

IT—Enabled Supply Chain Management

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ABSTRACT

Supply chain management and information technology are two areas of research, which have attracted a lot of attention in academic and practitioner's camps over the last decades. The discussion related to the deployment of information technology and electronic commerce in supply chain management has fostered a discussion about information technology enabled supply chains. The authors pinpoint, there is a lack of research which integrates this highly inconsistent and fragmented field. In this paper, the authors attempt to present a critical summary of the discussion of information technology enabled supply chain and supply chain management and attempt to provide a framework that helps managers and practitioners to tackle this phenomenon. It can be stated that management of information technology enabled supply chain is a complex process and that top managerial support is always welcome. Finally, we present limitations of the study and highlight some ideas for future research in this area.

Keywords: Marketing, supply chain management, information technology

INTRODUCTION

Many reviews and reports about supply chain management and information technology have been regularly written up in the popular as well as academic publications (see e.g. Supply Chain Today, 2005; Lancioni, Smith, and Schau, 2003; Skjott-Larsen, Kotzab, and Grieger, 2003). These discussions have provided a platform for closely related research of information technology enabled supply chain management (Johnston and Mak, 2000; Lancioni, Smith, and Oliva, 2000).

Before examining the literature that specifically deals with supply chains and supply chain management, we place this topic in the context of closely related research. Researchers have examined marketing channels and supply chains from many viewpoints. Basically, these include the transaction cost theory (Coase, 1937; Rokkan, Heide, and Whatne, 2003; Williamson, 1975), the relationship marketing (Berry, 1984; Grönroos, 1994; Gummesson, 1987; Palmer 1994; Parvatiyar and Sheth, 2000), the political economy view (Benson, 1975; Stern and Reve, 1980) as well as from the IMP (Industrial Marketing and Purchasing) perspective (Håkansson, 1982;

Turnbull, Ford, and Cunningham, 1996). All of these theories have been employed to shed light on the supply chain issues. The above mentioned research streams offer diverse perspectives and array of managerial recommendations. Thus the contributions dealing with information technology enabled supply chains are scattered among different journals and so integrative research is needed.

There are many stories told about how information technology and other related technologies are altering our way of life. Negroponte (1995) and Dertouzos (1997) claim that technology is radically changing business while others like Porter (2001) predict that new technologies are only facilitating managerial changes and marketing exchanges. Between the two extremes of nothing or everything changing lies the answer. It should be said here that the Internet and most importantly the WWW are not the only forms of information technology. Information technology has existed long before the Internet and in this paper the term information technology consists of all the technologies capable of transmitting and processing information. More precisely we use the following definition provided by Ryssel, Ritter, and Gemünden, (2004):

“Information technology is a term that encompasses all forms of technology utilized to create, capture, manipulate, communicate, exchange, present, and use information in its various forms (business data, voice conversations, still images, motion pictures, including those not yet conceived)”

To continue, a managerially and academically interesting research void can be identified in the intersection of supply chain management and information technology discussion. To further elaborate, there is growing interest to address information technology enabled supply chain management, but this expanding body of literature is highly inconsistent and fragmented (Johnston and Mak, 2000; Setzekorn *et al.*, 2003).

Much has been said about how a supply chain should be managed (Lambert *et al.*, 1998; Mentzer, 2004) and how the new digital economy i.e. Internet-based technologies, has changed the management of supply chains (Lancioni *et al.*, 2000). These supply chains come in different forms, lengths, and the management of the supply chain or supply chain network (SCN) is therefore a complex task. Many people from different organizations and organizational levels (strategic, operational, and administrative) contribute to the management of a supply chain. It goes without saying that there are supply chains that have been the same for decades and that the Internet has not altered business activities, while on the other hand there are areas where the impact has been enormous (Tapscott *et al.*, 2000; Porter, 2001). To further elaborate, the computer industry has gone through radical changes for example in distribution (e.g. Dell direct) while the paper industry has faced relatively low impacts from the new economy especially regarding distribution channels.

This paper attempts to contribute to existing research by partially closing the gap that exists between the supply chain management and information technology literature. This paper covers two research questions in particular. First, we will ponder the role of information technology in supply chain management. Second, we will examine how the evolution of these technologies is impacting on the management of supply chains. These two research questions will enable the authors to respond to the call for research in the era of information technology enabled supply chains. The literature review section of the study concentrates on the first research question

while the developed framework tackles research question number two. The developed framework will help managers and academics to cope with information technology enabled supply chains. The method used for this preliminary study is a literature review with conceptual analysis. The framework composed is a result of the review and analysis of current literature. All in all, we attempt to shed some light on evolving field of information technology enabled supply chains.

The paper is organized as follows. In next section we provide a literature review on supply chains and supply chain management. After that we review literature on information technology especially focusing on supply chain management issues. Subsequently, these two discussions will be integrated to elaborate on information technology supply chain management. We conclude this study by summarizing the main results and by reflecting on the limitations and future areas of endeavour regarding supply chain management.

SUPPLY CHAINS AND SUPPLY CHAIN MANAGEMENT

Literature describing supply chain and supply chain management is full of definitions for terms like supply chain and supply chain management (Christopher, 1992; La Londe and Masters, 1994, Cooper, Ellram, Gardner, and Hanks, 1997; Gattorna and Walters, 2001; Mentzer *et al.*, 2001; Mentzer, 2004). In here, we briefly review some of them to form a coherent picture of the phenomenon in question.

As with many other concepts, the definitions of supply chain are diverse and yet overlapping. Here are two of most commonly used.

“The supply chain is a set of firms that pass materials forward” (La Londe and Masters, 1994).

“A supply chain is the network of organizations that are involved, through upstream and downstream linkages, in the different processes and activities that produce value in the form of products and services delivered to the ultimate consumer” (Christopher, 1992).

Supply chain definition of La Londe and Masters (1994) is narrow in scope and therefore we are conceptualizing a supply chain through the definition proposed by Christopher (1992). Thus, in this paper supply chain consist of more than three actors that form a network. Usually manufacturer, wholesalers, and retailers form the core of supply chain. This type of structure of distribution channel is visible for example in retailing industry e.g. food industry.

More precisely, for the purpose of this study the supply chain includes a set of organizations, usually more than two and these organizations are companies, directly involved in the flows of products, services, finance, and/or information from a source to a customer. The supply chain concept is illustrated with an example presented in Figure 1 below that represents the possible supply chains for the sawmills.

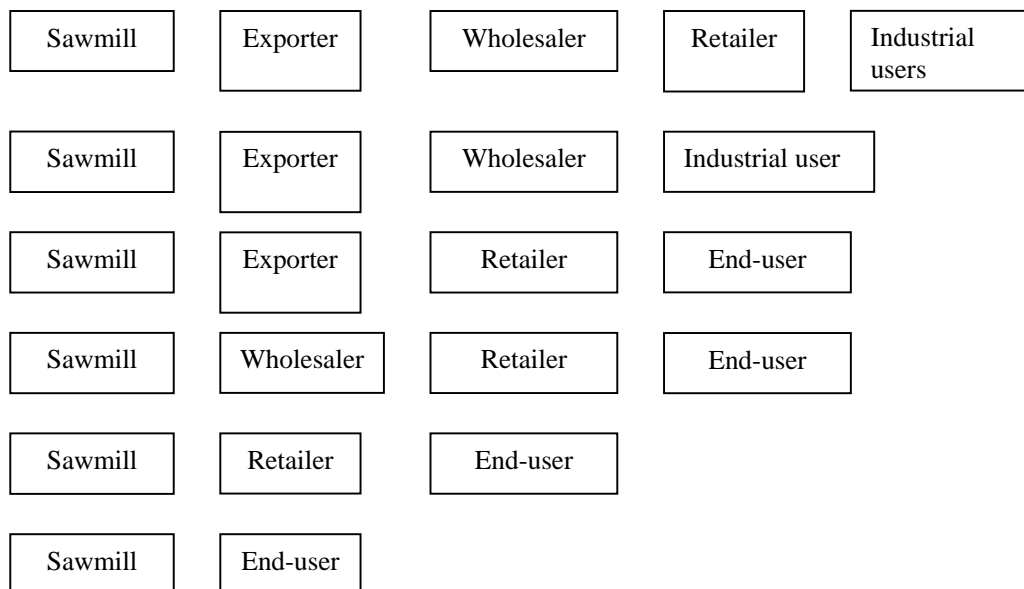


Figure 1 Sawmill Industry Supply Chains

Figure 1 presents how various actors of sawmill industry can form supply chains. Only the most important supply chains are depicted in Figure 1 and there are some special arrangements not presented above (e.g. direct exporting). Moreover, sawmills can employ many of the supply chain solutions presented in Figure 1 to reach their customers. Besides belonging to these supply chains sawmills can be integrated to paper mills and then those operate on the basis of output needed by the paper mills like in the most of sawmills in Finland, or they can be independent.

After reviewing the literature and defining the supply chain we move on to highlight some aspects of supply chain management. The concept of supply chain management has been extensively elaborated in the state of the art review article by Mentzer *et al.* (2001). They noticed that it was Forrester (1958) who first used the term supply chain management. It was also pointed out by Cooper *et al.* (1997) that supply chain management has raised to prominence. The Global Supply Chain Forum’s definition of supply chain management is the following:

“Supply chain management is the integration of key business processes from end user through original suppliers that provides products, services, and information that add value for customers and stakeholders” (Lambert, Cooper, and Pagh, 1998).

In this study we adopt this definition. It should be noted that supply chain relationships and supply chain networks are incorporated into supply chain definition used in this study.

The literature review concentrated on supply chain and supply chain management which are central elements of this study. We defined the concepts used and showed that there are both contradictions and similarities within and between those concepts. Later, we focus more on

information technology and how it enables supply chain management.

INFORMATION TECHNOLOGY

The focus of current electronic commerce discussion, i.e. one form of information technology mediated business, has been mostly in the marketplaces and the exchanges where electronic commerce has not improved the quality of existing supply chains (Wise and Morrison, 2001). More complete frameworks from the business perspective are needed since the technological solutions should not be the main focus of study. Technologies are resources that firms must use effectively by creating value and competitive advantage. Resource is anything that can be thought of as a strength or weakness of a given firm (Wernerfelt, 1984). Resources are heterogeneous this leads to the fact that some features of resources area always unused (Penrose, 1959). The concept of the firm growth is closely related to the resource pool available (Penrose, 1959).

While looking upon the literature on information technology or information systems they offer two extreme views on the phenomenon. These are the *techie* view and the *humie* view (Dertouzos, 1997). A combined view is employed here since information technology forms the basic structure of the supply chain management while human interaction forms another pertinent part of the supply chain. This means that technologies are for the people and used by the people. There exists a great deal of different definitions of information technology in the literature, academia, and business. There have been proposed many relations between information technology, information and communication technology, information systems, and electronic commerce technology. As pointed out by Wilson, Littler, and Bruce (1997) it is not fruitful to identify different approaches to define information technology. It should be only noted that information technology should be used as effectively as other resources that firm has access to.

The capital spending on information technology is increasing in many countries (Davenport and Prusack, 1997). The impact of information technology on many different aspects of economy has been discussed with the help of the conceptual models. However, only recently empirically grounded models have been presented. A review study of these empirical studies on information technology and economic performance is conducted by Dedrick, Gurbaxani, and Kraemer (2003), they found that information technology has a positive and significant impact on labour productivity and economic growth. In supply chain and supply chain management the investments in information technology may turn against business parties if those information technology investments are not used by the people that constitute an organization. If employees do not use new information technology in their work processes then the investments should not be made. Fuglseth and Gronhaug (1994) cleverly pinpointed that humans are the basic element in every information system.

In spite of all above, information technology in various forms and combinations ranging from the Internet, WWW, HTML and XML to different applications and systems including enterprise resource planning (ERP, ERP2), customer relationships management (CRM) supply chain management (SCM), and enterprise application integration (EAI), are enabling and facilitating business processes and creating new business contexts for companies to operate (see e.g. Angeles, 2000, Bond *et al.* 2000; Lancioni *et al.*, 2000; Mukhopadhyay, 1998; Porter, 2001; Stephens and Ramos, 2003; Themistocleous and Irani, 2002; Zablah, Bellenger, and Johnston, 2004). Some of these ideas are presented in the extended enterprise Figure 2 below.

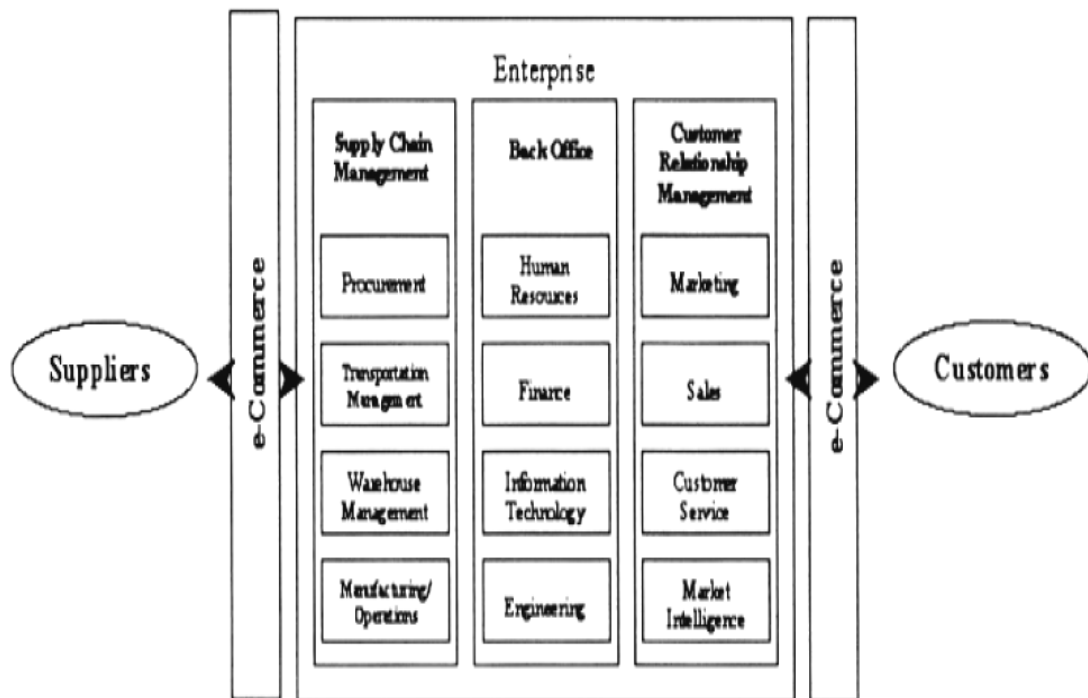


Figure 2 The Extended Enterprise Achieved Through Information Technology (Miller et al., 2003)

Figure 2 shows how back-office and connecting technologies enable smooth connections throughout the supply chain. With the help of this integration companies can manage the supply chain through their information technology and systems. Basically, the Internet and many new technologies make it possible for people and organizations to establish, create, and maintain supply chains between organizations in a novel way. The question to answer from the supply chain management perspective is how to use these technologies to connect to relevant people and organizations to make the most profitable exchanges possible.

The Internet, the web browser, and other information technology have made digital interactions possible between individuals and corporations. The seller and the buyer do not have to meet in person but they can interact digitally through their supply chain. With the help of information technology we now face a new phenomenon as many of the products, services and information can be digitized, in other words, converted to bits, and delivered to customers via or with the help of the Internet (Shapiro and Varian, 1999). The producers of goods have accelerated this evolution since the information element in almost every offering has increased (Porter and Millar, 1985). All of this implies that information technology in all its forms is gaining momentum.

Two information technologies effectively used in inter-firm relationships, in the early days of inter-organizational information systems (IOS), were electronic data interchange (EDI) and

electronic funds transfer (EFT) system which was used between financial institutions and large companies (Blanning and Bui, 2000). EDI and EFT have been used in business since the 1970s to share transactional data (Garcia-Dastuge and Lambert, 2003). EDI is a communications standard (UN/EDIFACT/ANSI X.12) and infrastructure for sharing business documents (such as invoices, purchase orders, shipping bills, product stocking numbers (SKUs stock keeping units), and settlement information among a small number of firms (Shaw, 2000). In a more formal way:

“EDI involves the computer-to-computer exchange of business documents in a standard, machine-processable format between and among inter-organizational trading partners” (Emmelhainz, 1993).

EDI is one type of IOS used between organizations. At that time the EDI benefits according to Mukhopadhyay (1998) were the following:

1. Reduced processing cycle time
2. Improved accuracy
3. Strategic value creation

The limitations of EDI were the following:

1. Expensive
2. Relationship specific investment (can not be used in any other relationship)
3. Technological know-how needed
4. Batch processing- delayed transactions

Due to these limitations presented above the traditional EDI did not reach high diffusion rates (Angeles, 2000). EDI was and still is expensive because it is carried over private lines or VAN (value added networks) and the technologies needed for the supplier and the buyer were also costly. According to Shaw (2003) 95 per cent of Fortune 1000 enterprises has EDI while only three per cent of other enterprises uses EDI. This is partly because the number of transactions and related administrative work costs are smaller in small companies while the benefits of implementing EDI in large companies is greater due to the larger costs of handling transactions related documents manually.

EDI networks are closed groups and traditionally, the channel leader would set the technology standard and encourage suppliers to become EDI-compliant using the preferred data standard. A small fraction of this development could be used with other members of the supply chain. This was the development in the 1970s to 1980s. By lock-in with high asset specificity (Clemons *et al.*, 1993) i.e. resources are not usable in any other supply chain and sellers like McKesson, the drug company, dominated the market for a long period of time in U.S. with help of proprietary hardware terminals and EDI. These tightly structured supply chains limited the number of partners but also radically destroyed innovative solutions inside and between organizations. At that time EDI was seen to create novel competitive advantage but it has been pointed out by Mata *et al.* (1995) those *information technology management skills* related to information technology activities provide sustainable competitive advantage.

MOVING TOWARD OPEN STANDARDS

The movement towards open standards (RosettaNet, Linux, the Internet and Web development) has provided efficiency and unrepresented flexibility gains to organizations involved and employing those suggested open standards. For example the Internet-based information technology infrastructure is meant for sharing information through the telecommunication network and it is used with many members and customers. It was developed originally for text and some pictures but not for the video streaming that it is nowadays many times used. Thereby, the second generation of the Internet was developed. Furthermore, the information technology infrastructure for the Internet, the Extranet, and the Intranet is moulded and used through open source codes and common standards.

It has been estimated that the Internet-based EDI can be up to 90% cheaper and 300 times faster than traditional EDI (see e.g. Angeles, 2000). Today, firms have increasingly moved to use EDI carried over the Internet to complement or replace traditional EDI (Garcia-Dastuge and Lambert, 2003). The amount of connections can nowadays be high since the cost of adding connection is almost nothing and it is more feasible to add on connections. The Internet also offers lower implementation cost and fosters standardization of data formats and coordination of those flows by making data sharing economically viable to more firms. Then, managers work to standardize data with other supply chain members or become compliant with the industry standard like RosettaNet (see e.g. Hannula and Vasama, 2002; www.rosettanet.org).

All this means that companies cannot be locked-in as easily as before and companies must make conscious decisions related to interoperability between software, hardware, databases and infrastructures. These all are important elements of information technology strategy and it is the CIO (Chief Information Officer) together with information technology department that is responsible for the smooth operation. Supply chain management and information technology integration must be part of the top management strategy list in order to yield top management support.

Clemons, Reddi, and Snow (1993) point out that:

“It is argued that information technology (IT) has the ability to lower coordination cost without increasing the associated transactions risk, leading to more outsourcing and less vertically integrated firms. Lower relationship-specificity of information technology investments and a better monitoring capability imply that firms can more safely invest in information technology for inter-firm coordination than in traditional investments for explicit coordination”.

Indeed we are moving from previously closed information technology and systems to a more flexible and open systems in which the idea is that owner or operator can invite chosen companies to their digital environment. This means that we are really operating in an information technology based open market environment where it is easy to form and manage supply chains.

IT-ENABLED SUPPLY CHAIN MANAGEMENT

In this part of the study we attempt to integrate previously introduced concepts in order to highlight the management of supply chain. Based on previously presented converging findings, some authors have divided the supply chain into virtual and physical (Rayport and Sviokla,

1995). After that division other authors have made corrections to this claim and said that it is not only the virtual value chain but also the physical value chain (Van Hoek, 2001) working together to form the supply chain that makes the “value” for the end-customer. Indeed the value in question is determined by subjective criteria as pointed out by (Dixon, 2002). Both the virtual and physical value are important elements of the information technology enabled supply chain management. Figure 3 below depicts the information technology enabled supply chain management concept.

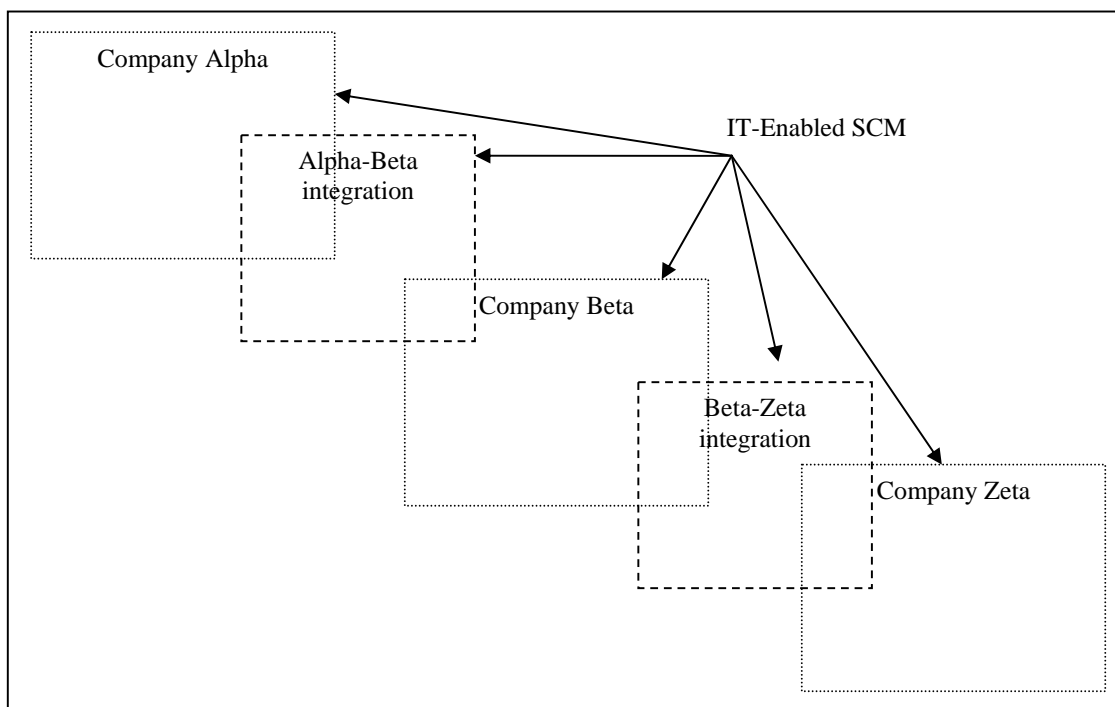


Figure 3 IT-ENABLED SCM

Figure 3 attempts to increase and deepen our existing academic and managerial understanding of information technology enabled supply chains. The model shows what needs to be in place in order to yield the benefits of information technology in the supply chain and supply chain management.

To unravel Figure 3, the term information technology enabled encompasses all information technologies that can be deployed inside and between companies to decrease the cost of coordination and increase benefits associated with supply chain coordination. The authors have not named any technologies for controlling and coordinating various organizational and inter-organizational activities. Additionally, there are no arrows drawn to depict informational or transactional activities in Figure 3 since the supply chain in question is transparent to all three companies forming the supply chain. Transparency of supply chain and business relationships is a widely discussed topic (Eggert and Helm, 2003), here it is highlighted that “...sharing a lot of information with everyone ensures that no one will have the right information when it’s needed”

(Liker and Choi, 2004 p.112). Thus, only information that is needed by the next party of the supply chain is available for that party and that goes on until the supply chain reaches their targeted customer. As said many times in the literature, supply chains are competing against other supply chains and thus no company is an isolated island but a part of large hybrid organization attempting to create customer and shareholder focused value.

As Ryssel *et al.* (2004) pinpointed that internal systems must be aligned and interoperable with the other members of the supply chains internal systems. This pertinent issue is illustrated in Figure 4 with two integration points between the channel members. Indeed, this integration point is crucial for the companies. There are many technologies available to integrate systems. To name a few EDI, I-EDI are the basic ones then the Extranet and ultimately EAI and Web services provide other means to connect and integrate with other members (Mukhopadhyay, 1998; Angeles, 2000; Vlosky, Fontenot, and Blalock, 2000; Stephens and Ramos, 2003; Themistocleous and Irani, 2002; Chen, Chen, and Shao, 2003). Furthermore, intelligent agents are also seen as a good way to facilitate the management of complex set of companies (Liu, Turban, and Matthew, 2000).

Generally speaking, it is summarized that chosen solutions to be integrated must be those that are relatively easy to re-configure (based on an open source software) since technologies inside and between channel members may change and most of the channel parties have many systems that need to be integrated in order to provide the managerial transparency needed to compete with other supply chains and supply chain networks like value creating networks (Kothandaraman and Wilson, 2001).

To sum up, we have pinpointed a void in the research and have shed some light on that void. All in all we provided some insights into the evolution of both supply chain management as well as information technology field. The new ways of coordinating with the help of the information technology are creating the phenomenon information technology enabled supply chain management. Previously, only some parties were coerced to EDI to form a business relationship. Nowadays, more flexible and scalable technologies are enabling a tighter and more meaningful integration. The authors pointed out that these two issues must be studied together not in isolation.

CONCLUSIONS

This paper presented a preliminary conceptual framework to study the management of information technology enabled supply chains. We pondered the impacts of information technology and digitization on supply chain and supply chain management. We argued that digitization and information technology have made some changes to how firms operate but the fundamentals of economics are still the same. In a nutshell, improving internal process with the help of the supply chain and by connecting to other supply chain members the business parties can be integrated and connected in a digital manner to form transparent supply chains. The main contribution of this study is the preliminary model developed to highlight the importance of integrating both internal and external systems in the supply chain to make the coordination of activities easier. Moreover, the authors illuminated that not all available information needs to be shared but the relevant information as too much confuses people. All in all, the authors have demonstrated that although many parties, with their own internal technologies, are involved in the supply chain management the chain can be made information technology enabled if top

management support is endowed and technologies for integration are selected carefully.

This study is exploratory in nature and thus is not without limitations. First and foremost, the rather general model is not empirically tested and there exist some inadequacies in the relationships between the concepts. Additionally, applicable technologies could have been more thoroughly presented. Further research should include an elaboration and crystallization of the developed model and also it is advisable to conduct empirical validation of the model through case studies and comparative case studies. Additionally, large scale quantitative study would provide considerable insights into this underresearched phenomenon. Hopefully, future studies will seek to further elaborate on this pertinent topic in the areas presented.

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