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PERFORMANCE INCREASE BY USING ENTERPRISE RESOURCE PLANNING IN SUPPLY CHAIN MANAGEMENT: AN APPLICATION

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ÖZET

Yüksek Lisans Tezi

Tedarik Zinciri Yönetiminde Kurumsal Kaynak Planlama Kullanımı ile Performans Artışı: Bir Uygulama

Özgür KILIÇ

Dokuz Eylül Üniversitesi

Sosyal Bilimler Enstitüsü

İngilizce İşletme Anabilim Dalı

İngilizce İşletme Yönetimi Programı

Teknoloji çağında olduğumuz bu günlerde, işletmeler firmalar arası işbirliği ve iletişimin önemini daha çok anlamaya ve bu bağlamda hem tedarikçileri hem de müşterileri ile olan ilişkilerini karşılıklı fayda ve işbirliği esasına bağlı olarak yeniden gözden geçirmeye başlamışlardır. Tedarik zinciri yönetimi; tedarikçiler, üreticiler, dağıtımcılar ve müşterilerin de içinde bulunduğu ağ içerisinde bilgi, malzeme ve para akışının yönetilmesinde işletmelere büyük kolaylık sağlamaktadır.

Yeni bilgi teknolojilerinin son yıllarda ortaya çıkması sonucu işletmeler tedarik zinciri yönetimini kolaylaştırmak adına kurumsal kaynak planlama yazılımlarının kullanımına başlamışlardır. Bu çalışmada kurumsal kaynak planlama yazılımlarının işletme içerisinde başarılı kurulumu sonrası tedarik zincirinde ne gibi performans artışlarına yol açabileceği araştırılmıştır.

Anahtar Kelimeler: Tedarik Zinciri Yönetimi (TZY), Kurumsal Kaynak Planlama (KKP), Tedarik Zinciri Kurumsal Kaynak Planlama Entegrasyonu.

ABSTRACT

Master Thesis

Performance Increase by Using Enterprise Resource Planning in Supply Chain Management: An Application

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Master of Business Administration Program

Due to the technological advances in recent years, companies realized the importance of collaboration and communication and thus began to look over the relationship both between suppliers and customers in terms of mutually beneficial for each. A typical supply chain consists of manufacturers, distributers, suppliers and customers. With supply chain management it is easy for companies to manage information, material and money flows within the supply chain.

As a result of rapid development in information technologies, organizations began to use enterprise resource planning software in order to make it easier to manage the whole supply chain. This study investigates the real impact of enterprise resource planning to supply chain management and performance increases in organizations.

Keywords: Supply Chain Management (SCM), Enterprise Resource Planning (ERP), Integration of Supply Chain and Enterprise Resource Planning

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ABBREVIATIONS

BPR: Business Process Reengineering
BSC: Balanced Scorecard
CRM: Customer Relationship Management
CSF: Critical Success Factors
EDI: Electronic Data Interchange
ERP: Enterprise Resource Planning
GM: General Motors
GSCF: Global Supply Chain Forum
IS: Information System
IT: Information Technology
JIT: Just in Time
MRP II: Manufacturing Resource Planning
MRP: Materials Requirement Planning
P&G: Procter & Gamble
POA: Performance of Activity
PSA: Product and Service Agreements
ROA: Return on Assets
ROI: Return on Investment
ROP: Reorder Point
SC: Supply Chain
SCM: Supply Chain Management
SCOR: Supply Chain Operation Reference
SCPM: Supply Chain Performance Management
SIS: Special Integration Software
WIP: Work-in-process

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INTRODUCTION

Interests and popularity of the term Supply Chain Management (SCM) has steadily increased since 1980s when companies have understood the benefits of collaboration with their suppliers and partners. The term supply chain management has been used by the consultants and academicians after 1980s. The term supply chain management is not the replacement of supplier partnership or it is not a description of the logistics function. Unfortunately, there is no explicit description of supply chain management or its activities in the literature (New, 1997). For example, Harland (1996) describes supply chain management as managing business activities and relationships (1) internally within an organization, (2) with immediate suppliers, (3) with first and second-tier suppliers and customers along the supply chain, and (4) with the entire supply chain.

As a result of improvements in information technologies (IT) by the end of 20th century, companies began to enjoy the benefits of IT systems. Enterprise Resource Planning (ERP) systems can be regarded as one of the most innovative developments in IT of 1990s. ERP can be basically defined as a combination of business management practice and technology, where Information Technology integrates and automates many of the business practices associated with the core business processes, operations, or production aspects of a company to achieve specific business objectives (www.sap.com).

In recent years, many companies installed and implemented Enterprise Resource Planning (ERP) and Supply Chain Management (SCM) systems successfully. Here we can see that the two information systems, ERP and SCM, have the similar mission in terms of information flow and synchronization. But the scope of the two systems is different. ERP provides the information flow and synchronization within and organization, and so the SCM system in supply chain. Many organizations had successfully done the integration of the two systems.

The objective of this study is that investigating the impact of ERP on supply chain management and how can ERP increase organizational performance. In the first chapter historical developments and how the term “supply chain management” began to be used is explained. Also detailed information is given how the performance of the supply chain can be measured. In the second part, like in the first chapter detailed information is given about the ERP concept and its evolution form MRP to ERP throughout history. Then in the third part, integration of the two systems is explained and effects of ERP on supply chain management are shown by the real cases and studies done in the literature. And finally in the fourth chapter, the effects of ERP on organizational performance and supply chain management are analyzed in an international alloy wheel manufacturer. Detailed information is given about some of the metrics before and after the implementation of ERP. The data is compared and interpreted in the light of the information given in the first three chapters.

CHAPTER ONE

SUPPLY CHAIN MANAGEMENT CONCEPT AND PERFORMANCE MEASUREMENT IN SUPPLY CHAIN MANAGEMENT (SCM)

1.1. Definition of a Supply Chain and Supply Chain Management

The term "supply chain management" was proposed by consultants in the early 1980s and at that years interest on supply chain management concept has began to increase steadily.

There are many different definition offered for both supply chain and supply chain management as the concept has gained its popularity. Before defining SCM, first we have to define supply chain. The APICS Dictionary which is the standard for defining terms used in the operations management field, defines supply chain as" the processes from the initial raw materials to the ultimate consumption of the finished product linking across supplier-user companies; and the functions within and outside a company that enable the value chain to make products and provide services to the customer (Cox et al., 1995).

The Supply Chain Council (1997) uses the definition "The supply chain, a term increasingly used by logistics professionals, encompasses every effort involved in producing and delivering a final product, from the supplier's supplier to the customer's customer.

Stevenson (2005; 693) defines supply chain as the sequence of organizations – their facilities, functions and activities – that are involved in producing and delivering a product or service. The sequence begins with basic suppliers of raw materials and extends all the way to the final customer.

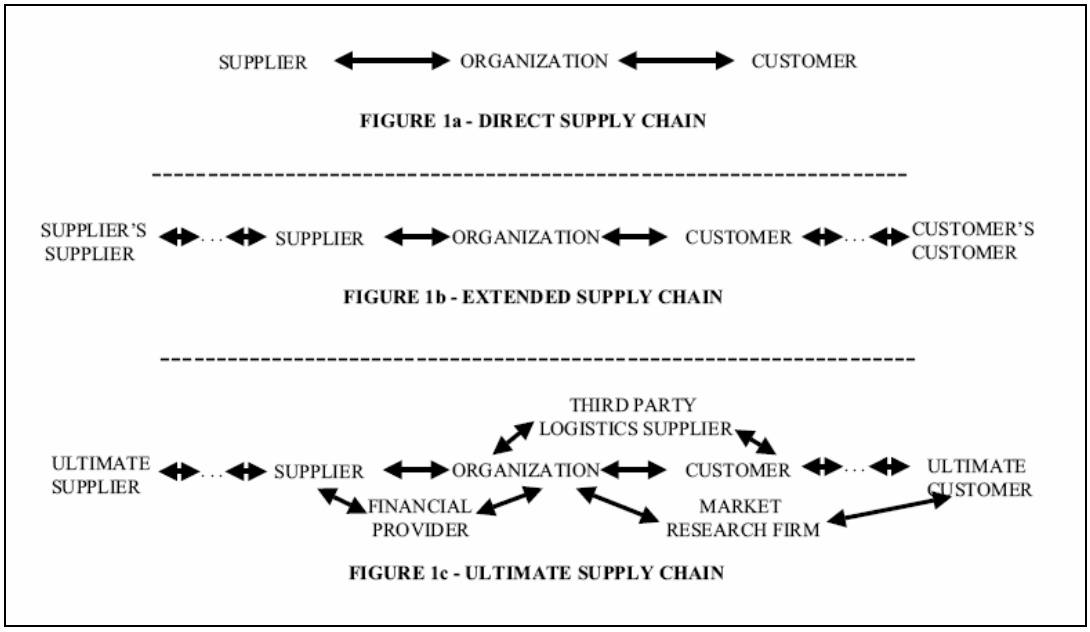
La Londe and Masters proposed that a supply chain is a set of firms that pass materials forward. Normally, several independent firms are involved in manufacturing a product and placing it in the hands of the end user in a supply chain—raw material and component producers, product assemblers, wholesalers, retailer merchants and transportation companies are all members of a supply chain (La Londe and Masters 1994; 38).

According to Chopra and Meindl, a supply chain consists of all parties involved, directly or indirectly, in fulfilling a customer request. The supply chain not only includes manufacturers and suppliers but also transporters, warehouses, retailers and customers themselves. Within each organization, such as a manufacture, the supply chain includes all functions involved in receiving and filling a customer request. These functions include, but are not limited to, new product development, marketing, operations, distribution, finance and customer service. Supply chain management involves the management of information, product and funds flows between and among stages in a supply chain in maximize total supply chain profitability (Chopra and Meindl, 2003; 23).

In an another definition, supply chain can be defined as a set of three or more entities (organizations or individuals) directly involved in the upstream and downstream flows of products, services, finances and/or information from a source to a customer (Mentzer et al., 2001; 4).

Mentzer et al. (2001; 4) identify three degrees of supply chain complexity: a "direct supply chain," an "extended supply chain," and an "ultimate supply chain." A direct supply chain consists of a company, a supplier, and a customer involved in the upstream and/or downstream flows of products, services, finances, and/or information (Figure 1a). An extended supply chain includes suppliers of the immediate supplier and customers of the immediate customer, all involved in the upstream and/or downstream flows of products, services, finances, and/or information (Figure 1b). An ultimate supply chain includes all the organizations involved in all the upstream and downstream flows of products, services, finances,

and information from the ultimate supplier to the ultimate customer. Figure 1c illustrates the complexity that ultimate supply chains can reach. Also in this definition the final consumer is considered a member of the supply chain. This point is important because it recognizes that retailers can be part of the upstream and downstream flows that constitute a supply chain.



Source: Mentzer, J. T., DeWitt W., Keebler, J. S., Min, S., Nix, N. W., Smith, C. D., Zacharia, Z. G. (2001). Defining Supply Chain Management. *Journal of Business Logistics*, 22, No. 2.

Figure1: Types of Channel Relationships

In the direction of given supply chain definitions above Supply Chain Management is an integrative philosophy to manage the total flow of a distribution channel from supplier to the ultimate user (Cooper et al., 1997; 68).

New and Payne (1995; 60) describe supply chain management as the chain linking each element of the manufacturing and supply process from raw materials through to the end user, encompassing several organizational boundaries. According to this broad definition, supply chain management encompasses the entire value

chain and addresses materials and supply management from the extraction of raw materials to its end of useful life (Tan, 2001; 40).

Supply chain management encompasses materials/supply management from the supply of basic raw" materials to "final product (and possible recycling and re-use). Supply chain management focuses on how "firms utilize their suppliers' processes, technology and capability to enhance competitive advantage. It is a management philosophy that extends traditional intra-enterprise activities by bringing trading partners together with the common goal of optimization and efficiency (Tan et al., 1998; 2).

The Global Supply Chain Forum (GSCF), a group of non-competing firms and a team of academic researchers, has been meeting regularly for the past 6 years with the objective to improve the theory and practice of SCM. The definition of SCM as developed and used by The GSCF is as follows: "Supply Chain Management is the integration of key business processes from end user through original suppliers that provides products, services, and information that add value for customers and other stakeholders" (Lambert et al., 1998; 1).

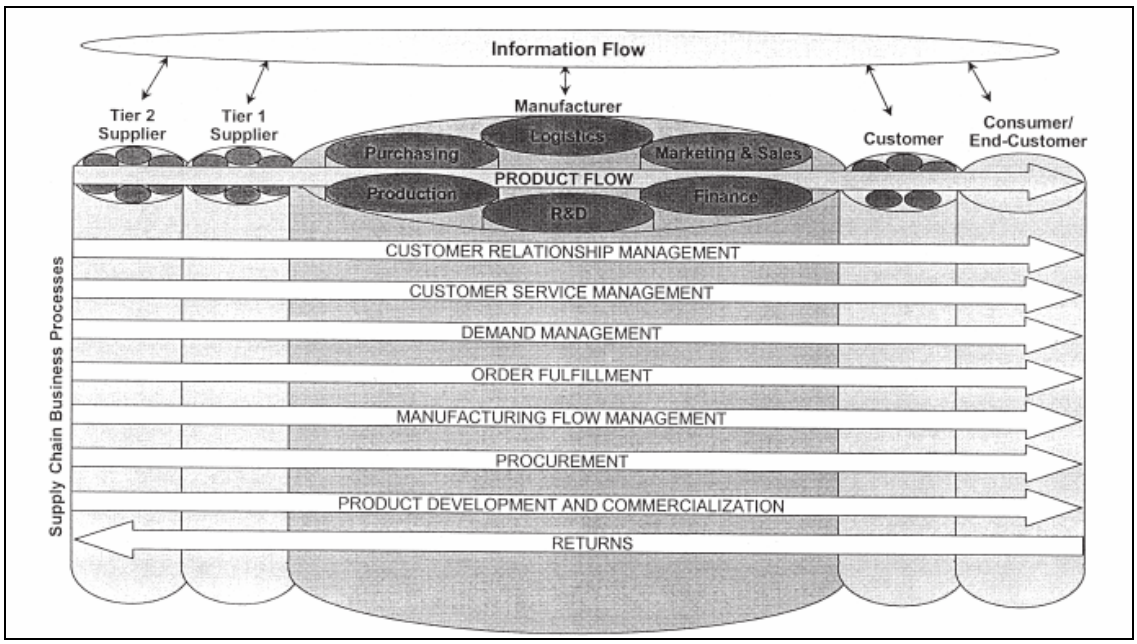
This broader understanding of the SCM concept is illustrated in Figure 2, which depicts a simplified supply chain network structure; the information and product flows; and the key supply chain business processes penetrating functional silos within the company and the various corporate silos across the supply chain. Thus, business processes become supply chain business processes linked across intra- and intercompany boundaries (Lambert and Cooper, 2000; 66).

From these definitions we can get these points (Ning, 2006):

- Supply chains are autogenetic in nature, whereas managed supply chains are artificially organized with collective efforts of supply chain members;
- A supply chain should consist of multiple firms, at least three, in both upstream (i.e., supply) and downstream (i.e., distribution operation;

- Supply chain management is a system approach to viewing the channel as a whole, a single entity, rather than a set of fragmented parts;

The implementation of SCM needs the integration of processes from sourcing, to manufacturing, and to distribution across supply chain.



Source: Lambert, D. M., Cooper, M. C., Pagh, J. D. (1997). Supply Chain Management: More Than a New Name for Logistics. *The International Journal of Logistics Management*, Vol. 8, No. 1, 1–13.

Figure 2: Supply chain management: integrating and managing business processes across the supply chain.

1.2. Evolution of SCM

In the 1950s and 1960s, most manufacturers emphasized mass production to minimize unit production cost as the primary operations strategy, with little product or process flexibility. New product development was slow and relied exclusively on in-house technology and capacity. “Bottleneck” operations were cushioned with inventory to maintain a balanced line flow, resulting in huge investment in work in

process (WIP) inventory. Sharing technology and expertise with customers or suppliers was considered too risky and unacceptable and little emphasis appears to have been placed on cooperative and strategic buyer} supplier partnership. In the 1970s, Manufacturing Resource Planning was introduced and managers realized the impact of huge WIP on manufacturing cost, quality, new product development and delivery lead-time. Manufacturers resorted to new materials management concepts to improve performance within the four walls of the company.

The intense global competition in the 1980s forced world-class organizations to offer low cost, high quality and reliable products with greater design flexibility. Manufacturers utilized just-in-time (JIT) and other management initiatives to improve manufacturing efficiency and cycle time. In the fast-paced JIT manufacturing environment with little inventory to cushion production or scheduling problems, manufacturers began to realize the potential benefit and importance of strategic and cooperative buyer-supplier relationship. The concept of supply chain management emerged as manufacturers experimented with strategic partnerships with their immediate suppliers. In addition to the procurement professionals, experts in transportation and logistics carried the concept of materials management a step further to incorporate the physical distribution and transportation functions, resulting in the integrated logistics concept, also known as supply chain management (Tan, 2001; 41).

As competition in the 1990s intensified and markets became global, so did the challenges associated with getting a product and service to the right place at the right time at the lowest cost. Organizations began to realize that it is not enough to improve efficiencies within an organization, but their whole supply chain has to be made competitive. The understanding and practicing of supply chain management (SCM) has become an essential prerequisite for staying competitive in the global race and for enhancing profitably (Lia et al, 2004).

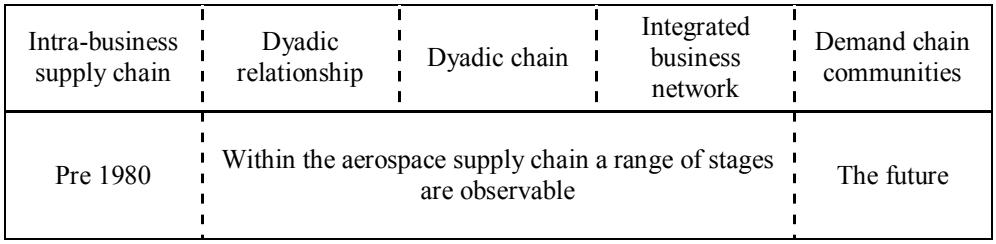
Harland (1996; 65) describes a four-stage supply chain typology (Figure 3), outlining four main uses for the term supply chain management:

(1) The internal supply chain integrates business functions involved in the flow of materials and information from inbound to outbound ends of the business.

(2) The management of a dyadic or two-party relationships with immediate suppliers.

(3) The management of a chain of businesses including a supplier, a supplier's supplier, a customer and a customer's customer and so on.

(4) The management of a network of interconnected businesses involved in the ultimate provision of product and service packages required by end customers.



Source: Harland, C. M. (1996). Supply Chain Management Relationships, Chains and Networks. *British Journal of Management*, Vol. 7, 63-80.

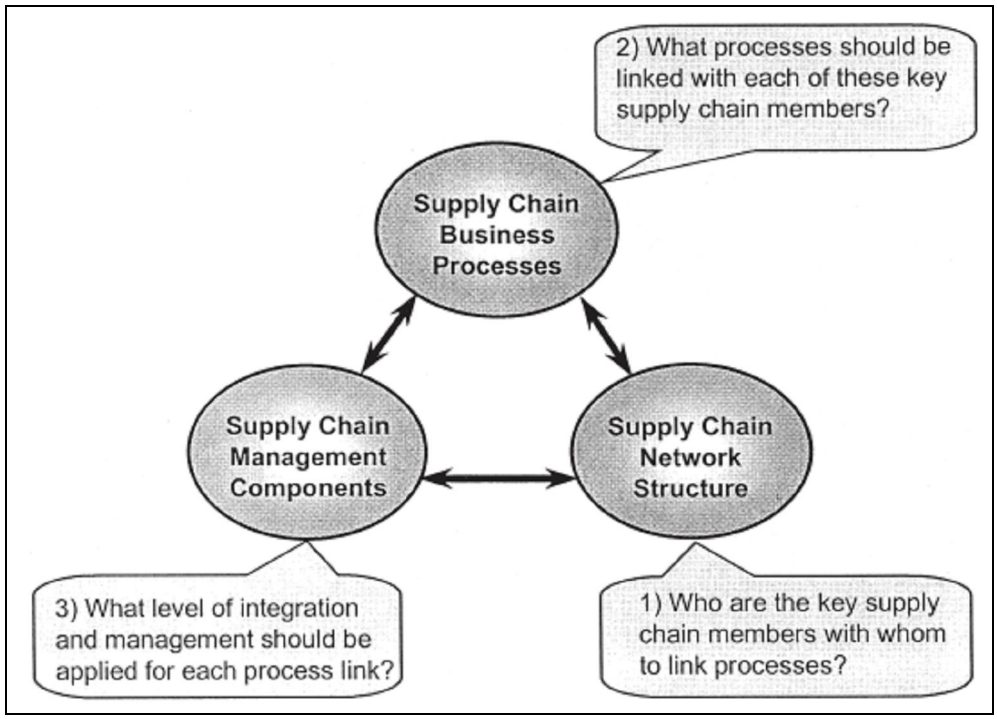
Figure 3: Development of SCM

1.3. Supply Chain Management Framework

The conceptual framework emphasizes the interrelated nature of SCM and the need to proceed through several steps to design and successfully manage a supply chain. According to Lambert et al. (1997; 5), the SCM framework consists of three closely interrelated elements: the supply chain network structure, the supply chain business processes, and the supply chain management components as shown in Figure 4.

The supply chain network structure consists of the member firms and the links between these firms. Business processes are the activities that produce a specific output of value to the customer. The management components are the

managerial variables by which the business processes are integrated and managed across the supply chain. Each of the three interrelated elements that constitute the framework is now described (Lambert and Cooper, 2000; 69).



Source: Lambert, D. M., Cooper, M. C., Pagh, J. D. (1997). Supply Chain Management: More Than a New Name for Logistics. *The International Journal of Logistics Management*, Vol. 8, No. 1, 1–13.

Figure 4: Supply chain management framework: elements and key decisions

1.3.1. Supply Chain Network Structure

All firms participate in a supply chain, from the raw materials to the ultimate consumer. How much of this supply chain needs to be managed depends on several factors including the complexity of the product, the number of available suppliers, and the availability of raw materials. Dimensions to consider include the length of the supply chain and the number of suppliers and customers at each level. It would be rare for a firm to participate in only one supply chain. For most manufacturers, the

supply chain looks less like a pipeline or chain than an uprooted tree, where the branches and roots are the extensive network of customers and suppliers (Cooper et al, 1997; 7)

The closeness of the relationship at different points in the supply chain will differ. Management will need to choose the level of partnership appropriate for particular supply chain links (Lambert et al., 1996; 4).

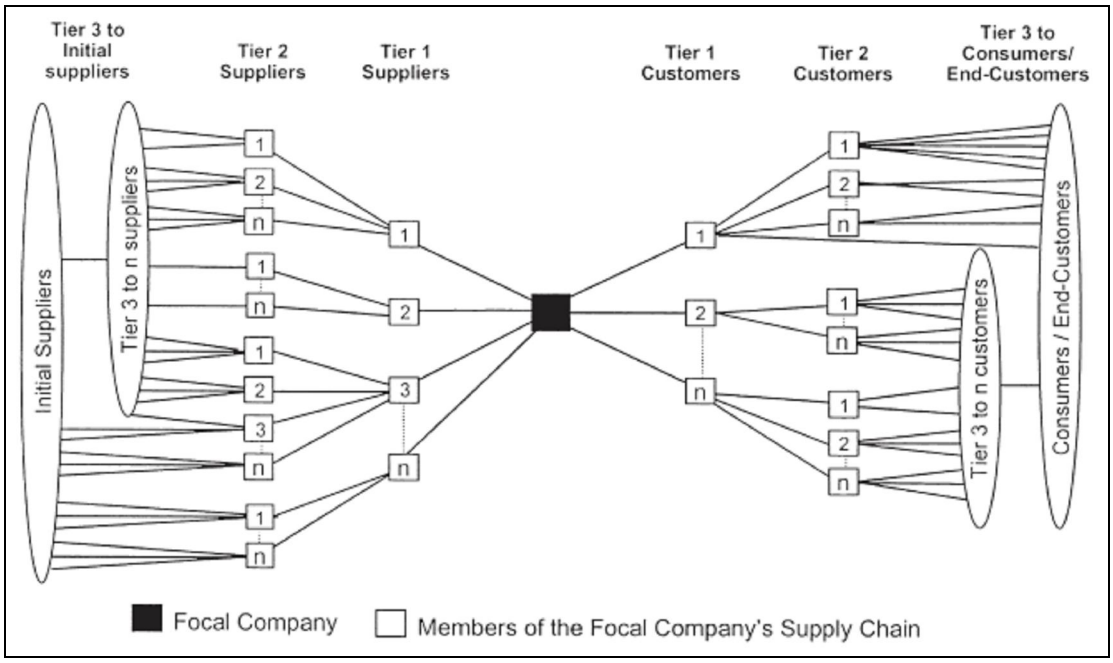
According to Lambert and Cooper (2000; 69), it is important to have an explicit knowledge and understanding of how the supply chain network structure is configured. They suggest that the three primary aspects of a company's network structure are: (1) the members of the supply chain, (2) the structural dimensions of the network, and (3) the different types of process links across the supply chain.

When determining the network structure, it is necessary to identify who the members of the supply chain are. The members of a supply chain include all companies/organizations with whom the focal company interacts directly or indirectly through its suppliers or customers, from point of origin to point of consumption. However, to make a very complex network more manageable, it seems appropriate to distinguish between primary and supporting members. Lambert and Cooper (2000; 70), define primary members of a supply chain to be all those autonomous companies or strategic business units who carry out value-adding activities (operational and/or managerial) in the business processes designed to produce a specific output for a particular customer or market. In contrast, supporting members are companies that simply provide resources, knowledge, utilities, or assets for the primary members of the supply chain.

The definitions of primary and supporting members make it possible to define the point of origin and the point of consumption of the supply chain. The point of origin of the supply chain occurs where no previous primary suppliers exist. All suppliers to the point of origin members are solely supporting members. The point of

consumption is where no further value is added, and the product and/or service is consumed.

Three structural dimensions of the network are essential when describing, analyzing, and managing the supply chain. These dimensions are the horizontal structure, the vertical structure, and the horizontal position of the focal company within the end points of the supply chain. The first dimension, horizontal structure, refers to the number of tiers across the supply chain. The second dimension, vertical structure, refers to the number of suppliers/ customers represented within each tier. The third structural dimension is the company's horizontal position within the supply chain. The supply chain structure is illustrated in Figure 5.



Source: Lambert, D. M., Cooper, M. C., Pagh, J. D. (1998). Supply Chain Management: Implementation Issues and Research Opportunities. *The International Journal of Logistics Management*, Vol. 9, No. 2, 1–19.

Figure 5: Supply Chain Network Structure

1.3.2. Supply Chain Business Processes

Successful SCM requires a change from managing individual functions to integrating activities into key supply chain processes. Operating an integrated supply chain requires continuous information flows, which in turn help to create the best product flows. The customer remains the primary focus of the process. However, improved linkages with suppliers are necessary because controlling uncertainty in customer demand, manufacturing processes and supplier performance is critical for effective supply chain management.

In many major corporations, management has reached the conclusion that optimizing the product flows cannot be accomplished without implementing a process approach to the business. The key supply chain processes, also shown in Figure 2, identified by members of the Global Supply Chain Forum (GSCF) are (Lambert et al., 2000; 72):

- Customer relationship management
- Customer service management
- Demand management
- Order fulfillment
- Manufacturing flow management
- Procurement
- Product development and commercialization
- Returns.

Customer Relationship Management (CRM) involves identifying key customer market targets and then developing and implementing programs with key customers (Lambert et al., 1997; 6). CRM systems also provide the infrastructure that facilitates long-term relationship building with customers (Hendricks, 2007; 68).

The objective of CRM at the strategic level is to identify customer segments, provide criteria for categorizing customers, provide customer teams with guidelines

for customizing the product and service offering, develop a framework for metrics and provide guidelines for the sharing of process improvement benefits with customers. However at the operational level, CRM process deals with writing and implementing Product and Service Agreements (PSA) (Croxton et al., 2001; 15).

The ***customer service management*** represents the company's face to the customer. It is the key point of contact for administering the PSAs developed by customer teams during the CRM process (Lambert, 2004; 2). CRM provides the set of products and services the firm can offer its customers. The strategic customer service management process is responsible for planning how each of the possible products and services to be included in the PSA is going to be delivered and managed. On the other hand, at the operational level, the customer service management process is responsible for responding to both internal and external events (Croxton et al., 2001; 17).

Demand management is the process that balances customer requirements with supply chain capabilities. With the right process in place, management can match supply with demand proactively and execute the plan with minimal disruptions. It is important to note that this process is not limited to forecasting. It also includes synchronizing supply and demand, increasing flexibility and reducing variability (Lambert, 2004; 3).

The demand management process must balance the customer's requirements with the firm's supply capabilities. Part of managing demand involves attempting to determine what and when customers will purchase. A good demand management system uses point-of-sale and "key" customer data to reduce uncertainty and provide efficient flows throughout the supply chain.

The supply chain which best succeeds in reducing uncertainty and variability is likely to be most successful in improving its competitive position (Towill and McCullen, 1999; 86).

Effective ***order fulfillment*** requires integration of the firm's manufacturing, logistics and marketing plans. The firm should develop partnerships with key members of the supply chain to meet customer requirements and reduce total delivered cost to customers (Croxton et al., 2001; 20). Here the objective is to develop a seamless system from supplier to the firm and then on to the various customer segments (Lambert, 2004; 3).

The manufacturing process in make-to-stock firms traditionally produced and supplied products to the distribution channel based on historical forecasts. Products were pushed through the plant to meet a schedule. Often the wrong mix of products was produced resulting in unneeded inventories, excessive inventory carrying costs, mark downs, and transshipments of product (Lambert and Cooper, 2000; 73). ***The manufacturing flow process*** deals with making the products and establishing the manufacturing flexibility needed to serve the target markets. The process includes all activities necessary for managing the product flow through the manufacturing facilities and for obtaining, implementing and managing flexibility

The effectiveness of the ***procurement process*** depends on the long-term alliances with suppliers. The desired outcome of these alliances is a win-win relationship, where both parties benefit. This is a change from the traditional bid-and-buy system to involving a key supplier early in the design cycle, which can lead to dramatic reduction in product development cycle times. Having early supplier input reduces time by getting the required coordination between engineering, purchasing, and the supplier prior to design finalization (Croxton et al., 2001; 24).

This supply chain management process provides the structure for working with customers and suppliers to develop products and bring them to market. Effective implementation of this process not only enables management to coordinate the efficient flow of new products across the supply chain but also helps other members of the supply chain to ramp up manufacturing, logistics, marketing, and other activities necessary to support product commercialization.

Managers of the ***product development and commercialization process*** must (Lambert and Cooper, 2001; 74):

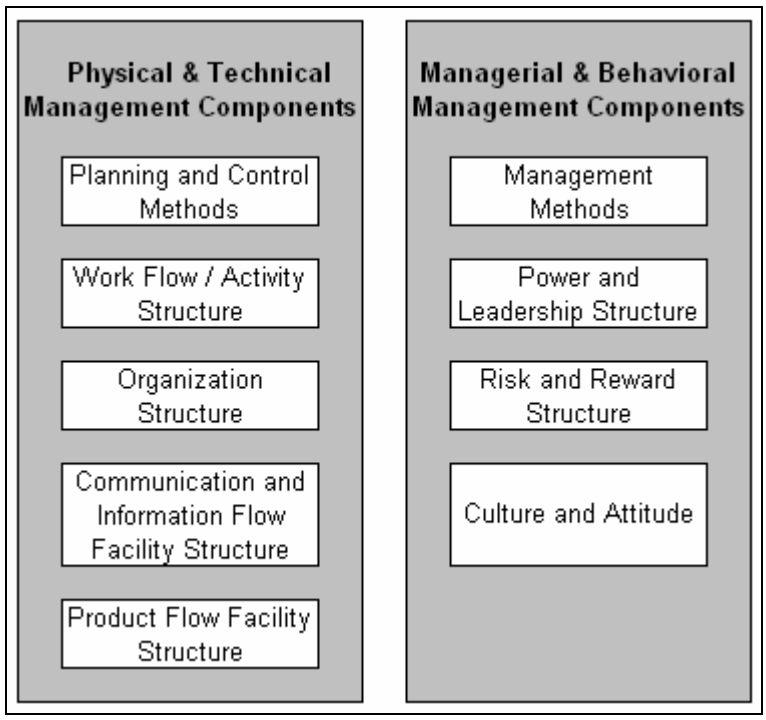
- Coordinate with customer relationship management to identify customer-articulated and -unarticulated needs
- Select materials and suppliers in conjunction with procurement
- Develop production technology in manufacturing flow to manufacture and integrate into the best supply chain flow for the product/market combination.

Returns management is the process by which activities associated with returns, reverse logistics, "gatekeeping" and return avoidance are managed within the firm and accross key members of the supply chain. Avoidance which is a key part of this process, involves finding ways to minimize the number of return requests. It can include ensuring that the product's quality and user friendliness are at the highest attainable level before the product is sold and shipped. Properly implemented returns management process enables firms not only to manage the reverse product flow efficiently but also to identify opportunities to reduce unwanted returns and to control reusable assets (Lambert, 2004; 3).

1.3.3. The Management Components of Supply Chain Management

The SCM management components are the third element of the SCM framework as shown in Figure 4. An essential underlying premise of the SCM framework is that there are certain management components that are common across all business processes and members of the supply chain (Cooper et al., 1997; 6). Cooper and others define nine common management components to be critical and fundamental for successful SCM (Figure 6) : planning and control; work structure; organization structure; product flow facility structure; information flow facility structure; management methods; power and leadership structure; risk and reward structure; and culture and attitude. These management components can be divided into two groups as: Physical and technical management components and Managerial and behavioral management components. Physical and technical group includes the

most visible, tangible, measurable and easy to change components. Some researchers believe that if this group of management components is the only focus of managerial attention, managing the supply chain will most likely be doomed to fail. The second group is comprised of the managerial and behavioral components. These components are less tan tangible and visible and are often difficult to assess and alter. The managerial and behavioral components define the organizational behavior and influence how the physical and technical management components can be implemented. If the managerial and behavioral components are not aligned to drive and reinforce an organizational behavior supportive to the supply chain objectives and operations, then the supply chain will likely be less competitive and profitable.



Source: Lambert, D. M., Cooper, M. C., Pagh, J. D. (1998). Supply Chain Management: Implementation Issues and Research Opportunities. *The International Journal of Logistics Management*, Vol. 9, No. 2, 1–19.

Figure 6: Supply chain management: fundamental management components

Planning and control of operations are keys to moving an organization or supply chain in a desired direction. The extent of joint planning is expected to bear heavily on the success of the supply chain. Different components may be emphasized at different times during the life of the supply chain but planning transcends the phases (Ellram and Cooper, 1993; 6). The control aspects can be operationalized as the best performance metrics for measuring supply chain success.

The ***work structure*** indicates how the firm performs its tasks and activities. The level of integration of processes across the supply chain is a measure of organizational structure. All, but one, of the literature sources that were examined cited work structure as an important component.

Organizational structure can refer to the individual firm and the supply chain; the use of cross-functional teams would suggest more of a process approach. When these teams cross organizational boundaries, such as inplant supplier personnel, the supply chain should be more integrated.

Product flow facility structure refers to the network structure for sourcing, manufacturing, and distributing across the supply chain. Since inventory is necessary in the system, some supply chain members may keep a disproportionate amount of inventory. As it is less expensive to have unfinished or semifinished goods in inventory than finished goods, upstream members may bear more of this burden. Rationalizing the supply chain network has implications for all members.

Virtually every author indicates that the ***information flow facility structure*** is key. The kind of information passed among channel members and the frequency of information updating has a strong influence on the efficiency of the supply chain. This may well be the first component integrated across part, or all, of the supply chain.

Management methods include the corporate philosophy and management techniques. It is very difficult to integrate a top-down organization structure with a

bottom-up structure. The level of management involvement in day-to-day operations can differ across supply chain members.

The power and leadership structure across the supply chain will affect its form. One strong channel leader will drive the direction of the chain. In most chains studied to date, there are one or two strong leaders among the firms. The exercise of power, or lack thereof, can affect the level of commitment of other channel members. Forced participation will encourage exit behavior, given the opportunity.

The anticipation of sharing of ***risks and rewards*** across the chain affects long-term commitment of channel members.

Culture and attitude are very important considerations. Compatibility of corporate culture across channel members cannot be underestimated. Meshing cultures and individuals' attitudes is time consuming, but it is necessary at some level in order for the channel to perform as a chain. Aspects of culture include how employees are valued and how they are incorporated into the management of the firm.

1.4. Performance Measurement in Supply Chain Management

One of the fundamental topics of SCM is measuring the performance of whole supply chain because no one can manage what he can not measure. Measuring the performance of the supply chain helps managers to see the current situation of the chain and by this way they can make more informed decisions and take appropriate actions to improve the performance so as to sustain their competitive advantage. Lee and Billington (1992; 67) stated 14 pitfalls about SCM. They argued that lack of the supply chain's overall performance measurement was the first and most serious pitfall of SCM. Beamon (1996; 277) also pointed out that the construction of an appropriate performance measurement is certainly one of the most important parts of the efficient SCM, since obviously a credible performance measurement system can be helpful to evaluate the effectiveness of SCM system. From the management point

of view, performance measurement provides necessary information of management feedback for decision makers. It plays the important role of monitoring performance, enhancing motivation, improving communications and diagnosing problems (Chan and Qi, 2003; 180).

In traditional approaches, literature offers countless number of metrics to evaluate and measure the performance of logistics and supply chain operations. Any typical framework includes three major categories of metrics: cost measures, service measures and return on assets (ROA) measures.

In the cost measures, traditional approaches focus on cost per order, logistics cost per unit. In terms of service measures, order cycle time, order fill rates, error rates play an important role. Regarding ROA, companies try to find out the extent to which their investment in logistics assets is earning the desired financial returns. These measures are fundamental part of the performance measurement system but on the other hand they can not give the answer to the question "how effectively are companies in the supply chain interacting?" or "how much non value-added time is spent while goods move in the supply chain?" To answer these questions there should be a specific set of performance measurement system that can go beyond the traditional measures of supply chain performance.

1.4.1. Supply Chain Performance Measurement Models

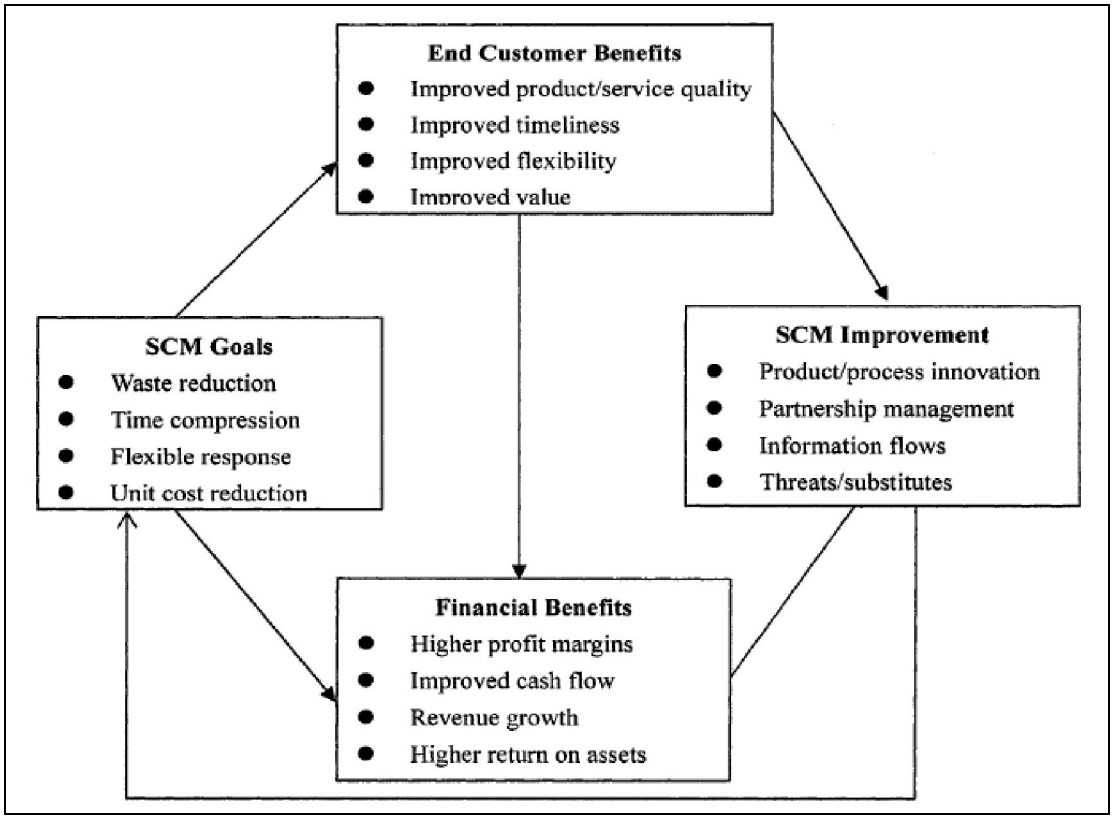
Many academicians and researchers made many researches about performance management of supply chain management and they developed different supply chain performance management systems (for example: Beamon, 1999; Brewer and Speh, 2000; Bullinger et al., 2002; Chan and Qi, 2003; Gunasekarn et al., 2001; Gunasekarn et al., 2004; Holmberg, 2000; Lau et al., 2002; Morash, 2001; Otto and Kotzab, 2002; Tan et al., 2002).

1.4.1.1. Balanced Scorecard Model

Kaplan and Norton (1992; 72) have proposed the balanced scorecard (BSC), as a means to evaluate corporate performance from four different perspectives: the financial, the internal business process, the customer, and the learning and growth. Their BSC is designed to complement "financial measures of past performance with their measures of the drivers of future performance"

Brewer and Speh (2000) recommend the use of modified version of BSC as a framework for Supply Chain Performance Management (SCPM). They suggest that more effective supply chains can be developed by relating supply chain goals to four perspectives defined in BSC framework.

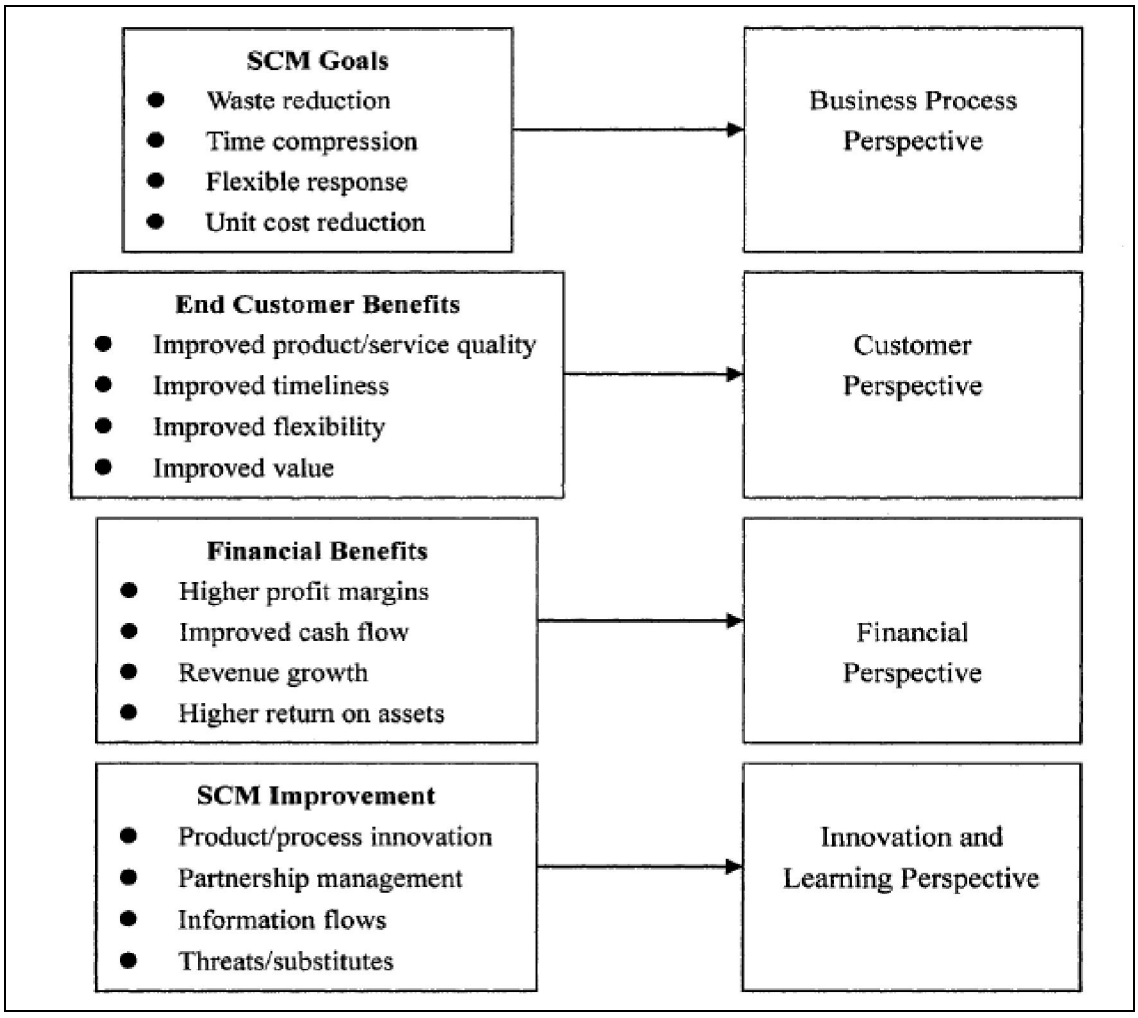
Brewer and Speh's (2000; 79) SCM performance framework is shown in figure 7 which is developed from four perspectives. The framework relates the goals of SCM to customer satisfaction, firm financial performance, and the ways in which firms continue to learn, innovate and grow. The framework also emphasizes the interrelationship between SCM and the balanced scorecard approach to performance evaluation.



Source: Brewer, P. C., Speh T. W. (2000). Using the Balanced Scorecard to Measure the Supply Chain Performance. *Journal of Business Logistics*, Vol. 21, No. 1, 75-92.

Figure 7: SCM Performance Framework

The linkage of SCM framework to the BSC framework is shown in Figure 8. This approach offers four primary benefits. First, it emphasizes the inter-functional and inter-firm nature of supply chains and recognizes the need to ascertain the extent to which firms effectively work together and the extent to which functions are coordinated and integrated. Second, the framework will increase the chance that a "balanced" management approach is indeed practiced within firms and among the supply chain partners. Third, the example measures are suggestions that may stimulate management to create other measures appropriate to their unique circumstances. Fourth, use of this novel approach should help employees and managers focus attention on achieving goals that are beyond the typical measures of performance used within firms.



Source: Brewer, P. C., Speh T. W. (2000). Using the Balanced Scorecard to Measure the Supply Chain Performance. *Journal of Business Logistics*, Vol. 21, No. 1, 75-92

Figure 8: Linking SCM framework to the BSC

1.4.1.2. Supply Chain Operation Reference (SCOR) Model

According to Logistics Management Institute; "The SCOR model is the only supply chain framework that we found that links performance measures, best practices and software requirements to a detailed business process model." (Stephens, 2001)

The SCOR model is based on five distinct management processes which are Plan, Source, Make, Delivery and Return. These processes are decomposed into three levels of detail.

In practice, Level One defines the number of supply chains and how their performance is measured. Here (Plan, Source, Make, Delivery and Return) supply chain performance can be directly tied to the business objectives of the organization. Level Two defines the configuration of planning and execution processes in material flow, using standard categories like stock, to-order, and engineer-to order. Level Three defines the business process used to transact sales orders, purchase orders, work orders, return authorizations, replenishment orders, and forecasts. At Level 2 and 3, processes elements are used to describe more and more detailed activities to provide greater insight into the operation of the supply chain. Because it is cross-industry model and because each organizations operations' are unique, the model must be extended by the implementing organization to Level 4.For each of the SCOR processes, the model provides several performance measures in five dimensions: reliability, responsiveness, flexibility, cost and efficiency. Table describes these performance attributes, identifies Level 1 metrics.

Table1: Performance Attributes and Level 1 Metrics

Performance Attribute	Performance Attribute Definition	Level 1 Metric
Supply chain delivery reliability	The performance of the supply chain in delivering: the correct product, to the correct place, at the correct time, in the correct condition and packaging, in the correct quantity, with the correct documentation, to the correct customer	Delivery performance Fill rates **Perfect order fulfillment**
Supply chain responsiveness	The velocity at which a supply chain provides products to the customer	**Order fulfillment lead times**
Supply chain flexibility	The agility of a supply chain in responding to marketplace changes to gain or maintain competitive advantage	**Supply chain response time** Production flexibility
Supply chain costs	The costs associated with operating the supply chain	Cost of goods sold **Total supply chain management costs** Value added productivity Warranty/returns processing costs
Supply chain asset management efficiency	The effectiveness of an organization in managing assets to support demand satisfaction. This includes the management of all assets: fixed and working capital	**Cash-to-cash cycle time** Inventory days of supply Asset turns

Source: Stephens S., (2001). Supply Chain Operations Reference Model Version 5.0: A New Tool to Improve Supply Chain Efficiency and Achieve Best Practice. *Information System Frontiers*, Vol. 3, No. 4.

1.4.1.3.Beamon's ROF Model

Beamon (1999) aimed in his research to develop to develop a framework for the selection of supply chain performance measures. He thought that current supply chain performance measurement systems are inadequate because they relied heavily on the use of cost as a primary and also only measure.

Selecting appropriate performance measures for supply chain analysis is particularly critical, since the system of interest is generally large and complex. Beamon (1996) presents a number of characteristics that are found in effective performance measurement systems, and can therefore be used in evaluation of these measurement systems. These characteristics include: inclusiveness (measurement of all pertinent aspects), universality (allow for comparison under various operating conditions), measurability (data required are measurable), and consistency (measures consistent with organization goals).

One of the most difficult areas of performance measure selection is the development of performance measurement systems. This involves the methods by which an organization creates its measurement system. Supply chain models have predominantly utilized two different performance measures:

- cost; and
- a combination of cost and customer responsiveness.

Costs may include inventory costs and operating costs. Customer responsiveness measures include lead time, stockout probability, and fill rate.

Beamon (1996; 286) identified and evaluated various individual supply chain performance measures. The author concluded that significant weaknesses were present in each of the performance measures evaluated, based on such criteria as inclusiveness, universality, measurability, and consistency. Repeatedly, the most consistent weakness for these performance measures was inclusiveness. In order for a measure to be inclusive, it must measure all pertinent aspects of the supply chain. Consider an example in which a company decides to use cost as the measure of supply chain performance. Although the supply chain may be operating under minimum cost, it may simultaneously demonstrate poor customer response time performance, or lack flexibility to meet random fluctuations in demand.

Table 2: Goals of Performance Measure Types

Performance Measure Type	Goal	Purpose
Resources	High level of efficiency	Efficient resource management is critical to profitability
Output	High level of customer service	Without acceptable output, customers will turn to other supply chains
Flexibility	Ability to respond a changing environment	In an uncertain environment, supply chains must be able to respond to change

Source: Beamon, B. M. (1996). Performance Measures in Supply Chain Management. *Proceedings of the 1996 Conference on Agile and Intelligent Manufacturing Systems*, Rensselaer Polytechnic Institute, Troy, New York, NY, 2-3 October.

The use of resources, the desired output and flexibility (how well the system reacts to uncertainty) have been identified as vital components to supply chain success. Therefore, a supply chain measurement system must place emphasis on three separate types of performance measures: resource measures (R), output measures (O), and flexibility measures (F). Each of these three types of performance measures has different goals, as illustrated in Table 2. The supply chain performance measurement system must measure each of the three types (R, O and F), as each type is vital to the overall performance success of the supply chain (Beamon, 1999; 286).

Resources

Resource measures include: inventory levels, personnel requirements, equipment utilization, energy usage, and cost. Resources are generally measured in terms of the minimum requirements (quantity) or a composite efficiency measure. Resource measurement is an important part of the measurement system. Too few resources can negatively affect the output and the flexibility of the system, while the deployment of too many resources artificially increases the system's requirements. Total cost, distribution cost, manufacturing cost, inventory costs, return on

investment (ROI) are some of the examples for supply chain resource performance measures.

Output

Output measures include: customer responsiveness, quality, and the quantity of final product produced. Many output performance measures are easily represented numerically, such as:

- number of items produced;
- time required to produce a particular item or set of items;
- number of on-time deliveries (orders).

Output performance measures must not only correspond to the organization's strategic goals, but must also correspond to the customers' goals and values, since strategic goals generally address meeting customer requirements. Sales, profit, fill rate, on-time deliveries, backorders and stockouts, customer response time, manufacturing lead time, shipping errors, customer complaints are some examples of supply chain output performance measures.

Flexibility

Flexibility, which is seldom used in supply chain analysis, can measure a system's ability to accommodate volume and schedule fluctuations from suppliers, manufacturers, and customers. Reductions in the number of backorders, reductions in the number of lost sales, reductions in the number of late orders, increased customer satisfaction are some of the advantages of flexible supply chain systems.

1.4.1.4. Chan and Qi's Model (Process Based Approach)

After literature review, Chan and Qi (2003) found out that most of the current performance measurement systems of supply chain were harassed by too many defects to meet the requirements of SCM. Lack of balanced approach to integrating financial and non-financial measures, lack of system thinking and loss of supply chain context are examples of these defects. So Chan and Qi (2003; 181) suggested a process based approach to mapping and analyzing the practically complex supply chain.

According to Chan and Qi main advantages of process based approach is as follows:

- to provide opportunity of recognizing the problems in operations and taking proactive actions (Kueng, 2000; 69)
- to support in direct management attention and and resources allocation
- to support in monitoring the process
- to facilitate linking with the operational strategies, identifying success and testing the effect of strategies.

They suggested seven steps and process of analyzing and decomposing the processes to be measured:

(1) Identify and link all the involved processes of inter and intra organization
(2) Define and confine the core processes
(3) Derive the missions, responsibilities and the functions of core processes
(4) Decompose and identify the sub-processes
(5) Derive and identify sub-processes
(6) Decompose and identify the elementary activities of sub-processes
(7) Link goals to each hierarchy from process to elementary activity

The process framework of hierarchical structure provides the base of measuring process performance through the method of performance activity (POA).

Performance of activity (POA) includes a board of performance metrics and each represents one of the dimensions of activity performance. They cover inputs and outcomes, and both tangible items and intangible ones. The board of performance metrics, called metrics board, is suggested summarily by the authors as follows:

(1) Cost: the financial expense to carry out one event or activity
(2) Time: the time between the beginning and completion of one specific event or activity
(3) Capacity: the ability of one specific activity to fulfill a task or perform a required action
(4) Capability: a talent or ability of one activity to be used, treated or developed for the specific purpose and required functions. Capability contains four more specific measures.
    a. Effectiveness: the ability of one specific event or activity to achieve an intended or desired effect in performing the functions or taking the responsibilities.
    b. Reliability: the ability of one specific event or activity to perform a required function under stated period of time.
    c. Availability: the ability to bring about effective or beneficial results or the degree to which one specific functional activity is ready when needed.
    d. Flexibility: the ability of one specific activity to adapt to the varying functional requirements or respond to the changes.
(5) Productivity: the rate at which one specific event or activity adds value at the cost of resources.
(6) Utilization: the utilizing rate of the resource to carry out one specific activity.
(7) Outcome. The results or value added of one specific activity and event.

1.4.1.5 Tridimensional Model

Gunasekaran et al. (2001; 73) suggested frameworks of performance measurement systems from three perspectives. The metrics discussed in one framework are classified into strategic, tactical and operational levels of management. This has been done so as to assign them where they can be best dealt with by the appropriate management level, and for fair decisions to be made.

In another; the performance metrics are also distinguished as financial and non-financial so that a suitable costing method based on activity analysis can be applied. In some cases, a metric is classified as both financial and nonfinancial.

In another performance metrics are classified as the four basic links and constitute the supply chain; plan, source, make and delivery. Such a classification signifies which metric should be used where, and which can together act as a fair indication of the problems persistent in respective links. The tridimensional model is shown in Table 3.

Table 3: Tridimensional Model

Level	Performance Metrics	Financial	Non-Financial	Process
Strategic	Total supply chain cycle time		x	Plan
	Total cash flow time		x	Plan
	Customer query time		x	Service
	Level of customer perceived value of product		x	Service
	Net profit vs. productivity ratio	x		Plan
	Rate of return on investment	x		Plan
	Range of product and services		x	Plan
	Variations against budget	x		Plan
	Order lead time			Plan
	Flexibility of service systems to meet particular customer need		x	Service
	Buyer-supplier partnership level	x	x	Source
	Supplier lead time against industry norm		x	Source
	Level of supplier's defect free deliveries		x	Source
	Delivery lead time		x	Delivery
	Delivery performance	x	x	Delivery
Tactical	Accuracy of forecasting techniques		x	Plan
	Product development cycle time		x	Plan
	Order entry method		x	Plan
	Effectiveness of delivery invoice method		x	Delivery
	Purchase order cycle time		x	Source
	Planned process cycle time		x	Plan
	Effectiveness of master production schedule		x	Make
	Supplier assistance in solving technical problems		x	Source
	Supplier ability to respond quality problems		x	Source
	Supplier cost saving initiatives	x		Source
	Supplier's booking procedures		x	Source
	Delivery reliability	x	x	Delivery
	Respnsiveness to urgent deliveries		x	Delivery
	Effectiveness of distribution planning schedule		x	Delivery
Operational	Cost per operating hour	x		Make
	Information carrying cost	x	x	Plan
	Capacity utilization		x	Make
	Total inventory as: - incoming stock level - work-in-process - scrap level - finished goods in transit	x		Make
	Supplier rejection rate	x	x	Service
	Quality of delivery documentation		x	Delivery
	Efficiency of purchase order cycle time		x	Source
	Frequency of delivery		x	Delivery
	Driver reliability for performance		x	Delivery
	Quality of delivered goods		x	Make
	Achievement of defect free deliveries		x	Source

Source: Gunasekaran, A., Patel, C., Tiritoglu, E. (2001). Performance Measures and Metrics in Supply Chain Environment. *International Journal of Operations & Production Management*, Vol. 21, No.1/2, 71-87.

CHAPTER TWO

ENTERPRISE RESOURCE PLANNING (ERP) CONCEPT

2.1. Introduction

As a result of latest developments in information technology (IT), dramatic changes occurred in the world economy and world became borderless. Business conditions became harder for many companies and they are looking for new ways of gaining competitive advantage.

Today's competitive marketing environment forces producers and customers to get closer and the power of customer in the market is increasing day by day. This means that companies have to pay great attention to customer desires and needs and also producer have to be closer to its customers in order to meet customers' needs.

The changes in business and economic environment emphasize the importance of information. These changing environment and characteristics of business enterprise also change the information usage, storage and requirements of business organizations. Although there are many types of information systems, management, organization and technology work together to create formal computer-based information systems that exist within the organizations. ERP System is one of these computer-based information systems that meet information integration requirements both within the organization and with its vendors and customers.

Enterprise Resource Planning (ERP) systems can be regarded as one of the most innovative developments in IT of 1990s. ERP can be basically defined as a combination of business management practice and technology, where Information Technology integrates and automates many of the business practices associated with the core business processes, operations, or production aspects of a company to achieve specific business objectives (www.sap.com).

Another definition is made by Bingi et al. (1999; 9) is that: ERP is a company-wide Information System that tightly integrates all aspects of a business. It promises one database, one application, and a unified interface across the entire enterprise.

Nah et al. (2001; 285) defines ERP as a packaged business software system that enables a company to manage the efficient and effective use of resources by providing a total, integrated solution for the organization's information-processing needs.

2.2. Evolution of ERP

In 1960s all the production planning and control activities had been doing by manually. In that years cost was the most critical factor for all companies. Product-focused manufacturing and high volume production was the most important strategy of the companies to minimize their costs.

Then the first computerized systems were called Re-Order Point (ROP) systems were developed and used to control manufacturing inventory by re-ordering materials when supplies of the material were low (Karnopp, 2006). These ROP systems which also include economic order quantity and economic reorder point satisfied the basic needs of companies at those years.

At those years software packages were designed for just handling inventory because the focus of the companies was just on producing as much as possible without considering the exact demand (Gumaer, 1996; 32) and consequently techniques are used are related with how efficient the large inventories can be managed.

Materials Requirement Planning (MRP) – the predecessor to and backbone of MRP II and ERP – was born in the late 1960s through a joint effort between J.I.

Case, a manufacturer of tractors and other construction machinery, in partnership with IBM. Inventory item master files were kept on tapes, transaction tapes were built during the week, and ‘‘passing the tapes’’ created a new master tape plus lists of orders based on calculated order quantities, safety stocks and on hand balances (Jacobs and Weston, 2006; 358). (Economic order quantities were calculated by hand using slide rules and entered into the system: first and early second generation computers were not capable of calculating square roots.)

There were three major types of computer-based MRP systems:

- MRP I
- Closed Loop MRP
- MRP II

The MRP I, Closed Loop MRP and MRP II systems are referred to three ancestors of ERP, in the literature (Blevins 1995).

MRP I is used for inventory control, production planning and purchasing. There was no capacity planning included in MRP. Shortly MRP can give the answers of these questions:

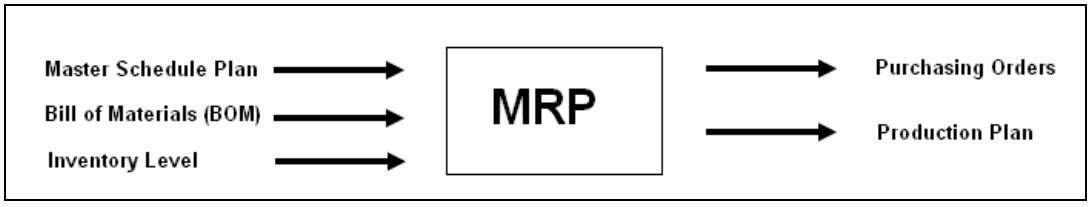
- What amount will be produced from which product?
- What are the required inputs for the product will be produced?
- What are the inventory levels for each product?
- How will the lacking materials be financed?

From this point of view, MRP is a powerful tool for producing orders with correct inputs and its aim is to minimize excess inventory cost, increase productivity and efficiency.

In 1970s companies could no longer afford the luxury of maintaining large quantities of inventory (Umble et al., 2003; 242). In the late 1970s the primary

competitive thrust was shifting towards marketing, which resulted in the adoption of target-market strategies with an emphasis on greater production integration and planning. MRP systems fit that requirement nicely because of the integration between forecasting, master scheduling, procurement, plus shop floor control. MRP fairly quickly became established as the fundamental parts and materials planning concept used in production management and control (Jacobs and Weston, 2006; 358). Due to the need for software designed specifically for manufacturing operations MRP systems, which were planning the product or part requirements according to the master production schedule, were introduced (Gumaer 1996; Rashid et.al., 2002; Umble et al. 2003).

The inputs of a basic MRP was master schedule plan, bill of materials (BOM) and inventory levels and the outputs of MRP are purchasing orders and production plan. A classical MRP process is shown in Figure 1.



Source: Umble, E. J., Haft, R. R., Umble, M. M. (2003). Enterprise Resource Planning: Implementation Procedures and Critical Success Factors. *European Journal of Operational Research*, Vol. 146, 241-257.

Figure 9: MRP Process

In 1970s, 'Closed loop' MRP emerged as a response to the shortcomings of MRP I. 'Closed loop' MRP systems control capacity as well as inventory. They contain feedback loops that ensure that checks are made against capacity to see if production plans are feasible. All but the most basic MRP systems are now closed-loop systems (The Manufacturing Advisory Service, 2005). Functions such as purchasing, work orders, capacity planning are included in closed loop MRP systems.

The mid-1970s saw the birth of major software companies that would later become key ERP vendors. In 1972 five engineers in Mannheim, Germany, started up SAP (Systemanalyse und Programmentwicklung). The purpose of the company was to produce and market standard software for integrated business solutions. Lawson Software was founded in 1975 when Richard Lawson, Bill Lawson, and business partner John Cerullo saw the need for pre-packaged enterprise technology solutions as an alternative to customized business software applications. J.D. Edwards (founded by Jack Thompson, Dan Gregory and Ed McVaney) and Oracle Corporation (by Larry Ellison) were established in 1977. Oracle offered the first commercial SQL (Structured Query Language) relational database management system in 1979. In 1978 Jan Baan began The Baan Corporation in the Netherlands to provide financial and administrative consulting services (Jacobs and Weston, 2006; 359).

With the beginning of 1980s, the MRP system has been extended from a simple MRP tool to the standard manufacturing resource planning (MRP II) (Chung and Snyder, 1999; 213).

The new system is called MRP II, Manufacturing Resource Planning, just to distinguish its capability from MRP, the simpler system. Functions like finance, procurement, personnel, cash, production planning etc. are included in MRP II which were not capabilities of MRP.

At these years, companies began to take advantage of the increased power and affordability of available technology and were able to couple the movement of inventory with the coincident financial activity. Manufacturing resources planning (MRP II) systems evolved to incorporate the financial accounting system and the financial management system along with the manufacturing and materials management systems. This allowed companies to have a more integrated business system that derived the material and capacity requirements associated with a desired operations plan, allowed input of detailed activities, translated all this to a financial

statement, and suggested a course of action to address those items that were not in balance with the desired plan (Ptak and Schragenheim, 2000).

The term MRP began to be applied to the increasingly encompassing functions, leading to the use of the phrase manufacturing resource planning rather than material requirements planning. Eventually the term manufacturing resource planning II (MRP-II) was coined to identify the newer systems' capabilities. Parallel with this change in the scope of software applications, the 1980's manufacturing competitive thrust changed to quality with the emergence of the quality ''gurus'' including Deming, Juran, Crosby, Ishikawa, and others. Manufacturing strategy emphasized greater process control, world class manufacturing, and a focus on reducing overhead costs. The closed-loop scheduling, enhanced shop floor reporting, and linkages to due-date scheduling and procurement, plus detailed cost reporting features of the ever-developing MRP-II systems, were designed to support these new initiatives (Jacobs and Weston, 2007; 359).

The main objective of MRP-II systems is to collect all resources in an organization into a common database and have all personnel share a common language.

The limitations of MRP II such as fixing lead times led to the development of total integrated solution called ERP that integrates the suppliers and customers with the manufacturing environment of organization.

By the early 1990s, continuing improvements in technology allowed MRP II to be expanded to incorporate all resource planning for the entire enterprise. Areas such as product design, information warehousing, materials planning, capacity planning, communication systems, human resources, finance, and project management could now be included in the plan. Hence, the term, ERP was coined. And ERP can be used not only in manufacturing companies, but in any company that wants to enhance competitiveness by most effectively using all its assets, including information (Shankarnarayanan, 2000).

The first ERP system was developed by two German engineers who founded SAP in the early 1970s (Okrent & Vokurka, 2004; 638). SAP has become the world's largest inter-enterprise software company and the world's third-largest independent software provider overall (www.sap.com). Since the foundation of SAP and the introduction of ERP, growth of ERP systems has been dramatic with many vendors offering ERP systems. Some of the major ERP vendors include: SAP, Oracle, and PeopleSoft.

Also one of the reasons why ERP and increase its usage significantly occurred in 1990s, is the Year 2000 problem within the IT industry. Businesses realized the benefits of ERP systems which try to integrate entire organization, including accounting, human resources and project management focusing more on quality, therefore overcoming the Year 2000 problem.

2.3. Historical Development of ERP Market

The applications that represented the beginning of ERP solutions appeared in the 1960s in the form of material requirements planning efforts, which helped companies plan and schedule materials shipments for the manufacture of products. The 1970s saw the founding of SAP, Oracle and JD Edwards, vendors that would eventually shape the ERP market.

PeopleSoft emerged in the 1980s with an enterprise application that enabled organizations to better manage human resources. This technology was essentially the first ERP product. Soon after, vendors released similar client-server platforms to support processes such as engineering, finance, project management and procurement.

Those products were the first to be called enterprise resource planning systems. In the years from 1990 to 1995, ERP systems were mostly implemented by manufacturing enterprises to replace their MRP packages or built-in legacy systems.

The latter part of the 1990s were boom times for the ERP market, as organizations plunged millions of dollars into projects to replace legacy systems because of Y2K concerns. Also, as businesses became more global, many implemented ERP applications to track transactions worldwide.

In recent years, consolidation has had a huge impact on the ERP market, with some of the major vendors gobbling up smaller competitors. Today, the major players include SAP, Oracle, Infor and Microsoft, however many smaller companies offer ERP products.

According to AMR Research, the increased demand of manufacturers for information integration, together with the potential Y2K compliance problems in the legacy systems and increasingly globalized business focus of the enterprises led to the explosion of the ERP market. By the year 1995, the overall ERP market size had exceeded $4 billion in terms of revenue from software licenses and vendor provided services, and its growth rate for 1996 was estimated to be 30% by AMR Research. In 1996, Jim Shepherd from AMR compared the rapidly growing demand potential of the ERP market to the gold rush and interpreted the expected growth rate of 30% as: "It appears now that even the notoriously optimistic software vendors were too conservative. This market is booming!" The extremely high growth rates continued for the next three years and in 1998, the ERP market had reached $16.9 billion in size with a 39% growth from 1997.

However, in the 1999 – 2002 period, the ERP market slowed down to nearly 0% growth rates. AMR Research attributes this slowdown to the following reasons:

- Enterprises shrinked their IT budgets and restricted capital spending severely due to the overall economic crisis.

- In the earlier years, the overall industrial enterprise applications market revenue was mostly generated by application software license sales, and the ERP software had the greatest share. However, starting from 2000, ERP

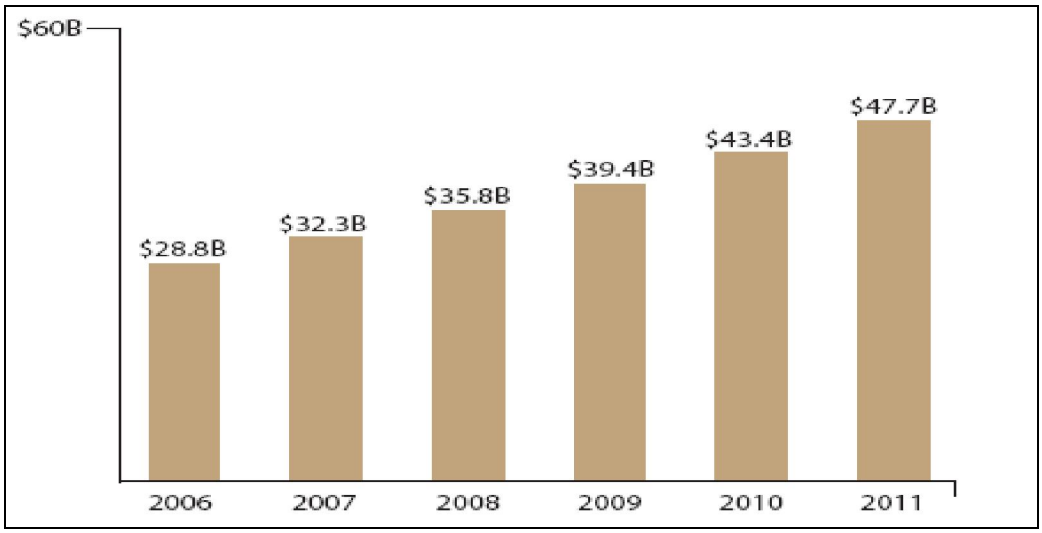
started to lose its share to other emerging software applications such as Customer Relationship Management (CRM) and Supply Chain Management (SCM).

- The great size and complexity of ERP applications was a strong handicap for the ERP vendors' response to market.

In the year 2003, ERP market started to experience positive growth rates again, but the rates were more modest this time. The market grew by 14% in 2003 and 7% in 2004, and is expected to expand in the upcoming years as vendors promote differentiated services. AMR Research attributes this improvement in the ERPmarket to:

- Improved economic conditions and the shifts in global currency valuations
- Growth strategy pursued by big vendors by acquiring smaller niche vendors

The ERP market had a spectacular year, with total revenue growing by 14% and license revenue up an amazing 18% from 2005. While sales of traditional ERP applications were very healthy in 2006, many vendors also saw substantial revenue growth from the acquisition of other software companies. Globalization, centralization, and regulatory compliance were the key drivers for continued ERP investment among large corporations. In the small and midsize business (SMB) segment, which continues to outgrow the overall market, companies are buying new ERP systems in response to new customer requirements and the desire to participate in the global market.



Source: AMR Research, 2007

Figure 10: ERP Application Revenue Estimate

Here are some major trends from the 2006 ERP market:

- ERP vendors that traditionally offered a single, internally developed product line now go to market with a broad portfolio of products targeted to specific industry and departmental buyers.

- Oracle and SAP continue to dominate the market among very large global companies. In the increasingly important SMB segment, though, they face formidable competition from Infor, Sage Group, Microsoft, Lawson, and Epicor.

- New pricing and deployment models, such as software as a service (SaaS) and enterprise licensing, are starting to gain acceptance. It is expected that most of the ERP vendors will begin offering on-demand in addition to onpremises options in the near future.

- The fundamental ERP concept of a single-vendor, pre-integrated suite of packaged business applications ismaking excellent headway in non-manufacturing markets such as retail, financial services, and public sector. As ERP vendors buy and build the necessary industry functionality, their available market rapidly expands.

2.4. ERP Suppliers

According to Albert Pang, director of enterprise applications research at research firm IDC, there are two main camps in ERP suppliers: the big vendors that offer broad product suites aimed at horizontal customers, and smaller niche vendors that sell to vertical industries such as health care, distribution and the public sector (Violino, 2008; 1).

In general there are two ways of getting ERP software. One is purchasing pre-package ERP software from an ERP provider, other is getting a tailor made software specifically customized and designed for the company.

Since 1972, the year that SAP AG is founded, SAP is the dominant leader of the market. Oracle Applications, PeopleSoft, Baan and JD Edwards are followers of SAP. These five companies have the 68 percent of the market by the year 1998. In 2003, PeopleSoft has acquired on of its rivals, JD Edwards, and became the second ERP vendor in the market.

Table 4: ERP Market Shares, 2003 and 2004

2004 Revenue Rank	Company Name	Revenue, 2003 ($M)	Revenue, 2004 ($M)	Revenue Share, 2003	Revenue Share, 2004	Growth Rate, 2003–2004
1	SAP	7994	9372	39%	40%	17%
2	PeopleSoft	2682	2880	13%	12%	7%
3	Oracle	2470	2465	12%	10%	-0%
4	Sage Group	900	1243	4%	5%	38%
5	Microsoft Business Solutions	683	775	3%	3%	14%
6	SSA Global	471	700	2%	3%	49%
Total (including other ERP vendors)		20711	23649	100%	100%	14%

Source: AMR Research, 2005

Oracle and SAP continue to command the lion's share of revenue from the ERP market. We predict they will not lose ground anytime soon, especially as both firms are going gangbusters for the midmarket. That said, expect some shift in the landscape populated by several other competent providers:

- Infor's growth cannot be underestimated. The company relies on an innovative business model that centers on acquiring products to generate additional maintenance and license revenue, as well as increasing cross-selling opportunities within its ever-growing installed base. The company believes it has developed a disciplined and effective process for evaluating, acquiring, and assimilating software businesses, and it intends to capitalize on this core competency. Infor has proven to be a successful cross-selling machine in addition to being extremely skilled in integrating acquired entities.

- Sage Group is bringing to its customer base CRM functionality plus business intelligence through the inquiry and analysis tools Business Insights Analyzer and Explorer. The Analyzer is the drill-down, basic reporting tool that has some wizards to build queries, and Explorer is the role-based, personalization-driven reporting structure.

- Microsoft Business Solutions, while focused on the midmarket, continues to be pulled into larger enterprise deals. With the widespread adoption of Microsoft technologies on the plant floor, firms looking to feed a modern ERP beast might find comfort in one of the Dynamics products.

- For Lawson, 2007 will truly test the success of its Intentia acquisition, since there is minimal crossover between the S3 and M3 products other than the shared services of the Lawson Business Intelligence (LBI) and financials offerings. The critical success factor will be gaining mass market appeal for the M3 product in North America, where the brand is not as well known as it is in Europe.

In 2006 leader is the same company, SAP, with 41 percent share in terms of revenue. Oracle is the follower of SAP with 21 percent and other followers are Infor, Sage Group and Microsoft. These five suppliers have the 78 percent of the total market.

Table 5: ERP Vendors Ranked by Application Revenue, 2005-2006

2006 Revenue Rank	Company	Revenue, 2005 ($M)	Revenue, 2006 ($M)	Revenue Share, 2005	Revenue Share, 2006	Growth Rate, 2005-2006
1	SAP	10542	11753	42%	41%	11%
2	Oracle	5166	6044	20%	21%	17%
3	Infor	480	2114	2%	7%	340%
4	Sage Group	1438	1830	6%	6%	27%
5	Microsoft	844	996	3%	3%	18%
6	Lawson	346	560	1%	2%	62%
7	Epicor	291	384	1%	1%	32%
8	IFS	279	309	1%	1%	11%
9	Exact Software	281	303	1%	1%	8%
10	Activant	260	289	1%	1%	11%
11	CDC Software	202	240	1%	1%	19%
12	QAD	222	236	1%	1%	6%
13	Deltek Systems	151	230	1%	1%	52%
14	Glovia	212	212	1%	1%	0%
15	SSA Global*	733	0	3%	0%	-100%
16	Geac*	445	0	2%	0%	-100%
17	MAPICS*	178	0	1%	0%	-100%
Subtotal		**22069**	**25499**	**87%**	**88%**	**16%**
Other ERP Vendors		**3289**	**3321**	**13%**	**12%**	**1%**
Total		**25358**	**28820**	**100%**	**100%**	**14%**

Source:AMR Research, 2007

2.5. Effects of ERP

Implementation of ERP system has both advantages and disadvantages for the organizations. Organizations have to take into account both disadvantages and disadvantages before the decision of ERP implementation.

2.5.1. Advantages of ERP

Researchers in the literature agreed in many potential advantages associated with ERP implementation. ERP provides the integration of whole value chain from

raw material to the finished product through mutually beneficial partnerships between producer, supplier and distributer.

Production planning is done by order rather than forecasts and none-value added activities are reduced through continuous improvement efforts. Continuous product flow is achieved through physical rearrangement and system structure and control mechanisms (Kotelnikov, 2005).

One of the significant benefits of the ERP system is the improvement in supply demand linkage. The ERP systems streamline all supply chain processes in order to create plans and forecasts with optimization tools. Besides, aggregate planning and detailed scheduling could be used to ensure maximum benefits.

Bancroft et al. (1998), Marcus and Tanis (2000; 176) are agreed on three common advantages of ERP systems; the ability to better meet various competitive goals, the desire to reengineer business processes and the ability to access integrated data.

ERP systems allow greater accuracy and timeliness of information, as data redundancy and duplicative data entry is reduced with a unique database. Information is organized in more efficient way and the system allows wide variety of individuals to access data. Therefore, management could have online access to information for decision making and managerial control.

Decision making is based on accurate information as the integration of subsystems is maintained so inventory problems, material shortages, delivery and cash management problems are eliminated with the accuracy of integrated data.

Benefits to adopting an ERP system include having a single system to support rather than several small and unrelated systems, enabling use of management information that could not be assembled across a mix of applications, providing access to best practice systems and procedures, increasing integration which may

lower coordination and labor costs, and increasing standardization of tasks which facilitate exchange of data (O'Leary, 1998).

Computer security is included within an ERP, to protect against both outsider crime, such as industrial espionage and insider crime, such as embezzlement. Can some terrorist mess with the Bill of Material so as to put poison in food products, or other sabotage? Preventing abuse is part of what ERP security takes care of (www.wikipedia.org).

The system support coordination across different business functions. The usage of the system with the requirements reduces paper documentation. For example the purchasing procedures include the approval hierarchy and notifications within the system.

The potential benefits could be in terms of increase in sales, improvement in margins, and savings in inventory carrying costs. According to Meta Group (1999) survey conducted among the large enterprises that adopted ERP systems, the need to implement the ERP system arises from:

- internal integration,
- to support growth,
- to support new processes or a changed business model in a firm's supply chain.

2.5.2. Disadvantages of ERP

Besides the advantages, there can be also limitations and disadvantages of ERP systems.

ERP systems can be very expensive to install. It requires massive investments. Total cost of acquisition and implementation of ERP package is very costly. These costs may be explicit costs of licensing and consultancy for

implementation. However, there may also be some implicit costs such as maintenance of system after implementation and training and recruitment of qualified employee.

Besides the massive investment, the implementation usually takes long time and needs high level of expertise to avoid the risk of a potential failure. ERPs are often seen as too rigid, and difficult to adapt to the specific workflow and business process of some companies, this is cited as one of the main causes of their failure.

Systems are sometimes can be difficult to use and personnel may have resistance to change the way of doing his/her job. Success of the ERP systems depends on the skill and experience of the work force. If an inefficiency occurs in one department of the organization, this will affect other departments and directly the performance of the whole system. Also personnel turnover affects the working performance of all the system.

2.6. Implementation of ERP

ERP implementation is a long and difficult process for companies. Companies not only have difficulties in implementation process but also in pre-implementation and post-implementation stages. Decision makers and have to implement a careful project management process and take right actions in order to pass these distressing stages. Expertise and experience plays an important role in ERP implementation process. If the project fails it will not only cost thousand of dollars but also too much effort and time.

Marcus and Tanis (2000; 179) identified four phases in an ERP life cycle:

- Chartering: decisions defining the business case and the solution constraints
- Project: getting system and end users up and running
- Shakedown: stabilizing, eliminating “bugs”, getting to normal operations

- Onward and upward: maintaining systems, supporting users, getting results, upgrading, system extensions

After deciding ERP implementation, companies have to find the answer of which ERP software package should be installed. In the chartering stage a project team should be formed and this team has to collect relevant data about ERP vendors and systems. Then the project characteristics should be identified and objectives of the project should be discussed and constructed. Next step is extracting the attributes for evaluating ERP systems from structure of objectives. In this step factors such as functionality, price, training and maintenance services plays an important role in ERP selection process. The last step is analyzing and discussing the results and making the final decision (Wei et al., 2005; 53).

The project phase in ERP lifecycle deals with the customization or parameterization and adaptation of the ERP package acquired to meet the needs of the organization. Usually this task is performed with the help of consultants who provide implementation methodologies, know-how, and training. Expertise of the consultants and project champion plays a critical role in ERP implementation success. Although training is present in all the phases, the largest training investment is made during the implementation phase.

The shakedown phase refers to the period of time from going live until normal operation or routine use has been achieved. Key activities include bug fixing and rework, system performance tuning, retraining and staffing up to handle temporary inefficiencies.

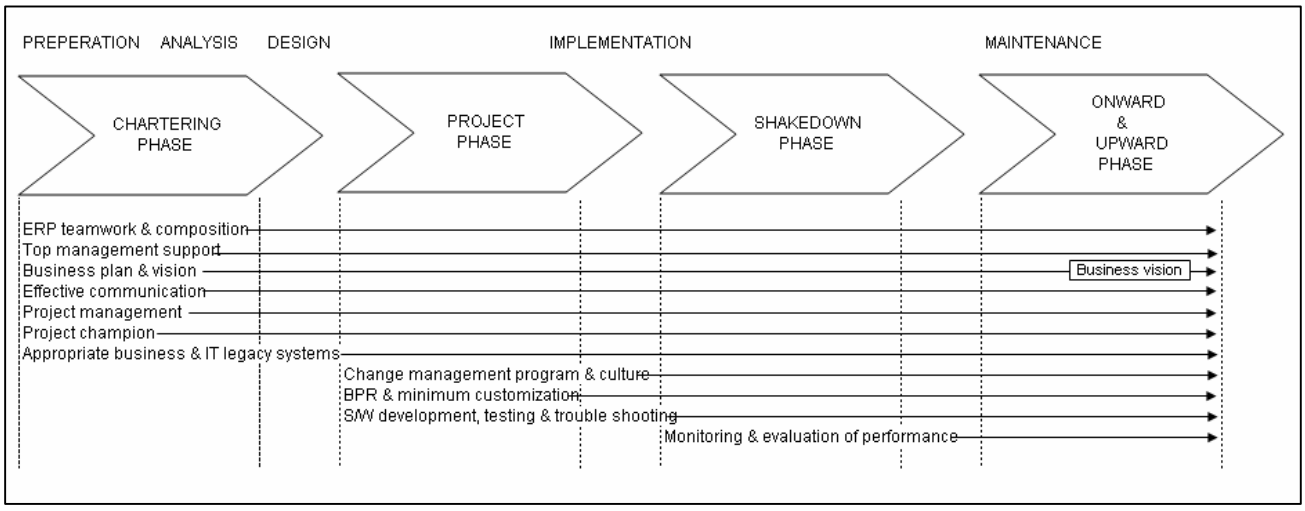
The last phase onward and upward phase refers to ongoing maintenance and enhancement of ERP system and relevant business processes to fit the evolving business needs of the organization. If necessary, upgrades done in this phase.

2.7. Critical Success Factors for Implementing ERP

According to Rockart (1979; 85), critical success factors (CSF) can be defined as "those few critical areas where things must go right for the business to flourish" and CSF's for any information systems project have been a topic for research in the IS research community for quite some time (Bacon, 1992; 338).

The difficulties and high failure rate in implementing ERP systems have been widely cited in the literature (Davenport, 1998), but research on critical success factors (CSFs) in ERP implementation is rare. Nah and Lau (2001) tried to find the answer of the question "what are the key critical factors for ERP implementation success". After a rigorous research on ERP critical success factors literature in they stated eleven CSFs emerged as critical to the successful implementation of ERP systems. The eleven CSFs that literature agreed are: (1) ERP teamwork and composition, (2) change management program and culture, (3) top management support, (4) business plan and vision, (5) business process reengineering and minimum customization, (6) effective communication, (7) project management, (8) software development, testing and trouble shooting, (9) monitoring and evaluation of performance, (10) project champion and (11) appropriate business and IT legacy systems.

The eleven CSFs are classified in Marcus and Tanis' (2000) lifecycle model is shown in figure 11.



Source: Nah, F. F. H., Lau, J. L. S., Kuang, J. (2001). Critical Factors for Successful Implementation of Enterprise Systems. *Business Process Management Journal*, Vol.7, No. 3, 285-296.

Figure 11: Classification of CSFs of ERP implementation into Marcus and Tanis' (2000) process oriented ERP life cycle model

2.7.1. Top Management Support

Like in all quality management philosophies, top management leadership and support plays the most important role in successful implementation of ERP. The IT literature has clearly demonstrated that for IT projects top management support is critical for success, as so top management must clearly identify the implementation project as top priority. Top management needs to constantly monitor the progress of the project and provide direction to the implementation teams.

Managers should legitimize new goals and objectives. A shared vision of the organization and the role of the new system and structures should be communicated to employees. New organizational structures, roles and responsibilities should be established and approved. Policies should be set by top management to establish new systems in the company. In times of conflict, managers should mediate between parties (Roberts and Barrar, 1992; 14).

Importance of top management support is also mentioned by Sumner (1999; 46) and Wee (2000), as one of the most important success factors during the implementation. According to Sumner (1999; 47) it is crucial that the project is aligned with strategic business goals and that it receives approval from the top management. One way to accomplish this is to tie management bonuses to project success (Wee, 2000).

Building cooperation among the diverse groups in the organization, intervention from management is often necessary to resolve conflicts. Constant commitment of top management generates overall organizational commitment which in turn felt as sure way to ensure a successful implementation (Bingi et all, 1999; 11).

2.7.2. ERP Teamwork and Composition

ERP teamwork and composition is one of themost frequently cited topic in CSF in ERP implementation literature. This indicates that teamwork and the composition of the project teams such as the availability of skilled project members and how to manage them, including external consultants, are essential for ERP success.

Senior management from different corporate functions, senior project management representatives and future users of the ERP system also have to be the part of the project team. The project team often takes part in important phases like the selection phase, control of external consultants and monitoring the implementation phase (Somers and Nelson, 2003; 318).

According to Bingi et al. (1999; 14) the work of the project team is critical for a successful implementation of an ERP system. The committee is important in the early phases and should also involve the management in the project.

2.7.3. Business Plan and Vision

Business plan and vision is the guide and the map of the project team which shows the goal of the project and the ways of reaching that goal. If you do not know your final destination it is not important where you are going.

Approximately 90% of ERP implementation projects are late or over budget (Martin, 1998; 96). Therefore, timeliness of project and the forcing of timely decisions should be managed, deadlines must be met and the project must be monitored closely to take the budget and time conditions under control (Nah et al, 2001, 292). Project plan should be well defined in terms of milestones and revised in some periods to analyze how we planned and how we realized the planned items.

2.7.4. Effective Communication

Clear and effective communication play an important role at all levels of the organization before and during the implementation of ERP.

Communication includes the formal promotion of ERP project teams and advertisements on the project's progress to the rest of the organization (Holland et al., 1999; 276). Communication has to cover the scope, objectives, and tasks of an ERP implementation project (Sumner, 1999; 49).

Amoako-Gyampah and Salam (2004) found that effective communication is one of the success factors that influence the acceptance of technology in an ERP implementation environment. In order to avoid failures in communication, an open and honest information policy communicated to the users can satisfy their need for information.

2.7.5. Project Management

Successful project management is the fundamental part of every ERP project. Slevin and Pinto (1987; 36) argue that in order to manage a project successfully, project managers must be capable both in strategic and tactical project management activities. They propose ten project management critical success factors that fall in either the strategic or tactical phases of a project. The strategic factors are: project mission, top management support and project schedule/plan; while tactical factors are: client consultation, personnel recruitment, technical task, client acceptance, monitoring and feedback, communication, and troubleshooting (Slevin and Pinto, 1987, 37).

In order to have a successful project plan, the milestones of the project should be underlined formally and the critical paths of the project should be determined (Nah et al, 2001; 292). Deadlines should be met to help stay within the schedule and budget and to maintain credibility (Wee, 2000).

2.7.6. Project Champion

The role of the project champion is often linked to technological innovations, the project champion should posses skills referred to transformational leadership, facilitation, and marketing. Another critical factor that is crucial for project champion is the acceptance and use of technology during the integration in the organization (Somers and Nelson, 2003; 325).

Project champions are not only important for the implementation of many systems such as IS, but also play a critical role in the implementation of ERP and in handling organizational change. The project champion should be a high-level executive sponsor who has the power to 'champion' the ERP project throughout the organization (Summer, 1999; 52).

2.7.7. Appropriate Business and IT Legacy Systems

Appropriate business and legacy systems are important in the initial chartering phase of the project. Business and IT systems involving existing business processes, organization structure, culture, and information technology affect success. It determines the IT and organizational change required for success (Holland et al., 1999; 285). Roberts and Barrar (1992; 15) argue that success in other business areas is necessary for successful MRPII implementations.

2.7.8. Change Management Program and Culture

The effective implementation of an ERP system requires change management strategies and an understanding of organizational culture. Change management is important from the beginning of the project throughout the entire life cycle and top management's leadership plays the most important role in change management process.

It is important that employees are willing to change and accept new technologies. It is suggested that the management should use the system to show how to achieve organizational goal (Roberts and Barrar, 1992; 16). ERP system totally will change the way of doing business for all the employees. Therefore, it is important that an organization goes through a carefully planned transformation that is based on adequate strategy and well-defined methodology of implementation (Bingi et al., 1999; 12). Top management and project team must make users part not only in implementing but also in designing the business processes so that users' resistance to new system can be minimized.

2.7.9. Business Process Reengineering (BPR) and Minimum Customization

In order to improve the functionality of the software in accordance with the needs of the organization, an organization should reengineer business processes to fit

the software instead of trying to modify the software to fit the organization's current business processes (Sumner, 1999; 56). Users have resistance to change the way of doing their job, and try to find ways of customizing the software in order to adapt the organization's business processes. On the other hand, the cost and the possibility of error will be increased if more customization for the software was undertaken. Here selection of ERP package plays the most important role; ERP package must be compatible with organization's needs and business processes as much as possible.

Broad reengineering should begin before choosing a system. In conjunction with configuration, a large amount of reengineering should take place iteratively to take advantage of improvements from the new system. Then when the system is in use reengineering should be carried out with new ideas (Wee, 2000).

2.7.10. Software Development, Testing and Trouble Shooting

The integration of software is not an easy task, and should be managed properly. Software may need to be developed to integrate the legacy systems and the ERP systems. Testing and troubleshooting of the ERP system is necessary to ensure that the software functions according to plan (Ngai et al, 2008).

Software development, testing and troubleshooting is essential, beginning in the project phase. The overall ERP architecture should be established before deployment, taking into account the most important requirements of the implementation. This prevents reconfiguration at every stage of implementation (Wee, 2000).

Troubleshooting for errors help organizations to find out possible failures in the system and find ways of solving possible problems while operating the system. Here experience plays the most important role and necessity of consultants occurs

2.7.11. Monitoring and Evaluation of Performance

The monitoring and evaluation of performance is a critical factor in the success of any IT system, including ERP systems. Implementation progress must be measured regularly for more efficient and effective control. Through monitoring and feedback from the users, the performance of the ERP system can be reviewed and evaluated to see whether it is achieving business goals and objectives.

CHAPTER THREE

IMPACT OF ENTERPRISE RESOURCE PLANNING (ERP) ON SUPPLY CHAIN MANAGEMENT (SCM)

3.1. Introduction

By the rapid development of information technologies in recent years, many companies installed and implemented Enterprise Resource Planning (ERP) and Supply Chain Management (SCM) systems successfully. Successful management of the supply chain for competitive advantage has resulted in development of the supply chain management philosophy and associated practices such as enterprise resource planning systems.

According to Tarn et al. (2002) SCM systems have two important function: (1) Maintaining timely information sharing across the overall supply chain, (2) Facilitating the synchronization of the entire supply chain. However, the major goal of ERP is to unite the various departments across an enterprise through one system application package (Tarn et al., 2002). The information managed by an ERP system can be utilized in many different ways. For example executives and employees in production, customer service, accounting and finance are able to rely on the information within the system to make more effective decision.

Here we can see that the two information systems, ERP and SCM, have the similar mission in terms of information flow and synchronization. But the scope of the two systems is different. ERP provides the information flow and synchronization within and organization, and so the SCM system in supply chain.

Management of supply chains requires continuous adjustments of the decision-making process including dynamic pricing and risk assessment, and evaluation of sourcing and logistics alternatives. While SCM systems are suitable for these functionalities, ERP systems are not designed for it (Bose et al., 2008). In ERP systems, material, capacity and demand constraints are considered separately. However, SCM systems consider all constraints simultaneously and develop a higher quality plan relatively quickly. Akkermans et al. (2003) identified the limitations of ERP systems in coping with the challenges of SCM, including difficulties in crossing organizational boundaries, lack of flexibility in dealing with ever-changing requirements, and dearth of functionalities that focus on managing transactions.

In recent years with the development of SCM philosophy, both the two system began not to answer the requirements of changing world for the organizations. The two systems should be integrated to provide higher business value in order to keep up with the changing environment.

Advanced improvements in internet technology also have supported a revolution in supply chain philosophy. Companies, its suppliers and also the customers began transferring data by Electronic Data Interchange (EDI) faster and also cheaper.

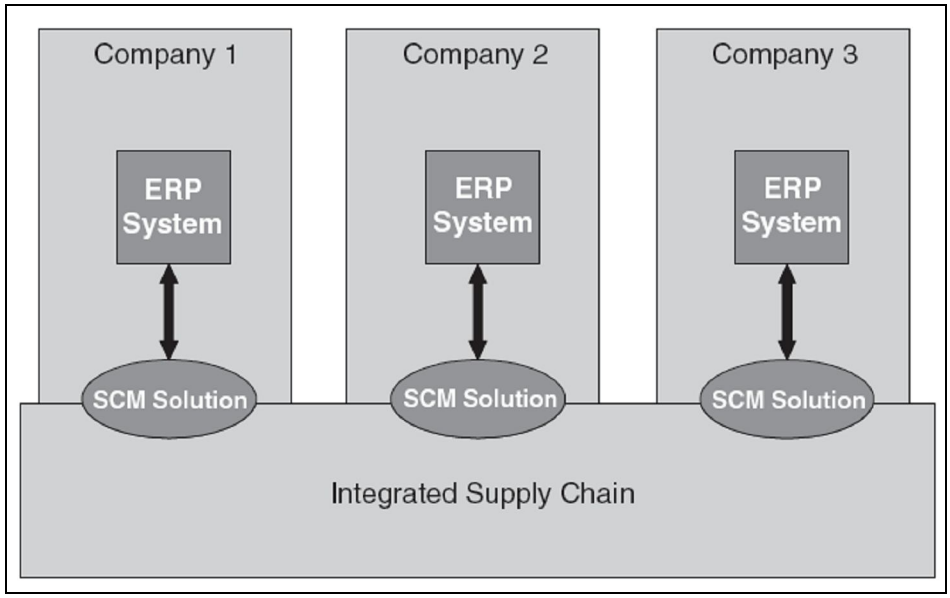
By the way, while the ERP software market entered its maturity stage, the SCM application market is still in growing stage and shows a dramatic growth in recent years (Tarn et al., 2002). In addition to electronic data interchange (EDI) and related technologies like XML / EDI, Supply Chain Management Software has become more important. For example, AMR Research Inc. estimates that the market volume of such software will continuously increase from approximately $5 billion in 2002 to about $8 billion in 2007 (Lapide & Davis, 2003, p. 3). Another survey indicates that approximately 80 per cent of manufacturers in the USA have launched major supply chain initiatives (c.f. Logistics Management and Distribution Report, 1999).

On the other hand, in order to compete with the fast growing SCM application providers, major ERP vendors are attempting to extend beyond the core functionality of their ERP products to include SCM capabilities. Evidence of this change can be seen in the numerous acquisitions and strategic alliances formed recently (Tarn et al., 2002). For example Baan acquired supply-chain application vendor Berclain, adding some internally developed supply chain capabilities to its ERP applications (Electronic Buyers News, 1997). It has become obligatory for ERP vendors to serve for SCM within their software packages in order to survive in the changing ERP market.

3.2. ERP and Supply Chain Integration

Nowadays for many companies, it is important to use the two systems integrated to provide higher business value. Many modern organizations began trying to integrate enterprise resource planning (ERP) and supply chain management (SCM) systems in order to gain competitive advantage against other organizations. However integration of the two systems is a complex and challenging process which is difficult to manage for companies. This integration requires efficient management of hardware, software, and human resources for successful completion.

Early ERP systems were not primarily focused on the supply chain. Their initial focus was to execute and integrate such internally-oriented applications that support finance, accounting, manufacturing, order entry and human resources. Even in the early days, however, a link to SCM was present in the form of inventory management (Davenport and Brooks, 2004).



Source: Buxmann, P., von Ahsen, A. , Diaz, L. M., Wolf, K. (2004) Usage and Evaluation of Supply Chain Management Software – Results of an Empirical Study in the European Automotive Industry. *Info Systems,* Vol. 14, 295-309.

Figure 12: Complementary Application of ERP and SCM Systems

While ERP software primarily provides inbound oriented functions (Premkumar, 2000, pp. 63–68; Yellurkar, 2002), Supply Chain Management systems focus on both intra- and inter-organizational processes. Currently, most Supply Chain Management Software vendors provide supply chain planning functions which are based on ERP systems to carry out the execution of the planned tasks. Figure 1 illustrates the complementary application of ERP systems and Supply Chain Management solutions. It is seen in the figure that the company in the middle of the supply chain offers different SCM solutions to each company, which can be either supplier or customer, by the ERP application.

While companies expanding into global markets, dynamic and rapid changing external environment pressures companies to take actions as quick as possible in order to compete effectively and survive at global markets. Companies have to build a strong and integrated information system that allows data transmission between the

branches of the company in different countries. Here fast and accurate data transmission is the key factor for taking right decision and acting agile.

Company need to establish a streamline business process, which can significantly enhance communication and cooperation among functional departments. To achieve this goal functional integration is required, which is the process of integrating all business functions work together. For example a firm's logistics or distribution functions must integrate with supply management, manufacturing and informational technology before the functional integration can be extended to other companies in the supply chain (Ferguson, 2000).

By considering objective, focus, goal and function of the two systems need for ERP and SCM integration can be explained better. Table 1 summarizes objective, focuses, goals and functions of ERP and SCM systems.

As seen in Table 6, ERP's objective is improving internal efficiency by integrating internal business processes within a single organization. On the other hand SCM aims to integrate the interaction of external business partners across the entire supply chain. This objective forces SCM to provide communication between supply chain agents and overcoming natural boundaries. So integration of ERP and SCM is a natural and necessary process in managerial consideration.

According to Tarn et al (2002), technologically ERP can be said as the backbone of SCM. Because they both rely on very similar framework such as intranet, extranet and EDI, it is very possible and feasible for their integration.

Improving the supply chain and proving the coordination between players in a supply chain is the future of ERP. In addition to this, the core of ERP, an integrated set of applications that link together such back office applications as manufacturing, financials and distribution will become a subclass of a much broader enterprise business system (Tarn et al., 2002). According to McGee (1998), ERP will extend

into transportation, warehousing, sales-force automation and even beyond that into engineering with computer aided design and product data management systems.

Table 6: Comparison of SCM and ERP Systems

	SCM Systems	ERP Systems
Objective	Integrating and optimizing internal business processes of a single organization as well as the interaction of the organization with its business partners across the entire supply chain	Integrating and optimizing internal business processes within the boundary of a single organization
Focus	Optimizing information flow, physical distribution flow and cash flow over the entire supply chain	Optimizing information flow and physical distribution flow within a single organization
Goal	Constraint-based tool providing reasonable and feasible business plans based on the availability of the required key resources	Non constraint-based tools providing business plans without the consideration of the availability of key resources
Function	Manufacturing management, inventory management, logistics management and supply chain planning	Manufacturing management, financial management and human resource management

Source: Tarn, J. M., Yen, D. C., Beaumont, M. (2002). Exploring the rationales for ERP and SCM integration. *Industrial Management & Data Syatems*, Vol. 102/1, 26-34.

3.3. Methods of ERP and SCM System Integration

Companies realized the necessity of ERP and SCM system integration as quickly as possible in order to adapt the rapid environmental changes in global world.

The SCM system applications added to existing ERP solutions as a modular enhancement. Tarn et al. (2002) defined three ways of integrating SCM and ERP systems.

- *Conformity*: It requires all of the members of the supply chain to embrace the same system. However in a supply chain consists of large amount of members, this method is not practical. Issues of trust and security further complicate any chance of success with this method.

- *Middleware*: In this method, links are established between various supply chain members via programming. This method is very practical, but an expensive way.

- *Special Integration Software (SIS)*: SIS is designed specifically to allow ERP and other systems to share processes and data. In this method, specialized integration technologies or software (SIS) is used to extend ERP functionality. The software is programmed to integrate SCM software with ERP system packages. With this method, the ERP system will become a business-services framework, a central information repository, and a data-distribution facility (Radding, 1999).

3.4. Limitations for ERP and SCM System Integration

The integration of ERP and SCM systems is a hard and challenging process for the companies struggling to achieve. Beside the advantages and necessity of integration, it is a difficult process with many limitations and challenges. Somers and Nelson's (2001) research pointed out that one third of integration applications have been found to be satisfactory only in China.

One of the basic limitations for ERP and SCM system integration is infrastructural insufficiencies within the current system. Commonly integration requires changes in the IT infrastructure of the company. Hardware, software and data communication system should be updated in order to satisfy integration needs. Commonly new interfaces formed to provide data transformation between supply chain members' systems and companies' enterprise system. But this interface may cause data losses while transforming data from one unit to another. And these loss data may cause important problems not only for main company, but also for the suppliers and even for the customers.

Another limitation for integration is financial. Company has to be financially strong to pay the investment cost of hardware, software and training of both employees and the suppliers. Modification and customization of existing system has a cost to be paid to the system service provider company. Also employees have to be trained to adapt working style of the new system. During the adaptation period, resistance for the new system by employees will be another limitation for the implementation. Employees will be doing their work, both within the existing and new systems during the implementation and demo period. Top management support and guidance plays critical role like in all quality management philosophies to overcome this difficulty. The knowledge and experience of the project leader is another important factor for successful implementation. Project champion is responsible from coordination of the team members. If the project champion does something wrong for the future of the project, all the effort performed by all the team members will be wasted.

3.5. Impact of Enterprise Resource Planning (ERP) Systems on Organizational Performance in Literature

There are many studies in the literature about impact of ERP on organizational performance. Hunton et al. (2003), investigated the longitudinal impact of ERP adoption on firm performance. In this study, financial performance of 63 ERP adopters and 63 non-adopters are compared in a matched-pair design. The performance metrics used in the research are: Return on assets (ROA), return on sales (ROS), asset turnover (ATO), and return on investment (ROI). The hypothesis of the research was that firm performance would be greater for adopters than non-adopters, primarily because the financial performance of non-adopters would decline by comparison. The study revealed that in the third year of ERP implementation, the ERP adopting firms had a significantly higher ROA, ROI, and ATO than non-adopters. Additionally, the average 3-year ROA and ROI were significantly greater for adopters when compared to non-adopters. The results also revealed that the performance metrics for adopters did not change significantly from pre- to post-adoption, but the metrics declined for non-adopters over the same time period.

Another finding of the study is that large/unhealthy firms could anticipate more performance increases than their large/healthy counterparts from ERP adoption. However, small/healthy firms could look forward to greater gains than their small/unhealthy counterparts from adoption of ERP systems.

Similar with Hunton et al. (2003) study, Poston and Grabski (2000) had found gains of ERP on organizational performance. In their research, they found out the positive impact of ERP on organizational performance. They performed a cross-sectional study in which they compared the performance of companies after three years from implementation and before implementation of ERP. SAP, PeopleSoft, Oracle, Baan and JD Edwards are some of the ERP software that is implemented by companies. Performance indicators of the study are, revenue, sales, general, and administrative expenses (SG&A), cost of goods sold (COGS), number of employees, and residual income. The study results of the study showed that the year after ERP implementation, the number of employees as a percentage of revenue decreased more for the firms that had not implemented ERP than for the ERP adopting firms.

Gefen and Ragowsky (2005) examined the associations between the business characteristics of manufacturing firms and their perceived benefits from ERP system investments. The perceived ERP benefits are measured at two levels: (1) an enterprise level and (2) a specific IT module level. The perceived value for ERP investments was consistently better explained at the specific IT module level. In order to discover the relationship between ERP investment and organizational productivity, the perception of senior managers of various manufacturing companies on organizational benefits of ERP systems and the factors that affect these benefits were studied. The study was based on the assumption that the activities of an organization form the organization's expectations from ERP, and these expectations are expressed better on a specified level. A field survey was conducted with 270 manufacturing companies implemented ERP. Perceived ERP benefits were collected at the enterprise level as well as the module level. The study results showed that when a specific benefit and a specific module were assessed, the ERP benefits were more evident than when benefits were assessed on an organizational level. Authors

noted that ERP systems, similar to other business solutions, should be implemented to address specific needs and conform to the business characteristics of an organization.

Holsapple and Sena (2005) conducted a cross-sectional study in order to find out whether any decision support benefits were obtained from ERP systems deployment. Study has established empirically that there are substantial connections between enterprise systems and decision support, in terms of both ERP plan objectives and resultant ERP system impacts. Surveys were mailed to 553 organizations across various industries. Most of the industries in the sample population were from the high technology, automotive, and consumer products fields. From the returned responses, 53 surveys from Fortune 1000 companies were used in the study. Respondents had adopted ERP systems from SAP, PeopleSoft, Oracle Applications, and JD Edwards and the majority of them (80%) were using their system for more than one year. The study results indicated considerable relationship between enterprise systems and decision support in terms of both ERP plan objectives and ensuing ERP system impacts. The study also identified highly ranked benefits from decision support systems, which included better knowledge processing, decision reliability, decisional substantiation, competitiveness, decision-making speed, and treatment of large scale and complex problems. All the perceived decision support benefits resulting from ERP systems at least moderately were achieved.

Olhager and Selldin (2003) presented 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. 511 surveys had been mailed to companies and with a response rate of 37.2% of the contacted companies; this survey was able to provide a fairly accurate overview the status of ERP system implementation issues. The study data were collected from manufacturing firms that had implemented or were in the process of implementing ERP systems. Study reveals that Swedish manufacturing firms are broadly adopting ERP systems; 83.6% have implemented such systems or

are in the process of implementing and they are choosing ERP vendors from Swedish vendors. The study indicated that information access and enhanced intra-organizational interaction were among the most desired improvements associated with ERP systems. Moreover, the study showed that ERP systems did not reduce information technology costs. But on the other hand, information availability and quality, and integration and interaction across the enterprise had improved as a result of adopting ERP systems. It was also noted that performance results (i.e., on-time delivery, inventory levels, and cash management) associated with customer order processing and financial management were among the poorest despite the popularity of these modules. The poor performance results associated with customer order processing and financial management could be attributed to the dataset that was used in the study.

In his research Nicolaou (2004) compared the financial data of 247 ERP adopting firms with 247 matched non-adopting firms. Return on assets, return on investment, operating income on assets (OIA), return on sales (ROS), operating income over sales (OIS), cost of goods sold over sales (COGS), selling, general, and administrative expenses over sales (SGAS), and the number of employees over sales (ES) were used as financial performance measures in the study. In this study, Nicolaou investigated the impact of long-term ERP usage in terms of streamlining both internal and also external interaction in the value chain of a company. As a result, research revealed that long-term ERP usage obtained a significant profitability improvement in companies' long term performance. Here profitability includes a combination of sales growth and cost reductions. The study also revealed an improvement companies' total return on investment occurred after two years system implementation and improvement in general return on assets after four years.

Another research about impact of ERP systems on management accounting and management accountant's work was conducted by Granlund and Malmi (2002). The purpose of this study is to explore the effects of integrated, enterprise-wide information systems on management accounting and management accountants' work. Data for the analysis were gathered through a field study of ten companies that

have experience of integrated information systems in Finland. The findings indicate that, the ERP projects have led to relatively small changes in management accounting and control procedures. Also, in most of the cases, advanced management accounting technique and many of the traditional ones too (e.g. annual budgeting) are operated in separate systems. It also was shown that ERP systems in some cases had freed management accountants from routine tasks and afforded them more free time for analysis. The general effects of ERP systems, although not consistent across various organizations, appeared to be moderate on management accounting practices. The results of this study reflect that management accounting in most of the studied organizations was not integrated wholly into their respective ERP systems.

Sacco et al. (2003) research tried to evaluate the impact of ERP systems on organizational strategic variables of those companies. The survey instrument adapts Mahmood and Soon's (1991) original model, which is aimed at evaluating the impact of Information Technology on such variables. The study measured 7 strategically important organizational variables: Buyers and Consumers; Competitive Rivalry; Suppliers; Market; Economics of Production; Internal Organizational Efficiency/Effectiveness and Inter-organizational Efficiency and conducted to 70 of biggest companies in Brazil. The companies in the list, 52.9% had ERP use experience for more than two years and of those 24.3% had more than five years of experience in using ERP. The companies that had less than one year of experience with ERP use made up only 8.6% of the sample population. The results reveal only a few contributions of ERP systems regarding the following organizational strategic variables: Buyers and Consumers, Competitive Rivalry, and Market. The ERP contributes to the Suppliers variable (relationship, monitoring, etc.) and to the Production variable (productivity gains, economies of scale in software usage, etc.). The ERP also contributes to the Internal Organizational Efficiency, and specially to the Inter-organizational Efficiency, improving the integration and communication between organizational units and with other institutions. Table 7 shows a summary of the results of this study, emphasizing the main impacts of an ERP system on organizational strategic variables in the sample considered.

Table 7: ERP impact on organizational strategic variables

ORGANIZATIONAL STRATEGIC VARIABLES	ERP IMPACT
Buyers and Consumers	-ERP does not make the products/services database available to customers -ERP helps companies to provide administrative support to Customers
Competitive Rivalry	-A direct contribution was not identified regarding the support of ERP for the company making a first strike against its competitors -ERP is not seen as something that supports the competition process
Suppliers	-ERP helps firms to gain leverage over their suppliers -Contributions were not found about ERP helping to reduce transaction costs by making it easier for suppliers to handle orders -ERP helps to reduce lead-time uncertainty -ERP helps firms to identify alternative suppliers and locate substitute products/services -ERP enhances a firm's "make versus buy" decisions -ERP helps firms to monitor the quality of products and services received from suppliers
Market	-ERP does not contribute to identify market trends -ERP enhances sales forecast accuracy -ERP does not help the company to better anticipate customers needs -A meaningful contribution was not identified regarding ERP contribution to reinforce customer's loyalty -ERP does not help the firm to reduce marketing costs -ERP contributes to improve the competitive efficiency of the firm
Economics of Production (cost structure and capacity)	-ERP does not show meaningful contributions to reduce the costs of designing new products/services nor to reduce the costs of modifying or adding features to existing products/services of the companies -ERP helps the firms to improve the level of production -ERP helps firms to improve productivity of labor through automation -ERP helps firms to improve the utilization of machinery -ERP allows economies of scale in software usage, but not as much in hardware usage
Internal organizational efficiency/Effectiveness	-ERP helps firms to improve the process and content of decision- making -ERP improves internal meetings and discussions -ERP provides better coordination between functional areas within firms -ERP contributes to better evaluations of annual budget reports -ERP helps to improve the strategic planning -ERP helps to increase a firm's profit margins -Meaningful contributions were not found regarding ERP increasing a firm's market share
Inter-organizational Efficiency	-ERP enhances the geographical inter-organizational communications pattern -ERP helps firms to coordinate activities regionally,nationally and globally -ERP helps firms to coordinate closely their interactions with customers and suppliers -ERP allows firms to aggregate more information to products/services

Source: Sacco, A. Z., Pedron, C. D., Cazella, S. C., Macadar, M. A., Neto, G. L. (2003). The impact of ERP systems on organizational strategic variables in Brazilian companies. *Ninth Americas Conference on Information Systems*, 466-475.

3.6. The Impact of ERP on SCM Performance

Integration of SCM and ERP gives the organization the opportunity to build effective processes with suppliers they trust, so they can get the maximum return on relationship with all their suppliers on a continuous basis (Koh et al., 2006).

One of the main effects of ERP on an organization's performance is in inventory management process. With well implemented ERP systems, companies can have reduction in inventories both in terms of raw material and as well as finished or semi-finished goods. Inadequate control of inventory can result both under and overstocking of items. Under-stocking results in missed deliveries, lost sales, bottlenecks in production and dissatisfied customers, which is the last thing any company wants. On the other hand, over-stocking ties up the funds of the company which might be used in other areas effectively. There is a very thin line between these two situations, overstocking and under-stocking. The trade-off between carrying inventory and investing money in other areas instead of inventory is the critical decision for managers.

In general, inventory management has two main concerns. One is the level of customer service which means to have enough safety stock in the right place and at the right time. Another is the cost of carrying and ordering inventories. Here the main point is that achieving satisfactory levels of customer service while keeping inventory costs within acceptable levels. The research of Bose et al. (2008) shows significant improvement of ERP in carrying inventory cost. The company at the research had reduction in raw material inventory by 15 days. Before installing ERP system the company was holding average 40days of safety stock, however after ERP now it is average 25 days. The reduction of average 15 days of inventory will result

as approximately 1 million USD saving for the company per year. The amount of saving will increase if the company can decrease the safety stock amount. Now in every year company can use this 1 million USD in different areas like investing in new equipment that will cut cycle times in production or this amount can be used in marketing applications to reach new customers. Here the amount of saving is not important. The point is that company can use this fund in the areas that will add value for company instead of carrying inventory.

Japanese manufactures are implementing the total quality philosophies like lean manufacturing, JIT manufacturing. In these philosophies the main point is eliminating wastes which do not add value to the final product and holding excess inventory is also defined as a waste. They use small lot sizes than their Western rivals. The rise of Japanese automotive manufacturer Toyota against General Motors Company since 1960s is a good example of different ways of looking at inventory. Now Toyota is the leader and GM is trying to escape from bankruptcy.

Besides the less carrying cost advantage of reduced inventory, also there are other advantages for companies. With reduced inventory companies will need less space for inventory. This space can be used in different purposes. Another advantage of reduced inventory is less rework will occur if a defect occurs in finished or semi-finished goods. These advantages can be gained by well implementation of ERP.

With well implemented ERP systems, companies have more accurate inventory. Accurate inventory makes sure that purchasing orders are given just in time and before the minimum stock levels. If company has enough inputs to satisfy customer demand, the production cycle time and customer respond times will decrease. Any decrease in production cycle times will result as an increase in on time delivery percentage. In today's competitive world, on time delivery percentage plays one of the most important roles. Customers not only want products with high quality but also want them on time. In recent years order batch sizes became smaller. Customer wants small batches and quicker. That is why the rise of China in textile industry slowing down due to the long order lead times. ERP helps not only your

lead time but also lead time of your suppliers. In SCM systems you have the right to control your supplier's inventory levels. So that you make your supplier to carry enough safety stock to satisfy your possible demand. After receiving any order from your customer, the purchase order will arrive your customer by the integration in ERP and SCM systems. The research of Bose et al. (2008) shows significant effect of ERP on SCM. In the case, after implementation of ERP the company, a company called Neway, a valve manufacturer in China, there are significant improvements in average lead time and on time delivery percentage. Average lead time has decreased form 45 days to 30 days and on time delivery percentage has increased from 80 per cent to 95 per cent after ERP implementation.

Akkemans et al. (2003) has identified a number of key SCM trends for which ERP provides clear support. These key trends are (1) mass customization, (2) standardization and (3) global IT/ERP systems.

Here mass customization involves the delivery of a wide variety of customer-specific goods or services quickly, efficiently and at low cost. With mass customization companies can both enjoy the benefits of mass production and craft production together. The point is that you can produce at the lowest cost with mass production and also can meet the customers' specific needs and wants with craft production. The two sides, customer and producer have great advantage. The manufacturer produces goods at the lowest cost and the customer gets the good as it wants.

However ERP supports mass customization only if customers can configure their products as a combination of predefined options. Here the configurator is software that translates individual customer demands into feasible product specifications with the software. Now it is possible to begin an assemble-to-order process. Here ERP system will transform customer demands into production orders. Also system will create purchasing orders if inventory of raw material or spare part is not enough. After customer enters an order through the system, the data go through the entire supply chain. The system updates the inventory numbers of the parts and

supplies automatically and world wide is needed. Production and purchasing orders are created automatically by the system. Here most efficient of all, the employees and managers in different departments in the organization, like Finance, Procurement, Production Planning, Manufacturing etc. have the information as quickly as possible and take actions to do their job. This feature in ERP systems cut the total order cycle time. Studies about ERP systems show that a well implemented ERP can cut the time between the order arrival and shipment by 15-40 percent. Total lead time can be reduced by as much as 75 percent (Davenport and Brooks, 2004). Improvements in customer response and lead times naturally will result as an increase in customer satisfaction and so the order fulfillment levels. Because now you can produce faster and on time. These improvements will result as an increase in total sales. Any improvement in delivery times will increase the chance of getting an order in the market with fierce competition. Customers always want to have their order as fast as possible. Being fast is one of the most important feature to survive in the competitive environment. One example is Colgate-Palmolive case. After SAP installation, Colgate reports that it has a cut in delivery times to customers by 25 percent and company surpassed Procter&Gamble's in the US market share in oral care products for the first time in its history (Grant, 1998).

Second key SCM trend for which ERP provides clear support is standardization of processes (Akkermans et al, 2003). Regarding standardization of processes, ERP almost enforces processes through its use of best-practice templates. ERP facilitates consistent behavior among all supply chain partners by harmonized processes and by providing access to a single source of data and processes. ERP technically enables consistent performance measurement for their own enterprise as well as for monitoring their partners' performance.

Standardization of processes and the data makes sure that all the players among the supply chain speak the same language. And so misunderstandings and loss of data while transferring can be avoided. It is important to understand customers' needs and wants clearly and exactly so that you can offer specific solutions for your customers. Standard processes also shortens the data transfer times

so that each two side can understand each other faster and can take actions and make decisions more quickly.

According to Akkermans et al. (2003) the third SCM opportunity for ERP is global IT/ERP systems. Globalization of businesses requires world wide ERP implementations. The main issue with global ERP implementation is not as much technology, state of art in IT allows for accessing an ERP system from any location in the world. Nowadays with information technology developments, ERP systems are increasingly web enabled, the technical limitations diminish even further. Compared to old legacy systems, ERP provides significant benefits. Some opf them lie in their technical architecture (client/server computing) others stem from their functional (multi-lingual, multi currency and time zone capabilities).

For most companies, streamlining operations within their own walls present enough of an immediate challenge. But the firms that are known for SCM have understood for a long time that really big game is external. The inefficiencies in the hands-off between different functions in a firm usually pole in comparison to those between firms that make up the broader supply chain (Davenport and Brooks, 2004). In 1980s the classic case study of P&G and Wal Mart cooperation, two companies shared their forecast and sales data. So they took huge amount of inventory out of the total system. At the same time by improving in stock performance they shared the financial benefit. Sharing information can easily be done by enterprise systems. In past firms were taking actions without taking into consideration of whole supply chain and partners. But nowadays by the improved IT and enterprise systems it is easy to share information and communicate among the supply chain members.

Another god example is Reebok International case. The company operates as a marketer, producing and selling footwear, apparel and sports equipment in a global basis. Besides the outlet stores of its own, Reebok is also a retailer in its own right. To cut inventories across the network, company implemented SAP in the marketing and retailing parts of the business and linked them through e-commerce and EDI connections. This combination allows Reebok to integrate everything, from new

product development to analyzing profits in individual stores. It is also integrating manufacturing partners and customer around the globe through internet EDI links.

Boeing is another example. By using BAAN enterprise systems, company integrates hundreds of suppliers and customers to do manufacturing at the planned time and quantity. Like in Reebok case, communication connections among internal parties are direct, from database to database, but the connection to external suppliers is through EDI links. Also customers can get the information with secure internet site, through part analysis and requirement tracking (PART) page.

In both two cases, internet plays the most important role in the middle of the all enterprise systems. It offers a considerable improvement over EDI in terms of the types of information that can be transmitted, the number of firms can access information over it. And the wide-spread availability and ease of use of software to access information.

CHAPTER FOUR

AN APPLICATION ABOUT THE IMPACT OF ERP ON SUPPLY CHAIN MANAGEMENT PERFORMANCE IN AN INTERNATIONAL ALLOY WHEELS MANUFACTURER SERVING FOR WORLD LEADING BRANDS IN AUTOMOTIVE INDUSTRY

4.1. Objective of the Field Study

Supply chain management and enterprise resource planning are new topics in literature and there are limited numbers of applications in Turkey. There is also limited number of successful implementations among these applications. Aim of this field study is to find out real effects of ERP on supply chain management performance and reveal potential performance increases with organizational performance after implementation of ERP.

Many modern organizations use and integrate enterprise resource planning (ERP) and supply chain management systems in the competitive environment of global industries. In this study it is tried to be shown the positive impacts of ERP on supply chain management systems. By using ERP as a decision making assistant in supply chain management, organizations gain a competitive advantage against their rivals. Beside these advantages ERP systems became an obligatory for managing many complex processes. Organizations implement ERP systems in order to make easier to manage business processes and use ERP as a decision support system. Many organizations enjoy the benefits of ERP in their supply chain management processes such as shorter cycle times, lead times, accurate inventory control, satisfying their customers' demands, reducing costs and inventories etc. This system also helps companies to have a systematic documentation and reports for healthy decisions. This study will expose one of the ERP success stories in a company which is a leading supplier of automotive industry in Turkey and also in the world.

4.2. Importance of the Study

As emphasized before, enterprise resource planning and supply chain management concepts are concepts that recently became popular in literature. There is limited number of successful implementation of ERP especially in Turkey. This study can be seen as a real success story and a good example for the companies which want to invest in enterprise resource planning systems.

4.3. Research Methodology

Related data for the study collected by one and one interviews in the company. First interview is done with the vice president of the CMS, Bertuğ Ösen. He explained the vision of the company in detail and with this interview it is tried to find the answers of why and how the company decided to install ERP systems. During the implementation process, he mentioned the importance of top management support and what should be done to avoid the resistance of the employees to change. Also with this interview he gave the answer of how they select the appropriate ERP system among various alternatives.

Second interview is done with the planning director of the company, Mehmet Tekin. He is also the project champion of the ERP project. He mentioned about the difficulties during implementation process because of Year 2000 problem with computer systems and gave brief information about the ERP system in CMS.

Third interview is done with production planning responsible. First he explained theoretical structure in company. After a compact tour in production area, ERP applications became clearer. Today's data and past data gathered from company archives.

4.4. Limitations of the Field Study

This study is done in one company, CMS and one sector, automotive industry. ERP concept is new in literature and a specific time period needed to find

out the effects to SCM. ERP is not a process that after implementation you can see the benefits in a small period of time. A significant time period has to be passed to get the real impact of ERP on SCM. There are also limited numbers of companies that use ERP systems successfully in Turkey. Because of the time constraint this study is done with one company. The result of this study can not be generalized for others; it is just valid for CMS. CMS is a good example of a success story for ERP implementation, however there are many ERP failure stories in the past. For better and significant results, study should be done with different companies and different sectors.

4.5. Company Profile of CMS Jant ve Makine Sanayii A.Ş.

Tonguç Ösen, who is the founder of CMS, has founded the first aluminium template casting company of Turkey together with his partner in 1955. Foundations of the biggest wheel manufacturer and exporter were laid in 1980 by the establishment of CMS Jant ve Makine Sanayii A.Ş. in İzmir.

Starting in 1985 the manufacturing of light alloy wheels for OEM and FIAT Turkiye Ford Otosan, today CMS keeps its position as one of the foremost wheel manufacturers in the world, in the field of Light Metal Wheel, implementing the latest technology and innovations.

Today CMS, which started manufacturing wheels made of aluminium alloy for Ford Turkey and Fiat Turkey in 1985, keeps its position among the leading wheel manufacturers of the world “Light Metal Wheels” sector as an implementer of the latest technology and innovations.

CMS, with its headquarter being in İzmir, has a plant in Pınarbaşı of 32,175 square meters with closed area of 20,944 square meters. Yearly wheel production capacity of the plant is 2 million units.

Çiğli plant, which was opened in 2003, is totally 30.838 square meters with closed area of 20,944 square meters. Yearly production capacity of this plant is 2 millions 200 thousand units.

Wheels with a diameter between 10" and 22" and width between 4" and 10" are manufactured in CMS Jant ve Makina Sanayi A.Ş.. CAS, CAD, CAE, FEA and casting simulation is used in designing wheel models and accessories whereas CAD/CAM and CNC technologies are used in mould manufacturing. Low pressure casting techniques are used as well.

CMS GMBH, one of the two sales companies of CMS, was founded in Frankfurt, Germany in 1997 and is one of the significant players of European aluminium wheel replacement market. CMS Otomotiv Dış Ticaret A.Ş. , operating as a sales company in free trade zone, targets the replacement market in the neighbour countries of Turkey, especially in Eastern Europe, and makes its sales directly to those countries.

The awards and certificates obtained by CMS Group since 2003 proved the effectiveness of its success formulas, which are summarized as following the world continuously, being open to innovations, believing corporate governance, being success and planning oriented, operating with respect to social responsibility.

CMS Jant ve Makine Sanayii A.Ş., the first and biggest light metal wheel manufacturer of Turkey, possesses Environmental Management System Certificate, which covers protection of the environment and prevention of pollution with a balanced way by meeting socio-economical needs. This certificate, which is possessed by only 1% of the automotive subsidiary industry firms in Turkey, was granted to CMS Jant ve Makine Sanayii A.Ş. on 23 September 2003 after the audit performed by Bureau Veritas Quality International (BVQI), which is the independent auditor entity.

Field of Activity

CMS Jant ve Makina Sanayii A.Ş.,the main company of CMS Group, manufactures aluminium alloy wheels by using Low Pressure Casting techniques. Today, there are roughly 400 models of CMS Wheels, which were started to be produced in 1985. The company, exporting 85 % of its production, is the leader of the wheel market in Turkey. The OEM customers of the company in Turkey are Fiat, Renault, Ford, Toyota, Karsan whereas its Customers abroad are Fiat Auto, Lancia, Alfa Romeo, Reanault, Bentley, VW, Seat, Audi, Dacia, Toyota, Honda and PSA.

Manufacturing

Wheels with a diameter between 10" and 22" and width between 4" and 10" are manufactured in CMS Jant ve Makina Sanayi A.Ş.. CAS, CAD, CAE, FEA and casting simulation is used in designing wheel models and accessories whereas CAD/CAM and CNC technologies are used in mold manufacturing. Machining is carried on with CNC technology.

OEM (Original Equipment) Customer Profile

CMS, the market leader in Turkey, is among top 10 companies in its sector in Europe. CMS, **the solution partner of the world automotive giants as an OEM**, provides services to companies such as - Tofaş, OYAK- Renault, Ford- Otosan, Toyota (TMMT) , Honda Türkiye, Karsan in Turkey whereas it provides sales and marketing services to foreign companies such as Fiat Auto, Alfa Romeo, Lancia, Volkswagen , Seat , Bentley, Ford, Renault , Dacia, PSA- Peugeot Citroen ,Toyota (TMEM) , Honda by designing the products of those foreign companies abroad (www.cms.com.tr).

4.6. ERP Need, Selection and Implementation Processes in the Company

With increasing sales volume and number of customers, CMS has decided to implement an ERP system in 1999. At those years company was serving for a couple of OEMs in Turkey and world, but top management had the vision of serving many OEMs in automotive industry within ten years. With growing production volume, company could not manage the business processes. CMS was using some MS Excel and other special software applications for production planning, production records, purchasing and other operations in different departments. The problem was that these applications were not integrated and working synchronized. Different and related departments were working separately and independent from each other. Any small mistake in any department reports may cause a big mistake in other department's decision making process and so top management decisions. For example any forecast mistake in sales department may cause an unnecessary and excess purchasing of raw material or human force in production planning process. To avoid any mistake caused by the mentioned reasons, management decided to have an ERP system to manage supply chain management processes more effective. Top management had a great stability and support to implement an ERP system.

Top management has chosen Baan ERP with the version BaanIVc4 as the most appropriate ERP system for CMS from a various number of ERP software packages. Baan was a vendor of enterprise resource planning (ERP) software that is now owned by Infor Global Solutions. Baan or Baan ERP was also the name of the ERP product created by this company. Baan Corporation was established in 1978 by Jan Baan in Netherlands. First years company provide financial and management consulting services. After a few years with consulting service, owners of the company focused on creating an ERP system. In the early nineties Baan get its popularity. Baan software is famous for its technical architecture and its 4GL language, which nowadays is still considered to be one of the most efficient and productive among database application development platforms. Most famous customer of Baan is world airplane manufacturer Boeing. After the agreement with Boing, Baan became a real threat for the dominant leader of the market, SAP. But the

fall of Baan was after the company went public and listed in the stock market. After the realization of the manipulated worth of the company stocks in stock market, company had a dramatic decline. In June 2000 first company has been sold to Invensys which is a UK automation, controls, and process solutions group and then in June 2003 it has been again sold to SSA Global Technologies. After all in May 2006, SSA was acquired by Infor Global Solutions of Atlanta, which was a major ERP consolidator in the market. Today Baan ERP software is still used by thousands of mid-range companies in the world, the majority on version BaanIVc4 and most of the rest on Baan5c

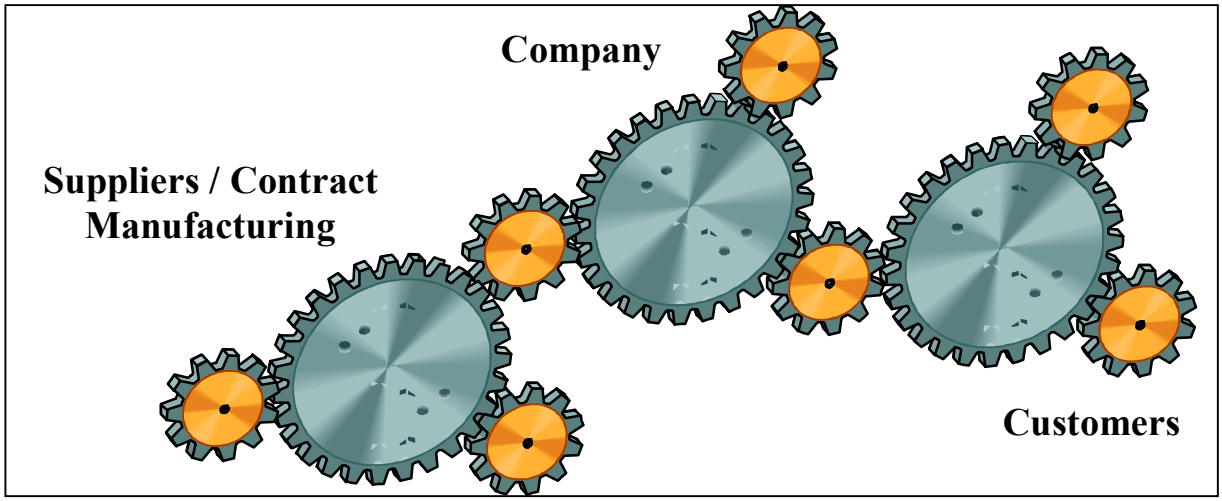
The implementation of Baan ERP software package has begun to be installed in June of 1999 and has been used since the beginning of year 2000 actively. There are around 200 users in the company. Implementation has taken 6 months which can be seen as a very short time for a successful implementation. Top management's stability and support, teamwork and cooperation within all the departments and project team, successful business plan and vision, effective communication among users and project team, expertise and experience of the project champion played the most important role in this short installation and implementation phase. Top management and project team has not seen this project as not only an IT project, but also a project that human factor plays important role. Training has been taken by employees that will use the system and top management had performed a great support for encouraging employees to get these training hours effectively. Company has eliminated people who show resistance for the change. Change management process has been implemented successfully and business processes are adapted the new system with minimum customization.

4.7. ERP System and Supply Chain Management in Company

CMS has deliveries 150 points around the world in which 50 of these points are OEM plants and 21 of these points are after market customers. Beside its customers, CMs has hundreds of suppliers which supply raw material, equipment, spare parts and also contract manufacturing. In order to control and manage all the

operations within both customers and suppliers, company has to have an effective supply chain management system to make production and delivery on time. Because OEMs want their orders with exact delivery time, not before or not after. In their purchasing orders any OEM give the exact delivery time for the supplier with hour and minutes. If any delay occurs with the delivery time, OEM suppliers have to pay important amount of penalty which is written in the signed agreement before working together. The purchasing agreement of OEMs includes details of the penalty and supplier has to move under the light of this agreement. Any late delivery may cause a breakdown in OEMs' assembly line which means money loss. Not only on time delivery but also producing products with demanded quality and quantity is important as it.

In CMS, SCM system takes place between customers and suppliers as a bridge like in all simple supply chain shown in figure. As seen in the figure every member has connection with each other. This figure is a simple one, there can be many suppliers and customers within the system. Integrated information flow, information technology and decision support system are the main functions of ERP in supply chain management. Any data loss occurred in the information flow will cause important results that will affect the whole supply chain with all its members. For example if company gets wrong information about sales forecast of its customer, company will give excess order to its suppliers and will buy excess raw material. These excess operations will increase the total production cost which is unwanted by the customer and directly affects customer's cost. Information accuracy is very crucial in design of supply chains. Any small change in any information will have great effects for other members in the supply chain. ERP systems play the most crucial role in the accuracy and transfer of data. Customer gives purchasing order from its ERP system. The data transmitted by EDI and supplier transforms the data with its own ERP system. Data loss can be avoided by a well designed ERP system in the supply chain.

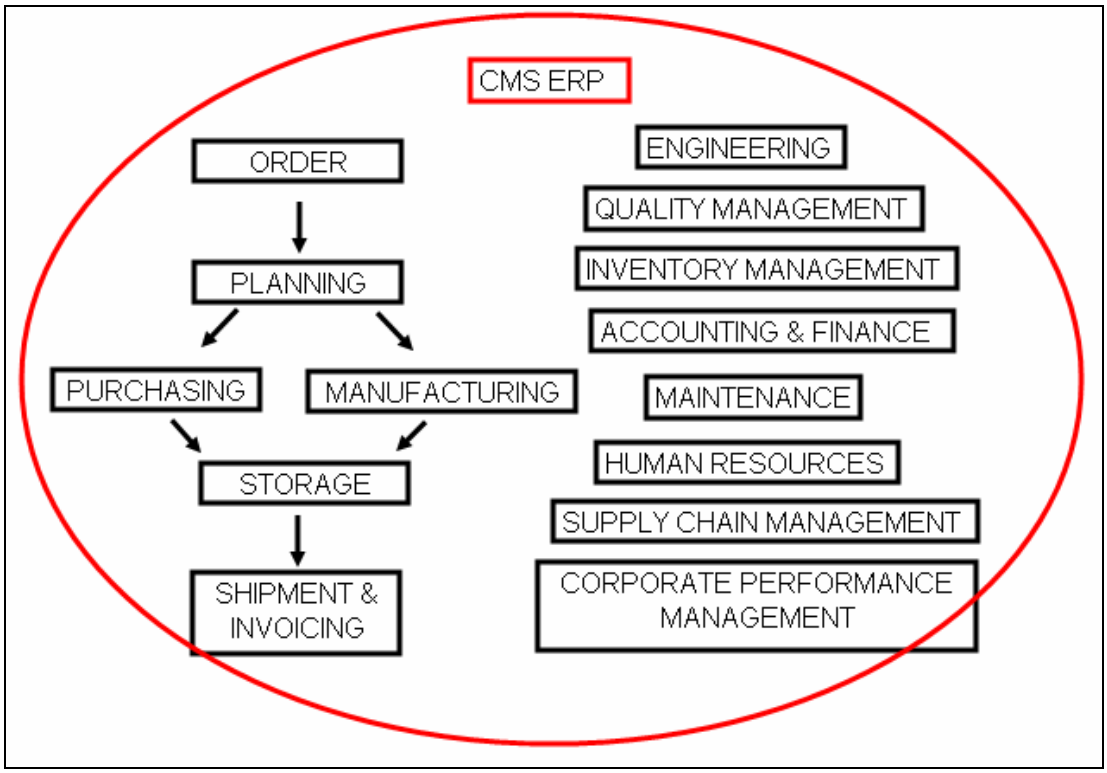


Source: CMS Company ERP Presentation

Figure 13: Supply Chain Management in CMS

ERP work flow process in CMS is shown in figure 14. Orders come from the customer via EDI from the OEM. After order arrival, order has taken into production planning. Planning process consists of two parts. One is certain customer orders and other is sales forecast gathered from sales department. These two data forms master production schedule. If capacity is appropriate, Material Requirement Planning (MRP) and Capacity Requirement Planning (CRP) are run. As a result of MRP and CRP, purchasing orders arrive to purchasing department and manufacturing orders to manufacturing department. After manufacturing process, whole work flow ends with shipment and invoicing. Engineering and quality management, inventory management, accounting and finance, maintenance, human resources, supply chain management and corporate performance management are supporter modules of main modules in CMS ERP system.

After arrival of any order, it is entered to Baan Order Management Sales module. Sales inquiries, sales contracts, sales prices, discounts, invoicing are performed and statistical data about sales can be reported with the help of this module. Order arrival date, quantity, shipment date of the order, delivery date to the customer, CMS product code, customer product code, customer data and sales price are included in ERP sales orders.



Source: CMS Company ERP Presentation

Figure 14: CMS ERP System

Master Production Schedule (MPS), Material Requirements Planning (MRP), Statistical Inventory Control (SIC) and Capacity Requirements Planning (CRP) are critical concepts in Production Planning module. Sales orders are transformed into manufacturing and purchasing orders with the help of MPS and MRP. Product routes, bill of materials, work station capacities, material data and CMS planning techniques are used in the creation of purchase and manufacturing orders. Product route and work station data can be gathered by work study and time study applications. Route and bill of material data are identified in Product Data Management (PDM) module. Manufacturing and purchasing orders, which are created by MPS and MRP modules, are optimized with restraint planning method by the help of Baan ERP. After optimization process, manufacturing and purchasing orders are approved and transferred to relevant module. Manufacturing orders are transferred to Manufacturing module and purchasing orders to Purchasing module. If

any change occurs within production plan, it can be revised by the help of Manufacturing Control module.

Actual manufacturing data is entered into Time Management module and with the integration of other modules manufacturing data are shared with other related departments. With the help of this module actual and standard costs created. With the integration of Finance module, actual and standard costs are compared. This comparison helps management to find out if any misses occur with planned manufacturing process.

Purchasing orders are created with three ways. One comes from MRP, other comes from statistical inventory control (reorder point method) and another is created manually. Material codes and general data about material, engineering data, order method, order lead time, purchasing frequency, reorder point, minimum maximum constant economic order quantity, safety stock quantity, supplier and customer data, material cost or sales price are some of the data related with purchasing module. Purchasing module automatically evaluates supplier performance and reliability.

With Baan Inventory Control module, inventory counting, warehouse inventory analysis (e.g. ABC analysis), statistical inventory control, forecasts can be done systematically.

Finance module has full integration with all logistics operations and processes with detailed control and opportunity of information accessibility. Finance module is open to improvements and customization. Top management can get actual performance reports from this module. Cash flows, credit and debt accounts, budgeting, expense distribution are some of the functions of this module.

Corporate Performance Management is performed by the help of Baan ERP and it is a very useful decision support system for top management. Report gives detailed information about performance of the whole company. It gives an output of

a fishbone diagram about company's main functions like organization, finance, manufacturing, sales. It is a visual diagram that shows red, yellow and green light according to the performance. If there is a problem with production costs or production capacity, it gives red light for the production. Similarly, if there is a problem with absenteeism or personnel turnover rate again red light is on for the organization. If there is no problem within these factors, green light is on or if the total performance is average yellow light is seen on the screen. On total corporate performance is calculated by the evaluation of these factors. This system allows general manager focus on real problems.

4.8. Improvements after ERP Installation and Impact of ERP on Supply Chain Management in the Company

Implementation of an ERP system is a very difficult process to be managed as a project. One of the most critical mistakes of many managers is that they see this installation as an IT project that will be done by experienced and talented software developers and experts. However there are many parameters that should be taken into account, like managing and leading employers that will use the system, processes that should be reengineered etc. People always show resistance to changes. With a new system like ERP they will change the way of doing their jobs. Maybe during installation period they will do their jobs twice. Once they will do their job traditionally, and once with the new system during the implementation period. In order to beat the resistance of people, top management performed great confidence and durability to reach the target. Management has to convince people that they can do that. Consistency and focus of management is one of the most important key factors in motivating and leading the employees. In CMS case, we can see the consistency and vision of management one of the most important elements in the success.

When project team began implementation of Baan ERP in CMS, product variability was not rich as today. In 1999 there were only 600 product types, however now at the end of 2008 this number is around 4500 types of different product. When

product variability and number of customers increase, it is hard to manage all the operations related with satisfying customers' needs. In 1999 CMS could produce 1.300.000 pieces of alloy wheels and 3.500.000 pieces in 2008, so the revenue of the company is increased from 40 million euro to 135 million euro in 2008.

Table 8 summarizes the improvements after ERP implementation in CMS from year 1999 to 2008. ERP implementation has begun in CMS, by the year 2009 and implementation ended in a 6 months time period. Companies that install ERP do not have an easy time of it. ERP vendors generally tell about three or six month is enough for the implementation. Those short implementations have a reason; the company was small, or the implementation was limited to small area of the company or the company only used the financial pieces of ERP system. Using financial pieces of ERP system is very common in among Turkey small and medium sized enterprises. Six months is a really short time for the successful implementation of ERP in a big sized company like CMS which has around 1.500 employees.

After implementation in year 1999, productivity increased 8 %, from 90 % to 97% in nine years. As a supporter result of increased productivity, cycle time of production of a wheel, man-power productivity, overall equipment efficiency and capacity utilization numbers has also indicates good signs of improvements. CMS was spending 1,12 man hour to produce a wheel. This number is 1,02 man hour in 2001 and 0,72 man hour in 2008. There is a 25 % decrease in man hour time spent for production of a wheel. As a result of the improvements in cycle time of a wheel production, work-force productivity increases. CMS was producing 0,89 pieces in an hour in 1999 and 1,29 pieces in 2008 which means that company produces 45 % more product with the same time spent in the past.

Table 8: Improvements after ERP Implementation

Operational Measures	**Pre-Implementation (Year 1999)**	**Post Implementation (Year 2001)**	**Today (2008)**
Cycle Time for One Wheel	1,12 man hour/ wheel	1,02 man hour/ wheel	0,72 man hour/ wheel
Productivity	90 %	92 %	97%
Work-force Productivity	0,89 Pieces / Hour	0,98 Pieces / Hour	1,29 Pieces / Hour
Overall Equipment Efficiency	70 %	80 %	85 %
Capacity Utilization	85 %	89 %	95 %
On-Time Delivery Performance	90 %	95 %	99,9 %
Time Period to begin Production after Order Arrival	1 week	5 days	24 hours
Average Inventory Level	35 days	30 days	18 days
Inventory Accuracy	85 %	90 %	99 %
Average Monthly Purchase Frequency	50	40	10
Purchasing Order Cycle Time	1 week	3 days	3 hours

Overall equipment efficiency (OEE) and capacity utilization numbers are also other signs of improvements after ERP implementation. OEE increased 21 % and capacity utilization increased 12 % after implementation. Increased OEE, decreased production cycle times, productivity increases are the metrics related with improvements within manufacturing operations which means that company began to use its sources more efficient than before. Results of theses metrics can tell us that

company now uses much less effort to catch production numbers in the past. Market environment with fierce competition forces companies to find out improvements inside of the company, not outside. Because, all of the rivals in the market have the technology to produce products in the same quality. Here what company have to do is making improvements with its inside processes like cutting down cycle times, increasing productivity etc. for profit-based organizations, productivity is an important factor in determining how competitive is a company is. Customers want high quality products with low cost. Think about a market that all the players can produce the same product with same quality and can deliver the good on time. Customer will choose the product with low cost because nowadays cost of the good is the most important factor to sell the product. When we consider supply chain management concept, any small improvements in the chain will result bigger gains for the whole supply chain.

Another dramatic result of the ERP implementation in the company is related with on time delivery performance. Before ERP, company has 90% on time delivery performance and after ERP implementation this number is now 99,9% which can be considered as a perfect result for automotive industry. Producing products with high quality and low cost is not enough for the customers. It is very crucial to deliver goods on time. Any delays in delivery time will result production and consequently sales loss for the customers. In order to do deliveries on time, company has to be agile enough to answer any customer orders. After ERP installation in CMS, company had ability to begin production in 24 hours time period. Before ERP implementation, company could begin production within 1 week time period. In today's competitive market environment one week for beginning production is unacceptable. After global crisis in the world, as a result of shrinkage in market demand OEMs give their orders in smaller lot sizes and with a little lead time for production. Here functions of ERP provide company to begin production in a very short time period. In order to begin production, first of all company has to have enough raw material, production capacity (idle machines, equipment etc.) and labour force. What ERP do is that, with a successful order forecast ERP creates enough production capacity, with previously determined safety stock numbers purchasing

orders are given on time and always there is raw material stock to begin production. Here inventory accuracy is also another factor for beginning production. After ERP implementation in CMS, inventory accuracy ratio has increased from 85% to 99%. With accurate inventory control system, the true picture of the company can be taken and management can take correct actions by considering company's inventory levels.

The goal of purchasing is to develop and implement purchasing plans for supporting organizational strategies. Identifying sources of supply, negotiating contracts, maintaining a database of suppliers, obtaining goods that meet operations requirements are among the duties of purchasing. With Baan ERP, CMS has changed purchasing habits. Before ERP, in a month company was doing 50 times purchasing, however after ERP now it is 10 times a month. With less purchasing, company get rid of some of the ordering costs. Ordering costs are generally expressed as a fixed amount, regardless of the order size. You have to pay a determined amount of money while you are importing any material from abroad for customs expenses. If you decrease the frequency of purchasing, you can decrease the amount of money paid for ordering cost. Another important issue in purchasing is the cycle time of giving your order. Before ERP, CMS could give any purchasing order in average a week period, however after ERP; it is only 3 hours needed to create a purchasing order after any order arrival.

As mentioned before, there are three ways of purchasing in CMS. One with MRP results, one is from statistical inventory control and other is manual way. With the decrease in purchasing frequency, CMS had reduction in average safety stock period. Before ERP CMS has 35 day of inventory and now it is 18 days which means approximately 500.000 euro saving per year. Holding and carrying costs of inventory includes interests, insurance taxes, depreciation, breakage and warehousing costs. Beside this known costs there is also an opportunity cost associated with having funds that could be used elsewhere instead of tied up in inventory. Good inventory management is the mark of a well-managed organization. Inventory levels must be planned carefully in order to balance the cost of holding inventory and the cost of providing reasonable levels of customer service. Successful inventory management

requires a system to keep track of inventory transactions, accurate information about customer demand and lead times, realistic estimates of certain inventory related costs. With Baan ERP, CMS had these qualifications.

4.9. Implications of the Study and Recommendations for Future Researches

It should be noted that increases in operational and so operational performance may be influenced by other external factors. CMS has been investing on lean manufacturing systems like six sigma in order to have improvements in organizational performance. Also investment on knowledge and human resources is another factor in managing continuous improvement process. The improvements after ERP installation found in the study are not only the result of successful implementation of ERP. Other factors also support this successful result. In this study, it was not aimed to measure effects of other factors.

Another limitation of the study is that ERP implementation in CMS was a real success story that will be a good guide for other companies which wants to install ERP systems. This study is conducted in one company. However there are many ERP failure stories in the past and will be in the future if the implementation process can not be managed well. In order to reveal real effects of ERP on SCM, study should be conducted on more companies. Also it should be well noted that type of the industry, company size, company's position in the supply chain, supply chain length, type of the supply chain, and type of the ERP may be the other factors that will affect the result. For example large organizations may have higher levels of SCM practices. They will have more complex SCM networks and it would be hard to manage the whole supply chain rather than in smaller companies.

CONCLUSION

Supply chain management (SCM) has begun to become popular in the early 1980s and this popularity has increased steadily in the following years. A supply chain consists of all parties involved, directly or indirectly, in fulfilling a customer request. The supply chain not only includes manufacturers and suppliers but also transporters, warehouses, retailers and customers themselves. Supply chain management is the integration of key business processes from end user through original suppliers. Information, material and money flows are included in the supply chain within two directions, from customer to manufacturer and from manufacturer to customer. The fierce and continuous global competition in 1980s forced organizations to offer low cost and high quality products together and on time. So companies realized the potential benefits and importance of strategic and cooperative buyer-supplier relationship in order to lower total cost of the product among the supply chain. In order to lower your cost, first you have to cooperate and improve your suppliers to make them make improvements in their own organizations. So the concept of supply chain management emerged as manufacturers experimented with strategic partnerships with their immediate suppliers.

Nowadays, effective supply chain management has become imperative for organizations to sustain a competitive advantage in the market. Researches reveal that organizations with high levels of supply chain management practices have high levels of competitive advantage and have high levels of organizational performance. In order to remain competitive in the market, organizations have to look for ways of increasing the performance of supply chain management. An ERP system is one of the factors that can affect the supply chain management performance. The potential benefits of integrating supply chain management with ERP can no longer be ignored.

Enterprise resource planning and supply chain management systems has been implemented and used successfully in many organizations around the world. But managing and integrating the two systems is not easy as it looks. It is

important to understand how the two systems complement each other. ERP and SCM, have the similar mission in terms of information flow and synchronization, however the scope of the two systems is different. ERP provides the information flow and synchronization within and organization, and so the SCM system in supply chain. Nowadays for many companies, it is important to use the two systems integrated to provide higher business value. Many modern organizations began trying to integrate enterprise resource planning (ERP) and supply chain management (SCM) systems in order to gain competitive advantage against other organizations. However integration of the two systems is a complex and challenging process which is difficult to manage for companies. This integration requires efficient management of hardware, software, and human resources for successful completion. Integration of SCM and ERP gives the organization the opportunity to build effective processes with suppliers they trust, so they can get the maximum return on relationship with all their suppliers on a continuous basis.

ERP implementation is a long and difficult process for companies. The difficulties and high failure rate in implementing ERP systems have been widely cited in the literature. There are several critical success factors which are generally agreed in the literature for a successful ERP implementation. These critical success factors are; top management support, ERP teamwork and composition, business plan and vision of the project, effective communication, well project management, expertise and knowledge of project champion, appropriate business and IT legacy systems, change management program and culture, business process reengineering and minimum customization, software development, continuous monitoring and evaluating performance. Decision makers and managers have to take into consideration these factors before making implementation. All these factors should be evaluated separately in order to reach a successful implementation process.

In this study, improvements after ERP implementation that affect SCM is evaluated. After ERP implementation in the company there are many improvements occurred that will cause performance increases in supply chain management. Some of the improvements are at operational and some of them are at strategic level which

directly affects organizational performance. After ERP implementation in the company, there is a decrease in total cycle time for one wheel, the time period for beginning production after order arrival, average inventory level, average monthly purchase frequency and purchasing order cycle time. Also increases in productivity, work-force productivity, overall equipment efficiency, capacity utilization, on-time delivery performance and inventory accuracy.

In order to sustain competitiveness in the market, companies have to pay attention on continuous improvement processes. CMS has increased its revenue after ERP investment since 1999, from 40 million euro to 135 million euro in 2008. However ERP can not be the only reason for this improvement. Investments on lean manufacturing systems, technology, human resources are other critical factors that CMS has applied.

REFERENCES

Books

Bancroft, N., Seip, H., Sprengel, A. (1998). *Implementing SAP R/3: How to introduce a large system into a large organization*. Manning Publications.

Chopra, S., Meindl, P. (2001). *Supply Chain Management: Strategy, Planning, and Operation*. NJ, Prentice-Hall.

Cox, J. F., Blackstone, J. H., Spencer, M. S. (1995). *APICS Dictionary* (8th ed.). American Production and Inventory Control Society, Falls Church, VA.

Stevenson, W. J. (2005). *Operations Management* (8th ed.). McGraw Hill Companies, Inc.

Articles

Akkermans, H.A., Bogerd, P, Yucesan, E., van Wassenhove, L.N. (2003) The Impact of ERP on Supply Chain Management: Exploratory Findings from a European Delphi Study. *European Journal of Operational Research,* Vol. 146, No. 2, 284–301.

Bacon, C. J. (1992), The use of decision criteria in selecting information systems/ technology investment, *MIS Quarterly,* Vol. 16, No. 3, 335–353.

Beamon B. M. (1999). Measuring Supply Chain Performance. *International Journal of Operations & Production Management*, Vol. 19, No. 3, 275-292.

Beamon, B. M. (1996). Performance Measures in Supply Chain Management. *Proceedings of the 1996 Conference on Agile and Intelligent Manufacturing Systems*, Rensselaer Polytechnic Institute, Troy, New York, NY, 2-3 October.

Bingi, P., Sharma, M. K., Godla, J. K. (1999). Critical Issues Affecting an ERP Implementation. *Information Systems Management*, Vol. 16, No. 7.

Bose, I., Pal, R., Ye, A. (2008) ERP and SCM Systems Integration: The Case of Valve Manufacturer in China. *Information and Management*, Vol. 45, 233-241.

Brewer, P. C., Speh T. W. (2000). Using the Balanced Scorecard to Measure the Supply Chain Performance. *Journal of Business Logistics*, Vol. 21, No. 1, 75-92.

Buxmann, P., von Ahsen, A. , Diaz, L. M., Wolf, K. (2004) Usage and Evaluation of Supply Chain Management Software – Results of an Empirical Study in the European Automotive Industry. *Info Systems,* Vol. 14, 295-309.

Chan, F. T. S., Qi, H. J. (2003), Feasibility of Performance Measurement System for Supply Chain: A Process Based Approach and Measures. *Integrated Manufacturing System*, Vol. 14, No. 3, 179-190.

Chan, F. T. S., Qi, H. J. (2003). Feasibility of Performance Measurement System for Supply Chain: A Process Based Approach and Measures. *Integrated Manufacturing System*, Vol. 14, No. 3, 179-190.

Chung, S., Snyder, C. (1999). ERP Initiation – A historical perspective. *Proceedings of the Americas Conference on Information Systems*, 213 – 215.

Cooper, M. C., Ellram, L. M., Gardner, J. T., Hanks, A. M. (1997). Meshing Multiple Alliances. *Journal of Business Logistics*, Vol. 18, No. 1, 67-89.

Croxton, K. L., Garcia-Dastugue, S. J., Lambert, D. M. (2001). The Supply Chain Management Processes. *The International Journal of Logistics Management*, Vol. 12, No. 2, 13-36.

Davenport, H. T., Brooks, J. D. (2004). Enterprise Systems and the Supply Chain. *Journal of Enterprise Information Management*, Vol. 17, No. 1, 8-19.

Davenport, T. (1998), Putting the Enterprise into the Enterprise System, *Harvard Business Review*, Vol. 76, No. 4, 121-131.

Ellram, L. M., Cooper, M. C. (1993). The Relationship Between Supply Chain Management and Keiretsu. *The International Journal of Logistics Management*, Vol. 4, No.1, 1–12.

Ferguson, B. (2000) Implementing Supply Chain Management. *Production and Inventory Management Journal*, Vol. 41, No. 2, 64-78.

Gefen, D., Ragowsky, A. (2005). A multi-level approach to measuring the benefits of an ERP system in manufacturing firms. *Information Systems Management,* Vol. 22, No. 1, 18-25.

Granlund, M., Malmi T. (2002). Moderate impact of ERPS on Management accounting: A lag or permanent outcome? *Management Accounting Research,* Vol. 13, No. 3, 299-321.

Gumaer, R. (1996). Beyond ERP and MRP II. *IIE Solutions*, Vol. 28, 32-35

Gunasekaran, A., Patel, C., Ronald, E., McGaughey, E. (2004). A Framework for Supply Chain Performance Measurement. *International Journal of Production Economics*, Vol. 87, 334-347.

Gunasekaran, A., Patel, C., Tiritoglu, E. (2001). Performance Measures and Metrics in Supply Chain Environment. *International Journal of Operations & Production Management*, Vol. 21, No.1/2, 71-87.

Harland, C. M. (1996). Supply Chain Management Relationships, Chains and Networks. *British Journal of Management*, Vol. 7, 63-80.

Hendriks, K. B., Singhal, V. R., Stratman J. K. (2007). The impact of enterprise systems on corporate performance: A study of ERP, SCM, and CRM system implementations. *Journal of Operations Management*, Vol. 25, 65-82.

Holland, P., Light, B. and Gibson, N. (1999), A critical success factors model for enterprise resource planning implementation, *Proceedings of the 7th European Conference on Information Systems*, Vol 1, 273-297.

Holsapple, C. W., Sena, M. P. (2005). ERP plans and decision-support benefits**.** *Decision Support Systems,* Vol. 38 No. 4, 575-590.

Hunton, J. E., Lippincott, B., & Reck, J. L. (2003). Enterprise resource planning systems: Comparing firm performance of adopters and nonadopters. *International Journal of Accounting Information Systems,* Vol. 4, 165-184.

Jacobs, F. R., Weston, F. C. T. (2006), Enterprise Resource Planning (ERP) – A Brief History. *Journal of Operations Management*, Vol. 25, 357-363.

Kaplan R. S., Norton D. P. (1992). The Balanced Scorecards - Measures That Drive Performance, *Harward Business Review*, Vol. 70, No. 1, 71-79.

Koh. S. C. L., Saad, S., Arunachalam, S. (2006) Competing in the 21st century supply chain through supply chain management and enterprise resource planning integration. International Journal of Physical Distribution and Logistics Management, Vol 36, No. 6, 455-465.

Kueng, P. (2000). Process Performance Measurement System: A Tool to Support Process Based Organizations. *Total Quality Management*, Vol. 11, No. 1, 67-85.

La Londe, B. J., James M. M. (1994). Emerging Logistics Strategies: Blueprints for the Next Century. *International Journal of Physical Distribution and Logistics Management*, Vol. 24, No. 7, 35-47.

Lambert, D. M., Cooper, M. C. (2000). Issues in supply chain management. *Industrial Marketing Management*, Vol. 29, No. 1, 65-83.

Lambert, D. M., Cooper, M. C., Pagh, J. D. (1997). Supply Chain Management: More Than a New Name for Logistics. *The International Journal of Logistics Management*, Vol. 8, No. 1, 1–13.

Lambert, D. M., Cooper, M. C., Pagh, J. D. (1998). Supply Chain Management: Implementation Issues and Research Opportunities. *The International Journal of Logistics Management*, Vol. 9, No. 2, 1–19.

Lambert, D. M., Emmelhainz, M. A., Gardner, J. T. (1996). Developing and Implementing Supply Chain Partnership. *The International Journal of Logistics Management*, Vol. 7, No. 2, 1–17.

Lee, H. L., Billington, C. (1992). Managing Supply Chain Inventory: Pitfalls and Opportunities. *MIT Sloan Management Review*, Vol. 33, No.3, 65-73.

Li, S., Ragu-Nathan, B., Ragu-Nathan, T. S., Rao, S. S. (2006). The impact of supply chain management practices on competitive advantage and organizational performance, *Omega*, Vol. 32,107-24.

Logistics Management & Distribution Report (1999a) Study Finds Growing Interest in ERP and Operations Software. *Journal of Logistics Management & Distribution*, Vol. 38, No.10, 48.

Logistics Management & Distribution Report (1999b) Supply Chain Market Tops $2 Billion. *Journal of Logistics Management & Distribution*, Vol. 38, No.9, 26.

Marcus, L. M., Tanis, C. (2000). The enterprise systems experience – From adoption to success. In R. Zmud (Ed.), Framing the domains of IT management research:

glimpsing the future through the past 173-207. Cincinati, Ohio: Pinnaflex Educational Resources.

McGee, M. (1998) Gift Company Gets R/3 Help – Supply Chain Engine to Feature Software from SAP. *Information Week*, No. 686, 26.

Mentzer, J. T., DeWitt W., Keebler, J. S., Min, S., Nix, N. W., Smith, C. D., Zacharia, Z. G. (2001). Defining Supply Chain Management. *Journal of Business Logistics*, 22, No. 2.

META Group. (1999). *Enterprise Resource Management (ERM) Solutions and Their Value*. Stamford, CT.

Nah, F. F. H., Lau, J. L. S., Kuang, J. (2001). Critical Factors for Successful Implementation of Enterprise Systems. *Business Process Management Journal*, Vol.7, No. 3, 285-296.

New, S. J., Payne, P. (1995). Research frameworks in logistics: three models, seven dinners and a survey. *International Journal of Physical Distribution and Logistics Management,* Vol. 25, No. 10, 60-77.

Nicolaou, A. I. (2004). Firm performance effects in relation to the implementation and use of enterprise resource planning systems. *Journal of Information Systems,* Vol. 18, No. 2, 79-105.

O'Leary, D. (1998). *Enterprise Resource Planning Systems,* Oxford University Press.

Okrent, M. D., Vokurka, R. J. (2004). Process mapping in successful ERP implementations. *Industrial Management & Data Systems*, Vol. 104, 637-643.

Olhager, J., & Selldin, E. (2003). Enterprise resource planning survey of Swedish manufacturing firms. *European Journal of Operational Research,* Vol. 146, No. 2, 365-373.

Poston, R., & Grabski, S. (2000). The impact of enterprise resource planning systems on firm performance. *Proceedings of the Twenty-First Conference on Information Systems,* Vol. 1, 479-483.

Premkumar, P. G. (2000). Interorganization Systems and Supply Chain Management: an Information Processing Perspective. *Information Systems Management*, Vol. 17, 56-69.

Ptak, C., Schragenheim, E. (2000). ERP: Tools, Techniques, and Applications for Integrating the Supply Chain. *St. Lucie Press*, Boca Raton, FL.

Radding, A. (1999) ERP – More than an Application. *Information Week*, No. 728, 1A-8A.

Rashid, M., Hossain, L., Patrick, J. D. (2002). The Evolution of ERP Systems: A Historical Perspective. *Enterprise resources planning solutions and management, IRM Press, Hershey*, 35-50.

Roberts, H.J., Barrar, P.R.N. (1992), MRPII implementation: key factors for success, *Computer Integrated Manufacturing Systems*, Vol. 5 No. 1, 8-31.

Rockart, J. (1979), Chief executives define their own information need, *Harvard Business Review*, Vol. 25, 81-92.

Sacco, A. Z., Pedron, C. D., Cazella, S. C., Macadar, M. A., Neto, G. L. (2003). The impact of ERP systems on organizational strategic variables in Brazilian companies. *Ninth Americas Conference on Information Systems*, 466-475.

Scott, C., Westbrook, R. (1991). New strategic tools for supply chain management. *International Journal of Physical Distribution and Logistics,* Vol. 21, No. 1, 23-33.

Slevin, D., Pinto, J. (1987) Balancing strategy and tactics in project implementation, *Sloan Management Review*, 33–44.

Somers, T.M., Nelson, K.G. (2003) The impact of strategy and integration mechanisms on enterprise system value: empirical evidence from manufacturing firms, *European Journal of Operational Research,* Vol. 146, 315–338.

Sousa J. E., Collado J. P. (2001). Enterprise Resource Planning Systems Research: An Annotated Bibliography. *Communications of the Association for Information Systems*, Vol. 7, No. 8, 1-51.

Stephens S., (2001). Supply Chain Operations Reference Model Version 5.0: A New Tool to Improve Supply Chain Efficiency and Achieve Best Practice. *Information System Frontiers*, Vol. 3, No. 4.

Sumner, M. (1999), Critical success factors in enterprise wide information management systems projects, *Proceedings of the Americas Conference on Information Systems (AMCIS)*, 4-232.

Tan, K. C. (2001). A framework of supply chain management literature. *European Journal of Purchasing & Supply Management*, Vol. 7, 39-48.

Tan, K. C., Kannan, V. R., Handfield, R. B. (1998). Supply chain Management: supplier performance and firm performance. *International Journal of Purchasing and Material Management*, Vol. 34, No. 3, 2-9.

Tarn, J. M., Yen, D. C., Beaumont, M. (2002). Exploring the rationales for ERP and SCM integration. *Industrial Management & Data Syatems*, Vol. 102/1, 26-34.

Towill, D. R., McCullen P. (1999). The impact of Agile Manufacturing on Supply Chain Dynamics. *The International Journal of Logistics Management*, Vol. 10, No. 1, p.86.

Umble, E. J., Haft, R. R., Umble, M. M. (2003). Enterprise Resource Planning: Implementation Procedures and Critical Success Factors. *European Journal of Operational Research*, Vol. 146, 241-257.

Wei, C., Chien C., Wang, M. J. (2005). An AHP based approach to ERP system selection. *International Journal of Production Economies*, Vol. 96, 47-62.

Yeo, K. T., Ning, J. H. (2006). Managing uncertainity in major equipment procurement in engineering projects. *European Journal of Operational Research,* Vol. 171, No. 1, 123-134.

Others

Blevins, P. (1995). Enterprise Resource Planning and Focused Factory Concept … Are They Compatible?. *38th International Conference Proceedings*, Orlando FL, 7-22 October, 9-396.

Donovan, R. M. (1999). Strategy and Preparation are Critical Success Factors. http://www.rmdonovan.com/pdf/perfor_99_5.pdf

Grant, L. (1998) Outmarketing P&G, *Fortune*, 12 January.

Karnopp, P. (2006). Enterprise Resource Planning. http://people.msoe.edu/~karnopp/em650s/EM-650S%20Paper%20%20Paul%20Karnopp%20v2.doc (Available 12.03.2009)

Kotelnikov, V. Lean Production: Doing More with Less. http://www.1000ventures.com/ten3_operations/customized/lean_production_india.html (Available 21.02.2009)

Lambert, D. M. (2004). The Eight Essential Supply Chain Management Processes. *Supply Chain Management Review,* 09.01.2004

Lapide, L., Davis, D. (2003). The Supply Chain Management Applications Report, *2002–2007. AMR Research Inc*, Boston.

Martin, M.H. (1998) An ERP Strategy, *Fortune*, 95–97.

Sap.com, (2008). http://www.sap.com/erp.html (Available 15.02.2009)

Shankarnarayanan, S. (2000). ERP systems—using IT to gain a competitive advantage. http://www.expressindia.com/newads/bsl/ advent. (Available 15.02.2009)

The Manufacturing Advisory Service, (2005). MAS Fact Sheet, MRP. http://www.mas.dti.gov.uk/pluto-resources/1130320229958.pdf (Available 15.02.2009)

Violino, B. (2008), ERP: A Morphing Market, *Ziff Davis Enterprise Holdings Inc,* http://www.cioinsight.com (Available 22.04.2009)

Yellurkar, D. (2002) Successfully managing distributed commerce. *Montgomerie Research Inc. 2002.Ascet 4*. http://www.ascet.com/documents.asp?d_ID=1121. (Available 11.04.2009)

Wee, S. (2000), Juggling toward ERP success: keep key success factors high, ERP News, February, (http://www.erpnews.com/erpnews/erp904/02get.html) (Available 22.04.2009)

Wikipedia.org, http://en.wikipedia.org/wiki/Enterprise_resource_planning, (Available 26.09.2008)