3.9		
Totally in-house developed	2.0		
In-house plus some specialised package functionality	2.0		
Estimated ERP system life (years)			
<3	3.4		
3–5	21.5		
5–7	27.5		
7–10	22.8		
>10	24.8		
Formal evaluation analysis for ERP			
Yes	41.8		
No	34.8		
No response	23.4		
Formal evaluation analysis approach			
Payback	66.7		
ROI	30.3		
EVA	12.1		
Other	19.7		
Total ^b	128.8		
Estimated return (%)			
<5	16.5		
5–15	38.0		
15–25	30.4		
25–50	11.4		
>50	3.8		

^a Scale 1–5, “not important” to “very important”.

^b Total greater than 100% because of multiple usage.

system life is expected to be longer than five years; the most typical system life (median and mode) being five to seven years. Still, less than half of the firms conducted a formal evaluation analysis. The most common approach by far is the payback

method (66.7%) followed by return on investment (ROI; 30.3%). The estimated return was higher than 15% in almost half of the cases (45.6%), and only 15.2% of the firms quoted a return of 25% or more.

The Swedish and US firms show several similarities, especially with respect to the motivation to implement ERP system where the ranks as well as the averages are almost identical in the two studies. The US firms were more inclined to perform an economic evaluation and were slightly more optimistic about the return of the ERP system investment.

4.2. Implementation experience

The implementation time as well as implementation cost differ substantially between enterprises; see Table 3. The average implementation time was 17 months with a median of 12 months, and the average total implementation cost is 1.68 M\$ with a median of 0.75 M\$. Some large enterprises did not specify the total implementation cost, wherefore the average is likely to be higher than indicated. Most firms have followed the “Big bang” implementation strategy and deployed the ERP system throughout the organisation at one time. The average implementation time is shorter for “Big bang” firms, especially when compared with firms phasing in the ERP system by module or by site. The latter implementation strategies tend to lengthen the implementation time by six months. The software cost accounted for one-fourth of the total ERP cost, surpassed by consulting as the highest cost in the implementation process. Training and implementation team costs accounted for another 25%. The overall implementation experience in these areas is quite similar in Sweden and the US Swedish firms have a shorter average and median implementation time, most likely due to the fact that the Swedish firms on average are smaller.

Table 3
Implementation experience

Implementation duration (months)	Percent	Time (months)	
		Mean	Std. dev.
≤ 6	13.0		
7–12	24.7		
13–18	36.9		
19–24	11.6		
25–36	8.0		
37–48	4.4		
>48	1.4		
Implementation strategy			
Big bang	42.1	14.4	8.0
Mini big bang	20.4	15.5	10.7
Phased by module	17.1	20.0	15.9
Phased by site	20.4	23.0	13.0
ERP system cost (\$ M)			
<0.5	37.7		
0.5–1.5	30.4		
1.5–5	26.1		
>5	5.8		
ERP cost components			
Software	24.2		
Hardware	18.5		
Consulting	30.1		
Training	13.8		
Implementation team	12.0		
Other	1.4		

The breakdown of ERP cost by enterprise size in terms of annual revenue in Table 4 reveals that small firms typically go for smaller ERP system and a smaller budget. However, the ERP investment tends to be relatively heavier for smaller companies. For small firms the ERP cost accounts for 3.5% of annual revenue, whereas the cost is about 1% for larger corporations. This is the same

Table 4
Breakdown of ERP cost by enterprises annual revenue

Revenue (\$ M)	ERP cost (\$ M)				Implementation cost as percent of revenues	
	<0.5	0.5–1.5	1.5–5	>5	Average	Std. dev.
≤ 15	21.2%	1.5%			3.45	4.86
16–50	15.2%	15.2%	3.0%		2.15	1.46
51–250	3.0%	16.7%	10.6%	4.5%	2.36	3.34
251–750		1.5%	3.0%	3.0%	1.31	1.24
>750			1.5%		0.38	–

pattern that can be identified in the US study. It should be noted that the number of responses specifying a total implementation cost among larger enterprises was rather low, wherefore the result for large firms may have been different should all large firms have responded to this question.

4.3. ERP system configuration

Since there are a number of Swedish ERP software vendors, it is not surprising that these system providers dominate the implementations in Swedish manufacturing firms; see Table 5. Intenia, IFS and IBS provide large systems for large corporations, whereas Jeeves, Scala and Monitor focus on medium-sized to smaller enterprises. Of the non-domestic system providers, SAP holds second place in this study and Baan the fourth place. The implementations of these are typically found in larger corporation that operate globally. Almost all implemented ERP systems have had to be customised to some extent (92.4%). Although most firms indicate minor customisation, about one third report on significant needs for customisation.

Table 6 specifies the implementation frequency and the customisation level per module. The modules that are related to the time-to-customer process are the most frequently implemented but also the most frequently customised. These are

purchasing, order entry, materials management, and production planning. Given the history from MRP via MRPII to ERP, these modules must be considered to belong to the core functionality of the ERP system. It is worth noticing that purchasing is the most frequent module, even more frequently implemented than traditional manufacturing planning and control modules such as materials management and production planning. Still, all four modules have a penetration rate of 90% or higher. Customisation relative implementation shows that the most frequently implemented modules also are the most modified ones. The four modules mentioned above, having the highest implementation frequency, have a customisation frequency of 60–70%. On the low end of implementation frequency (50% or lower) as well as customisation (36% or lower) we find quality management, maintenance, and R&D management. The largest levels of customisation among those modules that have had to be customised are found for quality management, order entry, and distribution/logistics. The median firm report “significant” customisation of these modules.

Swedish firms are keener on using European, and in particular Swedish, ERP systems while the US study rank SAP, Baan and PeopleSoft as the most popular systems. Swedish firms typically implement more modules; all individual modules have a higher implementation frequency in Sweden except financial accounting, which is the most widely implemented module in the US. The set of modules requiring customisation is similar. Order entry was singled out as number one in the US study followed by distribution/logistics, production planning, and materials management. Thus, it seems that the supply chain process from suppliers through manufacturing to customer generally is important and needs some tailoring to support the needs of the individual enterprise and its relationship with supply chain partners.

4.4. Benefits

Companies having implemented an ERP system are experiencing improved performance mainly from the information perspective. Information is more easily accessible and the interaction

Table 5
ERP package and overall customisation required

Single ERP package implemented	Percent
Intenia	30.1
SAP	15.0
IFS	11.3
Baan	5.3
IBS	4.5
Jeeves	4.5
Scala	4.5
Monitor	3.0
Other packages	21.8
Amount of ERP customisation required	
Major	8.9
Significant	50.6
Minor	32.9
No changes	2.5
No response	5.1

Table 6
ERP module implemented and level of customisation

Module	Implementation frequency	Total percent customisation	Customisation relative implementation ^a	Average level of customisation ^b	Median ^b	Mode ^b
Purchasing	93.0	56.3	60.5	1.43	1	1
Order entry	92.4	62.7	67.8	1.71	2	1
Materials management	91.8	55.7	60.7	1.51	1	1
Production planning	90.5	62.7	69.2	1.62	1	1
Financial accounting	87.3	44.3	50.7	1.39	1	1
Distribution/logistics	84.8	57.6	67.9	1.65	2	1
Financial control	82.3	43.7	53.1	1.35	1	1
Asset management	63.3	26.6	42.0	1.24	1	1
Personnel/human resources	57.6	19.0	33.0	1.20	1	1
Quality management	47.5	17.1	36.0	1.85	2	1
Maintenance	44.3	11.4	25.7	1.22	1	1
R&D management	34.2	10.1	29.6	1.44	1	1

^a The percentage of companies that implemented a module and have had to customise it.

^b Scale 1–3: “minor”, “significant”, “major”.

across the enterprise has improved, as indicated in Table 7. Issues such as interaction with customers and suppliers, on-time delivery, operating costs, inventory levels and cash management have been affected to a lesser extent. The areas that have benefited the most from the ERP implementation are the availability of information, the integration

of business operations and processes, and the quality of information. At the other end, information technology costs have not decreased. Thus, information speed, quality and availability have improved but the information technology costs have not decreased. These findings are quite similar to those experienced in the US.

Table 7
Benefits

ERP performance outcomes	Average ^a	Median ^a	Mode ^a
Quickened information response time	3.81	4	4
Increased interaction across the enterprise	3.55	4	4
Improved order management/order cycle	3.37	4	4
Decreased financial close cycle	3.36	4	4
Improved interaction with customers	2.87	3	3
Improved on-time delivery	2.82	3	3
Improved interaction with suppliers	2.78	3	3
Reduced direct operating costs	2.74	3	3
Lowered inventory levels	2.60	3	3
Improved cash management	2.57	3	3
Areas benefitting from ERP			
Availability of information	3.74	4	4
Integration of business operations/processes	3.42	4	4
Quality of information	3.31	4	4
Inventory management	2.99	3	3
Financial management	2.98	3	3
Customer responsiveness/flexibility	2.95	3	3
Supplier management/procurement	2.94	3	3
Personnel management	2.06	2	1
Decreased information technology costs	2.05	2	1

^a Scale 1–5: “not at all” to “a great extent”.

Table 8
Extensions to ERP system

	Implementing/implemented (%)	Planned for future (%)	Considering (%)	No plans (%)
Tying your customers to your ERP system	24.6	14.9	32.1	28.4
Data warehouse	19.4	16.3	27.9	36.4
E-business or e-commerce enabled	15.3	22.1	35.9	26.7
Tying your suppliers to your ERP system	14.1	12.6	48.9	24.4
Supply chain system	8.4	7.6	38.2	45.8
Customer relation management system	7.4	4.1	24.6	63.9
Advanced planning and scheduling system	5.2	11.1	34.8	48.9
Business intelligence capabilities	3.3	4.9	20.3	71.5

4.5. Future direction

Most companies having implemented an ERP system are implementing, planning or considering various extensions to the system, as shown in Table 8. The metrics concerning vertically integrated information throughout the supply chain score relatively high, even though firms tend to focus on immediate suppliers and customers, e.g. through e-business solutions. A majority of the firms are not even considering customer relation management systems and business intelligence capabilities. Compared to the US study, the most important difference is that data warehousing is more frequently implemented among ERP customers in the US than in Sweden. The metrics concerning supply chain integration show slightly different results, but taken all together the patterns are similar.

5. Summary and conclusions

In this paper we study the implementation of ERP systems in Swedish manufacturing firms. With a response rate of 37.2% of the contacted companies, this survey is able to provide a fairly accurate overview the status of ERP system implementation issues.

Some interesting findings are summarised below. First, Swedish manufacturing firms are broadly adopting ERP systems; 83.6% have implemented such systems or are in the process of implementing. Second, the cost for implementing ERP systems range from an average of 0.5% of annual revenues

for large enterprises up to an average of 3.5% for smaller companies. Thus, the ERP system cannot be considered to be an overwhelming investment for the enterprise. Third, Swedish firms often choose to implement ERP systems from Swedish vendors. Fourth, the modules that are implemented tend to be the core production management modules involved in the customer order process; these modules are also the modules requiring the most customisation. Financial accounting and control come next as the most implemented modules. Thus, ERP systems primarily support the material and information flows and secondarily the financial flows. Fifth, the most cited improvements related to ERP systems are concerned with information access and improved intra-organisational interaction. Sixth, given that the ERP penetration is high, most Swedish companies plan to extend their ERP systems with functional support for upstream and downstream supply chain operations.

Issues four and five above shed some light on the two propositions suggested by Chung and Snyder (2000).

Proposition 1. *If the high level of perceived benefits from IT integration with ERP is present, an organisation is more likely to adopt an ERP system.*

Proposition 2. *If the development of an integrative value chain is a high priority, an organisation is more likely to adopt an ERP system.*

From the point of view of ERP systems users, both propositions are supported by the results of this study.

The conclusions that can be drawn from the study are that the ERP maturity is high in Swedish manufacturing firms. ERP systems have not cut information technology costs, but have improved the availability and quality of information and the integration and interaction across the enterprise. Although the modules supporting the customer order process and financial management have the highest implementation frequency, the performance outcomes related to these areas are among the poorest, i.e. on-time delivery, inventory levels and cash management. Still, companies are ready to move on and extend their ERP functionality. These extensions are primarily oriented towards supply chain integration.

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