Dissertation Report

On

Assessment of Role of IT in SCM

Submitted By:

Hitesh Demla

2K11/MBA/19

Under the Guidance of:

Dr. Rajan Yadav

Associate Professor

DELHI SCHOOL OF MANAGEMENT

Delhi Technological University

Bawana Road Delhi 110042

<u>Certificate</u>

This is to certify the Hitesh Demla, 2K11/MBA/19, completed his dissertation on topic "Assessment of Role of IT in SCM" under my supervision. I acknowledge that his work is original and genuine.

Prof. P.K. Suri   Dr. Rajan Yadav

Head of Department,   Associate Professor

DSM   DSM

<u>**Declaration**</u>

I, Hitesh Demla, 2K11/MBA/19, student of Delhi School of Management hereby declare that I have pursued a research study on the topic **"Assessment of Role of IT in SCM"** under the guidance of Dr. Rajan Yadav, Associate Professor, Delhi School Of Management. I also declare that this work has not been submitted in part or full to this or any other organization/ institute as part of any project work by me.

<u>Acknowledgement</u>

It is indeed a matter of great pleasure to present this project report on the topic **"Assessment of Role of IT in SCM"** to The Head, Delhi School Of Management. I gratefully acknowledge my profound indebtedness towards my esteemed guide **Dr. Rajan Yadav, Associate Professor, Delhi School Of Management** for her invaluable guidance, excellent supervision and constant encouragement during the entire the project work. I also take the opportunity to thank **Prof.P.K.Suri, Head, Delhi School Of Management** for being a constant support in deciding the framework of the research study

Last but not the least; I would like to express my heartfelt gratitude towards my parents for their constant encouragement & support.

Hitesh Demla

Delhi School Of Management

Content

Executive Summary

Nowadays, companies are in the race for improving their organizational competitiveness in order to compete in the 21st century global market. This market is electronically connected and dynamic in nature. Therefore, companies are trying to improve their agility level with the objective of being flexible and responsive to meet the fast changing market requirements. Here we see what role IT has to play in equipping companies for this global competition. We also reviewed a few case studies which suggest that IT has an increasingly important role in various SCM activities. Based on the study of case studies, five propositions were developed for assessing the impact of IT in SCM for big Organizations which suggests IT has a key operational impact in enhancement of service level, improving operational efficiency, improving information quality, enabling agile supply chain operating models and that use of IT has to be coupled with process re-design to receive strategic benefits.

Than we interviewed few MSME players to see the level of penetration of IT in their organizations and if the results holds true for MSME as well and we concluded that there IT certainly improves the responsiveness of small organizations as well though the impact justifies the use of basic IT softwares only and there is least utility of high end IT solutions.

1. Introduction

Nowadays, companies are in the race for improving their organizational competitiveness in order to compete in the 21st century global market. This market is electronically connected and dynamic in nature. Therefore, companies are trying to improve their agility level with the objective of being flexible and responsive to meet the fast changing market requirements. In an effort to achieve this, many companies have decentralized their value-adding activities by outsourcing and developing virtual enterprise (VE). All these highlight the importance of information technology (IT) in integrating suppliers/partnering firms in virtual enterprise and supply chain. Supply chain management (SCM) is an approach that has evolved out of the integration of these considerations. SCM is defined as the integration of key business processes from end user through original suppliers that provides products, services, and information and hence add value for customers and other stakeholders.

SCM is an increasingly applied operations paradigm for enhancing overall organizational competitiveness. A recent survey of more than 300 supply chain related executives found that 92% of those surveyed were planning to implement one or more supply chain initiatives. SCM is based on the integration of all activities that add value to customers starting from product design to delivery. According to Simchi Levi et al. (2000), SCM is a set of approaches utilized to effectively integrate suppliers, manufacturers, warehouses, and stores, so that merchandise is produced and distributed at the right quantities, to the right locations, and at the right time, in order to minimize system wide cost while satisfying service level requirements.

However, it is impossible to achieve an effective supply chain without IT. Since suppliers are located all over the world, it is essential to integrate the activities both inside and outside of an organization. This requires an integrated information system (IS) for sharing

2

information on various value-adding activities along the supply chain. IT is like a nerve system for SCM. There are lots of debates around the applications of IT in SCM concerning business to business e-commerce model, matching to business model, etc.

1.1 Information technology in supply chain management

Recently the concepts of supply chain design and management have become a popular operations paradigm. This has intensified with the development of information and communication technologies (ICT) that include electronic data interchange (EDI), the Internet and World Wide Web (WWW) to overcome the ever increasing complexity of the systems driving buyer–supplier relationships. The complexity of SCM has also forced companies to go for online communication systems. For example, the Internet increases the richness of communications through greater interactivity between the firm and the customer. Researchers have highlighted the role of the Internet in building commercially viable supply chains in order to meet the challenges of virtual enterprises.

For example, General Electric's trading process network is an online business community that allows the company to transact about $1 billion worth of business with their suppliers located all over the globe. Big three auto makers in the US are in the process of launching the automotive network exchange (ANX) to further understand the impending effects of electronic business communities. ANX will establish a standard method for parts suppliers to communicate with and obtain order information from the auto manufacturers.

Supply chain management emphasizes the overall and long-term benefit of all parties on the chain through co-operation and information sharing. This signifies the importance of communication and the application of IT in SCM. Information sharing between members of a supply chain using EDI technology should be increased to reduce uncertainty and enhance shipment performance of suppliers and greatly improve the performance of the supply chain system.

Companies need to invest large amount of money for redesigning internal organizational and technical processes, changing traditional and fundamental product distribution channels and customer service procedure and training staff to achieve IT-enabled supply chain. The following are some of the problems often cited in the literature both by the researchers and practitioners when developing an IT-integrated SCM: lack of integration between IT and business model, lack of proper strategic planning, poor IT infrastructure, insufficient application of IT in virtual enterprise, and inadequate implementation knowledge of IT in SCM. There is no comprehensive framework available on the application of IT for achieving an effective SCM.

We will see the following case studies to see the role and impact of IT on SCM.

2. Classification of the literature on IT in SCM

In this section, a classification scheme has been proposed to review the literature available on IT integrated SCM, based on certain major critical areas for the successful development of IT-enabled SCM. This classification has the objective of bringing out pertinent factors that would support practitioners in their efforts to successfully achieving an IT-enabled SCM. This literature survey is aimed to identify the critical success factors for the applications of IT in SCM, integration of partners/ suppliers and IT, B2B e-commerce in SCM, and for successful implementation of IT in a supply chain. The classification is based on the implications of strategic decisions, potential areas of IT applications in SCM, and the level of interaction between various constituents in developing an effective supply chain.

(a) Strategic planning for IT in SCM

The strategic planning is a critical task especially for IT-enabled SCM. It has long-term implications on the performance of IT in SCM systems.

(b) Virtual enterprise and SCM

Virtual enterprise is based on outsourcing concept to take advantage of the core

competencies with the objective of being flexible and responsive to changing market requirements. Companies integrate various links of the supply chain and their supporting information systems that are driven by the need to streamline operations. The relationships of VE and the Internet have brought SCM to the attention of top management.

(c) E-commerce and SCM

With the development of Internet based technologies, integration of e-commerce with SCM systems is becoming a necessity. It can support various activities along the supply chain. B2B e-commerce has tremendous influence on integrating partners in an organization to achieve an effective SCM.

(d) Infrastructure for IT in SCM

Companies suffer without having sufficient knowledge on what type of IT infrastructure or systems required for their business model to achieve an IT-enabled supply chain. The infrastructure includes the hardware and software and the nature and type of systems required for IT system in a supply chain environment.

(e) Knowledge and IT management in SCM

Since we are operating in information and automation intensive world, there is a need for knowledge workers to contribute to the value-adding activities in advanced organization. Knowledge and IT management requires a systemic approach or framework for educating and training workers in teamwork and be innovative. Management of technology requires planning, developing and implementation decisions based on the characteristics of business processes and organizational objectives.

(f) Implementation of IT in SCM

Implementation of IT in SCM requires a project management approach with the right team for the planning and implementation of IT projects. Top management support is essential in order to provide moral support as well as the financial and technical support for the

5

implementation of IT for achieving SCM.

3. Review of previous research on IT in SCM

In this section, the literature available (through journal articles mostly) on IT in SCM has been reviewed for its application and development based on the classification scheme discussed in the previous section.

3.1. Strategic planning for IT in SCM

Companies are now focusing on the strategic planning with the objective of developing long-term plans and changes to their organization and in turn to improve their competitiveness. Planning for strategies require top management involvement taking into account both external and internal factors to an organization. Strategic planning of IT should support the long-term objectives and goals of SCM both in terms of flexibility and responsiveness to changing market requirements.

For example, IT will facilitate quick partnership formation by making available the right information and hence developing a virtual enterprise. Organizational restructuring may be required if a company decides to go for an enterprise resource planning (ERP) systems such as SAP, Oracle, Peoplesoft, and BAAN with the objective establishing an effective supply chain. There are also other potential implications such as investment in IT and reengineering business process, market orientation, technology position and employee relations, and workforce characteristics. The issue of societal implications and knowledge management should be given due consideration in developing strategic planning for IT in SCM. However, it is essential to prioritize strategic dimensions that influence IT in SCM taking into account an individual organizational structure.

Cerpa and Verner (1998) present a longitudinal study of the information systems strategic

6

planning process (ISSP) within a large Australian organization. They discuss ISSP with regard to its strategic relevance, factors affecting IS strategic planning, key issues in ISSP, the effects of infusion and diffusion levels, together with the effect of IS maturity on ISSP. However, the effect of operational impact has not been given due consideration including the application of ERP.

A study into the relationship between strategic use of information technology in financial service organizations and the strategic context within which such use is made. They found a good degree of integration of marketing and IT groupings with the strategic planning process, but document a high degree of strategic ambiguity and lack of strategic time frame for such investment decisions. The major reason for strategic ambiguity and time frame for investments in IT is the lack of understanding of the business processes and justification for a suitable IT system for SCM. Author suggest the use of fuzzy cognitive maps as an alternative approach to existing strategic information systems planning models. This is a useful tool to facilitate creativity and synergy; to develop consensus and win commitment of those on whose actions the organizations future defends. However, such tools should be user friendly and have significant commitment from the management while implementing the recommendations made using the tools.

Manufacturing information systems strategic role includes minimizing manufacturings negative potential, achieve parity with competitors, provide credible support to the business strategy and pursue a manufacturing based competitive advantage.

3.1.1. Marketing reasons of IT in SCM

To compete in a new market, organizations need to be capable of reconfiguring its resources to meet the changing requirements. This requires organizations to have an effective supply chain or physically distributed enterprises. Three major roles of IT as administrative, operational and competitive. However, there is a need to address the alignment between

7

operations strategy and IT strategy. A strategic alignment model for a manufacturing information system that specifically addresses the requirements of leveraging the emerging developments in information technologies would be useful. Firms are now capable to designing and developing IT platforms as competitive weapons at a fraction of the cost that prevailed only a few years ago. The second issue is the increased connectivity capabilities over time.

The insights developed within the sociology of technology, in which innovation is not simply a technical rational process of ''solving problems''; it also involves economic and political processes in articulating interests, building alliances and struggling over outcomes. This includes strategic interests of powerful corporate players and the struggles of these players for domination in the marketplace.

3.1.2. Economic reasons

The market is the driving force for any changes in an organization. Market factors such as customer requirements, competitors and price force organizations the way they manage their operations. For example, companies select to for IT-enabled SCM in order for companies to compete in a networked economy wherein you have to compete in a global market by multiple competitive performance objectives such as price, quality, flexibility, responsiveness and dependability. The economic reasons here is the cost reason. Though flexibility and responsiveness are important in order to compete in a global and networked market, the cost still plays an important role in being competitive. Obviously, flexibility and responsiveness are interconnected with cost. Many companies choose cost reduction as a competitive performance objective. In order to reduce the cost of production, companies have implemented the concept of SCM with a view to eliminate non-value-adding activities. IT helps to improve the accurate information flow and in turn accurate decisions to support the business process in an effort to meet the changing market requirements. Availability of resources locally make some companies to opt for global outsourcing and this again demands

8

an IT-enabled SCM with a view to overcome lack of resources.

Adaptability and previous experience of both data processing management and the user managers will be crucial for the planning and implementation of new systems. However, the top management support and due investment in training and education are essential for successful application of IT in SCM. The model integrates four critical performance measures, viz., flexibility, quality, time and cost. The focus on economic reasons have been misunderstood and misread due to lack of models and framework for decision making on IT in SCM.

3.1.3. Organizational

Strategic planning of IT in SCM includes organizational issues such as organizational structure, awareness of top management, business processes, strategic alliances, and information technology that influence the overall performance of IT-enabled SCM. Considering the organizations business and top level strategies, suitable information systems should be selected with a view to support the application of IT and in turn to develop an effective supply chain. Since the current enterprise structure is complex in nature and therefore, there is a need for an effective IT system to manage the system in a more productive manner.

Rogerson and Fidler (1994) presented a framework for classifying strategic information system planning methodologies involves on two dimensions; structural complexity and application complexity. But the issue of cultural complexity has been left out! Researchers developed a framework for measuring the impact of IT on quality management. Total quality management (TQM) requires teamwork, collaborative supported work, training and education in value-adding processes and the application of multimedia will enhance the communication and hence a good decision support system that is flexible and responsive. This is an interesting article wherein the author integrates the issues of TQM with IT in SCM.

The value chain, that is the chain of activities that creates customer value are interrelated. Business strategies require the organization to change. IS can be a supportive facilitator of change—extending and enhancing organization choice and improving the quality of decision making and supporter of innovation. Researchers proposed a comprehensive framework of IS strategic alignment incorporating four fundamental domain of strategic choice: business strategy, IT strategy, organizational infrastructure and processes, and IT infrastructure and processes. Nevertheless, the strategic human aspects have been ignored.

The emergence of new network technologies and expansion of the Internet can improve an organizations internal and external communication capabilities. Lower information processing costs make co-ordination and mutual adjustment processes more efficient, and therefore improve organizational performance. It also supports decentralized and less hierarchical organizational structure. Electronic communication is less formal, reduces organizational barriers. Electronic communication enhances innovation particularly in large dispersed groups. However, there is a need to standardize the information flow and access control to information along the supply chain. Researcher found that management commitment to the strategic use of IT/IS management knowledge about business, and top management confidence in the IS department are the top three critical success factors.

Organizational design for IT-enabled SCM is rather flexible as it takes the structure depending upon the business nature and strategic alliances including the characteristics of the market and business processes. For complex system organizational forms, researchers argue that (1) organizational forms that have neither too little nor too much structure; and (2) organizations that have an adaptive culture with semi structures use realtime communications. It is an interesting finding. However, standardization of business processes and IT systems facilitate an effective and protected access information in a supply chain.

3.1.4. Technological

Strategic planning involves decisions that affect the long-term performance of an organization. For example, lack of IT in an organization can make the organization obsolete and not to qualify being as one of the partners in a virtual enterprise. Since the market characteristics have changed, it would be difficult to survive in a global market without an IT-enabled SCM. IT helps to improve collaborative supported work using different automation that includes computer aided design/computermaided manufacturing (CAD/CAM) and CIM. For example, IT-enabled SCM facilitate effective technology transfer between partners in a network of firms.

Using e-business technologies, and hence ultimately providing a fully integrated e-business process can integrate activities along the value chain. Integration of the physical processes and e-businesses applications is essential to achieve an effective SCM. Researchers argue that a fundamental approach to setting up an e-business initiative is needed to fully utilize the capabilities of the Internet technology in a specific business setting. They proposed method to help clarify a strategic e-business vision and to solicit management commitment to change and on new business opportunities. This also takes into the unique possibilities of an organization's IT architecture, this further advancing the value of past investments in IT.

The widespread availability of highly flexible, functional and inexpensive information and communication technologies provides us with opportunities for a radical redesign of supply chains. Researchers develop general principles for ICT enabled redesign of supply chains. Redesign of supply chain should include a rethinking of the governance structures, a choice of the supply chain actors, redesign of the supply chain structure (sequence of activities in the chain), and redesign of information communication and coordination structures.

Strategic consideration of IT-enabled SCM is important since companies are interested in long-term survival and success with the objective of meeting changing market requirements. Global market and competitiveness center around global outsourcing and partnership and

11

these signify the ICT-integrated SCM. The risk of not having IT-enabled SCM is enormous both in terms of survival and productivity of an organization. For example, competitor action influences the strategies of each other whether in terms of strategies or technologies. Therefore, strategic planning of IT-enabled SCM is important in the development of a supply chain.

3.2. Virtual enterprise in SCM

Virtual enterprise (VE)/virtual organization (VO) is based on developing a network of collaborative firms with necessary core competencies for reaching the market on time with right products. Developing a network of firms requires a communication system to achieve a cooperative supported work. This could be achieved by utilizing various telecommunication technologies. That is IT is so important in developing and operating a VE/VO. There are numerous papers that deal with VE and IT. This includes the strategic planning of IT in VE development, infrastructure and implementation issues of IT in VE/VO.

Virtual enterprise is a network of independent companies, often former competitors, who come together quickly to exploit fast changing opportunities. The business partners are integrated using information and communication technology. Virtual Corporation is the industrial strategy for structuring and revitalizing the corporation for the 21st century. Lean production and agile manufacturing mainly focus on intra enterprise performance, while also recognizing the necessity and importance of partnerships with supplies and customers. The extended enterprise and the virtual enterprise can be seen in the context of enterprise partnerships, designed to facilitate cooperation and integration across the value chain. Some of the key factors in virtual enterprise development are IT-enabled SCM, partnership, virtual enterprise and supply chain, and virtual enterprise and IT. The literature available on virtual enterprise for SCM has been reviewed using these factors with the objective of identifying critical success factors for the development of VE.

3.2.1. Partnership

Growth of networking, both human and technological creates a virtual world with virtual products and services, virtual workplaces and virtual organizations. The virtual products and services are produced, delivered and sold through electronic networks. Researchers argue that the managerial and cultural aspects of strategic partnerships in logistics involving such issues as ''openness to innovation'' and ''trust'' are just as critical as IT.

Webster (1995) deals with the design and use of interorganizational information reflect the strategic interests of powerful corporate players and the struggles of these players for domination in the marketplace. He draws upon the insights developed within the sociology of technology, in which innovation is not simply a technical rational process of ''solving problems''; it also involves economic and political processes in articulating interests, building alliances and struggling over outcomes.

3.2.2. Virtual teams and supply chain

The design, manufacture and delivery of a product require ever higher levels of knowledge and expertise within the supply chain. Virtual teaming is the most appropriate mechanism to examine the relationship between all parties along the value chain, created across a distributed supply chain, with members separated geographically. In principle, virtual teaming could allow joint commitment, feelings of mutuality, trust and creativity and rapid decision making to operate within a supply chain. Virtual team needs to be built by concentrating on process, teaming and technology factors. However, experience from other IT-based initiatives is that technology will be concentrated onto exclusion of other factors.

Researchers present a framework for structuring and synchronizing phases and stagegates within the extended enterprise, and a new simulation tool that will provide a synthetic distributed hypermedia network. An increasing number of manufacturers adopt the virtual

enterprise metaphor, inter organizational interactions (customer–supplier relations) are being transformed. Sarkis and Sundararaj (2002) discuss how brokerings role and practice needs to evolve with evolving organizational forms and supporting tools, technologies, and mechanisms needed to implement e-commerce. Also, they explained how agent based e-commerce could support the development of a system for customization. More research is required to develop an agent based modelling to enhance the effectiveness of brokering in SCM.

3.2.3. Virtual enterprise and IT

Virtual enterprise is based on strategic alliances of partners based core competencies. The partners may be dispersed geographically either nationally or internationally. It becomes more complicated to integrate partners with different objectives and platforms to function. This could be achieved by suitable enterprise resource planning systems including e-commerce and IT for a cooperative supported work in such a virtual enterprise environment. Without IT, one could hardly imagine a virtual enterprise development.

There is increasingly growing interest in e-businesses. Its impact on supply chains is currently covered in about 150 articles and article number is growing. Most of them are biased towards the application of e-commerce towards sales and marketing. The supply chain dimension of e-business is largely ignored and managed poorly. According to him, the e-supply chain format resulting from these initiatives is different from traditional e-commerce and purchasing approaches in that:

- A supply chain wide information infrastructure is used to directly disseminate relevant market information throughout the chain as a whole, avoiding a loss of time.
- Information is used for long-term innovation and enhanced customer relationship.
- Cooperation among supply chain part.

Researcher presents the issues concerning developing international standards for virtual enterprises. They discussed the evolution of brokering paradigms in e-commerce enabled manufacturing.

3.3. E-commerce and SCM

EC can take a variety of forms such as EDI, direct linkups with suppliers, Internet, Intranet, Extranet, electronic catalog ordering, and e-mail. To support the inter organizational sharing of resources and competencies in network structure, communication and coordination need to be maintained. IT has a pivotal role to play in improving communication and coordination by acting as an enabler. E-business is the establishment of a computer network to search and retrieve information in support of business decision making and inter organizational cooperation.

The Internet helps to manage supply chain activities by offering information about what kind of product is demanded, what is available in the warehouse, what is in the manufacturing process, and what is entering and exiting the physical facilities and customer sites. For example, ERP systems such as SAP, via Extranets connect not only different functions within a firm but also among the firms supply chain partners (i.e. suppliers, distributors, and third party logistics (3PL) providers), enabling the partners to share information such as order status, product schedules, and sales records, to integrate major supply chain processes and to plan production, logistics and marketing promotions. Researchers discuss the role of IT in integrating the lean and agile manufacturing paradigms in the total supply chain. He highlights the power of EDI in supporting collaboration and resolving conflict in a supply chain.

3.3.1. Purchasing

The increased popularity of e-commerce is due to a multitude of operational benefits it can bring to purchasing practices. Examples of these benefits are cost savings resulting from

15

reduced paper transactions, shorter order cycle time and the subsequent inventory reduction resulting from speedy transmission of purchase order related information, and enhanced opportunities for the supplier/buyer partnership through establishment of a web of business-to-business communication networks. In spite of these benefits, EC purchasing has serious problems to the successful implementation of a cyber purchasing system include a host of security, legal, and financial problems.

He explored how electronic commerce can fundamentally change the inter organizational processes at the buyer-supplier interface. E-commerce is changing the competitive environment in a number of ways: (a) reshaping buyer-supplier relationships, (ii) improving core business processes, (iii) providing electronic intermediation, and (iv) reaching new segments and markets.

He also discussed the operational benefits of business-to-business purchase cyber-purchasing. He identified the potential problems of purchasing online. Some of the major issues in cyber purchasing include size of the firms, security concerns, global sourcing, contract laws and government regulations. EC success depends on the degree of acceptance and the extent of participation among suppliers due to the interdependent nature of EC. He examines the optimization of purchasing for maintenance, repair and operating supplies (MRO) through purchase process reengineering. The use and development of the Internet as a channel for procurement of MRO items was examined from a transaction cost perspective.

e-commerce should be viewed less as a phenomenon of business online and more as a challenge of organization redesign. He has proposed a quasi-general organizational design approach for EC projects. These approaches emphasize the organizational support for the EC strategy identification, network organization design, task design, and reward design in the EC age. However, each business process takes its own organizational structure and IT infrastructures. The Internet has the scope to transfer complex information accurately and to reduce the delays as information passes up and down the supply chain.

3.3.2. Operations

Internet trade is not without problems for the supplier. They also discuss several issues of interoperability, building trust, confidence and security; and the need for a regulatory and legal framework. Murillo (2001) discusses the implication of e-commerce on supply chain management and its effectiveness. He discusses the terms and conditions for the online auction and purchasing contracts. Build-to-order (BTO) not only requires Just-In-Time (JIT), but also the most advanced computerized versions of ERP. With its facilitation of realtime communications between suppliers, production functions, marketing functions and the final customer, e-commerce has become an inherent component of BTO.

Researcher discuss some of the key elements of research that will investigate the role of the Internet within the manufacturing supply chain and these are (a) a detailed examination of the current usage and operation of the Internet within manufacturing supply chains, and establishing industry practice in this area, (b) building a dynamic model of the web based supply chain in each of the collaborative industrial sectors, (c) HTML prototype for the supply web model, and (d) sector based models and prototypes.

Nowadays, collaborative network of partners is more popular with companies than before to be flexible and responsive to changing market/customer requirements. These collaborative network of partners are emerging to support business to consumers (B2C), B2B and government to citizen interactivity through Intranets. Lot of attention is focused towards B2B e-commerce. There are numerous web based exchanges that connect buyers and suppliers in realtime having a significant impact on procurement and supply chain management. Most of the B2B activity falls under the sphere of portals that dynamically match buyers and sellers or e-procurement, where buyers and sellers are aggregated.

The adoption of more integrated Internet-commerce (I-commerce) models should strengthen the relationship between a network orientation and global supply chain

management. Not only the Internet make foreign markets more accessible, it now makes it much easier to integrate foreign customers, suppliers, and intermediaries into closely managed supply chain relationships, boosting savings and speeding innovation. The emergence of e-commerce will only accentuates this move towards collaboration as technology creates the ability to forge relationships more effectively and efficiently. For instance, Dell now maintains over 3000 tailored domains for customers. Such differentiation services, not possible prior to the proliferation of the Internet, allow companies to compete on factors other than price and to forge valuable relationships. Companies like Dell assert that such efforts will actually conserve organizational resources and result in positive returns. Supply chains are especially well suited for the fast changing I-commerce environment, as organizations are able to enter and evolve much more quickly and efficiently than organizations in traditional joint ventures or vertical integration arrangements. Ball and Wright (2000) examine the information value chain and some of its concepts, first for printed information and second for electronic information.

3.3.3. Logistics

Emiliani (2000) describes the process for conducting downward price B2B online auctions over the Internet for direct material purchasing and presents common issues, process improvement opportunities, and the interpretation of auction results. He presents the experiences of UPS Worldwide Logistics, a company known to be leading in the development and implementation of a fourth party business model. This model applies information integration initially in logistics and transport operations. But UPS WWL has achieved full supply chain integration and strategic applications of the information availability to the benefits of the clients. It also includes supply web practices in which multiple players₃ team up flexibly to align to the end consumer.

He presents the concept of ''virtual logistics''. With virtual logistics, the physical and information aspects of logistics operations are treated independently from each other. In such

18

operations, ownership and control of resources is effected through the Internet (or the Intranet) applications rather than direct physical control, and resources can, thereby, be owned and utilized remotely.

He developed service controlled agile logistics as a new model for a logistics control system that fulfills (a) information driven logistics system, (b) user friendly logistics services, and (c) use of modern IT tools for logistic services. Many researchers explained the close links between information systems and the management of logistics. He presented an integrated framework for distribution firms to establish and so improve their distribution systems. Also, highlighted the role of IT in improving the efficiency of logistics value chain. E-logistics has been gaining ground after companies selected to go for third party logistics. The experiences reported indicate the IT is an indispensable tool for logistic operations.

3.4. Infrastructure for IT in SCM

Infrastructure for IT in SCM consists of Internet connectivity, hardware and software including application systems integration. Nevertheless, training and education cell for IT is important to fully utilize the IT available for SCM. There are different IT platforms and systems available to enable the application of IT in SCM.

Walsh and Koumpis (1998) presented a decomposable, ''autonomous agents'' approach was adopted to specify information supply chain ''agents'' (e.g. suppliers, buyers, distributors, etc.), including their structural relationships, interaction ''protocols'' and coordination policies. He present an empirical study of 57 top tier supplier to the North American automotive industry examined the direct and complementary effects of information system infrastructure (ISI) and process improvements on time based performance.

In evaluating the formation of customer–supplier relationships, Sarkis and Sundararaj (2002) focus on two major dimensions that will influence the formation process. The first is the type of organizational structure and relationships, and the second major dimension is the

electronic commerce environment.

3.4.1. Organizational

Adaptation of e-business infrastructure involves deep level changes that affect core elements of an organization, including mission, vision, business strategy, goals, culture, technology, training and policies. The organizational infrastructure requirements include top management involvement, strategic fitness of IT, major players in the organization (power brokers), IT skills available, etc. An organization should be a learning unit so that the IT can be absorbed for the benefit of SCM.

Attaran (2001) focuses on the organizational characteristics of online procurement systems which requires inhouse expertise, employees₃ education, content management, content rationalization, business process reengineering (BPR) implementation, do not count on downsizing and better communication. These seven caveats of effective web based procurement. He presents an e-business infrastructure for construction. The infrastructure focuses on resource planning, teamwork, process improvement tools and techniques, and information management, training and development, and performance measurement. The information systems for supply chain management should be accessibility, compatibility, user friendly, stability and reliability, minimal training and strong aftersales service.

Klouwenberg et al. (1995) argue that the distinction between business architecture and IT architecture is of major importance. In many organizations, the architecture is mainly determined by technical and economical considerations. The organizational aspects are therefore mainly realized by means of the technical opportunities (technology push) and not on the basis of strategic and/or organizational considerations. Within the scope of the business needs, the business architecture offers the possibility to choose the best IT solutions.

3.4.2. Technological

The industrial revolution that took place in the past decade can be traced to technological innovation such as the Internet and the web. Subsequently, ERP systems have played a major in developing SCM. Also, developments in hardware and telecommunication technologies have occurred in order to meet the rising demands from companies. The ERP systems represent an optimum technology infrastructure that when integrated properly with a process oriented business design can support the supply chain management systems.

Lau and Lee (2000) propose an infrastructure of a supply chain information system, focusing on the component module necessary for the building up of such a system with a description of the creation of these modules. The proposed supply chain embraces the concept of distributed object technology to enable efficient data exchange among various data objects that may reside in distributed platforms over geographically isolated regions. They develop an overall methodology for enabling better supplier involvement in new product development process and to demonstrate the framework through a prototype of web based platform on the Internet/intranets using the web technology.

Au and Ho (2002) discuss the B2B e-commerce enabled supply chain management and present the IT infrastructure required for SCM. He studied the effects of information system infrastructure and process improvements on supply chain time performance. They found that the IT factor along with process improvement variables (standardization and concurrent engineering, CE) had a complementary and significant positive influence on supply chain time performance.

SAP R/3 has been widely implemented to create value oriented supply chains that enable a high level of integration, improve communication within internal and external business networks, and enhance the decision making process. They discussed the SAP/R3 implementation case for reengineering supply chain and highlight the importance of IT

infrastructure for the successful implementation of SAP/R3 for the reengineering supply chain. Perry and Sohal (2000) analyzed quick response practices and technologies such as EDI, computer aided design and computer aided manufacturing in developing supply chains. Sharma and Gupta (2002) present the application of web centric to improve agility and reduce costs. They provide an overview of various application service providers (ASP) and issues and challenges. They also discuss the IT infrastructure required for application service providers. Yamaya et al. (2002) discuss about delivering ERP systems through ASP.

3.5. Knowledge and IT management in SCM

Knowledge management is concerned with recognizing and managing all of an organizations intellectual assets to meet its business objectives. Organizations are redesigning their internal structure and their external relationships, creating knowledge networks to facilitate improved communication of data, information, and knowledge, while improving coordination, decision making, and planning. Knowledge networks allow their participants to create, share, and use strategic knowledge to improve operational and strategic efficiency and effectiveness. E-business knowledge can be created and shared more effectively by a combination of new organizational designs and adoption of new technologies, such as data mining and intelligent agents. Managers are beginning to leverage their information system assets to react to market demands more efficiently. For example, in a B2B environment, different kinds of relationships or partnerships at different times. Partnership is critical to the creation and spread of knowledge, and creation and diffusion of innovations.

3.5.1. Technology management

Information technologies such as XML for representing corporate data, ERP infrastructure that provides support for logistics operations, and web infrastructure allow B2B e-commerce successful or SCM. In the emerging e-procurement marketplaces, firms establish efficient web based electronic relationships that allow for closer integration between buyer–supplier. The

22

reliance on application service providers for high value e-procurement and other business purchases makes the reliability of knowledge transfer paramount. Clearly, exchanging information must be consistent between buyer to portal and portal to seller and between seller to portal and portal to buyer.

Talluri (2000) in his paper highlights the importance of the efficient use of information technologies/information systems at strategic, tactical and operational levels of SCM. He presented a multi objective mathematical model for effective acquisition and justification of IT/IS systems for SCM. Spekman et al. (2002) argue that effective management of one‚s supply chain is not easily accomplished. They develop this capability as a core skill that will ultimately separate the winners from the losers. They develop the concept of supply chain competence and use learning as a proxy.

Boubekri (2001) describes how ERP is increasingly being used as a technology enabler for SCM and problems associated with its implementation. Motwani et al. (2000) explain the role of IT in managing global technology. There are several researchers (Angeles and Nath, 2000; Nah et al., 2001) whom deal with the information technology management in a supply chain perspectives.

3.5.2. Education and training

Education and training are the most important component of any change process in an organization. In order to be successful, it is important that we have the full cooperation of employees at all levels; otherwise, technologies alone will not help to improve the organizational competitiveness. To implement and subsequently use any IT/ IS, workforce needs to be motivated to work in a transparent and open communication environment. Knowledge workers are important to be successful in capital or technology intensive operations environments. Tracey and Smith-Doerflein (2001) point out that the human dimension of communication and cooperation across all parties comprises the chain. Van

23

Hoek makes a case for a stronger focus on integrating hot topics and research skill development in logistics courses.

3.6. Implementation of IT in SCM

People and processes in an organization must undergo significant change, learning, adaptation and growth in response to the introduction of IT. The changes are often drastic and cause intra organizational tensions (Kuruppuarachchi et al., 2002). Integration of the supply chain₃s activities and processes before development and implementation of the information systems in SCM is needed. Cumberland Packaging Corporation decided to replace its 20-year-old manufacturing system with a fully integrated ERP solution. After a careful evaluation, the company decided to deploy ADAGE, the powerful ERP and SCM solution from SCT Corporation. ADAGE is an object oriented, fully graphical software solution designed specifically for the process and hybrid industries. By implementing ADAGE Cumberland has been able to reduce inventory by 10–15%, or approximately $2 million worth. In addition, the system has helped Cumberland shorten delivery leadtimes, improve customer service, and better plan and forecast demand, thereby cutting production costs.

3.6.1. Organizational

Successful implementation of IT as an enabler of SCM depends upon the support of top management and overall organizational structure. The nature of skills available within an organization influences the success of IT in supply chain. Management of quality, risk and people are specific considerations in every IT project and these should be carried out over the life cycle of a project.

McIvor et al. (2000) show how electronic commerce can fundamentally change the interorganizational processes at the interface between the buyer and supplier. It is shown how electronic commerce is not only enabling the redesign of internal organizational processes, but

24

is extended into both the buyer and supplier organizations. They have presented three case studies outlining how various electronic commerce technologies have been implemented in a number of buyer-supplier environments. Ho (1996) discussed in detail IT implementation strategies for manufacturing organizations. Decisions of a structural nature contain three dimensions: system competencies, (ii) technology scope, and (iii) IT alliance.

3.6.2. Methodological

Methodological issues of IT implementation in SCM indicate the approach employed. For example, some companies choose to reengineer their business process with the objective of implementing IT and hence improve their performance. Also, project management and planning method can be sued for the implementation of IT in SCM. There are different tools that could be used for the implementation of IT in SCM and some of them include (i) quality function deployment (QFD), (ii) concurrent engineering, and (iii) life cycle approach (Scott, 1996).

Lauer (2000) describes the role played by a very active industry interest group that has served as a supporter and advocate for the adoption of EDI within the automotive supply chain. Some suppliers were unable to absorb the increasingly technological and unforgiving business environment, may either go bankrupt or sell out to their more powerful and agile competitors. Al-Mashari and Zairi (2000) presented a framework for effective SAP R/3 implementation that includes: (1) business case, (2) benchmarking, (3) implementation strategy, (4) project management infrastructure,

(5) change management, (6) BPR, (7) SAP R/3 installation. Angeles and Nath (2000) examine the importance of congruence between trading partners, along several dimensions, for the successful implementation of EDI networks. Williams et al. (1998) found that firms that were more methodical in choosing their trading partners were more likely to achieve greater range, depth, and width of EDI usage.

25

Pawar and Driva (2000) highlight six major issues in the implementation of EDI in supply chain environment to improve the success of the implementation framework that include the following steps: (i) develop strategy, (ii) assessment, (iii) create culture, (iv) prioritize improvements, (v) plan the change, (vi) implement improved situation and support implementation. Calza and Passaro (1997) present the experiences of reorganization of Unilever-Sagits logistics system. The reorganization of the logistics structure meets two requirements: (i) higher efficiency through the optimization of the product and information flows, (ii) higher effectiveness through progressive rebalancing of the prevailing role played by the supply chain. Cooper and Zmud (1990) propose a technological diffusion approach for information technology implementation. In the networked and collaborative enterprise environment, this diffusion approach will be appropriate.

3.6.3. Human resource

Human factors such as the behavioral attitude towards the implementation of IT in SCM, level of education, knowledge in computers, international exposure, training and education, reward and employee empowerment and incentive scheme impact the successful implementation of IT in SCM. Calza and Passaro (1997) examine the effects generated by the implementation of EDI technology on supply chain management. They discuss the theoretical aspects of the impact of EDI on strategic management of logistics and examine the Unilver-Sagit EDI network in the detail.

Williford and Chang (1999) describe the development of a macro model that predicts staffing, training and infrastructure funding over a five-year period for the FedEx Information Technology Division. A system dynamics model was built using regressions on business; system and productivity metrics coupled with business projections.

4. A framework for identification and application of IT in SCM

In this section, a framework has been presented for identifying the implications and applications of IT in SCM. This framework is based on the review of literature on IT in SCM. Critically reviewing the literature helped to identify the major strategies, enabling technologies and critical success factors for the application of IT in SCM. This framework is based on the following the logical development of discussions on the applications of IT in SCM:

(i) The literature available (selected) on IT in SCM has been classified based on the nature of IT and applications, major areas of decision making and major enabling strategies and technologies with the objective of achieving the full potential of IT in developing and managing an effective supply chain.

(ii) The sub-classification of the literature is aimed to assist both the researchers and practitioners in identifying the potential areas of development and critical success factors for the successful application of IT in SCM.

(iii) Subsequently, the gap between theory and practice and major tools used for modelling and analysis of IT in supply chain environments are discussed in this section.

The major issues that need to be addressed when attempting to enhance the role of IT in supply chain integration are discussed in this section along the criteria that have been used for literature classification and review that include:

(a) strategic planning for IT in SCM, (b) virtual enterprise and SCM, (c) e-commerce and SCM,

(d) infrastructure for IT in SCM, (e) knowledge and IT management in SCM, and (f)

27

implementation of IT in SCM. The details follow hereunder.

4.1. Strategic planning

Strategic planning of IT in SCM has the objective of making long-term decisions such as the selection and productive implementation of IT with the objective of achieving an effective and well-connected supply chain. Considering the characteristics of SCM, long-term decisions should promote functional cooperation as well as extended enterprise integration. IT plays a major role in both integration and creating demand/ market for products/services in SCM.
Implementation of IT

Top management support, Cross-functional project team with IT skills, Business process reengineering, Quality function deployment, Concurrent engineering, Life cycle approach, Project management, Required financial support, Employee empowerment, Performance measures and metrics, IT training and education, Core competency training, Investment in knowledge capital, E-learning, E-training, Groupware, Multimedia, Workflow technologies, Cross-functional training, Job rotation, Reward and incentive schemes, Empowerment, and team work, Contribution to knowledge capital

Top management participation is important in making strategic decisions in particular, IT investment decisions to achieve an effective SCM system. It is not just the implementation of a piece of software, but it requires some major changes in business processes and a way the company operates. This requires considerable investment in both capital and people. Since the market has become global due to trade liberalization policies and e-commerce, it is essential a company chooses the option of global outsourcing or virtual enterprise that is based on core competencies with the objective of being agile to meet the changing market requirements. This requires strategic decisions such as merger and acquisitions with a view to reach the market as quickly as possible and that too with the right products/services.

The literature on the strategic planning of IT-enabled SCM is further classified into marketing, economical, organizational and technological perspectives of IT in SCM. The following are the examples of strategic planning for different areas of IT in SCM:

- Some companies can implement an IT system to develop an effective SCM if it has to compete in a market where the speed of delivery and quality are important.

- In order to receive financial and technical sup-port from the government (in particular SMEs), companies implement an IT system to improve their supply chain performance.

- Companies have to compete along multiple competitive performance objectives, this requires the cost reduction as a key criterion, therefore, and they can go for, for example, an Internet-enabled supply chain management.

- Companies have to restructure their business processes with the objective of achieving lean production by implementing an IT system to eliminate non-value-adding activities by improving the communication along the value chain.

- Companies need to develop their e-commerce web site for creating a good image with their customers on technology competencies.

Similar to these, there are so many strategic reasons, companies choose to go for IT-enabled SCM. To summarize, the flexibility and responsiveness, globalization, new and innovative prod-ucts, new markets (fleeting opportunities) and mergers and acquisitions are the major reasons for IT in SCM are the major reasons for IT in SCM.

Many companies fail to consider the long-term implications of not investing in IT for achieving an effective supply chain. Also, assuming that the company is doing well currently and they do not need any IT means the lack of strategic thinking. May be within the next few

29

years, the company will loose its competitive position. Therefore, constant revision of strategies is important to take into account the changes in the market environment and technological development. This is applicable for strategic planning of IT for SCM. Researchers should focus on developing computer-aided models for analyzing the strategic implications of IT in SCM taking into account both the internal and external factors to an organization. Since the top management does not have much time to go through a large volume of information, a system that encourages executive information perspective would be helpful. For this, fuzzy logic and object-oriented modelling can be helpful including simulation. Game theory models and simulation would be to make strategic decisions regarding the selection and implementation of IT for SCM. Practitioners should focus on developing a consortium and strategic alliances to develop an appropriate strategy for IT.

5. Literature review conclusion:

It has been demonstrated that IT is an essential ingredient for business survival and improves the competitiveness of firms. As a result of the literature review, we can see that IT has a tremendous influence on achieving an effective SCM. Integrating the supply chain activities is driven by the need to streamline operations to achieve quality service to customers. There are many research articles on IT in SCM, but there is a lack of critical review of the literature with the objective of bring out the pertinent factors that would influence the successful application of IT in SCM. In this paper, an attempt has been made to review the literature on IT in SCM and to develop a framework for the development and implementation of IT in SCM.

The literature available on IT in SCM has been reviewed based on the major components of IT-enabled SCM. Although the literature survey is not exhaustive, it serves as a comprehensive base for an understanding of IT in SCM. This classification has the objective of bringing out pertinent factors that would support practitioners in their efforts to successfully achieving an IT-enabled SCM. As a result of the literature survey, the major components of IT-enabled SCM comprises of six major areas: (i) strategic planning, (ii) virtual enterprise, (iii) e-commerce, (iv)

30

infrastructure, (v) knowledge and IT management and (vi) implementation. The foundations of a well-developed IT-enabled SCM lie in the preparation of the ground factors of strategic planning and infra-structure from which all development emanates. IT in supply chain strategy needs to be determined by the senior executives in strategic plan. Senior managers and planners should understand that the importance of IT in supply chain and realize that without support of IT systems, it is difficult to provides information for making the best supply chain decisions.

Besides, the following are comments that de-rived from the literature survey on IT in SCM:

• The strategic information systems should include the strategic objectives of SCM.
• Information systems architecture needs to be designed for SCM that could be different from that of traditional organizations.
• Successful strategic information systems are not easy to implement in SCM. They require major changes in how a business operates internally and with external partner.
• Commercial enterprise information systems re-quire flexibility in order to accommodate individual organizational characteristics.
• Performance measures and metrics need to be established for measuring the performance and suitability of IT in SCM.
• There is a need for developing standards and le-gal frameworks for the application of IT in SCM.
• The alignment between information model and supply chain model or objectives needs further investigation.

The literature review identifies that IT is expected to have a pivotal role in managing supply chains, now and in the future. In fact it seems that the use of IT is crucial, especially in the fast moving industries: particularly for managing contemporary supply networks. Moreover, the close relationship of these two concepts, SCM and IT, make it sometimes hard to assess which one contributes what benefits. For example, implementing a VMI-model with EDI-information transmission can lead to substantial reduction of inventories, and at the same time increase

material availability. But could the benefits have been achieved without EDI by, for example, exchanging information via fax? Or, on the other hand, could the information exchange even have been possible in any other way? Finally, consideration is made of the lack of in-depth case studies describing optimum situations and recording the impacts and benefits of IT. Extensive, focused, quantitative surveys are also needed, but a phenomenon as non-trivial as IT in SCM also needs a thorough examination from a more qualitative perspective, thus enabling a broader scope of discussion.

6. Case Study review and Conclusion

Based on the study of case studies, five propositions were developed for assessing the impact of IT in SCM for big Organizations. The content of the propositions can be summarized as follows:

Proposition 1: A key operational impact of IT in SCM is the enhancement of service level.

Proposition 2: IT in SCM improves operational efficiency.

Proposition 3: IT in SCM improves information quality.

Proposition 4: IT in SCM enables agile supply chain operating models.

Proposition 5: Use of IT has to be coupled with process re-design to receive strategic benefits

Proposition 1: Successful companies have developed focused e-business solutions for improving customer service elements that are most important in their business

The relationship between SCM information and communication systems and customer service has been identified in several previous researches. Earlier studies have mostly focused on specific ICT solutions, such as EDI or integrated information systems. Lim and Palvia (2001) found that EDI contributes positively (statistically significantly) to order cycle time, product availability, distribution flexibility, distribution information, and distribution malfunctions. They studied 114 US companies of which 61 were from the automotive industry and 53 from the pharmaceutical industry. Ahmad and Schroeder (2001) reached similar results in their study that was based on data from the World Class Manufacturing

project involving 85 manufacturers from US, Japan, and Europe. Vickery et al., (2003) observed statistical causality of integrated information systems, supply chain integration, customer service and financial performance. Their study involved 57 first-tier automotive industry suppliers. Their results can, however, be criticized because the identified correlation coefficients were relatively low.

Customer service is commonly an essential part of any company's strategy, but views of its contents vary. In logistics it means making the products available for the customer. This involves, however, much more than just delivering the products when ordered. Christoper (1998) discusses logistical customer service using the classifications: pre-transaction, transaction and post-transaction elements. Good pre-transaction customer service means that customers understand what the company is able to supply, the company is easy to contact, and the company can adapt delivery systems to particular customer needs. The transaction elements of customer service are between order and delivery; for example order cycle time, delivery preciseness and order status information. The post-transaction elements refer to issues after the customer has received the original product, for example availability of spares and correct billing.

Our research revealed that there exist a wide variety of e-business solutions that aim at improving customer service. The solutions are commonly tailor-made for the company's situation and they focus on improving customer service elements that are most important in that specific business. This way the e-business solutions have reached a perceived acceptable return to investment and extensive leverage to the company's competitiveness.

An example of improving both pre-transaction and transaction elements of customer service is Kone Elevator's e-procurement system for modernization projects. When the customer places an order for Kone, it is also immediately visible for suppliers. Major suppliers receive an EDI-message directly by their ERP-system; for smaller suppliers Kone has an extranet solution. A few suppliers still receive the information by fax. With this operation model Kone is able to

33

check its suppliers' capability and confirm customer orders within three days. Using also a collaboration model with a logistics service provider, their delivery time has shortened from 8 weeks to 4 weeks, and delivery accuracy has improved. Customers' also have real-time access to information related to their order. In another case, Optiroc a supplier of construction materials is able, in tight collaboration with a logistics service provider, to send accurate pre-warnings to customers about forthcoming shipments. SE Mäkinen, a provider of vehicles (primarily new cars) transporting services, uses its real time information system to deliver at-right-time-to-right-place keeping its promises to customers while maintaining operational efficiency.

Finally, Wärtsilä Service a supplier of ship machinery and power plants, recognised that the post-transaction elements of customer service are critical in their business. Three years ago they implemented a Spares Online extranet system for shortening order confirmation time and helping their customer to order the correct spare part. The system also requires the customer to key in all the necessary information that Wärtsilä needs for processing the order. In 1996 the average time from order-to-order confirmation was 5,3 days, yet today it takes an average of only 1,8 days; and in best cases only a few hours. Approximately 80per cent of all spare part orders come through Spares Online.

Proposition 2: Efficiency has improved which allows company personnel to focus more on business critical activities.

The adoption of IT has enhanced the efficiency of SCM as reported in various studies (Power and Sohal, 2002; Supply Chain Council, 2002; Min & Galle, 2001; McAfee, 2002). Also the findings of this study supports the notion that by improving the efficiency in information transfer IT has made it possible to streamline logistics flows, reduce inventory and improve customer service. In the current study supplier web solutions are explored and how they have allowed procurement staff to spend more time focusing on building strategic supplier relationships. The purchasing function has traditionally been a very labour-intensive activity,

where a large proportion of procurement staff's time is spent on non-value adding activities such as data entry, correction of errors in paper work and delivery expedition.

Included in this study was Rocla, a manufacturer of electronic warehouses trucks and automated guided vehicles that implemented its supplier web solution in 2002. All of the direct procurement to a specific customer order is conducted through this extranet. This accounts for 30per cent of total purchases. Suppliers have real-time visibility to Rocla's demand (item, quantity, price, and requested delivery date) and they are requested to view Rocla's supplier web daily. Rocla has estimated its savings in ordering and checking invoices after implementing the supplier web to be 2.5 man-years. The second case Datex-Ohmeda has, since 2001, moved all communication (demand forecasts, purchase orders and order confirmations) with its suppliers to electronic form. It uses a third party transaction hub that is linked to Datex-Ohmeda's ERP system. Some 15per cent of suppliers have integrated their ERP systems with the service provider; some use EDI and the majority of the suppliers use the Supplier Web-solution. Currently, 95per cent of Datex-Ohmeda's purchases with 120 suppliers is processed electronically. The company reported that those twenty staff that were previously involved with routine paper work could now concentrate on more productive jobs.

Similar phenomenon was reported from the sell-side IT implementations, where the customer service personnel can focus on more value adding tasks. Wärtsilä Service has been able to keep the number of customer service personnel the same as before, whilst improving the response time to customer orders. SE Mäkinen has been systematically developing its IT system since 1995, and today approximately 75-80per cent of all incoming orders come in electronic form into a central database. Personnel that were earlier engaged in front-line customer operations can now allocate more time to ensure optimisation and so increase operative effectiveness and company competitiveness.

Proposition 3: The use of e-business solutions improves information quality

Informational benefits of IT are generally broken into information access, information flexibility, and information quality (Mirani and Lederer, 1998). Information access benefits provide supply chain decision makers with faster and/or easier access to internal and external information. Information flexibility benefits allow decision makers to easily manipulate the content and format of retrieved information. Information quality benefits make the available information more useful, accurate, and reliable. It improves the usefulness of information for strategic planning and operational control (ibid).

Information quality has been studied extensively by researchers interested in computing, management information systems, databases and their management, data security and data warehouses to mention a few (Melkas, 2004). Conventionally, information quality has been described as how accurate information is. English (1999) represents information by formula, where all three components, data, definition, and presentation must have integrity to provide information quality. In a supply chain context there are business processes that produce information (planning, designing, selling, distributing etc.), other processes that transcribe if from one form to another; and processes that can be considered as users of information. When planning e-business solutions and the underlying processes, attention should be paid on information quality management (English, 2001).

In this study we identified three different mechanisms of how the use of e-business solutions can improve information quality. The first mechanism identified is related to the actual design of the e-business solutions. An effective design is based on a clear understanding of the underlying process and the relevant information flows. Those cases where enough time and effort was invested in analysing what data is needed, in what context, to what purposes it is used in various parts of the process and what is the right accuracy and objectivity level, reported that the overall quality level of information had improved. Wärtsilä Service's and GNT Finland's, an IT wholesaler, sell-side web-portals force the customer to specify all the

36

necessary information to the web site before the order was processed. These companies reported that they had been able to rely on the quality of the information in decision-making. Kiitolinja, a logistics service provider receives complete customer orders through its web-portal. This helps in executing deliveries and pick-ups without any additional verification.

Second, we note that successful implementation of e-business solutions have forced companies to systematize data structures. Rocla's representatives commented that when implementing the supplier web it was necessary to systematically check all the product structures and related bill of materials (BOMs) to ensure that the information transferred from the web related to the components to be sourced was a flawless process. The company has benefited from this "by-product" as it is now possible to rely on documented product structures, which was not necessarily always the case before. Additionally, Rocla's suppliers have a real time view to their order backlog; and which has had a positive impact on accuracy of suppliers' delivery.

The first two mechanisms are associated with careful planning of the e-business solutions and its impact on accuracy and reliability of information. The third method is how information quality is improved and how all the network parties base their operative decisions on same data. Nokia's demand information management can be used as an example to illustrate this mechanism. Nokia's demand information is broken down to component needs and distributed to various suppliers either as an EDI or XML message or through the supplier web-extranet. New technology solutions enable almost real time demand information distribution to component suppliers. As a result all supply chain partners use same information when making demand fulfilment decisions. According to Lee and Whang (2001) this should counter the problem of demand information distortion – the bullwhip effect – in a supply chain, which is an important element of information quality.

Well planned e-business solutions also guarantee that all the parties use same version of the changed information. Orion Pharma's co-operation with a packaging company is a good example. It is a medical company that has 20 000 different packaging items. The information

regarding packages changes constantly. Previously, when photocopy of a changed package was sent through the mail, it took three days for the packaging company to process it. In addition, for the long lead-time there was frequently confusion about the latest version of a package. Now when Orion Pharma sends packaging information electronically (both EDI and Internet are used) this problem has disappeared.

Proposition 4: e-Business solutions that are based on planning collaboration improve agility of the supply network

Agility is a key capability for companies in an environment of rapid and unpredictable change. Christopher and Towill (2000, p 206) define agility as: "a business-wide capability that embraces organizational structures, information systems, logistics processes and, in particular, mindsets." They state that agile supply chain is market sensitive, which means capability to respond to real demand in volatile markets. Bruce and Daly (2004), state that information sharing between supply network partners is essential for reaching operational agility.

Our research revealed that information sharing is already common practice. For example 92per cent of the studied companies shared demand information, 47per cent order status information and 42per cent inventory level information with their suppliers. Most companies shared some material flow related information in addition to orders also with logistics service providers and customers. In many instances the information sharing was manual: telephone, face-to-face conversations, telefax or e-mail. Some companies, however, had developed e-business solutions in collaboration with their supply network partners. These solutions were more than just information sharing; they involved simultaneous process and technology development of several supply chain partners. The benefits of these kinds of e-business solutions were not just amendments of single

customer service elements, as in examples of proposition 1. In these cases the agility of a part of the supply network has improved.

An example of improved agility is the previously described Optiroc-case. The company

implemented an e-business solution together with their logistics service provider that is based on real time information transfer between the two partners. When the customer order is keyed into Optiroc's ERP system, it is instantaneously visible at logistics service provider's planning system. As the logistics service provider completes the order the updated information is also observable from Optiroc's ERP system. Most of the vehicles are equipped with mobile terminals and also status information is updated instantaneously. The use of mobile terminals enables optimisation of deliveries and pick-ups up to the last minute and this has as well improved Optiroc's competitiveness at the market. However, Optiroc has not limited the collaboration to the transfer of operational information. They have agreed on a process to meet regularly, four times a year, with the logistics service provider to discuss about the development plans and future business scenarios.

Another example is a dynamic vendor-managed inventory (VMI) system that Nokia Networks has developed with its suppliers. Nokia updates continuously the upper and lower inventory limits of its VMI-system and provides this information to its suppliers either by their supplier web-portal or by EDI or RosettaNet XML-messages. The suppliers have also visibility to Nokia's sales forecast and inventory accounts of their own products. The suppliers have developed their own planning processes to utilize this information. The VMI system together with dynamic control parameter updating, enhanced visibility and suppliers improved planning systems have had a positive impact on agility of the supply network.

A third case example is from the same industry as Nokia. Elcoteq, a contract manufacturer of electronics components, operates with a pull strategy to manage its production. When Elcoteq receives demand forecasts from its customer, they are immediately passed on to the supplier base. Subsequent to the suppliers' confirmation of their ability to fulfil the requested demand, Elcoteq confirms its ability to the customer. Fulfilment is based on the forecasts and no actual orders are passed between the supply chain partners. At the moment all the data is transferred as EDI messages, but the company is piloting RosettaNet XML that would enable more dynamic exchange of information in the supply chain. As a result, Elcoteq has been able to

build a supply chain that can quickly react to demand changes at the market.

Proposition 5: For receiving strategic benefits, the use of IT has to be coupled with process re-design

As identified in the literature review, IT is suggested to have a strategic impact on companies and supply chain management. Consequently, it is proposed that to receive strategic benefits with IT, supply chain processes have to be changed; and undoubtedly that some companies have been able to do this. In extant literature, authors in business process re-engineering (BPR) hold that the link of IT use and simultaneous design of business processes is a vital ingredient to bring benefit from development efforts (for example Venkatraman, 1994; Hammer, 1990; Davenport & Short, 1990). Several other studies in a supply chain context have identified the same finding. The study conducted by the Supply Chain Council (2002) reported managers' views that: technology is only a facilitator, not an end target itself. According to the interviewed supply chain managers the biggest challenge was 'changing the process'. Jayaram et al., (2000) show statistically that supply chain time-based performance drivers are an information intensive IT structure, the utilization of process improvement practices, and jointly deploying these two factors.

A suitable case in our data to support this notion is Vaisala Instruments, the manufacturer of high-tech measuring devices. Vaisala Instruments transformed its global operations with three main market areas (Asia, US, and Europe) into a true make-to-order mode, coupling process change in sales and capacity planning with the implementation of several IT solutions. As a result, the new supply chain coordinated by Vaisala Instruments is operating based on projected demand, transmits information without delays, is responsive to changes in demand, and less vulnerable to risks, as regional inventories of finished goods have been removed. In addition, previously, regional sales forces were tied with the supply of regional inventories. With a truly global make-to-order mode and centralized manufacturing operations in Finland, the regional sales forces can sell the full product offering of Vaisala Instruments. The key process change

40

was the sales planning: this includes incorporating the expected sales in key countries with highest sales with sales force opinion and based on this, planning of both own and supplier production capacity. After the capacity is set, the sales force receives sales quota that is the level of sales that can be fulfilled with promised lead-time of five days world-wide. The realized demand is monitored continuously and changes to projected demand are communicated electronically on a day-to-day basis with key suppliers. The IT solutions used in Vaisala Instrument's operating model are:

- third party transaction hub with suppliers enabling capacity collaboration on a day-to-day basis with key suppliers and exchange of transaction data with practically all suppliers
- ERP system integration with subsidiaries enabling real time visibility to end-customer demand in manufacturing operations
- System integration with global courier company enabling efficient handling of transaction data

The findings also show that only relatively few companies have been able to implement larger e-business solutions and use IT strategically, and most companies still view IT primarily as a means for operational efficiency rather than a tool for strategic advantage.

Discussion and conclusions

The results of this study indicate that the operational use of IT has developed in the last five years. In particular Internet technology and third party transaction integration services have provided companies with increased possibilities to network with supply chain partners. However, in most cases the solutions used are quite individualistic as they are developed from a single company's point of view. Of course user aspects (customer and supplier) have been taken into consideration when planning, for example, buy-side and sell-side portals; but the driving force has been to increase effectiveness of the e-business application. These applications are relatively general with clear specifications, and the solutions do not technically

41

differ significantly from each other. Furthermore, only implementing IT, as such, for example in invoicing automation, is not likely to lead to higher-level business impacts. Stating this, it is interesting to observe that in the SCM context the main body of companies view IT primarily from operational perspective. A reason for this may be the relative novelty of IT, meaning that larger scale and strategic solutions are still yet to come, and after companies have installed a basic IT infrastructure.

When observing those e-business solutions that genuinely are dyadic it can be noticed that it is important to allocate sufficient resources to planning the processes and selecting the technologies, in conjunction with the network partners. These e-business solutions are more specific to the particular application and there is more variety within implemented solutions. The case examples in this study demonstrate the multiple ways that IT can be deployed. There is no single way of using IT and, moreover, the broader the business area where IT impacts, the more solutions have to be customized. As applications are more tailor-made, it is also more difficult to copy a solution from one company to another. It was further observed that to achieve real competitive advantage it is important to focus on improving those processes that are most critical for customer service. Successful companies have been able to improve service level and effectiveness simultaneously.

Benefits of IT in SCM are multitude and vary in the context of their implementation. Moreover, as the use of IT is closely related to process changes, most of the benefits are overlapping and interlinked. Then, it is hard to specify the origin of benefit very explicitly. Notably, strategic benefits are only achievable when the introduction of IT is coupled with process re-design. The ideas of BPR are then closely related to current study. Our study corroborates that business process re-engineering skills are vital to benefiting from IT strategically in SCM. The change in processes needs not to be total, but without any process changes, IT becomes merely an automating force, providing efficiency benefits in a limited scope.

The study presented in this paper has limitations. First, the sample of companies included in the

42

study was selected by expert assessment and is biased towards companies willing to discuss and share results openly. Second, the viewpoint of this paper was on single companies rather than on the entire supply networks. Additionally, since each company was interviewed only once, some important insights might not have been captured during the process.

However, the findings of this study present an opportunity to further develop understanding of the underlying mechanisms of how IT investments benefits supply chain management. To further knowledge development is to study entire supply networks and analyse the situation from various points of view. Sufficient emphasis should be paid to various organisational issues. Additionally, propositions presented in this paper should be tested with larger data set to gain further understanding of various contingencies (type of network, business environment, used technology etc.) that have an impact how the benefits are composed.

7. Research Design/Methodology

As the research was exploratory in nature, qualitative and quanitative methods were deemed more appropriate. Case method selected permitted exploration to the question of what are the benefits of IT in SCM for Big Enterprises; but now our concern was to assess the impact of IT in SCM for SMEs

Phase 1: Interviews with 10 SME companies

A total of 10 interviews were conducted with manufacturing, trade and logistics services companies. The interview contained questions regarding use of IT in:

- Buy-side transactions

- Sell-side transactions

- Inbound and outbound material flows and inventory management

- Planning collaboration

Phase 2: After Implementing IT in processes, assessment of the impact was measured in terms of Return on Investment, Time, etc.

44

8. Penetration of IT in SME

To see the level of penetration and usage of IT tools in SCM areas by SMEs in India, interviews were conducted with personnel from 10 SME organizations. The interview guide used for the interview is attached in Appendix. The purpose of interview was to see if the SMEs in India are using IT in their processes. If yes, than to what extent and if no than what are the major constraints which are beholding the use of IT by SMEs. Below is a summary of the interviews. The results were contrasting.

A very small organization, Anand Power systems, which is into manufacturing of Electrical control panels, with turnover of less than a crore, started using emails, and basic software for drawings, quotations, price lists from last 5 years and they have experienced an increase in customer satisfaction, faster quote-to-order cycle and improved collaboration with its suppliers and customers. At the same time there were traditional organizations like Aar Ess Transformers, having a turnover of around 10 Cr, which were relying on traditional pen and paper approach and did not understand the potential benefits they could reap from using IT in their SCM processes.

We collaborated with Holisol Logistics Pvt Ltd, which is providing logistics services and SCM solutions to automotive and Glass manufacturing companies, to look into the potential areas where basic, open source IT tools could be leveraged for improved business performance. They were facing problems with their Bin management system. The lack of visibility was causing delay in responding to customers, loss of revenue and incurring extra costs. An open source, google drive solution was proposed to them for bin tracking which resulted in better visibility, easy management and faster response to customers leading to revenue generation.

Conclusion

After the interviews, it was clear that the potential of IT tools in improving the processes is high. SMEs need to identify and leverage the power of IT to make themselves more responsive, flexible, agile and offer higher level of customer service. Though the impact and the returns does not justify the use of highly sophisticated end-to-end IT solutions, but the organizations can start of with the available infrastructure which would satisfy most of the reuirements in small organizations.

46

Appendix:

<u>Interview Discussion Guide</u>

1   Nature of Business

Manufacturing [   ]   Services [   ]   Both [   ]

2   Business Turnover

< 1 Cr [   ]   1 Cr to 10 Cr [   ]   10 Cr to 50 Cr [   ]   More than 50 Cr [   ]

3   What all IT tools are you using (if any) for your business?
4   How much on an average are you expanding on IT (including Hardware/software)?
5   Have you faced/received any demands from customers to use IT services in your processes?
6   Are you losing revenue because of not using IT tools? If yes, how much (annually)?
7   What are the major constraints in implementing IT in your processes?

Cost [   ]   Low ROI/Impact on revenue [   ]   IT skills [   ]   Infrastructure [   ]

8   Do you think IT would improve the way you are doing your business?
9   Would you like to use IT solutions, using your existing infrastructure, which would address some of the issues you are facing?
10 What are the areas in SCM where you would like to use IT tools/solutions?

Organisations :

- Anand Power Systems
- Aar Ess Transformers
- Elitify.com
- Diesl
- Holisol Logistics Pvt. Ltd.
- All Cargo Logistics
- Ess Vee Constructions
- Khurana Furnishings
- Vrindavan Electricals
- Enco Engineers
- Goyal Traders

References

Ahmad, S. & Schroeder, R.G. (2001,) "The impact of electronic data interchange on delivery performance", Production and Operations Management, 10(1), pp. 16-30

Benjamin, R.I., Rockart, J.F., Scott Morton, M.S. & Wyman, J. (1984), "Information Technology: A Strategic Opportunity", Sloan Management Review, 25(3), pp. 3-10

Brynjolfsson, E. & Hitt, L. (1996), "Paradox Lost? Firm-Level Evidence on the Returns to Information Systems Spending", Management Science, 42 (4), pp. 541-558

Cagliano, R., Caniato, F. & Spina, G. (2003), "E-business strategy: How companies are shaping their supply chain through the Internet", International Journal of Operations and Production Management, 23(10), pp. 1142-1162

Grieger, M., (2004), "An empirical study of business processes across Internet-based electronic marketplaces – a supply chain management perspective", Business Process Management Journal, 10(1), pp. 80-100

Gunasekaran, A. & Ngai, E.W.T. (2003), "Information systems in the supply chain integration and management", European Journal of Operational Research, In Press

Lee, H.L. & Whang, S. (2001), "E-Business and Supply Chain Integration", Stanford Global Supply Chain Management Forum, White paper SGSCMF-W2-2001, p 20

Patterson, K.A., Grimm, C.M. & Corsi, T.M. (2003), "Adopting new technologies for supply chain management", Transportation Research Part E: Logistics and Transportation Review, 39(2), pp. 95-121