The roles of information technology in supply chain management

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ABSTRACT

The use of information technology (IT) is considered a prerequisite for the effective control of today's complex supply chains. Despite the acknowledged importance of the use of IT in supply chain management (SCM), the number of empirical studies assessing the use of IT in the supply chain context is limited. Based on empirical data from 16 Finnish industrial and service companies this paper presents a classification of the ways in which companies use IT in SCM, and examines the drivers for these different utilization types. According to the findings of this research, the use of IT for SCM purposes can be divided into 1) transaction processing, 2) supply chain planning and collaboration, and 3) order tracking and delivery coordination. The findings further suggest that the drivers between these three uses of IT in SCM differ.

Key Words: Supply chain management, Information technology, Inter-organizational systems, Supply chain collaboration, Information sharing, Case study.

1. Introduction

Today companies are often not considered independent entities, but parts of multi-company, multi-echelon networks, i.e. supply chains, delivering goods and services to the final customer (Christopher, 1992; Lambert and Cooper, 2000). Supply chain management (SCM) literature proposes that integrated control of these multi-company networks can provide significant benefits (e.g. Cooper et al., 1997; Burgess, 1998; de Leeuw et al., 1999; Mason-Jones and Towill, 1999; Norek and Pohlen, 2001). The utilisation of information technology (IT), in turn, is considered an imperative requirement for managing these networks, and has been associated with significant supply chain efficiency improvements (e.g. Lee and Billington, 1992; White and Pearson, 2001).

Although the importance of IT for efficient SCM is widely acknowledged, empirical research assessing how IT is in practice used for the purposes of SCM is narrow. More specifically, majority of the prior research has focused either on modeling the benefits of inter-organizational information technologies and information sharing, or on assessing the impact of specific technologies on supply chain efficiency. Consequently, the actual uses of IT in supply chain management as well as the reasons for using IT in a specific way still remain unclear. Due to these identified limitations in the previous literature we address the following research problem: "How and for what purposes do companies use information technology in supply chain management?"

The paper is structured as follows. First, the previous literature discussing the use of IT in SCM is reviewed. Second, the research design is presented, followed by the presentation of the findings of the study. Finally, in the last two sections, the main findings are summarized and discussed and the concluding remarks are drawn.

2. Literature review

Our literature review on SCM as well as on the IT solutions developed for SCM showed that the definitions for these two concepts are ambiguous. Therefore, we will first give our definitions for these terms and then proceed to discussing the relevant previous research.

2.1. Definitions

In this article, SCM refers to the practices and processes aiming for effective and efficient flow of materials and information between a company and its immediate suppliers and customers. This definition has a twofold justification. First, recent empirical studies have shown that management and integration of supply chains only rarely extends beyond the first tier suppliers and customers (e.g. Frohlich and Westbrook, 2001). Second, this definition corresponds to the perception our case companies have on SCM.

As for IT systems, when discussing the use of IT in SCM, we refer to the use of inter-organizational systems that are used for information sharing and/or processing across organizational boundaries. Thus, besides internal IT systems such as Enterprise Resource Planning systems, we also exclude identification technologies such as RFID from the scope of this study.

2.2. Prior research

An abundance of literature deals with the use of IT in SCM. Gunasekaran and Ngai (2004), for example, have included over a hundred journal articles in their recent literature survey addressing the use of information systems in supply chain integration and management. In this literature review, the aim is to discuss the main contributions and shortcomings of three research approaches – analytical research, empirical studies, and classification frameworks – in relation to the topic of this paper.

2.2.1. Analytical and modeling research

This stream of research aims to measure the impacts of information sharing between supply chain partners. This research addresses the operations of small-scale supply chains. For example, Gavirneni et al. (1999), Lee et al. (2000) and Raghunathan (2001) have studied two-echelon supply chains with one product, while the model of Evans et al. (1993) consists of four echelons. These studies have found that typically the sharing of demand information in supply chains increases the performance of the supply chain by increasing availability and reducing inventory related costs (Evans et al., 1993; Gavirneni et al., 1999; Cachon and Fisher, 2000; Lee et al., 2000).

The benefits of information sharing have been proposed to depend on the predictability of demand. For example, Cachon and Fisher (2000) anticipate that information sharing can have a significantly greater value in situations with unknown demand, for example, early sales of new products or promotion situations. Also Raghunathan (2001) has proposed information sharing to be less beneficial in situations where demand is predictable, and where past demand can be used to form a reasonably accurate demand forecasts. Moreover, Cachon and Fisher (2000) have proposed that the benefits of IT use are more due to the positive effects of IT on transaction processing efficiency potentially leading to shorter lead times and smaller batch sizes than to sharing of inventory and demand information. Evans et al. (1993), in turn, maintain that the feeding of actual demand information forward in the supply chain provides greater benefits than lead time reductions.

To conclude, while focusing on the effects of the information sharing between supply chain partners, the analytical and modeling stream of research does not discuss the actual means of information sharing. Thus, these studies do not directly discuss the use of IT for information sharing between supply chain partners. Nonetheless, these studies are relevant for our study as the sharing of planning information clearly is one the purposes for which IT can be utilized in SCM.

2.2.2. Empirical studies

Two streams of empirical studies on the use of IT in SCM can be identified. The first stream focuses on a specific technology or application area, and the second stream studies the application and benefits of IT in general.

In the research focusing on specific technologies or application areas, there exists a distinct body of research on the adoption factors and impact of Electronic Data Interchange (EDI) (see e.g. Iacovou et al., 1995; Mukhopadhyay et al., 1995; Tuunainen, 1998). Here, for example cost reduction objectives (Mukhopadhyay et al., 1995) and volume of transactions between supply chain partners (Tuunainen, 1998) have been associated with the adoption of EDI links. Further, for example, the use of Extended Markup Language (XML) for supply chain integration has been studied (Nurmilaakso et al., 2002). As for research focusing on specific application areas, for example, the tracking systems and their importance for the

efficient coordination of logistics flows have been widely studied (Harris, 1999; Stefansson and Tilanus, 2001; Ala-Risku et al., 2003; Kärkkäinen et al., 2003). According to this body of literature, tracking is needed especially in situations with in-transit consolidation, and in project-oriented businesses. These tracking studies, however, are not empirically founded and thus, do not reveal how tracking systems and tracking information is actually utilized by companies.

As compared to the research focusing on specific technologies or application areas, research on the use and benefits of IT in SCM without the focus on specific technology is fewer in number. The research on the benefits of the use of IT in SCM includes a number of surveys investigating the impact of IT on supply chain integration, customer integration and service (Closs and Savitskie, 2003), supply chain time performance (Jayaram et al., 2000), financial performance, or a combination of these (Vickery et al., 2003). Meanwhile, Auramo et al. (2005) performed an exploratory multiple case study on the benefits of IT in SCM, and McLaren et al. (2004) conducted a multiple case study on how different SCM IS capabilities support different operations environments. However, common to these studies is that while helping to assess and understand the value of IT use and integration for SCM, they do not help in determining how companies actually use IT in SCM.

2.2.3. Conceptual classifications

There are some few classification frameworks that describe how IT is used for SCM in the previous literature. Bagchi and Skjoett-Larsen (2002) examine the role of IT and organizational integration in supply chain integration and propose an IT integration path from low, through medium, to high integration. Themistocleous et al. (2004), in turn, use the scale of low, medium, to high to describe the integrativeness of different IT alternatives. The focus of these studies being on assessing the levels of supply chain integration, they do not describe how IT is actually used for SCM purposes.

Meanwhile, in their research, Kauremaa et al. (2004) have focused on the ways companies use IT in SCM and choose to classify the use of IT in SCM to transaction execution and information sharing. Based on the rarity of using IT for information sharing among their sample of companies studied, they hypothesize that the drivers and prerequisites of using IT in transaction execution and in information sharing differ, and that the benefits of IT in transaction execution are easier to quantify. Furthermore, they suppose that companies use IT for transaction execution in situations with high transaction volumes and stable business relationships, while IT is used for information sharing especially in environments with demand uncertainty and frequent product introductions. The most severe limitation of this study is that the drivers of using IT for transaction execution and information sharing are hypothesized, and can not be validated by their research data.

To conclude, based on our literature review, there is a lack of research on how companies actually utilize IT in the management of their supply chains. Furthermore, there is a limited knowledge on the factors that drive the companies to use IT in a specific way in their SCM efforts. These identified shortcomings of prior research create a need for research that this study aims to address.

3. Research design

3.1. A priori constructs

For the purposes of examining the use of IT in SCM, two a priori constructs were developed: 1) the types of IT use in SCM, and 2) the drivers for using IT in SCM. The a priori constructs are described in more detail below (Figure 3.1).

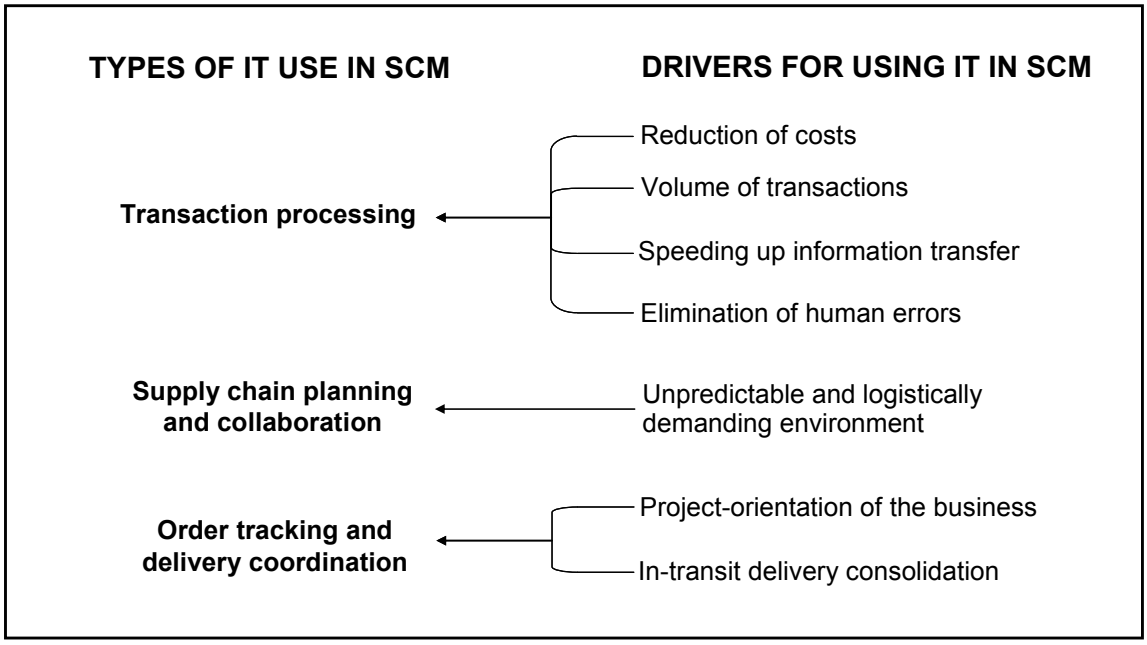

Figure 3.1 The a priori constructs and their presumed relationships

3.1.1. Types of IT use in SCM

The first construct, types of IT use in SCM, refers to the ways in which companies employ IT for the purposes of SCM. Based on prior research discussed above, three different types of IT use in SCM – transaction processing, supply chain planning and collaboration, and order tracking and delivery coordination – were identified and chosen to represent the first construct.

The first type of IT use, *transaction processing* stands for the use of IT for increasing the efficiency of repetitive information exchanges between supply chain partners. In this type of IT use the exchanged information is typically related to such tasks as order processing, billing, delivery verification, generating and sending dispatch advices, and producing order quotes. The second type of IT use, *supply chain planning and collaboration*, represents the use of IT for sharing planning-related information such as demand forecasts and other demand information, inventory information, and production capacity information, with the intention of increasing the effectiveness of the supply chain. Finally, the third type of IT use in SCM, *order tracking and delivery coordination*, refers to the monitoring of individual orders or shipments, which may consist of components or final products, with the aim of coordinating their delivery or conveying timely information of their location.

3.1.2. Drivers for IT use in SCM

The second construct, drivers for using IT in SCM refers here to the reasons why IT is used in a certain manner in SCM. Based on our literature review, we expected that following drivers for the use IT in transaction processing can be found in the case companies: *reduction of the costs* of operational processes (manual work), improvement of information quality by *eliminating human errors*, and *speeding up the transfer of information* between organizations. We further hypothesized that the *volume of transactions* acts as a driver for using IT for transaction processing. It was also assumed that supply chain coordination information is shared especially in volatile, *unpredictable, and logistically demanding business environments*. Finally, we expected that tracking and coordination activities are performed in *project oriented businesses* and in cases with *in-transit delivery consolidation*. The presumed relationships between these drivers and the a priori constructs are presented in Figure 3.1.

3.2. Data collection

A multiple case study approach was chosen for the purposes of this study. We collected data from 16 Finnish industrial and service companies in autumn 2004. The companies were selected using the approach of purposive sampling (Lincoln and Guba, 1985). Our objective was to include companies employing a variety of inter-organizational IT integration mechanisms and representing different business environments in the sample. The characteristics of companies in the research sample are exhibited in Appendix A.

Both qualitative and quantitative data were gathered using personal interviews as well as questionnaire. The questions for the interviews and the questionnaire were designed concurrently so that together they cover both the IT solutions employed by the companies in their SCM practices and the essential characteristics of the companies and their business environments.

The questionnaire and interview questions were sent to the companies prior to the interviews. This made it possible for the company representatives to prepare themselves for the interviews by acquiring answers to the questions, and by inviting additional representatives possessing the relevant information to the interviews. The questionnaire contained closed end questions including multiple choice, rank order, and Likert -scale questions.

The interviews were semi-structured in nature, lasting 2 hours in average. The typical composition of participants in the interviews included two to three interviewers and one to three company representatives. As a result, a total of 33 company representatives participated to the 16 interviews conducted. The interviews were recorded in case of memory lapses, and to support the correctness of interpretation. For each interview, a memo was written based on the recordings and sent to the interviewees to be checked for possible inconsistencies or errors.

The data gathered through the interviews and questionnaire was further supplemented by information acquired from secondary information sources, such as annual reports and company web-pages. All the data collected concerning the case companies was compiled into a case study database which then was used as the basis for the analysis. Furthermore, additional information needs that rose up during the analysis phase were filled by re-contacting the informants by telephone.

In order to increase the validity of the research, investigator, source, and method triangulation were used (Lincoln and Guba, 1985). Multiple researchers participated in the interviews and checked the memos written (investigator triangulation). Further, multiple respondents were typically present in the interviews in each company (source triangulation). Finally, the data

collected via the semi-structured interviews were complemented with the use of questionnaires to gather structured quantitative data (method triangulation).

The data regarding the a priori constructs was gathered as follows. As for the types of IT use in the case companies, the respondents where asked to describe each of their IT systems used for SCM purposes as well as discuss the activities performed with them. This data was gathered through the interviews, and it covers issues such as the type of technology used, and the types of data shared via the system.

The data describing the drivers for the different types of IT use was also gathered in the interviews. The drivers are largely determined based on the answers to the questions inquiring the reasons for the implementation of each system and the characteristics of the partners whom the system is used with. In addition, the volatility of the company's business environment was inquired by asking the respondents to describe the level of demand uncertainty, and the characteristics of their product offering such as the length of product lifecycles and the frequency of new product introductions.

Finally, to describe the business environment of the case companies, data on order penetration points, roles in the supply chain, the number and concentration of supply chain partners (suppliers and customers), the amount of product customization, number of products, and the level of internal IT integration was gathered both via the interviews and the pre-interview questionnaire.

3.3. Data analysis

The data was analyzed in two successive phases. First within case analyses were performed to assess how and with what kind of partners each of the case companies utilizes IT in its SCM processes, and to understand why they use the technology in that specific way. Hence, for each company, the types of IT use as well as the drivers for the identified ways of IT use were identified based on the interview and survey data.

After analyzing each of the cases separately, the cases were compared with each other in order to identify potential patterns within and between companies utilizing IT in a specific manner. In this cross-case analysis the companies using IT in a specific way with up- or downstream partners (for example companies utilizing IT for transaction processing with their customers) were first compared with each other to identify commonalities between them regarding the drivers for using IT and the business environment. After this, these cases were compared with the companies not using IT in that specific manner to chart the potential differences in the business environments between the users and non-users.

This kind of grouping and cross-case analysis were performed for the different uses of IT that are transaction processing with customers / suppliers, supply chain planning and collaboration with customers / suppliers, and order tracking and delivery coordination with customers / and suppliers.

4. Results

In the within-case analyses, the relationship between the two constructs, the types of IT use in SCM and the drivers for the use of IT in SCM, was examined (see Appendix B for a summary of the results). After looking at each of the cases separately, the cases were compared with each other in order to identify potential patterns between them. This cross-case analysis revealed commonalities between the companies utilizing IT in a specific way regarding the drivers of IT use. As for the business environment characteristics, the number and

concentration of supply chain partners as well as the role of the company in the supply chain seemed, in some occasions, to segregate companies utilizing IT in a specific way from the non-users. However, order penetration point, the level of product customization, number of products, and the level of internal IT integration did not, to our surprise, distinctly differ between the users and the non-users in any type of IT use. Next, the findings of the cross-case analysis are presented in more detail.

4.1. Transaction processing

Most of the case companies, 10 out of 16 (A, C, D, G, H, I, J, K, L, N), used IT to process transactions with their suppliers. Eight of the case companies (B, C, E, F, I, K, M, P), in turn, used IT to transaction processing with their customers. Consequently, only three of the companies (C, I, K) used IT for transaction processing towards both up- and downstream of the supply chain. EDI, XML, or Extranet solutions were typically used for the processing of orders and invoices in the companies. In some cases, IT was also used to process delivery verifications and dispatch advices.

As expected, reduction of manual work and costs, improvement of information quality, speeding up of information transfer, and volume of transactions were found to drive the use of IT for transaction processing. Furthermore, the reasons for using IT for transaction processing were rather homogenous between the companies. The companies aimed to reduce manual work associated with sales transactions to reduce the related costs, and to increase the reliability and speed of information transfer between companies. In most cases, the partners for the IT applications were selected based on the volume of transactions. However, several of the companies stressed that especially with lean IT solutions, such as Extranets, a high volume of transactions is not needed for receiving a positive payback of the integration effort. Instead, the continuous nature of the business relationship was considered important in these cases. Interestingly, when comparing the drivers for transaction processing towards customers to those towards suppliers, no significant differences were found.

Some conclusions can be made regarding the business environment of the companies that utilize IT for transaction processing with their customers. Based on our sample, these companies are located in the upstream part of the supply chain (i.e. they are either equipment or component manufacturers). Further, compared to the non-users, these companies have fewer customers and more concentrated customer base, which is well in line with the identified drivers of transaction volume and business continuity.

The only notable difference between the companies using IT for transaction processing with the suppliers and the non-user companies is that all companies in the latter category have a high or at least moderate number of suppliers. This relationship between the number of suppliers and the use of IT for transaction processing is in line with the identified drivers.

4.2. Supply chain planning and collaboration

The use of IT for supply chain planning and collaboration was more limited in our sample than the use of IT for transaction processing. This result supports the earlier findings on the sharing of planning information (Kemppainen and Vepsäläinen, 2003; Kauremaa et al., 2004). Less than half of the companies (A, C, D, I, J, K) used IT for supply chain planning and collaboration with their suppliers, and three of these companies (A, C, I) applied IT for this purpose also with their customers. Furthermore, unlike assumed, unpredictable and logistically demanding environment did not stand out as a driver for this type of IT use among the case companies. Instead, an important commonality among most of the companies using IT for supply chain planning and collaboration was that they used the information shared

through the IT system for running a specific cross-organisational process. For example, the sharing of inventory level information was invariably associated with VMI replenishment. In fact, VMI (or in Case D a pro-active replenishment) has been implemented in seven of the nine instances where IT is used for supply chain planning and collaboration. Furthermore, in Cases I and K demand forecast information was shared to suppliers so that they could verify their capability to meet the forecasted demand, and then the differences in the expected demand and potential supply were managed.

Actually the only instances where information is shared without a strong link to a specific cross-organisational process are the following: Case company I receives demand forecasts, Case company A distributes demand forecasts also to the suppliers not involved in the VMI replenishment scheme, and Case company J shares information on capacity utilisation to the suppliers. This apparent reluctance in information sharing via IT simply for the purpose of improving the planning processes of supply chain partners is rather surprising.

As for the characteristics of business environments, all the companies using IT for planning and collaboration with their customers have concentrated or highly concentrated customer base, which is well in line with the nature of IT use – building customer-specific processes with the aid of IT solutions and supply chain visibility. Other clear correlations between the use of IT in supply chain planning and collaboration and the characteristics of business environment of the companies were not identified.

4.3. Order tracking and delivery coordination

Five companies (H, I, K, M, P) in our sample utilize IT systems in order tracking and coordinating the progress of orders or deliveries or in providing this information. Of these, in Case I order-specific status reports were updated manually into an Extranet page if customers specifically requested it. In Case M, the company provided delivery status information to its customers as a high end logistics service provider.

In Cases H, K, and P, delivery status information is actively collected, disseminated and utilized. In Case K, the company offers delivery status information to its customers on project orders, enabling the customers to synchronize the project activities with the availability of the material. The Case company P, in turn utilizes the delivery status information of the main telecom components to ensure material availability before scheduling installation tasks. The tracking information is most comprehensively utilized in Case H, where the company uses delivery status information to control in-transit consolidation of the components of the end product. The delivery status information is also used to ensure that the final customer shipment includes all the necessary sub-deliveries.

As to business environment characteristics, the use of IT for order tracking and delivery coordination seemed to be associated with a customized nature of the offered products. Aside this, no further commonalities between the companies were found regarding the characteristics of their business environments.

To summarize, based on our sample of companies, project-orientation of business and in-transit consolidation seem to drive the use of IT for order tracking and delivery coordination. Furthermore, this role of IT is especially emphasized when other deliveries or human activities (such as installation tasks) are controlled based on the progress of specific tracked deliveries.

5. Discussion

The findings of this study give support to the proposed relationships between the drivers and the use of IT for transaction processing. Support was also found to the expected drivers for the use of IT for order tracking and delivery coordination. The analysis of the drivers for the use of IT for supply chain planning and collaboration, however, brought about some interesting new findings. Namely, in the companies examined in this study, the sharing of planning information via information systems is tightly linked to the development of respective cross-organizational processes. We suggest three possible reasons for this finding: 1) uni-directional benefits of information sharing, 2) the scope of this study on information shared with IT systems, and 3) the complexity of actually achieving benefits with the shared information. Next each of the reasons is explained in more detail.

Several authors have pointed that normally it is the suppliers that gain the most benefits from information sharing (e.g. Yu et al., 2001). In fact, Lee et al. (2000) suggest that suppliers should offer specific monetary or process-related incentives to their customers to encage them in information sharing. A good example of possible process-related incentive is the vendor-managed inventory (VMI) system, as it enables the customer to increase the efficiency of its purchasing process besides providing the supplier timely demand and inventory information (Holmström, 1998).

This study focused on formal inter-organizational information sharing via IT systems. Thus, it may oversee the sharing of information that is not utilized by any of the formal supply chain processes. This is supported by the answers given by Case companies B and E, which indicate that customers share some demand and forecast information with them but that they prefer to receive and analyze it manually. This is aligned with the findings of Kauremaa et al. (2004) who reported that manual sharing of planning information is more common than automated information sharing among the analyzed 36 companies.

The third possibility for the lack of information sharing without process re-design is that the companies fail to see and/or realize the expected benefits of information sharing. The research promoting the benefits of information sharing is usually based on analytical modeling or computational experiments, and relies on simplified representations of the supply chain (most often a linear supply chain with two to four echelons and one or a few products). However, in practice the situation is much more complex. For example, the supply chains are not linear, and thus the information available from any partner would only be a subset of all relevant information from that supply chain stage, there are usually thousands of products to be considered and managed in the supply chain, and products often have complex product structures (BOMs) making information sharing more difficult. Therefore companies can not use significant resources in analyzing the information collected on each product, and furthermore should always consider whether the information is a sufficient and representative sample of information from that supply chain echelon. For example, the representatives of Case B defined that they receive point of sale (POS) information from some of their customers but it does not bring the expected benefits. The value of information has been questioned also in previous research. For example, Cachon and Fisher (2000) in their study on information sharing between retailers and a supplier argue that sharing of demand and inventory information as such brings only relatively small benefits, even if all the retailers would provide the information for the single supplier. Furthermore, Disney et al. (2004) have discovered that in the beer game setting, the sharing of POS information can actually weaken supply chain performance as it complicates the analysis at each stage of the supply chain. Yet, the complexity of supply chain in the beer game setting is far from the real-life supply chains.

6. Conclusions

In this study the use of IT for SCM purposes was studied by dividing the use of IT into three categories, 1) transaction processing, 2) supply chain planning and collaboration, and 3) order tracking and delivery coordination. Further, the drivers behind these different IT use types were examined. Based on the empirical data collected for this study, the three IT use categories proposed represent well the roles that IT plays in SCM. In addition to clarifying this widely discussed topic, the categorization provides a basis for further research on the use of IT in SCM.

Furthermore, our findings suggest that the drivers between the three uses of IT in SCM differ. As expected, reduction of manual work and costs, improvement of information quality, speeding up of information transfer, and volume of transactions were found to be the drivers for the transaction processing role of IT in SCM. In addition, the continuity of the business relationship was found to drive this use of IT. The use of IT in supply chain planning and coordination, in turn, was found to be driven by the implementation of cross-organizational processes, most often the VMI system. Unlike assumed, unpredictable and logistically demanding environment did not stand out as a driver for this use of IT. Finally, project-orientation of business and in-transit consolidation were found to drive the use of IT for order tracking and delivery coordination. Moreover, this use of IT was mostly driven by the need to coordinate other activities or deliveries based on the progress of specific tracked deliveries.

To conclude, we want to acknowledge that the second category of IT use, supply chain planning and collaboration, was not defined in sufficient detail. Consequently, there is a need for further research on the different ways of using IT for supply chain planning and collaboration. Furthermore, a detailed analysis of the possible explanations for the lack of information sharing for supply chain planning is invited. Finally, in order to better understand the complex phenomenon of supply chain management, the research on the use of IT in SCM should be complemented by research on the other means of supply chain coordination.

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Appendix A: Characteristics of the research sample

Case company	Industry	Number of employees	Revenue (million €)	Number of customers	Customer base concentration	Number of suppliers	Supplier base concentration
A	Manufacturer of motors, drives, and power electronics	> 25.000*	> 10.000*	moderate	concentrated	low	dispersed
B	Manufacturer of meat product and convenience foods	2.100	470	low	highly concentrated	low	concentrated
C	Manufacturer of confectionery	2.100*	330*	moderate	highly concentrated	moderate	strongly concentrated
D	Manufacturer of ballasts and lighting electronics	300	70	moderate	concentrated	low	concentrated
E	Manufacturer and retailer of design homeware	1.400	160	consumers & high	consumers & highly concentrated	moderate	dispersed
F	Manufacturer of engineering steels and steel products	1.200	200	moderate	concentrated	high	strongly concentrated
G	Retailer of home furniture and interior furnishing	700	170	consumers	consumers	moderate	strongly concentrated
H	Manufacturer of customized elevators	> 25.000*	> 5.000*	low**	dispersed	moderate	concentrated
I	Contract manufacturer of electronics	130	28	low	concentrated	moderate	concentrated
J	Provider of valve solutions for process industries	> 25.000*	4250*	high	highly concentrated	moderate	concentrated
K	Provider of infrastructure for telecommunication networks	> 25.000*	> 10.000*	moderate	concentrated	moderate	dispersed
L	Manufacturer of display refrigeration	350	39	low	dispersed	moderate	strongly concentrated
M	Logistics service provider	> 25.000*	> 5.000*	high	highly concentrated	low	dispersed
N	Retailer of food and homewares	5.000	1.200	consumers	consumers	high	concentrated
O	Supplier of fixing and assembly materials	700	125	high	highly concentrated	high	concentrated
P	Provider of telecommunications networks	1.200	130	consumers & moderate	consumers & highly concentrated	high	strongly concentrated

** The business unit or subsidiary examined is a part of a larger group of companies and the group level data is exhibited*
*** The examined business unit serves internal customers*

Number of customers:
low = less than 50 customers
moderate = 50 - 5000 customers
high = more than 5000 customer
consumer = company's customers are consumers

Customer base concentration:
highly concentrated = less than 10% of company's customers responsible for 80% of sales
concentrated = less than 20% of company's customers responsible for 80% of sales
dispersed = more than 20% of company's customers responsible for the 80% of sales
consumers = company's customers are consumers

Number of customers:
low = less than 200 suppliers
moderate = 200 - 500 suppliers
high = more than 500 suppliers

Supplier base concentration
highly concentrated = less than 10% of company's suppliers for 80% of purchases
concentrated = less than 20% of company's suppliers responsible for 80% of purchases
dispersed = more than 20% of company's suppliers responsible for the 80% of purchases

Appendix B: Within case analyses

Case company	TRANSACTION PROCESSING		SUPPLY CHAIN PLANNING AND COLLABORATION		ORDER TRACKING AND DELIVERY COORDINATION
	With customers	With suppliers	With customers	With suppliers	With customers & suppliers
A	◐ The unit examined receives orders from customers via sales units through internal information systems.	● Receives order confirmations and bills and shares orders via S2S links with large suppliers and via extranet with small suppliers. IT adopted for increased efficiency.	● Receives aggregated forecasts from sales units and daily inventories from VMI customers.	● Shares demand forecasts to all suppliers and inventory levels or frozen demand to VMI suppliers.	○
B	● Receives orders and shares bills via EDI with customers with high number of orders. IT adopted for efficiency and reliability of information exchange.	○ *IT has not been adopted for transaction automation due to insufficient benefits attainable with the adoption. **	○	○	○
C	● Receives orders and shares order confirmations and bills via EDI with handful of customers with long term business relationships and high volume of transactions. IT adopted for automation of work and faster and error free order flow.	● Receives bills and replenishment proposals via S2S links from few largest suppliers and via extranet from couple of dozen suppliers with high volume of transactions. IT adopted for reduced workload and faster transfer of information.	● Receives inventory levels and order information from customers via EDI for enabling co-managed inventories.	● Shares inventory levels and production plans via extranet and S2S links for automatic replenishment by suppliers.	○
D	○ *IT has not been adopted for transaction automation due to low number of exchanged orderlines.*	● Receives order confirmations and shares "kotiinkutsut" via extranet with few dozen frequent suppliers. IT adopted for the rationalization of work.	○	● Shares demand forecasts to suppliers via extranet.	○
E	● Receives orders and shares bills and bills of laiding via EDI with about a dozen customers with largest transaction volumes. IT adopted mainly for reducing manual work but also for enabling faster and error free exchange of information.	○ *IT has not been adopted for transaction automation because the volume and frequency of transactions with all suppliers is low.*	○	○	○
F	● Receives order confirmations, bills, bills of laiding, and other information and shares orders via EDI with few suppliers with high volume of transactions. IT adopted due to customer requirements and efficiency and speed of information transfer.	○ *It has not been adopted for transaction automation because the company has not found the operational benefits of the system to suffice development effort.*	○	○	○
G	○ *IT is not used for transaction automation because the company's customer base consists mainly of consumers.*	● Shares orders via S2S link to handful of largest suppliers. Receives order confirmations and shares orders via extranet with couple of dozen key suppliers. IT adopted for automation of order handling and reliability and speed of information transfer.	○	○	○
H	◐ Receives orders from internal customers. Transaction volume with outside customers is not sufficient to justify investment on IT links.	● Receives order confirmations, bills, and other information and shares orders via extranet and S2S links with suppliers with continuous volume. IT adopted for the reduction of routine work.	○	○	● Delivery status information received from suppliers is used for controlling intransit consolidation of components.
I	● Receives order confirmations and shares orders and bills via EDI with few most important customers. IT adopted for efficiency, reliability of information transfer, and reduced manual work.	● Shares orders via EDI with most important suppliers. IT adopted for the easiness of operations and reliability.	● Receives demand forecasts via customers extranet systems and uses this information for inventory planning and other purposes.	● Shares demand forecasts via EDI and extranet to suppliers some of which provide VMI.	● Manually generated production status reports are provided via extranet to company's customers.
J	○ *It has not been adopted for transaction automation because the company's products are complex and not suitable for S2S ordering.*	● Receives order confirmations, bills, and information on exceptions of confirmed orders and shares orders via extranet.	○	● Receives exception alerts for scheduling and capasity planning and shares capasity information via extranet.	○
K	● Both extranet and S2S links used to exchange transaction data with customers. IT adopted for increased efficiency.	● Receives order confirmations and shares orders and bills via extranet and S2S links with suppliers with high number and volume of purchased components. Extranet used with suppliers not capable of S2S integration. IT adopted for increased efficiency of routine tasks.	○	● Receives capasity information for demand-supply-balancing and shares forecasts to support VMI.	● Delivery status information is provided to company's customers on project orders.
L	○ *IT has not been adopted for transaction automation because the company's products are complex and not suitable for S2S ordering.*	● Shares orders via customized S2S link to one contract manufacturer because the volume of transactions could not be handled manually.	○	○	○
M	● Receives orders and bills of laiding and shares bills via extranet and S2S links with customers in continuous business relationships. IT adopted for increased effiency.	◐ The transportation companies use the logistic service providers information system.	○	○	● Delivery status information is provided to company's customers.
N	○ *IT has not been adopted for transaction automation with the customers because the company operates in the consumer market.*	● Receives bills and bills of laiding and shares orders via EDI with suppliers with large volumes of exchanged information. IT adopted for efficiency, reduced manual work and reliability.	○	○	○
O	○ *IT has not been adopted significantly for transaction automation because the company's business concept does not require the use of IT.*	◐ Receives bills and information on incoming orders and shares orders with parent company. IT adopted because the parent company developed its processes and for reducing human errors.	○	○	◐ Delivery status information of incoming inhouse orders is received via EDI from the company's parent company.
P	● Receives orders and technical information related to orders and shares order confirmations with largest customers via extranet and S2S links. IT adopted for increased effiency and reduced manual work.	○ *IT has not been adopted for transaction automation due to company's disperced supplier base.*	○	○	● Status information on the delivery of main telecom components received from a customers system is used to coordinate onsite installations.

* Descriptions for why a company does not use IT for a specific purpose have been provided where available

● *= Company uses IT in SCM for this purpose* ◐ *= IT is used for this purpose between the different units of the company* ○ *= Company does not use IT in SCM for this purpose*