ERP II - Next-generation Extended Enterprise Resource Planning

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ABSTRACT

ERP II (ERP/2) systems is a new concept introduced by Gartner Group in 2000 in order to label the latest extensions of the ERP-systems. The purpose of this paper is to explore the next-generation of ERP systems, the Extended Enterprise Resource Planning (EERP or as we prefer to use: eERP).

The results of the paper are threefold: First a conceptual framework for eERP is established. Secondly, the business and research issues of this new framework are evaluated in the perspective of ERP and in particular the SCM developments. Third, the conceptual framework is applied in a discussion of potential impact on extended enterprise architecture..

Keywords: Enterprise Resource Planning; Supply Chain Management; Extended Enterprise; E-business

1. INTRODUCTION

The development of Enterprise Systems (ES) have progressed through almost fifty years in a constant interaction between changing business requirements, technological and organizational maturity and software vendors capabilities (Wortmann 2000).

ERP II or ERP/2 systems is a new concept introduced by Gartner Group in 2000 to label the latest extensions to the ERP-systems (Classe 2001). Gartner Groups conception of ERP II is almost similar to what AMR Research define as Enterprise Commerce Management (ECM) (Mello 2001). In this paper we use the concept of Extended Enterprise Resource Planning (eERP) as a generic concept combining ERP II, ECM as well as the state-of the-art systems provided by the ERP vendors.

From a research point of view the new eERP concept may be discussed and some might argue that the concept is just "another one of theese marketing gimmicks" designed by the software vendors and the consultants. Other may argue that the ERP II systems are "just" e-business enabled ERP and other again will claim that the new generation of extended enterprise systems will require business to rethink their approach to enterprise systems, implementation and to designing supply chain architecture – or will they?

In this paper we will set out to develop a conceptual framework for understanding the next-genration of enterprise systems. The framework will be based on an analysis of the new modules and functions supplied by the software vendors. Then we will explore and discuss the new challenges to the extended enterprise systems based on a retrospective analysis of the logistics and supply chain management concept. Then the conceptual framework applied in a discussion of potential impact on extended enterprise architecture.

The methodology behind this paper has been to establish an understanding of the evolution of the enterprise systems. Therefore chapter two is a retrospective analysis enterprise systems and chapter three sum up the developments in supply chain management concept. The trend and tendencies are embodied in the extended enterprise concept described in chapter four and the synthesis of these two parts are used to establish the conceptual framework for extended enterprise systems architecture in the fifth chapter. Finally the emerging new concepts of the extended enterprise framework will provide a background for concluding on the new research and business challenges in the last chapter.

The paper is based on a research project sponsored by the Danish Ministry of Industry and Trade on the Implementation of ERP (Enterprise Resource Planning) and APS (Advance Planning and Schedulling). The framework and the conclusions have been presented and discussed on workshops and interviews with ERP managers in Danish companies representing SAP, Baan and Navision, but from studying the other major eERP vendors websites (Oracle, Peoplesoft, JD Edwards etc.), no significant difference are noticeed.

2. THE EVOLUTION OF ENTERPRISE SYSTEMS

Enterprise Resource Planning (Bancroft 1996) emerged in IS in the late 90'es. Davenport (Davenport 1998) sum up the first wave of experiences from implementing ERP systems in a much cited paper on putting the enterprise system into the enterprise and point to the new central business impact of the ERP systems. Skok and Legge (Skok and Legge 2002) summarize the key drivers for the use of ERP systems in world-class organizations as:

- Legacy systems and Year 2000 system concerns
- Globalization of business
- Increasing national and international regulatory environment, e.g. European Monetary Union
- BPR and the current focus on standardization of process, e.g. ISO9000
- Scaleable and flexible emerging client/server infrastructures
- Trend for collaboration among software vendors

ERP is often viewed as a newer approach to ISD because of the following factors (Skok and Legge 2002):

- The number and variety of stakeholders in any implementation project
- The high cost of implementation and consultancy
- The integration of business functions
- The consequent configuration of software representing core processes

- The management of change and political issues associated with BPR projects
- The enhanced training and familiarization requirement

The rush implementations in the beginning of the period has been replaced by what is refered to as an "Enterprise Systems Experience" where the implementation process is confined into four distinkt phases (Markus and Tanis 2000). The notion of implementation and succes or faillure is however more complex, and Ross and Viale (Ross and Vitale 2001) introduce an: "ERP journey" and the idea of business transformation enabled by ERP.

In Kræmmergaard & Møller (Kræmmergaard and Møller 2000) these ideas are elaborated on and ERP is combined with the Extended Enterprise leading to formulate an "Extended Enterprise System", an an "Extended Transformation Process" and an "Extended Implementation Process". Furthermore Kræmmergaard & Møller (Kræmmergaard and Møller 2001) presents a multi-dimensional essentially encopassing: people, business, technology and process issues.

However ERP systems has antedecendants more than forty years back and the evolution of enterprise systems have progressed through history in a constant interaction between changing business requirements, technological and organizational maturity and software vendors capabilities (Wortmann 2000).

Planning and Scheduling (APS) and Internet procurement or e-procurement (Callaway 2000). Below we will elaborate on this definition in order to establish a framework for eERP functionality (see figure 1).

The traditional ERP is the main component in the eERP system. But for the purposes of the collaboration, an eERP system is opened to inflow and outflow of information. The ERP applications are now web enabled meaning that the functions are available from the internet, either on a corporate **Intranet** or through a corporate controlled **Extranet**.

E-commerce denotes the carrying out of commercial transactions be it with businesses or with individual customers over the electronic medium, commonly the Internet. This indeed requires an extensive infrastructure of which the main features are a catalogue, online ordering facilities and status checking facilities. ERP system serves as the transaction processing back end for the Internet based front end. Some of this functionality may be build on legacy EDI modules.

e-procurement or Internet Procurement improves the efficiency of the procurement process by automating and decentralizing the procurement process. The traditional methods of sending Request for Quotes (RFQ) documents and obtaining invoices etc. are carried out over the web through purchasing mechanisms such as auctions or other eletronic Marketplace funktions, including catalogues.

Those four items constiues the portal for the eERP system.

Table 1. Enterprise Systems in retrospective.

Decade	Label	New concept
60	Inventory Control Systems, forecasts	Computer in business applications
70	Material Requirement Planning (MRP)	Bill of Material (BOM) and material requirement calculations
80	Manufacturing Resource Planning (MRP/II)	Closed Loop Planning and capacity constraints
90	Enterprise Resource Planning (ERP)	Integrated database and HRM and quality management
00	Enterprise Resource Planning (ERP/II)	Inter-organizational collaboration

With the introduction of computers to industry the first applications were automating manual tasks such as book-keping, invoicing and reordering. Gradually as the sophistication of computers and models increased the enterprise systems begun to take a more active role as a planning and control agent. After the CIM (Computer Integrated Manufacturing) experiences in the eighties the role of the enterprise systems has been redefines to a decision support tool. Also the scope of the enterprise systems has evolved from manufacturing to the entire enterprise (ERP).

Thus in the begining of a potential new era for enterprise systems (ERP/II) we need to explore the the new concepts of the enterprise systems in detail.

The ERP/2 concept is a term designed by Gartner Group in 2000 (they also named the ERP systems) as "an application and deployment strategy to integrate all things enterprise centric". AMR Research defines ECM as: "Enterprise Commerce Management (ECM) is a blueprint that enables clients to plan, manage, and maximize the critical applications, business processes and technologies they need to support employees, customers, and suppliers" (www.amrresearch.com/ECM).

The prime functionalities of the eERP systems are E-commerce, Supply Chain Management (SCM), Customer Relationship Management (CRM), Business Intelligence (BI), Advance

Both Business Intelligence (BI) and Advance Planning and Scheduling (APS) provide decision support. While the BI function analyses the data collected in the corporate Datawarehouse for providing decision support, the APS system optimizes the production capacity based on the forecasted orders, inventories and production capacity.

Supply Chain Management (SCM) systems provide information that assist in planning and managing the production of goods. For instance, SCM assists in answering questions such as where the good is to be produced, from which the parts are to be procured and by when it is to be delivered. The SCM systems build on APS for decision support.

Customer Relationship Management (CRM) systems facilitates the managing of a broad set of functions that primarily include the categories of customer identification process and customer service management. The ERP system provides the CRM systems with the required back end information.

In addition to the above mentioned there are numerous new systems and emerging concepts not touched upon here, e.g. **Corporate Performance Management (CPM)** and **Human Resource Management (HRM)** systems.

Figure 1. eERP conceptual framework.
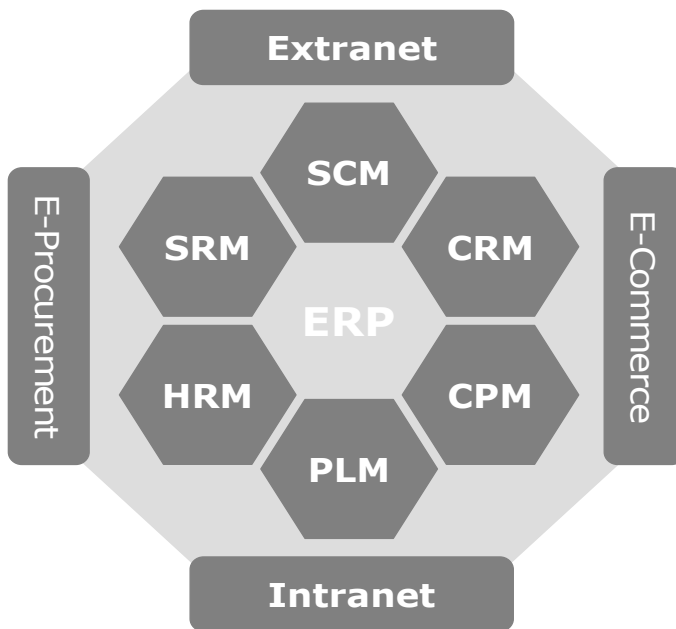
Product Lifecycle Management (**PLM**) including Product Data Management (PDM) enables enterprises to bring innovative and profitable products to market more effectively, especially in the evolving e-business environment. PLM enables enterprises to harness their innovation process through effective manegment of the full product definition lifecycle in their extended enterprises. (cgi.appliedcaecouk.force9.co.uk/cgi-bin/group/e-Eng/pdm.php).

Supplier Relationsship Management (**SRM**) is the vendor side analogy to CRM aimed at the management of the supplier base. SRM is rapidly transitioning from a competitive advantage to a competitive necessity, and is an essential element for companies to successfully compete in the evolving new world of e-business.

These new functions are provided through a combination of best-practices processes and technologies such as product data management, collaboration, visualization, enterprise applications integration, components supplier management, knowledge management, etc. However we coclude that the generic functionality of eERP systems may be conceptualised as illustrated in the framework in figure 1 above.

What we have seen so far is an evolution of the ERP systems explained from an information systems point of view. To understand the development further we need to analyse the concepts of logistics and supply chain management in order to be able to understand the driving force behind the new business models that eERP enables.

3. LOGISTICS AND SUPPLY CHAIN MANAGEMENT

Supply Chain Management (SCM) has gained increasingly importance to industry over the last decade. Global competition has implicated outsourcing to industry and internal improvement potentials have been exhausted and companies have thus turned their attention to their supply chain. In many cases supply chain excellence is seen as an important leverage to competitiveness and thus vital to manage.

The conception of the entire supply chain as one system embodies the core of SCM. SCM has evolved from an internal logistics management perspective, towards a slightly more strategic and an external integrated process view on the supply chain.

The concept of Supply Chain Management (SCM) has its roots in the late fifthties where researchers on system dynamics explored the systemic properties of enterprises collaborating in chains.

Business dynamics (Forrester 1958) dealt with delays and information flow and addressed contemporary problems like the "Bullwip effect" which is still an issue. The business implication of this research remained insiognificant due to the maturity of the computers and also due to the fact that the inventory control systems solved problems with success (c.f. previous chapter).

The lack of tools and techniques have postponed this approach for decades, but the concepts re-emerged from the beginning of the 80'ies in production planning and logistics research, and by the 90'ies businesses were implementing major structural changes under the label of Supply Chain Management (Cooper, Lambert et al. 1997).

SCM took a systems approach to planning and controlling the material and information flow from the raw material to the final customer, and therefore SCM was defined as "The management of upstream and downstream relationships with suppliers and customers to deliver superior customer value at less cost to the supply chain as a whole (Christopher 1998)".

The strategic and the contractural discussions dominated the research agenda (Scott and Westbrook 1991), but the software industry responded to the business requirement by producing a new breed of software add-ons to ERP essentiaslly extending the MRP/II planning concept to encompass the entire supply chain (Advanced Planning and Schedulling, APS). This was enabled by the refinement of mathematical programming and in particular the genetic algorithms.

Although SCM approach the entire chain, the academic discurs of SCM vary slightly between an upstream view and a downstream view. In the upstream SCM view the problems dealing the supplier network are dominating. Issues like supplier relations, partnerships, competence development and technology transfer becomes barriers for devoping the supply chain. The downstream issues are related to the demand management, order fulfillment, and Custumer Relationsship Management (CRM).

In practice the issues depend on the specific situation of the company. A tendency is however to promote SCM to an cross-functional organizational structure. Purchase managers, production planners and sales people team up with the suppliers and the customers in order to execute logistics in the supply chain. This creates a very complex situation new to most enterprises and hence managing information in the supply chain becomes very important.

Hau Lee defines e-business in a SCM context as: "The term "e-business"— as distinct from "e-commerce" — can be used to describe this exciting adoption of the Internet to accelerate the goal of supply chain integration. In this context, e-business specifically refers to "the planning and execution of the frontend and back-end operations in a supply chain using the Internet" (Lee & Whang, 2001). In fact they argue that e-

business already has enabled supply chain integration and that focus therefore should be redirected towards managing the demand chain.

If we look at the industrial best practice e.g. the cases collected from the ASCET projects (http://www.ascet.com) we see mainly supply chains that has a dominating enterprise – a supply captain – directing the supply chain. But we have several new teoretical concepts dealing with true networks.

4. THE EXTENDED ENTERPRISE AND BEYOND

Most industrial enterprises has been confronted with new challenges and opportunities, derived from globalization, new business dynamics and manufacturing concepts. An U.S. report from 1991 on the 21st century manufacturing enterprise strategy concluded that the transition towards agility would be an imperative to become the strongest competitor in the global marketplace (Nagel and Dove 1991). They observed that there was a common infrastructure requirement for all agile manufacturing enterprises, regardless of their industry sector. This led to a larger nation-wide research project that aimed at identifying the next-generation manufacturing enterprise, in which the extended enterprise is gaining an increasing importance.

The Extended Enterprise is a concept, which have been used to characterize the global supply chain of a single product in an environment of dynamic networks of companies engaged in many different complex relationships. The interorganizational network may be defined as a system consisting of all the relevant functions of a company, its suppliers and its customers, who together are termed the extended enterprise. The distinction between a "Company" and an "Extended Enterprise" is suggested in the Next Generation Manufacturing report (Patterson, Hardt et al. 1997):

- A Company is a conventionally defines profit-making entity with "management sovereignty" and well-established bounds of ownership and liability. It is charged with responsibility and control over its own actions.

- An Extended Enterprise is a group of institutions that develop linkages, share knowledge and resources, and collaborate to create a product and/or service. This collaboration maximizes combined capabilities and allows each institution to realize its strategic goals by providing integrated solutions to customers' needs.

Consequently, the Extended Enterprise is a generic systems perspective of the network of companies performing the manufacturing task. O'Neill & Sackett (O'Neill and Sackett 1994) categorize the extended enterprise as being mainly characterized by engineer to order. However, the overall challenge of the "extended enterprise" is to ensure effectiveness of supply chains and production networks, at both national and global level.

A central process of the Extended Enterprise is the material flow in the supply chain. SCM has been dominating the fields of logistics and production management. All through it is discussed (Cooper, Lambert et al. 1997) whether SCM provide new perspectives on logistics or not, the supply chain has been cemented both companies and in industries. SCM addresses the managerial issues of the supply chain, i.e. the internal perspective of managing the relationships towards the suppliers (Olsen and Ellram 1997) and the external perspective of developing partnerships. This is consolidated in the network perspective of the network interaction model (Håkansson 1982).

The first wave of SCM have been preoccupied with supply chain structure. The level of outsourcing, relationsships in the chain and integrations mechanism has and will be instruments for managing the supply chain. A new emerging dimension is the dynamics of the business environment in which the supply chain operates. The rate of which framework condition changes and new business opportunities arises is increasing and as a consequence the supply chain is no longer a static entity but needs to be agile. Take E-commerce as an example of a challenge most enterprises has do deal with in some way or another.

The constant adaption or configuration of the supply chain in order to meet the requirements of a voilatile market consisting of individual customers is comparable to the refocusing in manufacturing from cycle times to change-over times: not only new tools were needed but anso new concepts and approaches. This is the challenge of the next generation supply chains. Gartner charaterize this change of SCM towards networks as adaptive supplier networks and SAP has been fast to adapt this concept.

Mass Customization is one of the new manufacturing concepts that require the enterprise to be agile. The pressure on industry to embark into the manufacturing of individually customized products is amongst others rooted in the emergence of new Internet-based business models. These new business models require companies to manage individual customer orders from upstream in the value chain through the entire supply chain to direct deliveries to the customer.

For the average industrial enterprise, the transformation towards agility is a major challenge. For years, the company may have optimized on the single function with focus on cost and capacity utilization. The price of functional focus is usually the performance of the customer-oriented processes.The transformation of the company towards process orientation must be accomplished without jeopardizing the rationale of the functional organization. This is the central design dilemma in the Extended Enterprise.

5. DISCUSSION

When we combine the network oriented Extended Enterprise concept with the evolution of the enterprise systems we find a gap between state of theory and state of practice. Theory seems to advocate loose coupled business and systems architecture where as ERP systems in practice seems to support tight coupled supply chains and integrated systems.

We have interpreted this gap as an architectural challenge to manage. This raises the important question of the structure of Enterprise Systems in the Extended Enterprise perspective?

Markus and other dicuss the evolution of ERP system (Markus, Petrie & Axline 2000) and they come up with two scenarios for the future: a continuity view with monolitic systems ("Wall to wall SAP") and a discontinuity view with componentized systems ("Best of Breed").

This architectural dilemma extends into the Supply Chain and thus it may be replicated at the inter-organizational level, but it

is not determined by the information systems alone but also the by the business structure in the supply chain. How can we represent the structure of the systems?

Figure 2. Intra-organizational systems architecture.
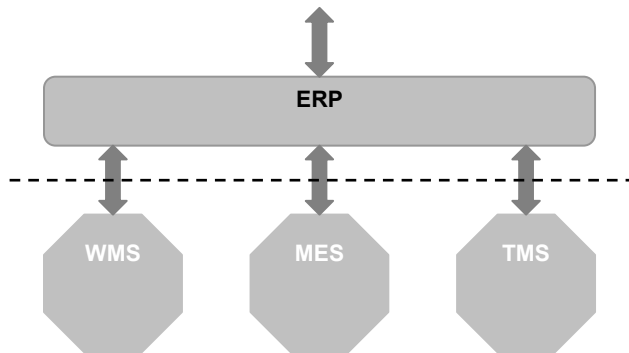
At the lowest level (c.f. figure 3 above) of the architecture we have the shop floor systems: Manufacturing Execution Systems (MES), Warehouse Management Systems (WMS) and Transportation Management Systems (TMS) not yet standardized. The shop floor systems interface to the ERP systems, which may be of different make or even a legacy system, but essentially of same architecture. Theese ERP systems are integrated along the supply chain using a Supply Chain Planning system like i2 or SAP APO. This high level structure is the eERP architecture (c.f. figure 3 below).

Figure 3. Inter-organizational system architecture.
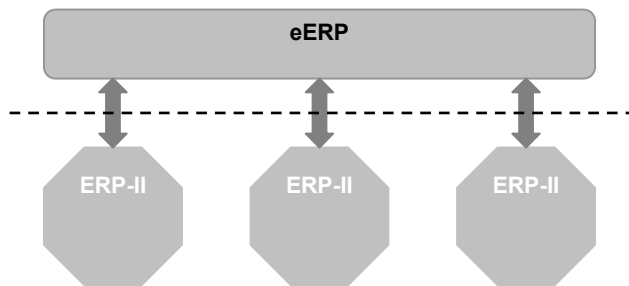
Based on the above evaluation of half a century developments in logistics and information systems we find that the fundamental architecture, the dominating structure, of the enterprise systems has been determined in a dialectic development process between the supply chain business models and IS application models. The available IS applications has largely been determined by the state-of-the-art IT technology but also by the software vendors interpretation of business requirements. On the other hand is the business requirement largely determined by the strategic business issues but also by the available IS opportunities for supply chain collaboration.

Consequently we may explore the extended enterprise systems architecture by using two dimensions: 1) the supply chain dimension and 2) the enterprise system dimension.

The supply chain dimension characterize the coherency of the business systems along the supply chain. Until the emergence of the SCM concept and long-term relationsships, logistics were confined to the single enterprise, but with the emergence of the Extended Enterprise concept the idea of dynamic configuration of relations and short-term relationsships were reborn. We assume supply chains are either tight coupled or decoupled.

The enterprise systems dimension characterize the coherency of the information systems along the supply chain. Originally the enterprise systems in a supply chain was completely fragmented until the developments in the DBMS made integrated ERP systems possible. The Internet and web based technologies are now enabling both centralized and distributed solutions. We assume that the enterprise systems are either integrated or modular.

Given these two dimensions we can establish a model of the extended enterprise systems architecture c.f. figure 4. In this model we can identify four archetypes each representing a specific extended enterprise system configuration.

Figure 4. eERP architecture.
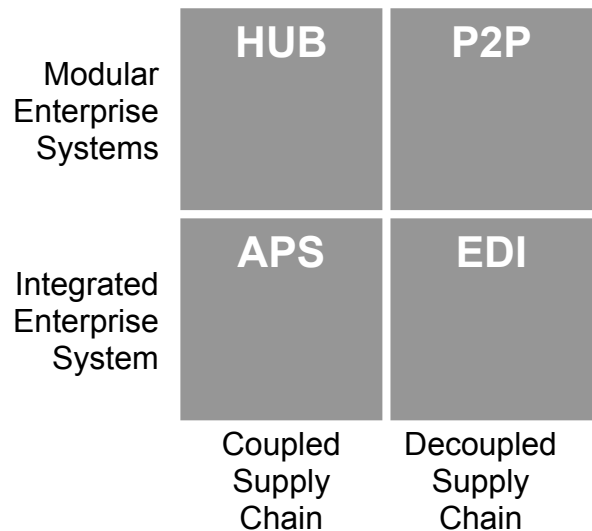
The **APS** configuration. This kind of configuration is an extension of the MRP/ERP planning and controlling philosophy were an aggregated and centralized state model of the static supply chain is established in an Advanced Planing and Schedulling (APS) system.

The **EDI** configuration. This is a classical static enterprise-to-enterprise configuration were structured data interchange between main actors using an agreed standard such as EDIFACT or XML.

The **HUB** configuration. Is the marketplace or exchange configuration were specialized intermediaries assure dynamic supply chain relations can be established on an application-to-application level (e-procurement).

The **P2P** configuration. Is the true network configuration where autonomous organizations are collaborating using computer supported processes enabled by new P2P (Peer-to-peer) technologies like used in file-sharing services like Kazaa.

These four situations are archetype configuration and are not likely to appear in any single or in purified form. However this model may serve as a conceptual lens or as a framework for understanding extended enterprise systems architecture. The different configurations has different implications and require different business strategies. An industrial manager may therefore use the model for analysing the present situation and plan for the future.

6. CONCLUSION

In this paper we have developed a conceptual framework for eERP systems and an extended enterprise systems architecture. In the model we have identified four different archetype situations, and the model may be applied in the analysis and planning of future enterprise systems strategy.

At this stage the model is mainly speculative but the models has been validated through prototype workshop sessions with ERP managers from Danish industry. The preliminary results shows that the issues raised by the models are critical to the companies but also that further development is required.

The new generation of ERP systems, the extended enterprise systems or eERP systems include the applications to support the new supply chain models. In some of the cases we can extend the concepts of ERP to extended enterprise systems but in other cases we will require business to rethink their approach to enterprise systems, implementation and to designing new supply chain strategies.

The future research challenges are obvious on the HUB situation, which include e-procurement and marketplaces. Especially we are concerned how we should redefine our ERP implementation framework to adapt to the interorganizational issues in ERP/II.

Also more basic research on interorganizational models are needed. Today we mainly have to rely on the software vendors "language". The challenge here is to establish generic models like the SCOR model (www.supply-chain.org).

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