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THE CONCEPTION, DESIGN, IMPLEMENTATION OF A COLLABORATIVE DECISION SUPPORT SYSTEM FOR MANAGEMENT

Ph. D. Thesis Summary

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Abstract

In this thesis we have researched theory and best practices related to Decision Support Systems based on Web technologies, for management and especially for supply chain management. We have identified, as well, the most efficient IT instruments used by SCM applications on the market. Another research direction was finding solutions in order to support complex problem solving in supply chain, using the best practices in management, together with web standards and technologies. The results of this research were used for the design of an eSCM prototype that supports collaborative decision making in supply chain. This prototype was implemented and developed for a supply chain of a manufacturing company with good result: significant cost reduction, increase of customer service and sales.

Keywords

Decision Support System, Collaborative Decision Support System, Supply Chain, Virtual Private Networks, B2B Integration Standards, e-Business, SOA, eSCM, Agile Unified Process.

Introduction

Globalization, competition intensification and customer expectation growth led to searching new management methods to support companies to resist in the market. For this reason companies have focused on the management of supply chain as a source of efficiency growth and gaining competitive advantage. The capacity of creating competitive advantage depends on the ability to identify resources in the supply chain and to collaborate with business partners in order to exploit them. The explosion of IT technologies allowed electronic business development and applications for supply chain business processes management. These applications are based on Web technologies and include business concepts and tools for decision support that exploit the resources and competences in supply chain in order to satisfy the demand in real time. ERP systems integrate internal business functions of a company but they don't answer to the question: what should be produced, where, when and by whom. These answers are provided by decision support systems for supply chain management. Actual SCM applications are designed for big companies and in order to purchase and implement them, significant resources are needed. For this reason, we have proposed a prototype for medium and small companies in order to provide a model for increasing business efficiency, to be accessible and easy to implement. The purpose of this reasearch is to design a colaborative DSS for SCM, based on Web technologies, to support real time collaboration with business partners, cost reduction, respectively sales and efficiency growth. A second purpose is to design a virtual supply chain that ensures visibility on the activities executed in the chain, partner connecting in order to coordinate and synchronize all business processes. The DSS for SCM will also provide flexibility and agility so that to make decision through collaboration with business partners, to respond in real time to market changes and customer demand. Thus, the right decision will be made to gain competitive advantage and to maximize the profit. The prototype will involve acceptable investments for its purchase and implementation by small companies. The thesis consists of two parts: the first part is theoretical and is related to decision support systems for supply chain management and the second part presents our vision on DSS for SCM.

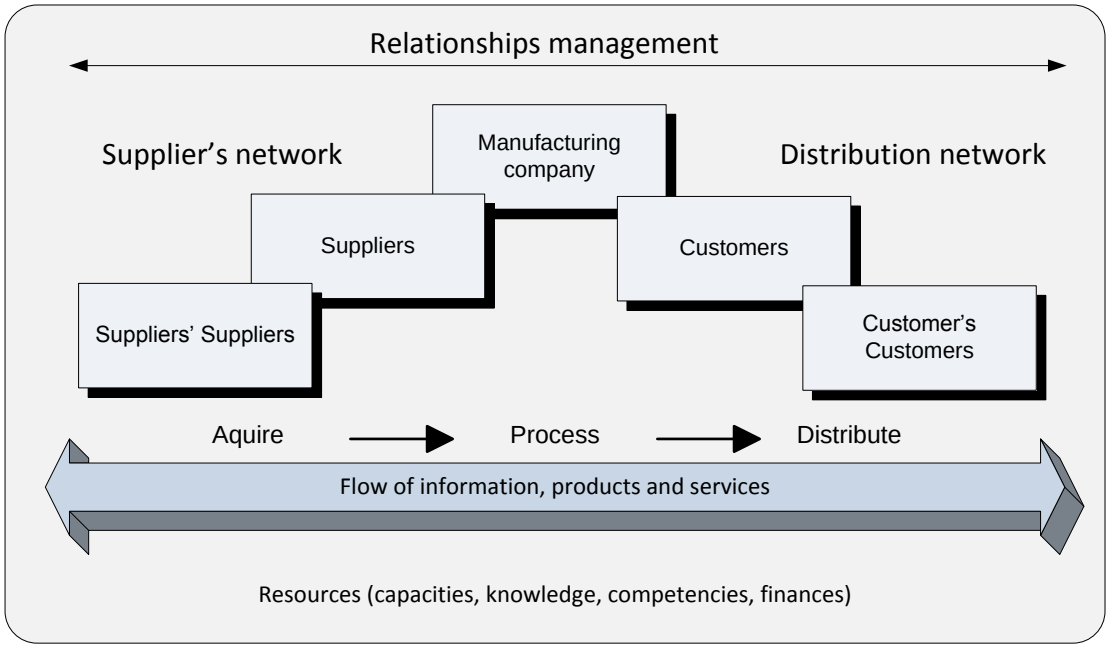
Part One. Theoretical Aspects Concerning Collaborative DSS for Management

Chapter 1. Classic and Collaborative Decision Support Systems

The first chapter describes the theory and practice related to classis and collaborative DSS: definition, classification, characteristics, DSS evolution, decisional problems they solve. Then, we have described the DSS architecture, the phases necessary for building DSS and the technology employed. Collaborative DSS represent a special class of DSS based on communications that support decision making through cooperation between the participants in decisional process.

Decision making for supply chain is limited by information availability at the right time, from business partners, in the right form or by the fact that there are not enough resources to implement the most adequate solution. Other decisions have to be made together with business partners and there is no collaboration framework. In order to reduce these limits, methods, techniques and tools were deployed to support decision making: ordering and increasing of decisional meeting, communication facilitation between participants in decision making using influence diagrams and decisional trees, data online analysis and extraction of relevant knowledge and information stored in company information systems, using Data Warehousing techniques, online analytical processing and Data Mining, simulation („What if" analysis), optimization, artificial inteligence like expert systems, genetic algortihms neural networks, etc. We consider that nowadays organizations need Web based DSS because it is neccessary to collaborate with business partners and to share infomration, in order to make good decisions. For this reason, we study in this thesis collaborative Web based DSS for SCM. SCM applications have the purpose to add value for the entire supply chain through collaboration with their partners in order to satisfy the demand and increase profits. This can be accomplished only through making the right decision foe every SC activity: manufacturing, procurement, sales, planning, etc.

Figure 1. Integrated supply chain



Chapter 2. The State of Art for Web Based SCM Applications

The second chapter presents the state of art in SCM field, the phases for designing the SC infrastructure, as well as the technology that allowed the design of SCM applications. The last part of the chapter describes the most popular SCM applications on the market, with the facilities they offer.

The supply chain encompass all the organizations and activities associated with the flow and transformation of goods from raw material to the final customer, as well as the information flows involved (Handfield, 2002). SCM approches the integration and management of the organizations and activities from the supply chain through collaboration between companies, efficient business processes and information sharing in order to create performant value sistems providing competitive advantage to SC members. For a company, the supply chain encompasses its upstream and downstream partners. SCM involves information system management, procurement management, sourcing, manufacturing planning, order processing, inventory management, warehousing and customer service. The value system is a connected

series of organizations, resources, knowledge flows used for creating and deliverying value to the final customers.

There is a common view that in order to build an infrastructure for SC, we have to follow several phases: process mapping, internal integration between business functions, collaboration with suppliers and customers, B2B integration, operation automation and optimization. The technologies that support document transmission for process streamlining are Internet technologies, EDI, and standards for data interchange for B2B collaboration: RosettaNet, BizTalk, OAG and ebXML. SCM applications work usually through virtual private networks.

Chapter 3. Technological and Management Aspects of the Decisional Process in the Supply Chain

The third chapter elaborates the technological and managerial aspects of the decisional process in the supply chain. These problems are numerous and complex and are related to issues like: network configuration, inventory management, relationships with suppliers and strategic partnerships, the value of information, procurement, logistics, risk management, collaborative development of products and services, prices.

The present approaches concerning SCM, decisional processes and automation of activities in the supply chain by using Web technologies, take into consideration:

- managerial aspects that have to be analized permanently to know in detail every processes that take place on the market and all the changes occured in supply and demand
- technological aspects involve employing the most adequate and new IT instruments available and their implementation as efficient as possible so that to optimize the managerial activities from the supply chain, respectively to facilitate the collaboration between partners in order to make the best decisions.

The managerial problems can be solved by designing a commun model to work for the entire supply chain and by standardization of processes,products and operations. Strategies like: push, pull, postponement allow a better adaptation to market demand.

We consider that by using Web based SCM application we can create a large knowledge and data warehouse for the supply network that allows decision making that can solve all the SC problems desribed in this chapter.

Chapter 4. The Configuration, Design and Planning of the Supply Chain

Chapter four sinthesizes the methods used for the configuration, design, planning and execution of the supply chain and the Web applications that support these activities: ERP, MRP, APS, CRM, SRM, LRM, etc. These actvities have to be connected to the SCM application in order to give detailed information about processes and resources they support and provide a holistic view, in the due time, on the materials and information flows in the supply chain.

We consider that the main objective of SCM resides in supplying products and services based on customer requirements, as efficiently as possible. The aim is to supply more utility or value added for the customer, with a low cost, as well as the level of customer needs satisfaction to be as high as possible. The optimization of individual entities or activities does not involve the global optimization for the entire supply chain.The optimization of the hole system is much more difficult. The optimization criteria are total cost and global profit.

There are several models for the representation and management of SC activities: Supply-Chain Operations Reference-model (SCOR), SCM model oroposed by Global Supply Chain Forum (GSCF) and The Supply Chain Best Practices Framework.

In order to build an efficient supply chain it is neccesary the design of an configurable supply chain that adapts itsself to its environment and is needed in order to adapt to market conditions and globalization. The SC optimization begins with productive resorces optimization in order to allocate the resources as efficient as possible. The management of resources involves their planning and control: design, materials, work, expenses; without them processes can not work, this resulting in profitability decrease and network dissolution. In order to work properly production processes need to be managed by applications like MRP (Material Requirement Planning) and ERP (Enterprise Resource Planning) to calculate material planning, activities planning and control and the integration of business functions (Walker, 2005). Collaborative Product Commerce (CPC) is a set of applications that allow the design and

manufacturing of products, collaborative management of product lifecycle management. The tools associated with CPC are: CAE/CAM (Computer Aided Engineering/Manufacturing), CAD(Computer Aided Design), CRM, CSM (Component and Supplier Management, DCS (Design Collaboration Software), PDM/PLM (Product Design Lifecycle). APS (Advances Planning and Scheduling) systems manage factory constraints and the demand optimization, synchronization, scheduling with production capacity of the manufacturers. (Heinrich, 2002). In order to make the supply chain planning system work, exact data, strategic, tactical and operational planning are needed, optimization techniques, manufacturing plans management and CPFR. The relationships with supply chain partners are supported by specific applications such as: SRM (Supplier Relationship Management), CRM(Customer Relationship Management) and LRM (Logistic Resource Management).

Part two. Our Approach on Collaborative DSS for Management

Chapter 5. eSCM Applications. Framework and Generic Architecture

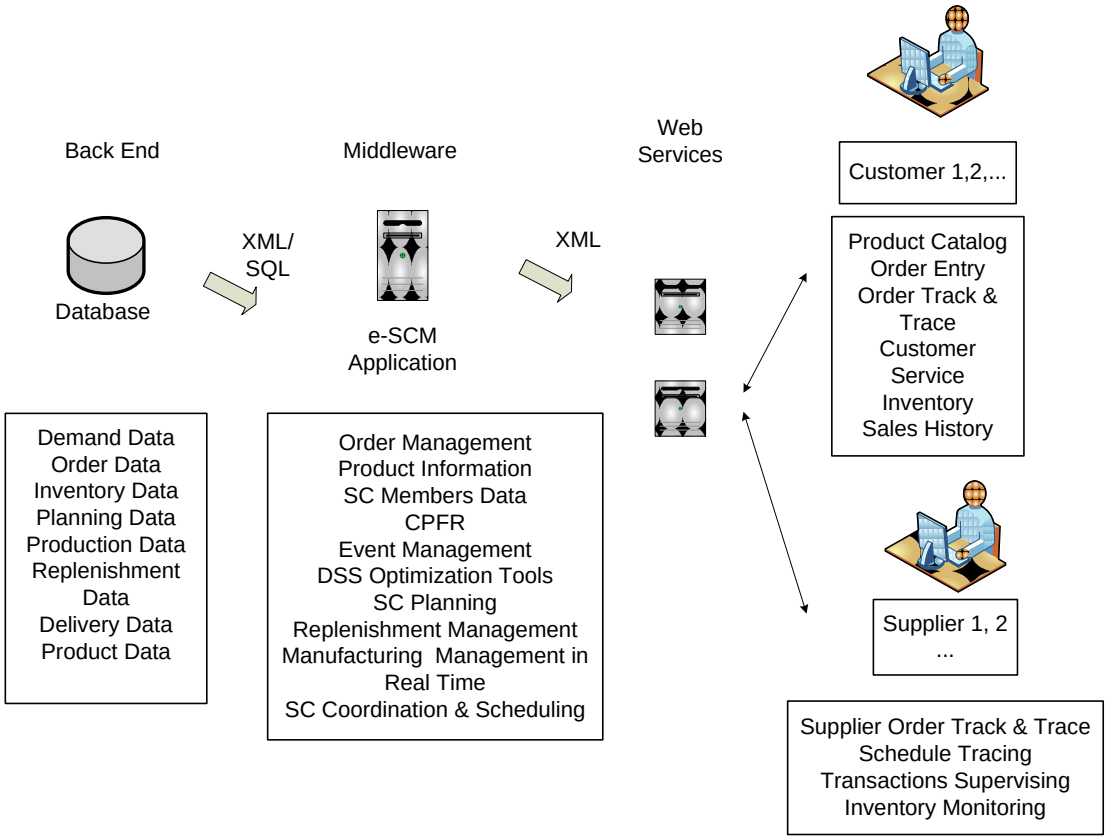
Chapter six presents the phases that must be followed in order to create an eSCM application, the technologies needed for interorganizational collaboration and information system integration into this application. ERP systems of partners must be connected to eSCM through middleware components. The SC integration takes place at dufferent levels: services connection to provide a singla access point for the user, business process integration, work flow integration, application integration, complementary information integration. All these provide a holistic view and control over the processes and information.

We consider that companies should have the possibility to choose the level of integration, which will determine the amount of information, resources and advantages shared with business partners. The eSCM prototype we have designed allows companies to choose the level of integration they want, providing flexibility and agility to each member and to the entire network.

We consider that the design and implementation of an eSCM application involves multidisciplinary knowledge and the collaboration with business partners for every

development stage. In order for the supply network to work efficiently, it is necessary that network architecture and business processes model to be redesigned at every level: strategic, tactical and operational. Also, we shall choose those Web technologies which provide real time communication and the right information to the right node, at the right time so that the demand to be satisfied quickly and efficiently. The general architecture of the application is represented in figure 2.

Figure 2. eSCM architecture



Chapter 6. DSS Tools for Developing eSCM Application

The sixth chapter describes the specific tools for classic and collaborative decision support systems as well as Web technologies that can be used for the configuration, management and coordination of business processes in the supply chain. These tools should be used efficiently to satisfy the demand and increase customer service level.

The IT infrasctructure can support business process integration at different levels: IT systems are independent, internal integration among businss functions, integration among companies, colaboration for the entire supply chain

The data collected by company information systems must be analyzed. There are two methods for data analysis:

1. Using tools for general purposes that process data extracted from ERP systems and others. These tools use techniques like: interrogation, statistics, data mining, OLAP.
2. Using DSS that provide special interfaces. These DSS include analytical tools and knowledge about the problems that must be solved. These will be used in order to find efficient solution. The techniques used are: calculations, simulations, artificial intelligence. Intelligent agents, expert systems, euristics provide good solutions but not neccessary optimum. Service Oriented Architecture supports the efficient development of SCM applications. Multiagent based systems can be employed for SCM for e-procurement, event management, resource management, e-commerce, real-time operations, process modeling in dynamic environments, coordination, planning, manufacturing, etc.

We consider that IT technologies and management techniques must be approached together because at every level of the supply chain and in every phase of SC activity, there are problems with their usage. They must be mixed as well as to support the right amount of information sharing, for the right company in order to support decision making.The purpuse is profit maximization. The evaluation of decisions' consequences is done through the measurement of value added for the customer at every level of the supply network.

Chapter 7. The Design of a Collaborative DSS Prototype for SCM

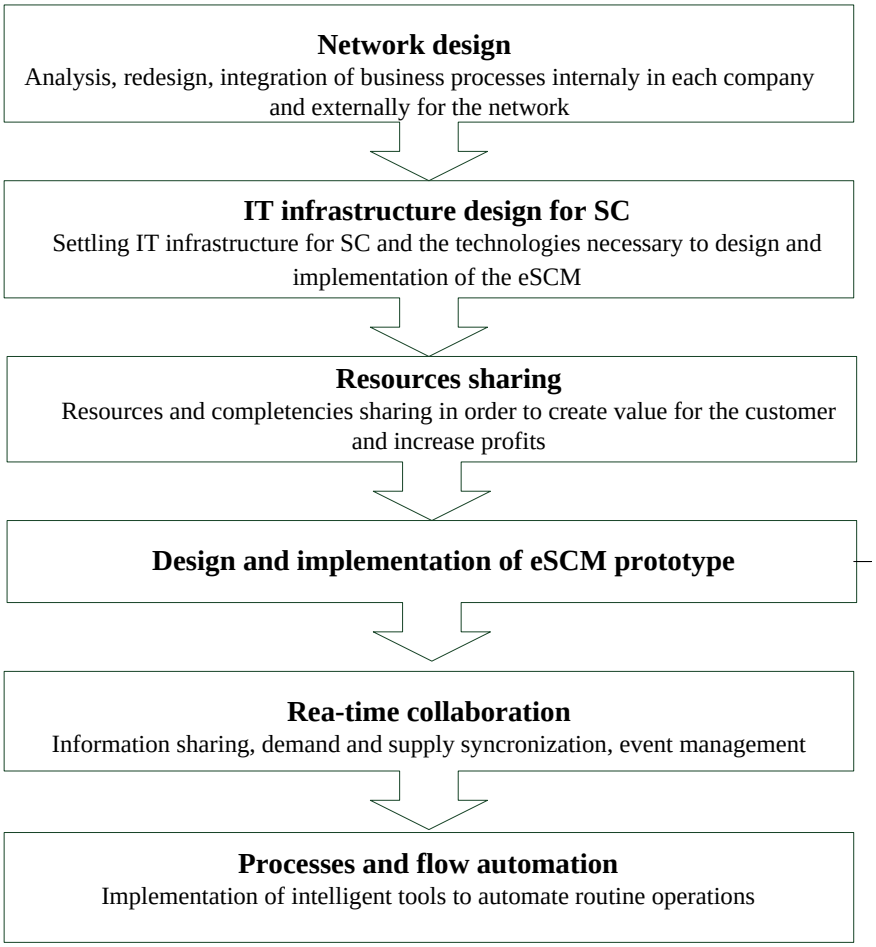
We have designed and implemented a eSCM prototype that has the role to support decision making together with business partners in order to maximize the value added for the entire network. For design we use agile design which supposes releasing more versions of the eSCM. Each iteration will execute the functions the customer needs in order to achieve efficient collaboration with business partners.

In order to design the eSCM prototype, we followed a series of phases: requirements analysis, planning, iteration, testing, respectively designing new versions to meet new customer requirements.

The prototype will share important information wih customers and suppliers about: actual and forecasted demand, materials and products inventories and production flow. These information will be delivered fast and can be used for deciosn making for purchasing, manufacturing and delivery. The prototype has optimization options for these activities that support decision making for the first tier of the supply chain.

The prototype will allow collaboration and integration at different levels: electronic document interchange, accessing the neccessary data from partners information system, process manipulation and triggering operations in partners system.

Figure 3. The steps for designing an eSCM prototype



The future versions will support collaboration to enable real time decision making and to automate the entire supply chain using intelligent agents and analytical tools for

global optimizations. The purpose of this protorype is to properly allocate resources in order to satisfy customer requirements at a higher level and increase profits.

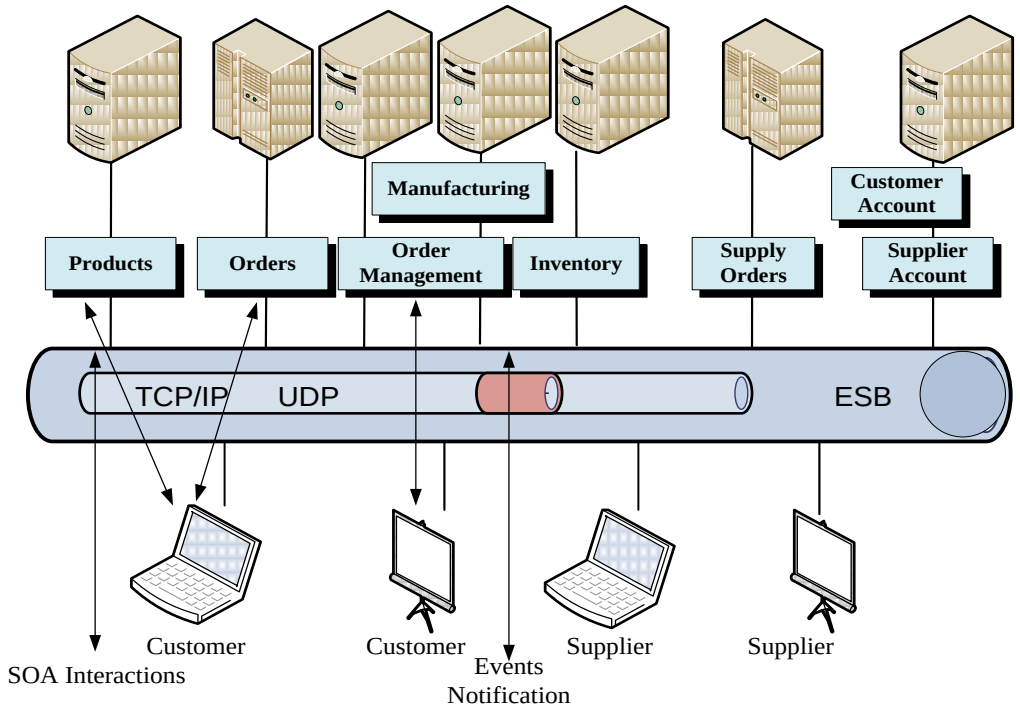
The theory and best practices we have analyzed in the previous chapters, showed us that SCM has to be approached and executed taking into consideration technological, managerial aspects and the general purpuse for the supply network: profit maximization. We have proposed a set of steps that must be followed in order to design an efficient SCM application, as we can see in figure 3.

The prototype will be incrementally developed, so that each partner to choose the level of integration he wants:

- the first level provides data exchange punctually between applications
- employing middleware tools for data exchange between applications
- designing a common pattern for processes and information flows
- integration and automation of all the processes in the supply chain

The prototype architecture is based on the three-tier model, including the three levels: client-side, middleware and server-side. Figure 4 illustrates the integration of the eSCM components through ESB middleware technologies. ESB is considered a standard for service oriented architectures and event based models.

Figure 4. The integration of eSCM components through middleware technologies



The eSCM prototype supports the decisional process for the supply chain and the information sharing necessary for collaborative decision making related to:

- what to produce: the present and previous demand is known by all partners, respective customers needs
- where to produce in order to better allocate resources and deliver in due time
- who should produce product: the company or its partners, considering the delivery time and the available resources
- how to produce: customer interaction history gives important information about customer preferences, experience with the company, etc.

Case Study: eSCM Application Design and Implementation

We have used a middle-up approach for application design, a mix of top-down and bottom-up approach. We have used also agile design methods by executing the following phasis: customer requirements analysis, architecture design, planning, eSCM release, testing and new versions exploitation. The project was split into modules that need a minimum planninfication and developed iteratively. The functions of each module are:

- E-commerce module which is connected to the back-end system that manages the company internal functions
- Modules for suppliers and customer that allows access to company extranet depending on the user profile, to track and trace present and previous orders, inventory levels, for communication with manufacturing company. The exceptions will be triggered for low levels of inventory, unexpected changes in demand level, etc.
- Optimization module for automated purchasing, manufacturing, forecasting, customer service improvement, reports, etc.

The application was developed using PHP, mySQL, Apache as Web server, postgresql, Visual Studio, C#. The application is accessed through a browser, providing easy connection and interaction between network partners.

The application enables a more efficient management of manufacturing, commerce, delivery and supply for a large range of very complex products, which can not be produced by a company, efficiently. The product manufactured by the company is oil boiler having three dimensions and various options for additional equipments.

The application supports the improvement of products and time reduction for manufacturing, supplying and delivery. Customer related processes are in the centre of economic activities in the supply chain. Company architecture, technological and interorganizational architecture which support the collaboration in supply chain network is focused on these processes.

Conclusions

The SCM issue is complex and multidisciplinary, it is difficult to manage, but using Web technologies we can build collaborative DSS to integrate business partners in virtual networks and to support decisional process.

The eSCM prototype represents an efficient and accessible solution for small companies because it provides the support for decision making and can be developed according to customer needs. ESCM ensures process correlation in the supply chain by sharing the information they need with customers and suppliers, in real time, connecting the front-end with the back-end through Web technologies for companies in the supply chain and online access to updated information. The originality of the model resides in sharing an optimum amount of information for decision making based on complete, real time data. The prototype can be implemented and developed using cloud computing technologies.

Personal Contributions

Our personal contribution is the research and identification of standards used for designing and management of SCM applications. Another direction was to find new solutions based on collaborative DSS for complex problems in the SC. A third direction was to find the most adequate strategies and tools to integrate company applications with the eSCM application. This research was the basis for the design and implementation of an eSCM prototype that provides the data for decision making. ESCM represents an efficient and accessible solution for small and medium size companies because supports the decision maker and can be developed according to customer needs.

The eSCM model we proposed for a collaborative DSS is based on Web technologies and is communication and data-driven and supports process synchronization through information sharing, with partners in real time. Customers benefit from a customized interaction with the company and thus, their needs can be better satisfied, leading to sales growth. Suppliers can deliver products faster and can react timely to order changes or in demand dynamics. Purchasing, production, delivery costs can be reduced and the service level can be increased together with sales volume. The model shares the right quantity of information for decision making and supports automating decision using intelligent agents. The proposed architecture enables information gathering for the supply chain network, database update in real time, in a secure manner, in order to make decisions to satisfy the demand. The cost/benefit ratio for the design and implementation of this prototype is very profitable and can support small and medium sized companies in decion making through collaboration. Thus, eSCM proposed can enable competitivity growth and business development.

Directions for Future Research

The next versions of the eSCM will include more complex tools for forecasting demand and supply such as neural networks and fuzzy logis, datawarehousing, datamining and OLAP. For the automation of purchasing, manufacturing maangement and customer behaviour analysis, alerts and information sharing we will emply intelligent agents. The next level of integration will allow process and infomration flows automation so that to transform the network in am automated virtual entreprise. The experts' knowledge can be integrated in knowledge and model databases and can be used for the collaboration in supply chain, real time communication, process coordination and optimization. Thereby, we can create a framework for process synchronization and problem solving in the supply chain, respectively for collaboration. The result will be better decisions that will allow to attain the purpose of the supply chain: cost reduction, efficient allocation of resources and profit maximization.

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