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ERP in large Danish enterprises: Implications for SCM

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ABSTRACT

This paper argues that with the present state of Enterprise Resource Planning (ERP) adoption by the companies, the potential benefits of Supply Chain Management (SCM) and integration is about to be unleashed. This paper presents the results and the implications of a survey on ERP adoption in the 500 largest Danish enterprises. The study is based on telephone interviews with ERP managers in 88.4% of the "top 500" enterprises in Denmark. Based on the survey, the paper suggests the following four propositions: (i) ERP has become the pervasive infrastructure; (ii) ERP has become a contemporary technology; (iii) ERP adoption has matured; and (iv) ERP adoption is converging towards a dominant design. Finally, the paper discusses the general implications of the surveyed state of practice on the SCM research challenges. Consequently we argue that research needs to adjust its conceptions of the ERP concept towards ERP II in order to accommodate to the emerging practices.

Keywords

Enterprise Resource Planning (ERP), Supply Chain Management (SCM), Denmark, Survey

INTRODUCTION

SCM is perhaps the most critical logistics issue in the majority of today's businesses. The challenge of SCM is to integrate and to coordinate activities across organizational boundaries in order to manage the entire supply chain as a whole. Various Enterprise Systems (ES) and above all the most recent ERP systems from the major vendors include new technologies to integrate the supply chain. The ERP system provide a platform for SCM and businesses can adopt the new functions offered by the new generation of enterprise systems thus taking advantage of the technological innovations.

ERP is a constantly changing and evolving concept (Klaus, Rosemann and Gable, 2000). The ERP systems have gradually been designed, developed and improved by the ERP vendors in response to new technologies and emerging business requirement (Mabert, Soni and Venkataramanan, 2001). As a result, the contemporary ERP packages from the major vendors now include not only the basic ERP functionality but also e-business functions like CRM, EAI, and in particular SCM and other functions that previously were associated with other classes of systems (Callaway, 2000).

Research is less responsive to the emerging new business practices, and often we have seen ERP research using an outdated perspective. Most papers on ERP cite Davenports (1998) paper as a baseline for their perception of the ERP phenomena or the more generic concept of enterprise systems (ES). Another large body of ERP papers quotes forecasts from analyst like Gartner, Forrester or AMR to argue for the importance of ERP and the state of the ERP market. In general these sources are reliable but the research companies themselves are actors in the ERP industry and their predictions are often rather optimistic.

In the aftermath of a Danish research project on the implementation of APS (Advanced Planning and Scheduling) and ERP the discrepancies between the conceptions based on theoretical studies and the practices experienced in the case studies led to a study of the adoption of ERP based on practitioner perception. Consequently a study of ERP practices in large Danish enterprises was initiated (Møller, Kræmmergaard and Rotbøl, 2003). The aim of this paper is to present an overview of the findings and to discuss the implications for SCM.

This paper will first discuss the dynamics of enterprise systems concepts and the relation between the ERP systems and SCM. Based on this discussion the survey focus is established. Then the survey is outlined along with the research method. The findings from the survey are then presented and discussed in the proceeding chapter. Finally the conclusions are summarized and further research on ERP and SCM is proposed.

ENTERPRISE RESOURCE PLANNING SYSTEMS

The concept of ERP has often been explained through the historical development of ERP (Klaus, Rosemann and Gable, 2000; Chen, 2001; and Markus and Tanis, 2000). The fundamental structure of ERP has its origin in the fifties and in sixties with

the development of the early Inventory Control (IC) systems and Bill of Material (BOM) processors. The progress continued during the seventies and eighties with the development of the Material Requirement Planning (MRP) systems and the Manufacturing Resource Planning (MRP II) systems. The vendors gradually integrated more areas into the scope of the standardized information systems and the advances peaked in the early nineties with the advent of the Enterprise Resource Planning (ERP) system – often embodied in the SAP R/3 system.

ERP is a standardized software package designed to integrate the internal value chain of an enterprise. According to Nah (2002) the American Production and Inventory Control Society (APICS) defines ERP as: "a method for the effective planning and controlling of all the resources needed to take, make, ship and account for customer orders in a manufacturing, distribution or service company". The APICS definition extends the concept of ERP from an IT system towards a technology to manage and organize the processes of an enterprise.

The research on ERP up until year 2000 is reasonably well documented and analyzed through the works of Esteves and Pastor (2001). They review the ERP literature through an ERP lifecycle model reflecting the phases of the adoption process. Adoption is the foundation of a large strand of ERP implementation research (e.g. Nah, Lau and Kuang, 2001; and Shanks, Seddon and Willcocks, 2003). Adoption and phased lifecycle thinking is also found in Markus and Tanis (2000) who provide an overview of the implementation issues.

Another strand of ERP research is the process-oriented research. This strand emphasizes the ERP technology as an enabler of BPR (Business Process Reengineering) and change (Siriginidi, 2000). The research deals with issues of process orientation, integration and the organizational change – both internally and as a second phase in the supply chain (Willis and Willis-Brown, 2002).

A third strand of ERP research is concerned with ERP in a strategic business context. Davenport's sequel on enterprise systems evolution (Davenport, 1998; Davenport, 2000; and Davenport and Brooks, 2004) is an excellent indicator of the evolution of business managers' perception of ERP. The discussions on ERP developed over the first enthusiastic expectations regarding business integration, via a growing number of horror stories about failed or out-of-control projects, towards a more profound understanding of the issues of integration. Today we see the same expectations being uttered on the impact of e-business and SCM (Davenport and Brooks, 2004).

Supply Chain Management

Supply Chain Management (SCM) has become one of the most important new business concepts and the source of competitive advantage (Christopher, 1998). In SCM the role of the ES is to extend the internal business processes into the extended enterprises and thus to develop integrated supply chains. Theoretically SCM has emphasized the management of the entire supply chain as one entity, and one of the frequently quoted cases of successful SCM is Dell. IT played a major role in the transformation of the Dell supply chain and IT has a tremendous influence on achieving effective SCM in general (Gunasekaran and Ngai, 2003).

European supply chain executives identified four important key SCM issues (Akkermans et al, 2002): i) further integration of activities between suppliers and customers; ii) on-going changes in supply chain needs and required flexibility from IT; iii) more mass customization of products and services leading to increasing assortments while decreasing cycle times and inventories; iv) the locus of the drivers' seat of the entire supply chain; and v) supply chain consisting of several independent enterprises. The same executives saw only a modest role for ERP improvements in future supply chain effectiveness and a clear risk of ERP actually limiting progress in SCM.

On the other hand Davenport and Brooks (2004) argue that early ERP were not primary focused on the supply chain, but the businesses that have been able to extend their enterprise systems into the supply chain with "bolt on" SCM systems have experienced substantial benefits. The key to this is the development of infrastructural and strategic capabilities embodied in ERP and SCM systems, also known as the next generation of ERP or ERP II.

The next generation ERP

The ERP market experienced a hype triggered by companies rushing to solve the Y2K problem, but after Y2K the ERP market soured. Back in those days the Internet boomed and Gartner Group which originally named ERP, redefined ERP into ERP II (Bond et al, 2000). ERP II includes six elements that touch on business, application and technology strategy: i) the role of ERP II; ii) its business domain; iii) the functions addressed within that domain; iv) the kinds of processes required by those functions; v) the system architectures that can support those processes; and vi) the way in which data is handled within those architectures. These ERP II elements represent an expansion of traditional ERP and ERP II is essentially componentized ERP, e-business and collaboration in the supply chain (Møller, 2003).

It was doubtful that traditional ERP would meet the e-business challenge (Mabert, Soni and Venkataramanan, 2001). New vendors of "bolt-on" systems like e.g. i2 Technology with Supply Chain Management (SCM) systems and Siebel with Customer Relationship Management (CRM) systems emerged on the scene (Calloway, 2000). Application Integration (EAI) became a serious issue (Thermistocleus, Irani and O'Keefe, 2001) and a new ERP integration strategy called "Best of Breed" (BOB) opposed to the single-vendor strategy became a feasible strategy to integrate an enterprise (Light, Holland and Willis, 2001) by using EAI and the BOB solutions. New delivery and pricing methods like ASP (Application Service Provider) and ERP rentals were conceived (Harell, Higgins and Ludwig, 2001) and the traditional ERP vendors were challenged.

The single ERP vendor strategy competed with the "Best-of-Breed" strategy. Markus, Petrie and Axline (2000) discuss two possible views on the future of ERP: a continuity view extending on the existing ERP systems and a discontinuity view where exchanges drive the supply chain integration and ERP is replaced by BOB.

Throughout the ERP industry the new philosophy of ERP and e-business was gradually incorporated into the legacy system offering, systems architectures were redesigned and modularized, e.g. like SAP did with the NetWeaver platform. This is why the contemporary standard systems incorporate ERP II. The ERP industry survived the challenge, and a recent market analysis does not render any signs of market fragmentation.

To conclude the discussion on Enterprise Systems we believe that ERP has evolved from being a state of the art technology towards being a state of practice. The new package offered by the major vendors has been extended by adoption of the e-business technologies into the ERP systems and by extending the systems scope into the supply chain – they have in fact transformed into ERP II systems. Thus a company, which has adopted a recent ERP system from one of the major vendors, will now have an adequate platform for integrating its processes into the supply chain. The managerial implication of this development could be that most enterprises now have a huge potential for reaping the benefits that ERP has lead them to expect for years (Davenport and Brooks, 2004).

SURVEY METHOD AND FOCUS

The purpose of the study is to explore the adoption of ERP in large Danish enterprises. Danish enterprises are relative small compared to the US companies. However, we expect findings comparable to those of other European countries and maybe to North America. Experience has shown that a traditional survey using a detailed questionnaire yields a low response rate. Therefore we chose telephone interviews as our survey instrument.

A recent study by Hunton, Lipincott and Reck (2004) suggested better financial performance for ERP adopters, but the pattern of ERP adoption is not homogeneous. Different business sectors (Duplaga and Astani, 2003) and different company sizes (Mabert, Soni and Venkataramann, 2003) have different practices. Therefore the survey has been focused on: (i) ERP installation, (ii) business sector; (iii) company size; and (iv) financial performance.

This survey is based on telephone interviews with ERP managers in 500 Danish enterprises. The interviews were carried out from the beginning of March until the end of April 2003 (Møller, Kræmmergaard and Rotbøl, 2003). The 500 companies were originates from the Børsen list (DK-500) of the largest Danish companies. The Børsen 500 list is the equivalent of the US Fortune 500 list. Børsen 500 (DK-500) is published annually by the Danish magazine "Børsen". The large Danish corporations are ranked according to revenue and other publicly available data.

	N	Minimum	Maximum	Mean
Revenue (€ m)	500	71	11,876	408
Employees	485	5	259,813	2,422
Own capital (€ m)	500	-970	1,824	17

Table 1. Overview of DK-500 enterprises (2002)

The Danish enterprises are small compared to US companies. The US Fortune 500 company ranking #500 alone pulls over 3 billion USD and that would qualify to a Danish rank of above #15. Table 1 presents an overview of the 500 surveyed Danish companies.

The 500 enterprises are grouped into 3 groups based on size: (i) the large "top 10" companies with average revenue of DKK € 5,446 million; (ii) the medium sized "top 100" companies with average revenue of € 953 million; and (iii) the small "top 500" companies with average revenue of € 160 million. The DK-500 list operates with one single line of business code per company. In this survey we have aggregated these codes into four groups of almost equal sized sectors: (i) general trade; (ii) traditional industry; (iii) new industry; and (iv) service etc.

The interview was conducted using a structured interview guide recording both quantitative and qualitative data. The ERP managers were asked about: i) their position in the organization; ii) the company's ERP system(s); iii) the ERP supplier/consultants; iv) the number of users in Denmark; v) the time of going-live with their present system/release; and vi) this year's ERP investments. The ERP managers' answers and assessments (e.g. their definition of ERP) were never discussed but they were presented with sample answers if they were in doubt.

The survey is intended to render the Danish condition and was designed to optimize the response rate. The sample was not intended for generalization purposes and there are interpretation issues in the survey that may jeopardize reliability. For instance the definition of primary ERP system, number of Danish users etc. are statements made by the interviewed manager. Also the key figures calculated for the DK-500 list are based on estimates on the Danish share of business. Danish enterprises have previously been known as fast adopters of ERP but as the ERP market is becoming global, the conclusions based on Danish conditions are believed to be valid for European and North American enterprises too.

SURVEY RESULTS

In total we got interviews with 88.4% of the 500 companies. 73.4% had their own ERP system and 2% had group or corporate ERP and these are considered adopters too. 5.2% had no ERP and 7.8% specifically declined to participate in the survey, and finally 11.6% did not answer or were not identified. The non-responses were mainly from new industries, and all of the largest companies participated in this study and they were ERP adopters.

Response	*Frequency*	*Large companies*	*Medium companies*	*Small companies*	*Percent*	*Cumulative Percent*
Have their own ERP	367	10	61	296	73.4%	73.4%
Have corporate ERP	10	0	4	6	2.0%	75.4%
Have no ERP	26	0	5	21	5.2%	80.6%
Declined to participate	39	0	8	31	7.8%	88.4%
Did not answer	29	0	8	21	5.8%	94.2%
Were not identified	29	0	4	25	5.8%	100.0%
Total	*500*	*10*	*90*	*400*	*100.0%*	

Table 2. Overview of the responses (N=500)

Of the 26 companies with no ERP, one company had an implementation date set, and five present group IT/ERP issues as the reason for not having ERP. 100% of the companies in the "top 10" participated in the survey (vs. 87% of "top 100" and 89% of "top 500"). The responses are summarized in table 2 and shown for each of the three different size groups: the "top 10" large companies, the "top 100" medium sized companies, and the "top 500" small companies.

The ERP managers were asked to name their ERP system and if they had more than one ERP system (13.6%) they were asked to identify their primary system. We found 55 different ERP systems (several variants) of which only 25 systems were found in more than one company. Almost two-thirds of the ERP systems were systems supplied by the "top 5" vendors. Table 3 shows the frequency of the "top 5" vendors' installations. Only 6.6% of the companies have no ERP and 9.4% have an in-house developed legacy ERP system as their primary ERP system.

As many other countries Denmark has several small and local vendors specializing in various sectors or dedicated to various aspects of the ERP domain. But above all, two successful vendors originate in Denmark, namely Navision and Damgaard Data, which now have been merged into Microsoft Business Solution, from now on just Microsoft. Microsoft (also offering Great Plain and Solomon) has an outstanding position on the Danish market based on a broad but also older range of platforms, primarily focused on the small and medium-sized enterprises (SME). EDB Gruppen is a local vendor partly owned by IBM.

ERP adoption relies on company size. All the large companies have adopted ERP. SAP is the preferred vendor in large and medium-sized companies, whereas Microsoft is the preferred vendor in small companies. ERP adoption also relies on the business sector. The non-adopters of ERP are mainly found in general trade. Also the preferred vendor relies on business sector. This is mainly due to the stronghold of Intentia in traditional industry, Oracles stronghold in new industry, and due to the extent of in-house developed systems in general trade businesses.

Installation	Total Percent	General Trade	Traditional Industry	New Industry	Service, Etc.	Total	Cumulative Percent
Microsoft	34.2%	25.4%	32.8%	23.9%	17.9%	100%	34.2%
SAP	19.9%	21.8%	39.7%	28.2%	10.3%	100%	54.1%
Other vendors	17.3%	29.4%	30.9%	16.2%	23.5%	100%	71.4%
In-house	9.4%	48.6%	27.0%	13.5%	10.8%	100%	80.9%
EDB Gruppen	5.1%	45.0%	25.0%	15.0%	15.0%	100%	92.6%
Intentia	4.1%	18.8%	75.0%	0%	6.3%	100%	96.7%
No ERP	6.6%	38.5%	34.6%	19.2%	7.7%	100%	87.5%
Oracle	3.3%	7.7%	30.8%	53.8%	7.7%	100%	100.0%
Total	*100%*	*28.6%*	*34.7%*	*21.7%*	*15.1%*	*100%*	

Table 3. Overview of the identified ERP installations (N=392)

The companies in the survey were asked when they went live (year/quarter) with their most recent system/release and from that the age of the systems is deduced. The age of the ERP systems was 2.8 years on average ranging from 0 to 27 years. Figure 1 provides an overview of the distribution of the most recent going-live years. Only the first quarter of 2003 was observed during the survey. Almost 40% of the companies went live during the first quarter and 20% in each of the other quarters. Therefore the total number of new installation in 2003 is estimated based on first quarter. Figure 1 also illustrates the impact of Y2K on the rate of ERP adoptions. An increasing number of enterprises went live with a new system towards year 2000, then a recession followed in 2001, and then again from 2002 we experience an increasing number of new installations.
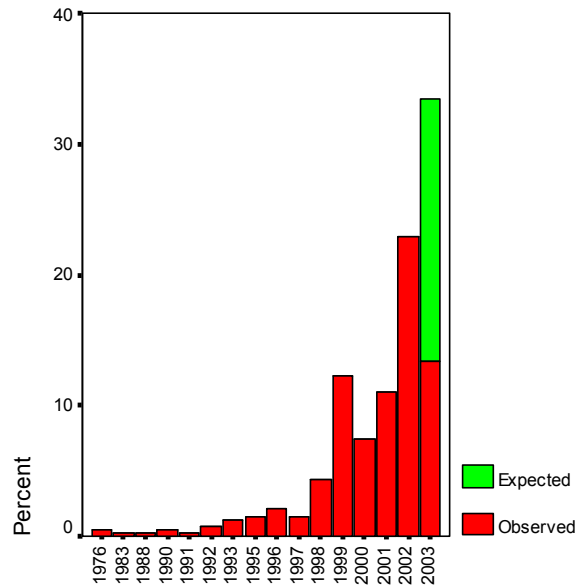

Figure 1. Most recent ERP going live years/system age (N=334)

The companies were asked to estimate their ERP-related investments in 2003. Almost one third of the companies answered that they have no plan for ERP investments, and 50% of the remaining two-thirds of the companies only had plans for maintenance. The rest invest in upgrades as well as maintenance. There are different practices amongst the vendors concerning new releases, but in general maintenance contracts include new releases. In average the ERP investment was € 3.9 million or 0.9% of the average revenue, but the majority of companies had more modest projects. In figure 2 the distribution of the ERP investments is illustrated (DDK 100 = € 13.3).
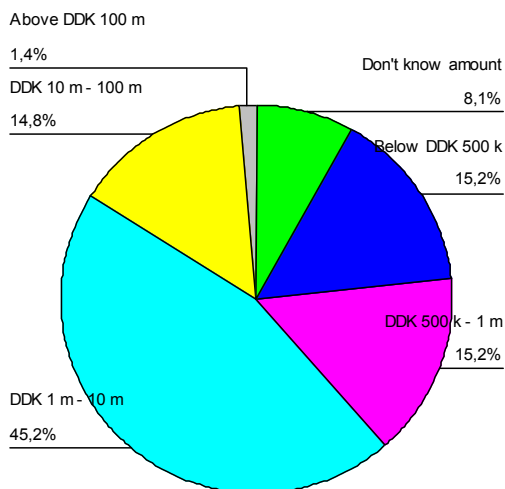
Figure 2. Estimated 2003 ERP investments (N=210)

The managers were asked the estimated number of users (in Denmark) giving an average of 397 users per installation. Given the average company size is 2,708 we have 15% ERP user per staff in average.

Table 4 compares averages of the ERP installations. The table compares different ERP vendors and non-adopter on the number of installations, average: revenue, staff, ERP users, ERP age and return on revenue (ROR). Based on revenue, staff, and number of ERP users the dominance shifts between Microsoft and SAP. Also we see poor financial performance for the non-adopters and for companies with in-house developed systems. Companies with an Oracle installation also have poor financial performance, but those installations are the most recent in this study.

Installation	*# of ERP installations*	*Revenue (€ m)*	*Revenue (%)*	*Staff*	*Staff (%)*	*ERP users*	*ERP users (%)*	*ERP age*	*Return on revenue (%)*
Microsoft	34.2%	188	15.0%	793	10.1%	137	12.8%	2.4	4.2%
SAP	19.9%	930	43.2%	8,196	61.2%	779	41.0%	2.4	3.6%
EDB Gruppen	5.1%	323	3.8%	1,529	3.0%	401	5.6%	3.2	2.3%
Intentia	4.1%	169	1.6%	1,165	1.8%	267	3.0%	2.8	3.0%
Oracle	3.3%	781	6.0%	3,355	4.2%	372	3.4%	0.7	-3.8%
Other vendors	17.3%	344	13.9%	1,489	9.4%	265	12.5%	3.6	5.5%
In-house	9.4%	564	12.4%	2,324	7.9%	885	21.7%	4.8	1.2%
No ERP	6.6%	253	3.9%	1,083	2.5%	-	-	-	-19.8%
Total	100%	428	100%	2,708	100%	397	100%	2.8	2.3%

Table 4. Summary of the installation averages

DISCUSSION

ERP has been adopted by large Danish enterprises in general. Only 6.6% of the companies have not adopted ERP, their financial performance is poor, and their number is decreasing. On the other hand there is a large group of companies not investing actively in ERP as well as a group of businesses with aging ERP. Based on the theoretical studies we would have expected to find an aging ERP base and a flourishing e-business market, which, however we cannot detect in this study. Anyhow this study suggests the following four propositions: (i) ERP is the pervasive infrastructure; (ii) ERP is a contemporary technology; (iii) ERP adoption stable; and (iv) ERP adoption is converging towards a dominant design.

ERP is the pervasive infrastructure because it is so widely adopted. Based on the high percentage of adopters and based on the explanations from the non-adopters we conclude that ERP as a technology is a prerequisite to run any business, and that it should be considered an infrastructure rather than a new technology. Therefore it will be of great interest to explore how the adopters have implemented and developed their capabilities based on ERP. However, can we conclude that the businesses have developed streamlined internal logistics processes just because they've adopted ERP?

ERP is a contemporary technology because the installed base is renewed. Based on the average age of the systems (2.8 years), we conclude that the ERP technology follows the normal IT lifecycle. There are differences, and we can see that the in-house developed ERP systems are still to be considered a legacy technology. The overall implications are that the latest releases and technologies are available to be used by the industry. However, can we conclude that the advanced collaborative supply chain functions have been adopted and deployed?

The ERP adoption is stable, because the market is consolidated. Based on the adoption level, the vendors market shares and the systems age, we conclude that the ERP market is matured. Indications are that we end up with one (SAP) maybe two or three major vendors, a handful of global vendors, and a small number of vendors specializing in specific industries or countries. We find a similar pattern amongst the systems suppliers and implementation consultants. This is further reinforced by the fact that ERP investments are below 1% of the revenue in average. However, can we conclude that the ERP market is no longer innovative?

ERP adoption is converging towards a dominant design due to the facts mentioned above. Only 14% of the companies use more than one ERP vendor. This indicates that the businesses are pursuing a "single-vendor" strategy rather than a "best-of-breed" strategy. Consequently, the ERP II functions are provided by the major vendors systems, and add-on modules or third part bolt-on systems may only have a limited scope. This may have the implication that supply chain planning will be dominated by, e.g. SAP APO (Advanced Planning and Optimization) modules and hence that the reference models provided by the major vendors will be the future supply chain templates. This might imply that the variety in the applied logistics concepts is reduced to the standards defined by the major vendors. However, can we conclude that inter-organizational integration will be much easier with enterprises using the same platforms?

CONCLUSION

This study has provided some new insight into the ERP market and into the adoption of ERP by large Danish enterprises. We conclude that ERP is an institutionalized component of enterprise infrastructure. The implications to research are that the time is now ripe to rethink the concept of enterprise systems and to gain a deeper insight into the business impact of ERP, which ERP II may provide the conceptual framework for. This is especially critical to research into SCM. The potential benefit from supply chain integration is contingent on a large number of factors determined by *how* the ERP II technology is adopted by companies.

One of the potential directions could be to develop a generic taxonomy of processes and the SCM functions. Industry has been working on the SCOR model for analytical and benchmarking purposes. Inter-organizational logistic concepts and processes like CPFR or VMI are also developed by industry. Research need to formulate general theories on the effective use of enterprise system functions to support SCM. A first step could be to develop detailed maturity models for ERP II adoption in tandem with the process taxonomy. These models would be instrumental in the management of second-wave ERP adoption. Theories for managing enterprise systems architecture is an emerging discipline of paramount interest to the practice of supply chain management to unleash the potential of SCM.

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