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SUPPLY CHAIN ARCHITECTURES IN AN E-ENVIRONMENT

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The concept of supply chain management (SCM) has occupied serious research attention in recent years. This concept goes beyond intra-organizational boundaries to achieve a greater value of the entire supply chain network.

The development of ICT, together with the Internet environment, has an impact on the management concept of traditional supply chains, allowing the integration of participants and the management of complex interfaces between organizations in the supply chain network. The e-business model connects the separate activities of the supply chain in an integrated, coordinated, flexible, efficient and responsive system.

This paper analyzes the key aspects of e-SCM and different supply chains architectures in an e-environment as the starting point for defining the generic architecture model of e-SCM.

Keywords: supply chain architectures, supply chain management, e-environment, e-SCM

JEL Classification: L29, M10, M11, M15

INTRODUCTION

The focus of contemporary organizations, based on the concept of supply chain management, was created as a response to ongoing business requirements related to the business process improvement, flexibility, agility and supply chain collaboration.

Looking for additional sources for cost reduction and process improvement, organizations are beginning to introduce modern management tools in their chains of suppliers and customers. During the last decade, computational techniques and methods of management for internal functions in business have systematically been applied, such as Enterprise Resource Planning – ERP, Total Quality Management – TQM and Business Process Reengineering – BPR, to optimize operations of organizations and activate high agility, lean manufacturing and distributed functions with the highest quality and service.

Cost reduction and process optimization in supply chains, which used to be predominant inside organizations in the past, focus on applying the same paradigms of management and technology, but outside internal supply chains. The goal of management is to eliminate all forms of dissipation created by some entities in the supply chain, such as logistics, inventory, purchase, product development, finance and others.

The application of the Information Communication Technology (ICT) tools based on the concept of the

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Internet enables organizations to observe the supply chain as a source of competitive advantage. With the emergence of e-business, these tactical advantages rapidly increase, so additional strategic capabilities enabling the entire supply chain create the radically new regions of the market value, which was practically impossible in the past. E-business technologies enable even small organizations to connect their supply chains with each other and be able to implement competitive business models that, previously, only large organizations had (Arsovski et al., 2012).

Numerous authors observe the SCM concept from different perspectives. Sachan and Datta (2005), Cousins et al. (2006) and Storey et al. (2006) define the concept, principles, nature and development of supply chain management and indicate the existence of intensive research conducted in this field worldwide. Also, they critically evaluate trends in the theory and practice of supply management.

SCM represents the strategic and systematic coordination of traditional business functions inside and outside an organization and in the supply chain, in order to improve long-term performances of individual organizations and the supply chain as a whole (Mentzer et al., 2001).

Gunasekaran and McGaughey (2003) extend the scope of SCM outside material management, partnerships, and information technologies to the TQM field, the achievement of the commitment, organizational structures, and training and behavior issues of employees.

Fawcett et al. (2008) indicate the necessity of analyzing an environmental pressure driving SCM and a barrier analysis as well as the implementation of appropriate solutions providing the supply chain performances necessary for the maintenance of competitive advantage.

The emergence of the Internet and electronic communications has enabled organizations to better respond to customer requirements. Tarn et al. (2002), Sanchez and Perez (2003) and Wieder et al. (2006) examine the functions, current development and reasons for the ICT integration, analyzing the problems of ERP, Electronic Data Interchange (EDI) and presenting possible solutions to SCM.

The experiences of organizations that have used ERP systems indicate that the application of these systems achieves a higher overall performance, but there is no evidence of a similar effect on the performance of the entire supply chain. On the other hand, organizations using EDI have generated more benefits and fewer technical and organizational difficulties than those that have not implemented the EDI technology.

Papers on this topic generally indicate the impact of the Internet on the SCM. Lee (2002) indicates that there are four types of Internet impacts:

- information exchange,
- knowledge exchange,
- e-commerce, and
- a new structure of supply chains.

Swaminathan and Tayur (2003) describe three ways of how the Internet influences supply chain. The first is reflected in the system using resource planning more easily. The second points to information exchange. The third considers the possibility of the information exchange integration and decision-making through the supply chain.

Johnson and Whang (2002) examine how the Internet is changing SCM and they classify papers into three main categories:

- e-commerce,
- e-purchasing, and
- e-collaboration.

In recent years, numerous studies have emphasized the importance of information exchange within supply chains (Lambert & Cooper, 2000; Lau & Lee, 2000; Barratt, 2004).

The goal of this paper is to perform an analysis of the key aspects of e-SCM and different architectures of supply chains in an e-environment, the key components and relationships between different actors in the supply chain (internal and external), and the definition of the generic architecture model of e-SCM.

The key hypothesis set in this paper is the following: Considering a large number of factors affecting the architecture of supply chains in the e-environment, the definition of the generic architecture model of e-SCM reaches a higher level of integration, synchronization and resource optimization in supply chains.

The results of the analysis indicate the key elements in the supply chains architecture and enable us to design the generic model of the e-SCM environment.

The methodological approach is based on the general theory of the supply chain, the quality management system, the management of business processes and stakeholders' requirements.

The paper is structured in such a manner that the second part describes the development of SCM concepts with a special emphasis on the analysis of the role of ICT and e-SCM. The third section describes the key features of the concept, and in the last fourth, part, an analysis of the key components of supply chains architecture in an e-environment is presented as well as the generic model of supply chains architecture in an e-environment.

SUPPLY CHAIN MANAGEMENT IN E-ENVIRONMENT

The development of SCM has gone through several stages. The first stage defines the era of internal logistics as important functions in an organization. In the second stage, the logistics are transferred from the decentralization to the centralization of basic functions, leading to new attitudes in optimizing costs and customer service. The third stage testifies the drastic expansion of logistics, including new concepts of interest in connection with the internal operations of the analogue functions performed by business partners in the supply chain. As the concept of integration in the supply chain expands, the old concept of logistics is being replaced in the fourth stage, an integrated approach to supply chain management. With the implementation of the Internet technologies in the concept of SCM, the fifth stage appears, supply chains in an e-environment, e-SCM. The stages of the development of e-SCM are shown in Figure 1.

E-SCM provides supply chains with resources for the implementation of the strategic options of the SCM original model. In the late 1990s, organizations recognized that they were not only isolated entities defining the business strategy for their existence, but also a part of a much broader environment in which various business systems exist.

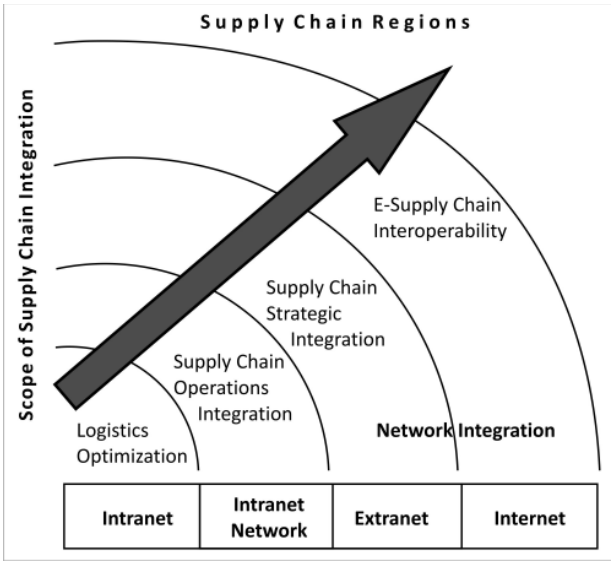

Figure 1 SCM development stages

Source: Ross, 2003, 15

ERP systems and the EDI technology impose serious limits to communications and the information range and erect barriers by restraining the participation of organizations. On the other hand, the integration of the Internet and SCM provides the entire supply chain with a possibility of creating a value for their customers, by defining a plan for achieving agility, creating a flexible system and high-performance networks with a Web accessible to customers and suppliers and a critical flow of information. Therefore, the application of the Internet technology gives a new dimension to the concept of SCM (Arsovski, et al., 2012).

E-SCM is a three-stage process. The first stage is characterized by the integration of processes and functions within an organization. The second stage is characterized by the cross-integration of operational functions in the supply chain partners, such as transportation, inventory in supply chains and supply forecasting. The third stage is the highest level of achieving synchronization functions in the entire supply chain from the whole purchasing network into a single virtual organization able to optimize the competencies and resources from anywhere and at any time in the supply chain in order to gain an insight into market opportunities, by using the Internet capabilities (Rejman & Milanovic, 2012).

Using e-business tools has created major changes in the SCM, in the field of the product and processes design, e-markets and exchanges, planning cooperation among organizations and managing the execution of customer orders (Ross, 2003, 11-13) (Figure 2).

In this environment, there is a constant migration from vertical to virtually integrated organizations. Organizations representing the business systems that consist of narrowly defined functional areas are oriented towards internal processes and are not interested in establishing cooperation between organizations. However, organizations with a strategy of expansion and winning new markets have realized that working with all members of the supply chain, including competitive channels, is a good way to meet the ever-higher requirements of customers.

Instead of a physical system of the channels network, managed by time and space, the virtual supply chain,

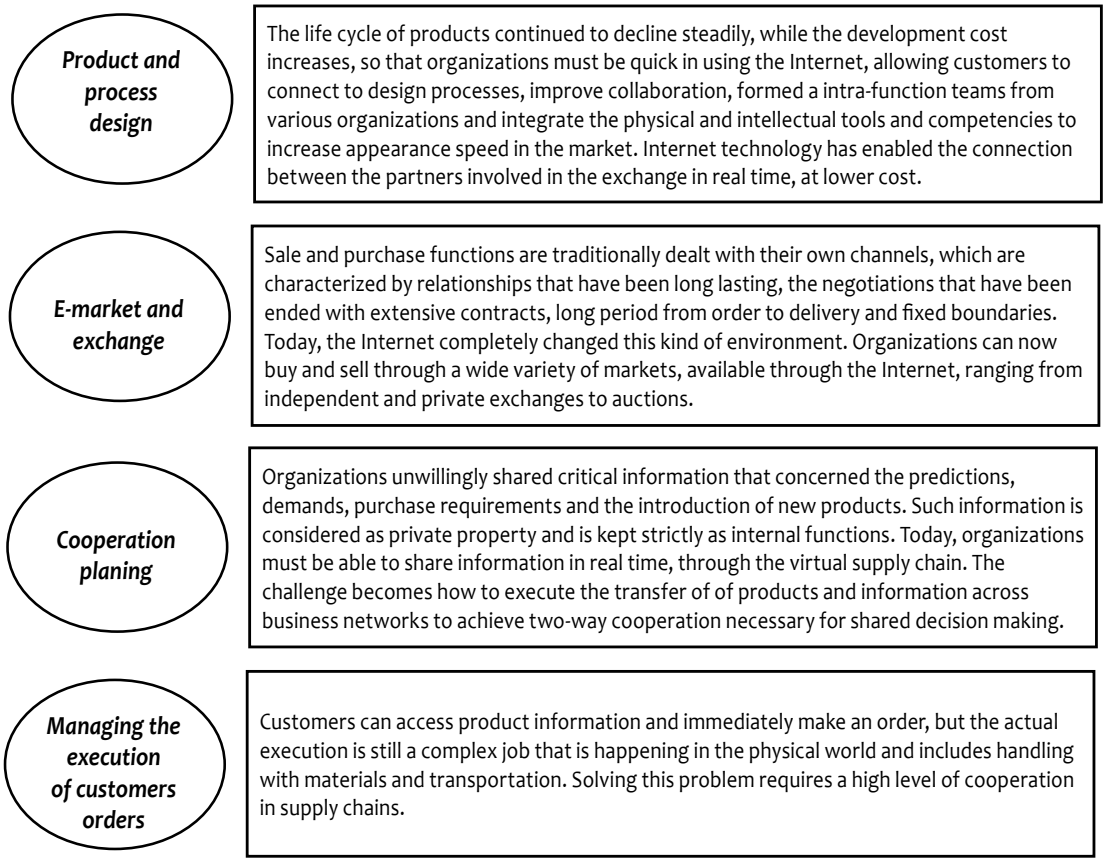

Figure 2 Areas of changes in supply chain management

Source: Ross, 2003, 11-13

supported by the Internet technologies, provides partners from all parts of the world with an insight into the possibilities and possible unanticipated events in real time. Virtual organizations enable the development of strategies oriented towards the supply chain and redefine the fundamental assumption about who the customers are and how to shape internal and partner competencies (Arsovski et al., 2011).

Conventional supply chains are not able to meet the needs of today's customers and thus hamper business partners within the network to be effective. Mostly, they can be described as slow, expensive, insufficiently accurate, inconsistent, inflexible and inaccessible. On the contrary, supply chains supported by the Internet are ready to provide customer service that conventional supply chains were not able to.

Competitors are changing business environment and at the same time irreversibly changing the supply chain and the management of its functions. The traditional supply chain (purchasing/production/distribution) is linearly connected. The modern approach to supply chain management means that organizations need to improve their communication and information flow. In this way, the traditional supply chain turns into an adaptive and real-time supply network. This enables organizations to manage a flexible, responsive supply chain network as a whole.

Supply chain networks are highly complex, interdependent structures with a number of related suppliers, service providers and customers who are also members of other supply chains. Individual elements of the supply network interact at different levels:

- the products level,
- the information level,
- the relations level,
- the institutions level, and
- the finance level (Gomm & Trumpfheller, 2004) (Figure 3).

Therefore, designing an efficient supply chain network involves an analysis of the key components and requirements of stakeholders with interfaces at the horizontal and vertical levels, in order to achieve

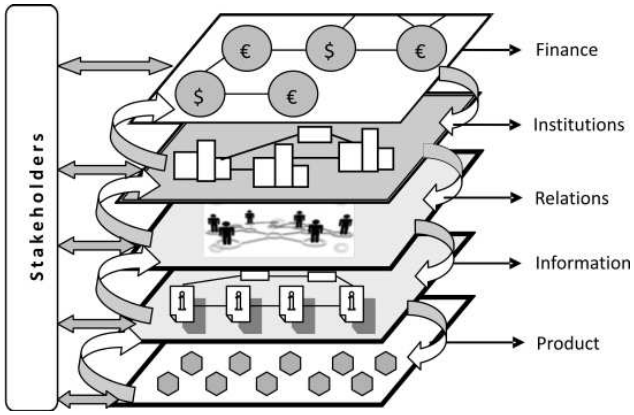

Figure 3 Interaction of different network levels in the supply chain

Source: Gomm & Trumpfheller, 2004

an effective interaction between the participants in the supply chain and improve the performances of processes, functions, organizations and the entire supply chain.

CHARACTERISTICS OF SUPPLY CHAIN MANAGEMENT IN E-ENVIRONMENT

With the appearance of the Internet technologies, the concept of supply chain management assumes a completely new dimension. The main problem that was a barrier to the total activation of SCM models was the a mechanism that would allow a connection between business systems. The Internet overcomes this gap.

Actually, in the entire supply chain, an access to and display of database data, forecasts, an inventory, capacity planning, product information, financial data and other aspects of organizations needed for effective decision-making are allowed.

To ensure operations, the full benefit and advantage provided by the implementation of e-SCM, it is necessary to define:

- e-information,

- e-collaboration, and
- e-synchronization.

E-information

E-SCM enables a completely new insight into the functioning of information throughout the supply chain. Today, the fundamental competitive advantage is speed, being the fundamental attribute of information obtained from the Internet. Organizations acquire capital using e-information on the basis of the created system allowing a simultaneous use of data about the supply chain in real time. In this way, it is possible to manage the supply chain in any situation and effectively respond to the planned as well as unexpected situations. E-information allows greater transparency and more control throughout the supply chain. The aim is to strengthen the organization with more efficient models of process management in supply chains as well as provide managers with an insight into the key events in order to timely implement potential corrective measures. Information about unforeseen events allows a management-efficient analysis, as well as planning and forecasting in the supply chain.

E-information ensures a deeper and broader relationship between organizations in the supply chain network, while facilitating cooperation at all levels, from product design to customer services (Johnson & Whang, 2002).

E-collaboration

E-SCM allows organizations to achieve successful relations with partners throughout the supply chain and create a channel structure without "cracks". If information between networked business partners is better synchronized, the whole supply chain is able to work as if it were a single organization. At the same time, the supply chain network is created with traditional entities such as suppliers, manufacturers, distributors and retailers, as well as a new kind of intermediaries, such as virtual/contract manufacturers, service providers and on-line trade exchange. The realization of completely new sales methods and new sales channels is also enabled. For a business to be successful, organizations must keep pace with new principles of cooperation within the supply chain. This includes the establishing of the partners network throughout the supply chain supported by web connections (Johnson & Whang, 2002).

E-synchronization

To accept challenges of operating on the market, organizations must adopt new methods of timely connecting e-information. It is the transfer of e-information in the quickest possible way through the supply chain and the interconnecting of all parts of the network in order to form a smooth supply chain, i.e. e-supply chain synchronization. The goal of synchronization is to achieve a direct link between demand and supply in all parts of the supply chain network by using ICT resources (Johnson & Whang, 2002).

SUPPLY CHAIN ARCHITECTURES

The management of supply chains in an e-environment requires that organizations in the supply chain should analyze the concepts, methods, techniques and business processes, internal and external interfaces, stakeholders' requirements , the level of the applied information and communication technologies and define optimal models of an integrated supply chains architecture.

Supply chains architecture consists of:

- the architecture of internal operations,
- the architecture of inter-organizational operations, and
- the architecture of inter-organizational technologies (Ross, 2003, 313-332).

Architecture of Internal Operations

Organizations and supply chains are not monolithic structures and always search for the realization of a comparative advantage. They grow and develop internally, and at the same time, increasingly become dependent on other systems. The constant destruction and rebuilding of organization architecture are

a response to the principles of internal business development and increased interdependency.

The term organization architecture has a broad meaning. It consists of the components of an organization responsible for the process performances, including purchasing, production and sales. Also, it refers to a corporate culture evolved in time, and running the current and future attitudes, expectations and evaluation of opinions on what the mission of an organization is. It consists of ICT resources that collect, analyze and use the data warehouses of an organization, as well as the core competencies of employees in organizations.

Without an effective architecture, an organization's evolution would be interrupted and its ability to adapt to changing business paradigms and ICT resources would significantly be reduced.

Before the appearance of the e-SCM nature of information and communication technologies, organizations' ability to go beyond their own borders was seriously limited. Technologies such as the telephone, fax and EDI enabled information to be exchanged between business partners; however, the connecting of business, data and knowledge transfer was limited in space and time. In addition, databases are considered to be an organization's property. The organizational architecture built on such an information model has significantly been limited and highly institutionalized. The structure of the organization was designated as a special configuration of the responsibility centers that had their goals and had to be aligned with the organization's strategy. The management's role was to resolve conflicts between responsibility centers and encourage and lead to overlapping targets.

At the beginning of the late 1980s, there were two new concepts: Just-in-Time manufacturing – JIT and BPR. The first focused on the fact that each individual in an organization aspires devotedly to the continuous improvement of business processes. The BPR concept was radical and focused on the fundamental change in thinking and a radical redesign of business processes to achieve dramatic improvements. Instead of a continuous improvement, the BPR concept meant the complete redefinition of business processes and their rebuilding. Although the implementation of these two concepts enabled the achievement of competitive advantage, their effects could not be felt throughout the entire supply chain. Instead of being a revolutionary business philosophy, in fact, they were a logical culmination of old organizational models which considered organizational frameworks to be a boundary preventing organizational change from crossing it.

Transition from BPR and JIT/TQM to e-SCM requires changes in the following business architectural elements:

- the management of organizational processes,
- the focus on customers,
- the reengineering of employee roles,
- employee management, and
- the development of a virtual organization (Ross, 2003, 316-321) (Figure 4).

E-SCM requires that organizations create such an organizational environment where processes, data and information in the supply chain are interconnected via communication channels and integrated databases. Today, SCM in an e-environment is recognized as a strategic business philosophy and a concept affecting all aspects of the supply chains network via process channels engineering, a continuous improvement and an overall integration of business partners in the exchange.

Architecture of Inter-organizational Operations

Organizations need to cooperate through a predefined common mission to achieve the highest level of customer service. The development of new technologies, methods, techniques and standards affects the definition of an effective architecture between organizations and the promotion of the management's and employees' knowledge in an organization. The role of the Internet is to ensure the integration of databases in organizations, too. This vision of organizations requires that all members of the supply chain be closely integrated and their databases and information flows synchronized in order to eliminate obstacles in information sharing. The construction

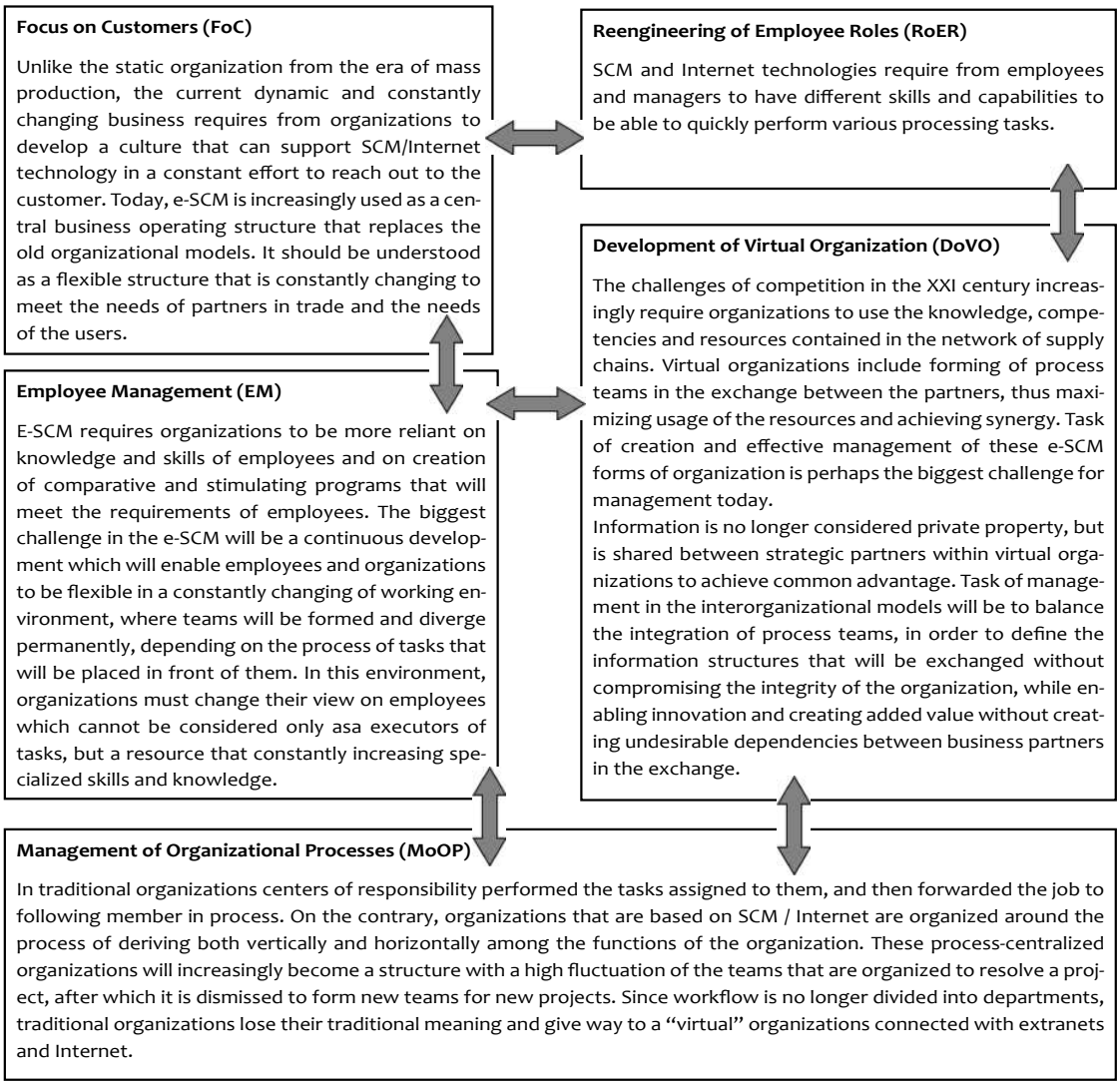

Figure 4 Architecture of internal operations

Source: Ross, 2003, 316-321

of such structures among organizations capable of synchronizing their information flows requires that partners in the supply chain continuously develop and maintain effective e-SCM strategies. This involves:

- the creating of a shared vision between organizations,
- the modeling of operations between organizations, and
- the modeling of processes between organizations (Ross, 2003, 321-325) (Figure 5).

Architecture of Inter-organizational Technologies

Strategic and operational business opportunities are directly related to the possibilities of ICT. An organization's ability to effectively manage relationships with customers and suppliers and the function of production, logistics and finances are directly

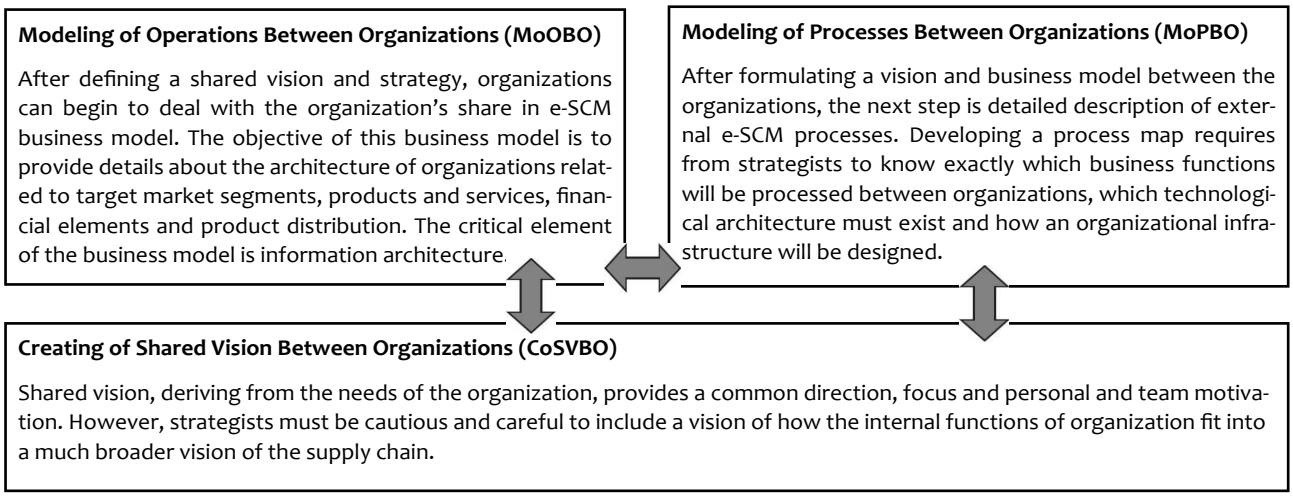

Figure 5 Architecture of inter-organizational operations

Source: Ross, 2003, 321-325

proportional to the speed at which organizations can create, store, access or transfer information and data.

In recent decades, information and communication technologies have extensively been introduced into organization operations. In the mid 1990s,the arrival of new concepts and technologies, such as e-SCM, forced organizations to use the ICT model going beyond the boundaries of an organization. Creating a necessary architecture amongst organizations requires new sets of ICT tools and significant infrastructure changes.

There are two critical dimensions influencing the development of technology architectures among organizations, namely:

- integration and
- networking (Ross, 2003, 325-330) (Figure 6).

The appearance of new information and communication technologies and information systems in recent years has changed the relationship between the integration and flexibility of inter-organizational information systems.

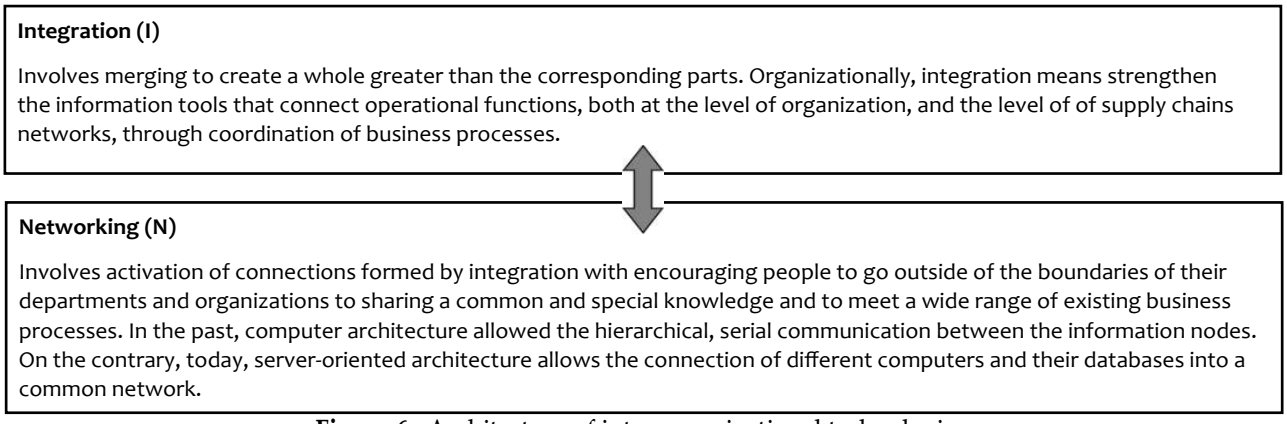

Figure 6 Architecture of inter-organizational technologies

Source: Ross, 2003, 325-330

The basis for the improvement of e-supply chains are web services including the collection of interrelated information systems connecting technologies, regardless of the programming language used to create these components or the platform they operate on (Fensel & Bussler, 2002, Hagel, 2002).

They allow organizations to integrate with suppliers with possibly different internal systems in an easier way (Vidgen, et al., 2004; Wu, 2004). While web services offer many advantages in this field, their use with other technologies and systems offers great opportunities to improve the agility of the system.

There are other technologies contributing to the improvement of the agility of the system as follows:

- electronic trading hubs, in order to facilitate communication and trade between partners (Kaplan & Sawhney, 2000),
- business process management systems, in order to harmonize inter-organizational processes (Leymann, et al., 2002), and
- automatic data collection, in order to align the physical location and asset tracking with the information flow (Fisher, 1997) and others.

GENERIC MODEL OF SUPPLY CHAIN ARCHITECTURE IN E-ENVIRONMENT

To define the generic model of e-SCM, different architectures were analyzed, as well as the elements and aspects of the architecture of supply chains in an e-environment as follows:

a) Architecture of internal operations:

- the management of organizational processes,
- a focus on customers,
- the reengineering of employee roles,
- employee management, and
- the development of virtual organization.

b) Architecture of inter-organizational operations:

- the creation of a shared vision between organizations,
- the modeling of operations between organizations, and
- the modeling of processes between organizations.

c) Architecture of inter-organizational technologies:

- integration, and
- networking.

By integrating internal operations architecture , inter-organizational operations architecture and inter-organizational technologies architecture for each particular organization in the supply chain network, the cost savings of transactions among organizations can be achieved, enabling access to information in real time, increasing the network flexibility and creating a basis for an effective management of complex interfaces between various participants in interlaced supply chains.

The proposed supply chain architecture generic model is based on the e-business model involving the development of an information system through the application of the information system's life cycle development including the planning, analysis, design, implementation and support of the information system (Arsovski, 2008).

Thereby, such an information system enables an efficient data transformation of documents, resources, processes and stakeholders in a corresponding integrated logical data model, which, by using appropriate Database Management Systems – DBMS, transforms itself in associated databases, members of supply chains (Rejman, 2010).

Figure 7 accounts for the supply chain architecture generic model of in an e-environment inclusive of the key elements of the supply chain architectures and their mutual interactions. The main interfaces exchanged between an e-organization and e-purchasing (suppliers) are: procedures, purchasing plans, contracts with suppliers, the verification of the zero series, certification, the audit process record, the organization's e-orders, supplier invoices, delivery notes, complaints, etc. The main interfaces exchanged among an e-organization and e-commerce (buyers) are: procedures, purchasing plans, contracts with customers, sales orders, the e-organization's invoices,

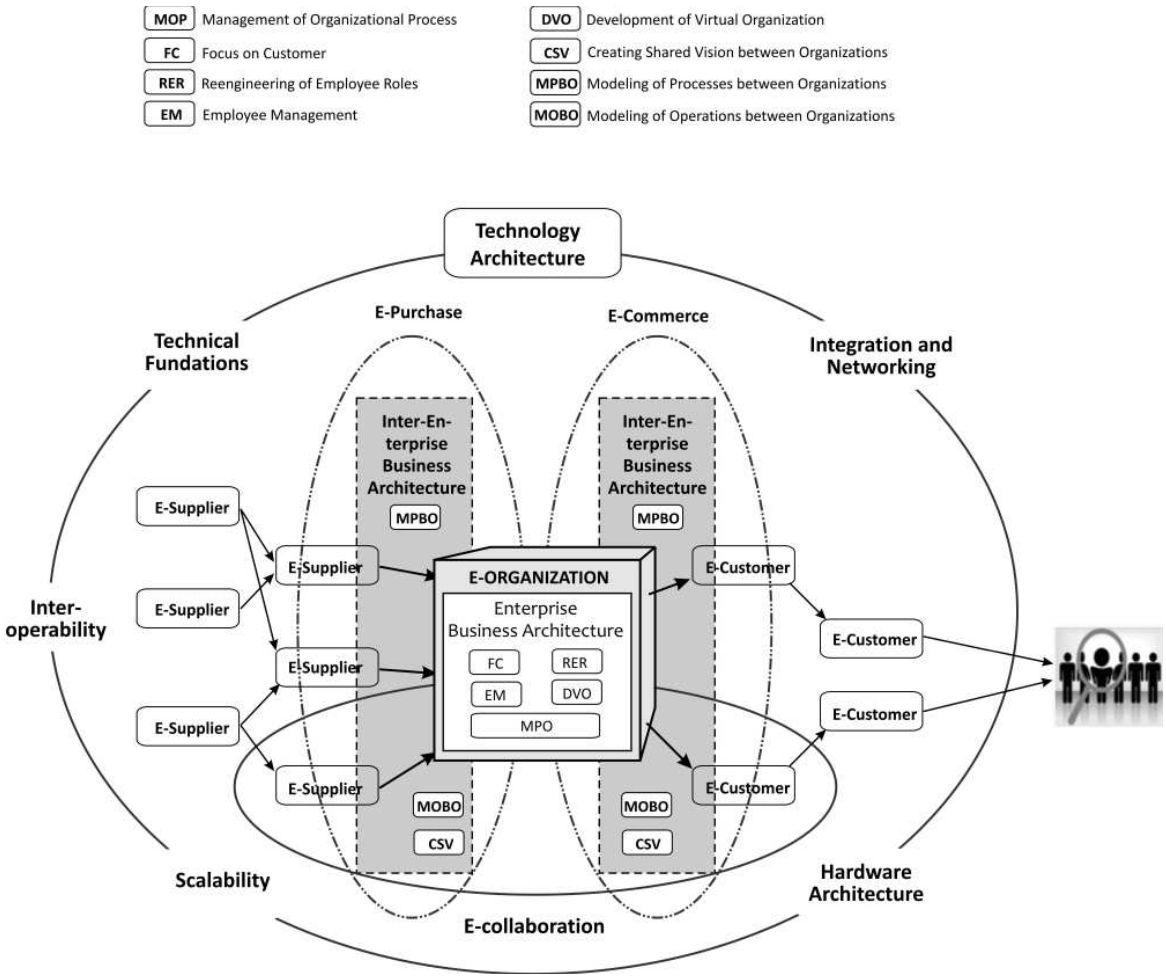

Figure 7 Generic model of supply chain architecture in e-environment

sales orders, transport orders, complaints, quality in warranty and post-warranty period, etc.

The scope of e-business is very wide. It starts from market research through a collaborative product development, and ends with sending invoices, billing and transactions in a supply chain and data analysis. The proposed model enables operations in real time and recording indicators of trends on the market at the moment they occur. The e-business model includes two main sub-models of electronic operations defined on the basis of the parties involved in the business process and the nature of their business relationship, such as e-purchasing and e-commerce. The result is the restructuring of business doing exclusively in an electronic form with continuous learning, changes and innovations.

The synchronization of chains at the horizontal level means e-collaboration providing a transparent way of planning demands to all organizations within the supply chain. The goal is to minimize the potential "bullwhip effect" resulting from an independent realization of purchases at every level in the supply chain. Achieving this goal implies an exchange of operational and strategic information throughout the supply chain using the EDI technology, extranets and monitoring through appropriate information and communication technologies.

The integration of all e-organizations in the supply chain, e-purchasing, e-commerce and e-collaboration is realized by using modern ICT resources defined in the framework of technology architecture. The essence of such an integrated supply chain model is based on maximizing the value for the end user, including not only the final consumer, but also all intermediate members in a supply chain whose product/service is used as an input for further production.

CONCLUSIONS

The so-far analyses of the e-SCM concept have been indicative of the acceleration of the expansion of e-business; the improvement of the SCM concept and the fact that pieces of information from the supply chain have been gaining more significance, because they allow the definition of future production, services, market and competitive advantage.

E-SCM provides an efficient organization and control of data, optimal distribution of information to all members of the supply chain and all levels of management within an organization. E-SCM enables organizations to connect the key aspects of their business, from product/service development to customers' orders, with all business partners in the supply chain.

The architecture of e-SCM enables the integration and e-synchronization of supply chains in a turbulent environment, sales plans, sales orders, complaints, etc. In this way, the optimization of all member resources (human, material and financial) in supply chains is achieved.

There are no identical supply chains even when it comes to a product/service, and especially a flow of different goods. This indicates that there are many factors influencing the creation of a specific supply chain, as well as that these factors are very different (a business organization, applied quality standards, methods and techniques applied in business, the applied ICT level, the structure and methods of the exchange of different interfaces among participants and others). The developed e-environment-located supply chain architecture generic model in, including e-organization, e-purchasing, e-commerce and e-collaboration, can serve as a good basis for developing specific models for participants at different levels in the supply chain network and for different manufacturing and service organizations, particularly taking into account the interaction between the management of organizational processes, the reengineering of the role of the employee, the development of virtual organizations, a shared vision among organizations, business modeling among organizations and the modeling of processes between organizations.

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