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INFORMATION INTEGRATION AND ITS IMPACTS ON LOGISTICS PERFORMANCE

Using information technology and systems to facilitate information integration

Master's thesis in Operations and supply chain management

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CPFR	Collaborative planning, forecasting and replenishment
ECR	Efficient consumer response
EDI	Electronic data interchange
ERP	Enterprise resource planning
ICT	Information and communication technology
IOIS	Inter-organizational information system
IS	Information system
IT	Information technology
KMO	Kaiser-Meyer-Olkin measure
NDA	Non-disclosed agreement
paas	platform-as-a-service
QR	Quick response
R&D	Research and development
saas	software-as-a-service
SCI	Supply chain integration
SCM	Supply chain management
SPSS	Statistical Package for the Social Sciences
SRM	Supplier relationship management
VMI	Vendor managed inventory

1 INTRODUCTION

1.1 Background of the study

Fast changing environment and increasing uncertainty set pressure on firms to share greater amounts of information with their customers and suppliers. Organizations have moved from single-site facilities to globally integrated networks, where firms coordinate and collaborate. (Stock, Greis & Kasadra 1999, 224.) To tackle the challenges set by the environment, firms have needed to integrate and coordinate their activities (van Donk & van der Vaart 2004, 22) but also to include information systems and technologies to facilitate collaboration and information integration. As a result, supply chain partners have been able to tighten coordination and optimize supply-wide performance with the help of information technologies and systems development. (Lee & Whang 2000, 373.)

External information integration and information sharing (terms are used interchangeably in research literature) are essential to firms who collaborate and integrate their activities and processes beyond firm boundaries. Lee and Whang (2000) refer to information integration as sharing of pertinent data and information among the supply chain partners. Information sharing has been defined to include same aspects as in information integration, and it refers to sharing of critical information between a supplier and a buyer that is detailed enough, frequent enough and timely enough to meet the requirements of the firms (Carr & Kaynak 2007, 349). The amount of critical information which needs to be shared has expanded during the last decades and continues to do so. Information integration has been extended to include numerous suppliers and customers. The extent of information integration pays attention to the scope of shared information and to the level of intensity on which information is shared. Also direction of shared information is an important factor when defining information integration. (van Donk & van der Vaart 2005a, 99.)

Information systems and technologies facilitate and extend information integration. Several researchers (e.g. Saeed, Malhotra & Grover 2005, 387) have acknowledged that adopting new ways of using information technology (IT) is one important resource for staying competitive on the rapidly changing market. By integrating systems and exploring opportunities created by the new Information and Communication Technology (ICT), firms are able to gain competitive advantage (Garrido Azevedo, Ferreira and Leitão 2008, 7). According to Fawcett, Osterhaus, Magnan, Brau and McCarter (2007, 364-365), leading companies have invested vast amounts of resources to analyzing just about anything with their information systems (IS). These leaders have invested heavily on their IT operations to improve their performance (Fawcett et al.

2007, 365). As a result, information is nowadays integrated by utilizing variety of different information technologies and systems. Information systems, enterprise resource planning (ERP) systems, software applications or other information technology based systems provide a variety from which to choose. (Simchi-Levi et al. 2008, 407; 414.) Also cloud computing and sharing information via a cloud service has added a new aspect to traditional sharing information (Pervilä 2012).

The desired outcome of integrating information is to improve a firm's processes and overall performance. By integrating and sharing information, firms have been able to improve their operational and strategic performance. (Hsu, Kannan, Tan & Keong Leong 2008; Lee et al. 1997; Lee & Whang 2000; Narasimhan & Kim 2001; etc.) By sharing for example demand, capacity or inventory information with key suppliers and customers, firms have been able to shorten order fulfillment cycles, decrease inventory levels, improve co-ordination of supply chain activities as well as increase service levels and demand forecasting (Lee, Padmanabhan & Whang 1997; Chen, Yang & Yen 2007, Lee 2000). Regardless the benefits derived from information integration, the implications of empirical studies suggest that there is still a need for cautious interpretations. Uusipaavalniemi (2009, 16), Fawcett et al. (2007, 358) and Fabbe-Costes and Jahre (2008, 140-142) underline that only a few firms have been able to enhance their performance despite they have shared information.

More efficient and clear practices which facilitate information integration and improve operational efficiency are needed to tackle the fast changing challenges (Uusipaavalniemi 2009, 167). Opportunities provided by the use of modern information technologies and systems, are one solution which could facilitate information integration and further on contribute to a firm's improved processes and logistics performance. By developing information integration with the use of information technologies and systems, firms can achieve performance improvements they are seeking.

1.2 Research purpose and objectives

The three main concepts of this study are information integration, information technology and systems, and logistics performance. The purpose of this research is to test and understand *the relationship between information integration with key suppliers and/or customers and firm's logistics performance - especially when information technologies (IT) and information systems (IS) are used for integrating information.* This research is paying attention to the scope, level and direction of information integration in a limited dyadic relationship.

With ‘logistics performance’ this study refers to operations and processes relating to the competency of external and internal logistics operations and being efficient in them. Competency is often contrasted to performance and it can be defined as quality or extent of being competent (Oxford Dictionary 2011). A limited dyadic relationship in this context refers to integration between a focal firm and, its customers and suppliers (i.e. both up and downstream, but separately (Fabbe-Costes & Jahre 2008, 135).

The relationship of information integration, information technology and systems and logistics performance is studied in this research by using quantitative and qualitative research methods. To provide a better understanding of the wide research topic, three research questions (Q1-3) have been formed. The quantitative part of this study aims at *testing the relationship between the use of information technology and systems and information integration with key suppliers and/or customers (Q1), and also testing the relationship between information integration with key suppliers and/or customers and firm’s logistics performance – both operational and strategic performances are included (Q2).* By testing and examining the cause-and-effect relationships, this study aims at assessing to what extent the use of information technology and systems are related to information integration, and to what extent information integration is related to firm’s logistics performance (operational and strategic). Four hypotheses were formed to test these relationships.

The qualitative part of this study aims at *understanding and interpreting what influences the relationship between information integration with key suppliers and/or customers and logistics performance, especially when information technology and information systems are used for integrating information (Q3).* The qualitative research also provides an understanding of how and why information is integrated and shared, and what are the underlying practices and mechanisms that impact on the relationship. The three research questions (Q1-3) are outlined below:

1. To what extent does the use of information technologies and systems impact on integrating and sharing of information with key suppliers and/or customers?
2. How much does information integration with key suppliers and/or customers impact on a firm’s operational and strategic logistics performance?
3. How does the use of information technology and systems influence the relationship of information integration with key suppliers and/or customers and logistics performance?

This study is testing the research questions one (Q1) and two (Q2) by using quantitative analysis and SPSS. To provide a better understanding of the relationships, qualitative analyses are also performed to understand the relationships between IT and IS and information integration, and the relationship between information integration and

logistics performance. The third research question (Q3) is striving to go deeper and understand how the use of information technology and systems influences on the relationship of information integration and logistics performance by using qualitative research methods.

A mixed methods research design was used for performing the research. Finnish Logistics Survey 2010 (Solakivi et al. 2010) provides the quantitative data for the research. This research examines large and medium-sized Finnish manufacturing and trading firms. A large firm in this context, has a company turnover over 50 million Euros, and a medium-sized company has a turnover between 10-50 million Euros, as is also defined in the Finnish Logistics Survey 2010 (Solakivi et al. 2010, 6). In the qualitative part of this study, representatives of four large and two medium-sized firms were interviewed to collect in-depth information about these firms' information sharing and integration and the use of information systems and technologies to facilitate information integration and information sharing process. To capture and understand the complexity of information integration, use of information technology and systems and logistics performance, appropriate theoretical frame of reference has been selected to support the research and its findings.

Information integration has been widely researched, especially from supply chain perspective. Fabbe-Costes and Jahre (2008, 137) noticed in their literature research that although discussion has included the extended supply chain perspective, research measurements often have only included limited scope meaning the closest suppliers and customers of the focal firm. Therefore, it is justified to examine and apply supply chain literature although this study concentrates only on studying a dyadic relationship. The dyadic perspective is also well-grounded in a sense that most often firms tend to manage their dyadic partnerships more than holistically manage the entire supply chain. (Hsu et al. 2008, 305).

1.3 Structure of the thesis

The structure of this thesis follows a typical research structure. Chapters two, three and four present and discuss the theoretical frame of reference. In chapter two, supply chain perspective influences on the background and lays foundation for collaboration, information integration and information sharing. Information integration and extending it are discussed in detail in the chapter two. The third chapter examines the relationship which information integration and logistics performance have according to the research literature. In addition, information technologies and systems based performance improvements are outlined. The chapter four concludes the theory part, and discusses the theoretical frame of reference, and outlines hypothesis for further research.

Methodological approaches are presented in chapter five. Both quantitative and qualitative research approaches are discussed. Also data collection methods, data analyses and trustworthiness of the study are presented. Further on, chapter six presents the quantitative results and analyses of this study, whereas, chapter seven outlines the qualitative results and analyses. Research findings and conclusions are presented in chapter eight including discussion part, validity, reliability and limitations of the study. Chapter nine summarizes this thesis. References and appendices are presented in the end of this thesis.

2 INFORMATION INTEGRATION

According to Sandkuhl (2009, 43) information in the modern information society is considered as an important "production factor" among capital, human resources and material. It is challenging for firms to find the right information which is needed to support decision-making, coordination of business operations or even a simple work task. The main challenge which firms are facing is no longer the fact that information does not exist in an electronic form, but rather to find the right information. (Sandkuhl 2009, 44.)

The first section of this chapter will be dealing with the complex nature of information and what it is. In the second section supply chain collaboration and coordination lay foundation for external information sharing and information integration. The third section introduces the elements of information integration which are information technology and systems, information flow, collaboration (i.e. integration of actors) and processes and activities. The fourth section will go deeper into the extent of information integration: scope, level and direction of information integration will be outlined and discussed. Finally, the fifth section identifies how information integration can be facilitated with the use of information technology and systems.

2.1 The nature of information

Information is undoubtedly one of the most complex concepts to define because of its nature. First definition of information is that it has a meaning (Boddy, Boonstra & Kennedy 2005, 10). This semantic approach would define information as meaningful to its receiver. In accordance with this interpretation of information is that it also has a subject – in many cases information is considered as instructions or intelligence about something or someone to the person interpreting the information. (Webster 2006, 26.) The classical definition of information has been defined by Shannon and Weaver (1949). These developers of information theory defined information more from a mathematic perspective. According to them, information is known as entropy which quantifies the expected value of information in a message. This is expressed as bits needed to store or communicate a symbol in a message. (Shannon & Weaver 1949.) Webster (2006, 26) continues this mathematic point-of-view and adds that information "*is a quantity which is measured in bits and defined in terms of the probabilities of occurrence of symbols*".

Information is highly inter-related to concepts of data and knowledge. Data refers to "*recorded descriptions of things, events, activities and transactions – their size, color,*

cost, date, etc." (Boddy et al. 2005, 9). Data can be described as a subset of information or just as data which has been given a meaning. This can be defined as facts. In addition, with the help of IT, data can be transferred and processed into being meaningful and relevant information. This research considers information as data which has been given a meaning. Information, which is shared with key suppliers and customers, needs to be regarded as relevant and pertinent by the focal firm who is sharing selected information. Information can consists of processed data, raw data and facts or whatever a focal firm finds relevant. The Figure 1 illustrates relation between data, information and knowledge by Boddy et al. 2005, 9-10.

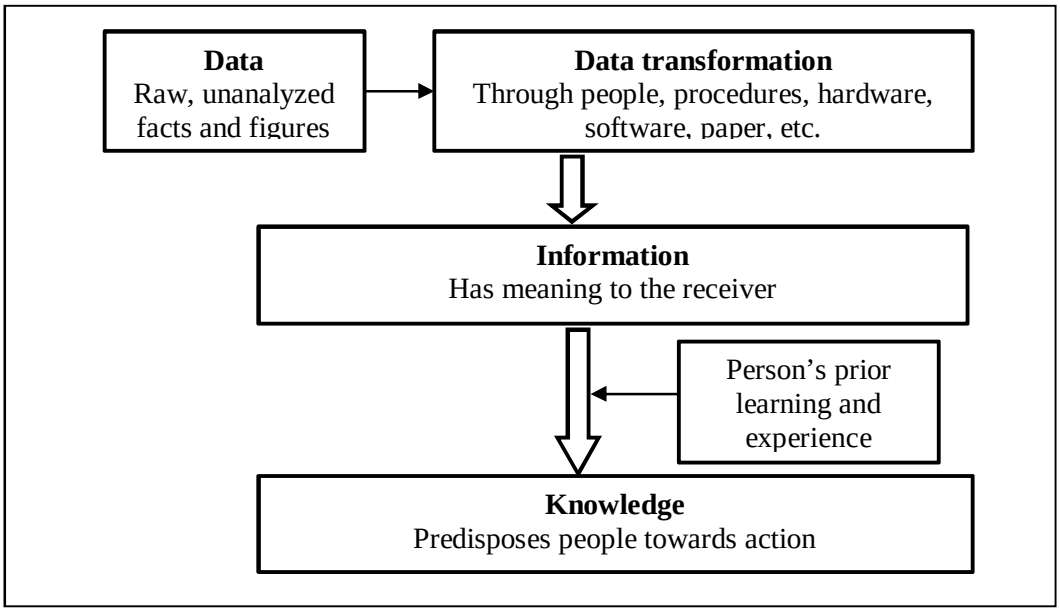


Figure 1 Links between data, information and knowledge (Boddy et al. 2005, 10)

Knowledge on the other hand, is a lot more difficult to define. According to Boisot (1998, 12) "*Knowledge builds on information that is extracted from data*". Boddy et al. (2005, 9) add by illustrating that knowledge is property of people and it causes them to act in a certain way. In addition, prior knowledge shapes a person's understanding, experience and learning. (Boddy et al. 2005, 9-10.) Although knowledge and knowledge sharing are significantly inter-related to concepts of information and information integration, these two concepts have been excluded from the focus of this study.

2.2 Competitive environment sets a need for collaboration and information integration in supply chains

Today's highly competitive environment sets several challenges on organizations. Stock et al. (1999, 224) have acknowledged that in order for the organizations to survive in the

competition, they have needed to reorganize their activities and realign their global strategies. Organizations have moved from vertically integrated single-site facilities to globally and geographically dispersed networks of resources. In order to respond to the "windows" of market opportunities, organizations need to have formed horizontal links and include strategic partners to the firm's own structure of networks. (Stock et al. 1999, 224.) One way to tackle the challenges set by the environment is to integrate, coordinate and collaborate

The traditional perspective of doing business has been based on transactional relationship, with only little focus being set on information sharing and integration as important aspect in the relationship. In the end of the 1980's and 1990's significant changes took place. During the 1980's, the concept of supply chain management (SCM) was introduced in accordance with information integration. The idea was to improve business processes by paying attention to open sharing of information with other firms in the same supply chain. This would, in return, lead to cost reductions and improved performance. (Skjoett-Larsen, Thernoe & Andresen 2003, 531.)

Information integration and more precisely information flow are essential to collaboration and integration of supply chain management. Simchi-Levi et al. (2008, 1) define supply chain management as "*a set of approaches utilized to efficiently integrate suppliers, manufacturers, warehouses, and stores, so that merchandise is produced and distributed at the right quantities, to the right location, and at the right time, in order to minimize system wide cost while satisfying service level requirements*". This definition is rather comprehensive and takes into consideration the most important aspects of supply chain management. When speaking of supply chains, terms logistics or logistics networks (Simchi-Levi et al. 2008, 1) are often used interchangeably with the supply chain aspects. Instead of focusing on improved supply chain performance, this thesis will be dealing with improved logistics performance. The terms are used interchangeably in research literature. Logistics is defined by Lowe (2002, 147) as "*Total concept covering the planning and organizing of the supply and movement of materials/goods, etc. from original source through stages of production, assembly, packing, storage, handling and distributing to the final consumer*". Observing these two concepts and their definitions, a clear link and interchangeability does exist. Many researchers (e.g. Cooper, Lambert & Pagh 1997, 1) have acknowledged that in current supply chains, there is definitely a need for business operations that go beyond traditional logistics.

To tackle the challenges set by the environment, firms need to integrate, coordinate and collaborate. Integration is an important aspect for the success of the supply chain (van Donk & van der Vaart 2004; 2005a; 2005b). Supply chain integration (SCI) is a term used to describe the existing integration of actors, flows, processes and activities, and information technologies and systems (Fabbe-Costes & Jahre 2008, 135). Supply

chain integration can be challenging and difficult for the supply chain members to manage because of its complex nature – it is challenging to manage a wide network of different facilities dispersed over a large geography. According to Stank, Keller and Daugherty (2001, 31) partnership-type arrangements, which create highly competitive supply chains, need more than just arm's length interactions. O'Leary-Kelly and Flores (2002, 226) state that, "*integration refers to the extent to which separate parties work together in a cooperative manner to arrive at mutually acceptable outcomes. Accordingly this definition encompasses constructs pertaining to the degree of cooperation, coordination, interaction and collaboration.*" These definitions emphasize the importance of integration between different operations, strategies and the work force. According to van der Vaart and van Donk (2004, 21) the goal of integration is to remove barriers to ease the flow of materials and information. Collaboration and coordination lay foundation for information integration and information sharing.

As a result, the lack of integration can lead to lower levels of organizational performance and increase in working at cross-purpose tasks (Pagell 2004, 459). Increased collaboration and integration in supply chains enhances service performance and reduces total costs. The growth of IT, Internet and E-commerce has increased opportunities to integrate supply chains. Overall, integration, collaboration and coordination are essential to organizations and firms. With the help of these, organizations can be able to enhance and improve their performance. (Stank et al. 2001, 31-32.) The Table 1 below summarizes various concepts relating to SCI and information integration that are referred in this thesis.

Table 1 Essential concepts relating to information integration

Author	Definition
Integration **O'Leary-Kelly & Flores (2002)**	Integration refers to the extent to which separate parties work together in a cooperative manner to arrive at mutually acceptable outcomes. Accordingly this definition encompasses constructs pertaining to the degree of cooperation, coordination, interaction and collaboration.
Supply chain integration **Fabbe-Costes & Jahre (2008)**	SCI is defined based on aspects that have to be integrated. These are integration of flows, integration of processes and activities, integration of technologies and systems and integration of actors.
Supply chain integration **van der Vaart and van Donk (2004)**	Integration is defined as removing barriers to ease the flow of materials and information.
Information integration **(Uusipaavalniemi 2009; Uusipaavalniemi & Juga 2009b)**	Information integration is the foundation for supply chain integration. It is formed of six elements: processes and activities, information technology in use, information attributes, information sharing practices, collaborative foundation and time-related issues.
Information integration **(Lee & Whang 2000)**	Sharing of pertinent data and information among the supply chain partners.
Information sharing **Carr & Kaynak (2007)**	Sharing of critical information between a supplier and a buyer that is detailed enough, frequent enough and timely enough to meet the requirements of the firms.

Supply chain integration and information integration has been studied from variety of different perspectives and has been defined in numerous ways (Fabbe-Costes & Jahre 2008, 131). Pagell (2004, 460) states that many authors who have studied integration offer no formal definition of construct. Fabbe-Costes and Jahre (2008, 131) acknowledge that a better understanding of the concept of integration, its dimension and

implications, as well as its academic importance can contribute to theory-building in logistics, operations and supply chain management.

2.3 Elements of information integration

A firm can share information with its key customers, suppliers or with the entire supply chain as supply chain integration highlights. Firms collaborate with their external partners, key suppliers and customers to enhance their operations. Information integration is important and lays foundation for collaboration and actual sharing of information that is considered an essential part of integration (van der Vaart and van Donk 2004; 2005a; 2005b; Stock et al. 1999; Fabbe-Costes & Jahre 2008; Uusipaavalniemi 2009). Information integration and information sharing are often used interchangeably in the research literature. This is profound since sharing information and integrating information are eminently inter-related and intertwined with each other. (Uusipaavalniemi 2009, 14.) Information sharing with key customers and suppliers refers to sharing of critical information between a supplier and a buyer that is detailed enough, frequent enough and timely enough to meet the requirements of the firms (Carr & Kaynak 2007, 349).

Aspects that enable information integration and information sharing vary among researchers and they are not systematically defined by the current research literature to form a holistic picture of the wide research topic. The research field focusing on information integration and information sharing is still rather mixed and fragmented despite the attention it has received. (Fabbe-Costes & Jahre 2008, 131.)

The elements of information integration discussed in this thesis are drawn from Fabbe-Costes's and Jahre's (2008, 135) literature research findings of supply chain integration (SCI). The elements or layers, as Fabbe-Costes and Jahre (2008, 135) identify them, are integration of flows (1), integration of processes and activities (2), integration of technologies and systems (3) and integration of actors - structure and organizations (4). The four elements are applied as they have been outlined by Fabbe-Costes and Jahre, except for the integration of flows which in this context focuses only on the flow of information, excluding material and physical flows. To support and illustrate the complexity of the four integrative elements, Uusipaavalniemi (2009, 33) states that information integration and information sharing need information technologies and systems to enable efficient information flow. Processes and activities support the smooth flow of information from a supplier or customer towards the focal firm and vice versa. Finally, the willingness and commitment of actors (collaboration foundation) lays foundation for the actual integration and exchange of information. (Uusipaavalniemi 2009, 33.)

Aside to Fabbe-Costes's and Jahre's integration elements, Uusipaavalniemi (2009) discusses six different elements which lay the foundation for information integration. The six elements are processes and activities, information technology in use, information attributes, information sharing practices, collaborative foundation and time-related issues. The elements of information integration by Uusipaavalniemi (2009) are illustrated in the Figure 2 below. By paying attention the six elements, firms are able to increase the level of information integration.

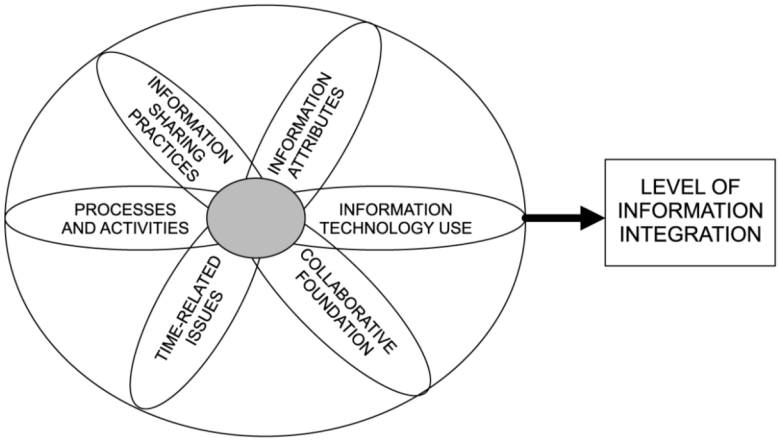


Figure 2 Information integration (Uusipaavalniemi 2009; Uusipaavalniemi & Juga 2009b)

Some of the elements identified by Uusipaavalniemi (2009) and Uusipaavalniemi and Juga (2009b) are included in the four elements defined by Fabbe-Costes and Jahre (2008). The collaboration foundation is included in the actor element. Information sharing practices and time-related issues of integrating information are considered to be part of the 'information technologies and systems' element. Information attributes (characteristics of information) are highlighted in the flow of information. The four information integration elements by Fabbe-Costes and Jahre (2008) will be discussed in the next four sub sections and form part of the theoretical frame of reference.

2.3.1 Information technology and systems

Information systems, information technology and the use of information and communication technology (ICT) have shaped organizations and ways to share information. Firms use information systems, enterprise resource planning (ERP) systems, electronic data interchange (EDI), software applications or other types of information technology based systems to provide business managers the information they need for decision-making. (Boddy et al. 2005; Garrido Azevedo et al. 2008.)

Information integration with partners can also take place via a cloud service where software-as-a-service (saas) or platform-as-a-service (paas) type of services are most commonly used (Pervilä 2012).

Due to the wide variety of information technologies and systems used for sharing information, it is challenging to define what is meant with the term 'information technologies and systems'. This thesis considers the term 'information technologies and systems' to include information systems and information communication technology based systems, solutions and software which facilitate information integration and information sharing among organizations. As several authors have acknowledged over the past decades, utilization of integrated information systems for managing supply chains will not just enhance quality but they will reduce delivery time and costs, as well as, increase competitiveness and generate future growth (Gustin, Daugherty & Stank 1995; Narasimhan & Kim 2001).

Information system (IS) can be defined as "*a set of people, procedures and resources that collect data which it transforms and disseminates*" (Boddy et al. 2005, 10). An information system does not only consist of software and hardware but also procedures and people are included. Therefore, an information system is a part of a wider organizational context. (Boddy et al. 2005, 10). Although information systems depend on people, are people and organizations also becoming more and more dependent on the information systems. Several reasons for this have been outlined, and according to Boddy et al. (2005, 7-8) the three main reasons are electronic coordination (E-coordination), globalization, and a need for information intense-firms. Without E-coordination (i.e. when information is coordinated and exchanged electronically) the global growth of companies would not have been as extensive as it has been and the efficient flow of information could not have been secured. (Boddy et al. 2005, 7-8.) Porter and Millar (1985, 149) highlight competitive advantages provided by information systems, and state that a proper use of information technology helps to create and maintain competitiveness of a company. In addition, Boddy et al. (2005, 16) note that information systems are an opportunity for organizations to redesign their business processes to add more value to the resources.

From logistics perspective, information systems contribute to eliminating uncertainty, reducing inventory and increasing responsiveness to customer requests (Fawcett et al. 2007, 365). In other words, information technology facilitates the replacement of inventories with information that is stored in a system and in an electronic form. After information is stored in an IS, the main challenge is to find the right information needed to support decision-making. (Sandkuhl 2009, 44.) According to Boddy et al. (2005, 26) an information system that provides people the information they need for performing their work, will support company performance.

Information sharing practices often include a technical perspective. The use of current information technology facilitates communication between a focal firm and its suppliers and customers. Carr and Kaynak (2007, 348) divide information sharing practices into two groups: to traditional methods and advanced communication methods. The traditional methods include use of telephone, fax, E-mail, written and face-to-face contact. The advanced communication methods consist of computer-to-computer links, electronic data interchange (EDI) and enterprise resource planning (ERP). Also different web-based procurement systems, electronic trading systems and supplier relationship management (SRM) systems have gained ground and are examples of advanced communication methods (Saeed et al. 2005, 336). In most cases, firms use traditional and advanced communication methods as a combination (Carr & Kaynak 2007, 348-349). EDI can be defined as "*a set of standards, hardware and software technology that permits computers in separate organizations to transfer documents electronically*" (Boddy et al. 2005, 268). Several studies indicate that the use of EDI facilitates timely and usually more accurate information exchange between firms (Banerjee & Golhar 1993, 30). This increases timeliness of information. In addition, the study of Carr and Smeltzer (2002, 293) highlights that information technology promotes and facilitates more frequent communication, interaction and information sharing between a supplier and a buyer firm. Table 2 below sums-up different information sharing practices.

Table 2 Information sharing practices (Carr and Kaynak 2007, 348)

Traditional communication methods	**Advanced communication methods**
Telephone	Electronic data interchange (EDI)
Fax	Enterprise resource planning (ERP)
E-mail	Web-based procurement systems
Written and face-to-face contact	Electronic trading systems
	Supplier relationship management systems

According to the study of Yigitbasioglu (2008, 82-83) concerning 119 Finnish firms, around 40 % use EDI, ERP systems and Web portals. The use of ERP systems, EDI and Web portals are widely used for they are cost efficient and easy to set up. Supplier Relationship Management (SRM) Software on the other hand, is still relatively low on adoption rate. (Yigitbasioglu 2008, 82-83.)

IT investments can help create different returns for firms when the investment creates dynamic capabilities for the company. According to Fawcett, Wallin, Allred, Fawcett A. and Magnan (2011, 40) information needs to be accessible at a right time. Therefore, creating IT capabilities that suit to the firm's interests and which can improve connectivity with key customer, suppliers and supply chains are essential. For

example tools such as bar codes, Radio Frequency Identification (RFID), data warehousing and data mining technologies allow managers to detect changes in trends and in the environment as well as monitor real-time customer behavior. (Fawcett et al. 2011, 40.)

Although advanced communication methods, such as EDI and other Web-based trading systems provide additional opportunities for firms to share information, they do not replace the traditional face-to-face communication that is still regarded highly when communicating (Wognum, Fisscher & Weenik 2002, 341). Pagell (2004, 479) considers that IT is still not a substitute for face-to-face communication and supply chain integration despite its usefulness. In his research, Pagell (2004, 470) found that there is no real evidence of IT being an enabler of integration. This is in contrary with several other studies which emphasize the role of information technology and information systems as facilitating integration (e.g. Fawcett et al. 2011). However, in the case where it is difficult to arrange face-to-face communication to share information, Pagell states that (2004, 474) information systems facilitate integration and enable information exchange. He also adds that, if information systems are important for information integration and information sharing process, the systems also need to work properly and to provide correct information (Pagell 2004, 472).

2.3.2 Flow of information

Information systems enable efficient flow of data and information to which many operations depend heavily on. Supply, manufacturing and distribution operations can comprise from complex global networks where flow of orders, components and payments needs to tracked and monitored timely. Without information systems to coordinate the efficient flow of information, firms would have not been able to grow to their present scale. (Boddy et al. 2005, 7-8.)

Three different integration flows (physical, material and information) influence supply chains and are recognized by Fabbe-Costes and Jahre (2008, 135). Also Lee and Whang (2000, 374) describe information flow as being one of the three flows of integrated supply chain management. Physical and material flows between suppliers, manufacturers and customers coordinate movement of products in supply chains (Frohlich & Westbrook 2001, 186). Each of the flows is equally important but in this context, the flow of information is emphasized and it is in the focus of this research.

The direction of information flow can either be towards upstream or downstream, depending on with whom the focal firm is sharing information and integrating its activities. Information flow most often follows the direction of the integration. Coordination of information technologies and the flow of data from suppliers and

customers are essential to information integration. (Frohlich & Westbrook 2001, 186-191.) Figure 3 below presents information integration and delivery integration. In the figure below, information integration presents the backward flow of information towards suppliers, and the delivery integration presents the forward flow of deliveries towards customers.

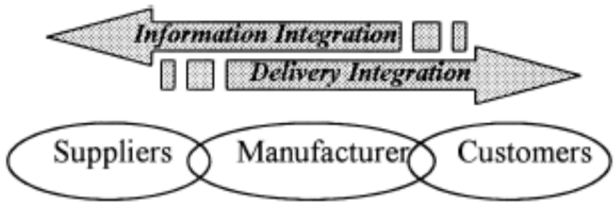


Figure 3 Direction of integration in a supply chain (Frohlich & Westbrook 2001, 186)

The flow of information can consist of whatever organizations find relevant, pertinent or useful. Information can be either strategic or operational according to the needs of the organizations. In supply chain context, information often consists of inventory, sales, demand forecast, order status or production schedule information. (Lee & Whang 2000, 373.) Also performance metrics and capacity information is shared. By sharing performance metrics information (product quality, lead times, queuing delays at work stations and service performance) firms can identify bottlenecks in the supply chain and improve overall performance. Capacity information on the other hand, is shared to mitigate potential shortages, to better coordinate and prepare for shortages, and to reduce the bullwhip effect. (Lee & Whang 2000, 380-381.) To assist the empirical part of this study, information is considered from ordering process, operational and strategic perspectives.

Information can be presented in a variety of different forms. EDI provides documents in an electric form to the supplier's or customer's system. Information can be stored in a warehouse, in an ERP system, in another enterprise software system, to which customers and suppliers have access to, or information can be exchanged by fax, Email or personal hand-over. (Boddy et al. 2005, Carr & Kaynak 2007; Fawcett et al. 2011.)

Validity of information is important. Information does not have much value if it isn't reliable or if its validity is poor (Moberg, Cutler, Gross & Speh 2002, 758). Therefore, quality of information is essential and it has been studied from different perspectives such as accuracy, timeliness and proper formatting (Closs, Goldsby & Clinton. 1997; Gustin et al. 1995). For example Closs et al. (1997, 14) state that information must be accurate, timely and properly formatted to facilitate its usage. Accuracy of information

indicates available information being error free. Timeliness refers to information being currently relative to a situation. Information is properly formatted when the information layout is designed to bring together different data needed. Availability is another important determinant of information quality. Availability indicates that information can be accessed whenever needed and wherever desirable. Current information systems and information technology have enhanced availability of information. (Closs et al. 1997, 9.)

2.3.3 Collaboration (integration of actors)

The third element consists of collaboration and the integration of actors. Although information systems and efficient flow of information enable information integration, external collaboration with partner firms lays foundation for more intensive information integration. Researchers (e.g. Stank et al. 2001, 39) have stated that external collaboration on its own might not enhance firm performance and that internal collaboration needs to be considered as well. Therefore, collaboration is needed both within and beyond firm boundaries. Also moving from arms-length and adversarial attitudes to a partnership type of a relationship will foster cooperation and increase free information exchange. (Stank et al. 2001, 39.)

Firms share different kind and amount of information with different suppliers and customers – more information is shared with some than others. One criterion is the value of information. Bagchi, Ha, Skjoett-Larsen and Soerensen (2005, 288) found in their study that much of information is shared on “need-to-know” basis. In other words, information transparency is selective. Therefore, firms share information if they find value in it. The recipient of the information is most often interested in the information if it is useful to them. (Bagchi et al. 2005, 288.)

Management initiatives for collaboration and sharing information can vary according to the importance of the customer’s or supplier’s products or components. Kraljic (1983, 112) presented a well-known purchasing portfolio approach which describes the need for managing different types of purchasing products and external relationships. The portfolio indicates the importance of the relationships with specific items’ suppliers and/or customers. Kraljic states that a portfolio can be divided into four categories: bottlenecks, non-critical items, leverage items and strategic items depending on two variables, supply market complexity (supply risk) and financial impact of the purchase (profit impact). The portfolio is presented in Figure 4 below.

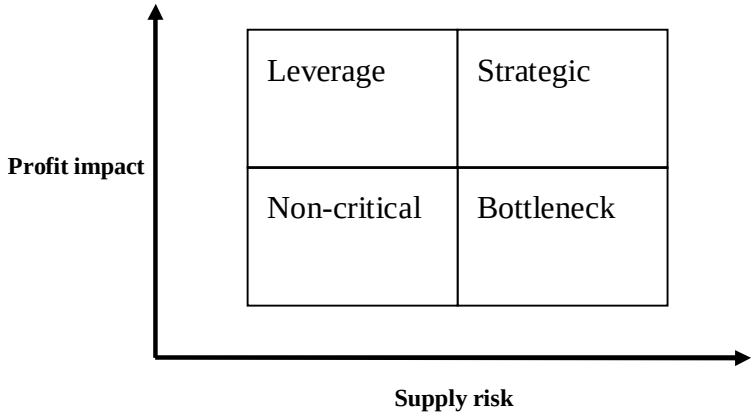


Figure 4 Categories and dimensions in Kraljic model (1983, 112)

According to Kraljic's portfolio model (1983), a firm will try to establish collaboration with those suppliers whose products are strategic for either purchasing or selling. On the contrary, if there is only a little need for close collaboration and cooperation, as in the case of non-critical items, strong collaboration and information integration between external partners might not be strived or are not beneficial to the focal firm. In addition, van Donk and van der Vaart (2005a, 102) state that if firms in a business-to-business (B2B) relationship value their relationship as being strategically important and supply chain uncertainty is high, firms will try to pursue a more collaborative relationship and share resources, such as information.

The scope of integration i.e. the nature and number of organizations and participants in supply chain varies (Fabbe-Costes & Jahre 2008, 135). Fabbe-Costes and Jahre classified five different perspectives in which organizations and participants have been included. Below are presented the different choices for external collaboration (Fabbe-Costes & Jahre 2008, 135). The relationship under examination in this study is the limited dyadic relationship.

- *Limited dyadic downstream:* Integration between the focal firm and its customers
- *Limited dyadic upstream:* Integration between the focal firm and its suppliers
- *Limited dyadic:* Integration between the focal firm, and on the one hand its customers, and on the other its suppliers (i.e. both up- and downstream, but separately)
- *Limited triadic:* Integration of suppliers, focal firm and customers (without differentiating upstream and downstream relationships)
- *Extended:* Integration between more than three parties along the supply chain (e.g. includes customers' customers, suppliers' suppliers or other stakeholders)

Bagchi et al. (2005, 287) noticed in their research that although information is shared, very few seem to give access to suppliers or customers to the focal firm's ERP system or access to sensitive areas such as design or strategic decisions. In many cases, the lack of trust hinders information integration. (Bagchi et al. 2005, 287). Mutual trust between a firm and its key suppliers and customers is important when firms share information and collaborate on higher levels. According to van Donk and van der Vaart (2005a, 99) mutual trust is a necessity for integrating activities between firms. When companies are willing and able to share vital and exclusive decision-making information, can mutual trust be established and collaboration promoted (Fawcett et al. 2007, 359). In addition, the amount of commitment increases as the relationship between a focal firm and its supplier or customer strengthens and deepens (van Donk & van der Vaart 2005a, 101-102).

2.3.4 Integration of processes and activities

The personnel working in the interfaces of the firms are in essential roles in the external collaboration and information exchange process (Stank et al 2001, 40). According to Boddy et al. (2005, 270) process is "*a set of logically related tasks performed to achieve a defined business outcome*". In the information exchange process, people collect the necessary information or intelligence, they enable the contact to the trading partner firm and they enable coordination of operations across business entities and activities. In order to accomplish these tasks, the personnel needs be informed and educated - they need to be able to ask the right questions and define what information is needed. (Stank et al. 2001, 40.) By using EDI or other IT-based information sharing techniques and practices, a focal firm is able to link its internal business processes to the customer's and supplier's processes. (Lee & Whang 2000; Boddy et al. 2005; Saeed et al. 2005; Fawcett et al. 2011.)

As the integration of processes and activities deepens, managers need to be aware of the integrative practices that could benefit their circumstances the best, and how to start linking their business processes to supplier's and customer's processes (van Donk & van der Vaart 2005a, 98). Collaboration and information sharing directs more resources, both financial and human, on operational business processes. This allows more informed decision-making and reduces risks. The benefits of integrating processes and activities are wide and result in a win-win situation which should enhance and improve service performance. (Stank et al. 2001, 39-40.)

There is some evidence that linking business processes to suppliers' and customers' is a prerequisite for success. According to Frohlich and Westbrook (2001, 185), manufacturers who have combined their internal processes to their suppliers' and

customers' processes in unique supply chains have been more successful than those manufacturers who have not integrated their processes. In general, information integration is often linked to process improvement (Lee & Whang 2000, 379) or to process redesign (Boddy et al. 2005, 16). Streamlining the process and increasing the amount of information have been seen as integrative practices (van Donk & van der Vaart 2005a, 100).

There are several ways for the focal firm to execute and link business processes to include suppliers' and customers' processes. The activities and practices related to information integration process need to be linked together among the collaborating firms. Information integration with downstream operators can be executed through Quick Response (QR) or Efficient Consumer Response (ECR). Also Vendor-Managed Inventory (VMI) and Continuous Replenishment Programs enable information integration with key suppliers. (Lee, So & Tang 2000, 627).

In 1995, the concept of Collaborative Planning, Forecasting and Replenishment (CPFR) was introduced as the integration between partners became stronger and a more comprehensive picture of the integration needed to be formed (Skjoett-Larsen et al. 2003, 531). Skjoett-Larsen et al. (2003, 531) define CPFR as "*collaboration where two or more parties in the supply chain jointly plan a number of promotional activities and work out synchronized forecasts, on the basis of which the production and replenishment process are determined*". This definition of CPFR entails the importance of shared information and collaboration on higher levels. Implementation of a CPFR is a dynamic process. In the beginning, it can include only a few processes but as the number of business processes and shared information increases, so does the need for higher levels of integration as well (Skjoett-Larsen et al. 2003, 533).

2.4 The extent of information integration

The extent of information shared in supply chains has expanded and continues to do so (Lee & Whang 2000, 381). Van Donk and van der Vaart (2005a, 99) have investigated information integration in supply chains. They have discovered three dimensions affecting on integration. These are *scope, level and direction of integration*. The essential idea behind their research is that removing barriers and boundaries is crucial in SCM. This can be achieved by integrating activities on number of different areas (scope) and with certain level of intensity (level) (van Donk & van der Vaart 2005a, 99.) In their other research, van Donk and van der Vaart (2005b, 38) recognize direction of integration as affecting on the integration. According to the researchers, these three aspects reflect a rich and multidimensional integration. The following three sub sections will be discussing scope, level and direction of integration more in-depth.

2.4.1 Scope of information integration

Scope, the first dimension affecting on the information integration, deals with the number of different areas on which cooperation and integration is being developed (van Donk & van der Vaart 2005a, 99). According to Bagchi, Ha, Skjoett-Larsen and Soerensen (2007, 31-33) and their comprehensive study of Nordic firms, the researchers found that firms share information on areas such as R&D, procurement, inventory management, manufacturing, distribution, supply chain design and supply chain software implementation. Cooper et al. (1997, 1) note also that marketing, product development, manufacturing and logistics have been included in the integration of business operations.

Van Donk and van der Vaart (2004; 2005a) have distinguished five dimensions of the scope. These are flow of goods (1), flow of planning and control (2), flow of organization (3), flow of information (4) and product development (5). Each of these dimensions consists of different integrative practices which add scope to the integration. Flow of goods includes integrative practices such as packaging customization, common containers and VMI. Planning and control includes joint forecasting or planning and multi-level supply control. With flow of organization the researchers are referring to partnership, quasi and virtual firm type of arrangements. Flow of information consists for example of sharing production plans, EDI and bar codes. Product development includes information shared on technical details, mutual involvement in product development and process improvement. (Van Donk & van der Vaart 2004; 2005a.)

Uusipaavalniemi (2009, 52) notices that the dimensions of scope mentioned by van Donk and van der Vaart (2004; 2005a; 2005b) have some similarities to the four layers identified by Fabbe-Costes and Jahre (2008). Although in the context of this research and in the dissertation of Uusipaavalniemi (2009), the same layers are referred as elements of integration, some similarities do exist. By observing the dimensions of scope according to van Donk and van der Vaart (2004; 2005a), it can be stated that the more the scope is extended, the more integration there is. If all the information integration elements would be included in the information sharing process, the scope of the information integration would presumably and referring to previous studies, be greater than in a situation where information is provided only through straightforward EDI transfer and no integration of processes, people or activities were needed to establish. As also demonstrated in the literature review of Fabbe-Costes and Jahre (2008), the definition of scope is unclear. In the current research literature, scope of integration has been characterized as using concepts of level, stage, degree, arc, type and supply chain structure. (Fabbe-Costes & Jahre 2008, 143.)

2.4.2 Level of information integration

The level of integration can be described as intensity or depth, or as the extent of how much an integrative activity is being developed (Frohlich & Westbrook 2001; van Donk & van der Vaart 2005a). The level of integration is applied to all the areas to which the scope is extended. The level of integration has been discussed in the literature by using a variety of different terms. Fabbe-Costes and Jahre (2008, 143) noted that the level has been called as the degree, stage, intensity, capability, etc.

Reasons for having higher levels of information integration with some suppliers and/or customers than others depend on many things. The amount or level of integration needed depends on the extent of uncertainty within the supply chain (van Donk & van der Vaart 2005a, 100). Also the products or components of the key supplier might be critical for the focal firm's operations and therefore higher levels of information integration might be pursued (Kraljic 1983, 112).

There are various ways in which researchers have distinguished the levels of integration. Bagchi et al. (2005, 283) have described the level of collaboration (i.e. integration) in three stages: low, medium and high. Van der Vaart and van Donk (2004, 26) have identified three stages which describe the level of integration. The stages are transparency stage, commitment/coordination stage and integrative planning stage. The stages are presented in the Figure 5 below.

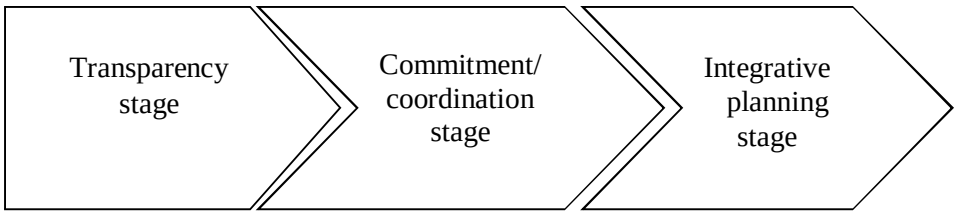


Figure 5 Stages in level of integration (van der Vaart & van Donk 2004, 26)

The three stages are identified as follows (van der Vaart & van Donk 2004, 26-27).

- *The transparency stage:* The supply chain members share relevant information on inventories, demand, promotions, etc. but information is shared without any form of commitment. The mayor barriers at this stage are incompatibility of information systems and the fear that information shared is being misused by one of the channel members.
- *The commitment/coordination stage*: In this stage, the supply chain members share all relevant information and information is shared with commitment. Coordination is more advanced than in the first stage. Same barriers apply for

this stage as was mentioned in the transparency stage, but mutual trust is stronger than in the first stage.

- *The integrative planning stage*: Major decisions have been centralized in this stage, and the supplier uses its critical resources no more than on a few buyers i.e. major barriers are formed if same supplier is supplying to too many buyers instead of focusing on only a few important ones.

These stages present the levels of information integration. Van der Vaart and van Donk (2004, 27) note that the stages are rather overlapping than exclusionary and that a firm might be "located" between two different stages. According to Bagchi et al. (2005, 288) larger firms were more willing to give their suppliers an access to detailed information than smaller firms were.

2.4.3 Direction of information integration

The direction was briefly mentioned when discussing information flow (in the chapter 2.3.2). Van Donk and van der Vaart (2005b, 38) identify the direction as being the last aspect of integration. The direction illustrates the movement to which shared information is going and integration is directed: downstream from the suppliers or upstream from the customers. It depends on a firm's individual interest whether it is more directed towards downstream or upstream in the supply chain. (Van Donk & van der Vaart 2005b, 38.)

Frohlich and Westbrook (2001, 190-191) identified five integration strategies or arcs of integration depending on the direction. These strategies illustrate the direction of information integration and with whom information is shared. In addition to describing the direction, the strategies by Frohlich and Westbrook influence the degree (i.e. the level) of information integration. The first direction strategy is inward-facing which consists of the loosest degree of integration between customer and supplier, whereas, in periphery-facing the degree of integration is slightly higher. In the supplier-facing and customer-facing the degree of integration is higher and directed more towards either the supplier side or the customer side. Finally in the outward-facing, integration is extended to include both wide supplier side and wide customer side in the integration. This latter form consists of high levels of integration. (Frohlich & Westbrook 2001, 190-191.) Figure 6 below illustrates two different arcs (i.e. strategies of integration). These are the supplier-facing integration and the most extended outward-facing.

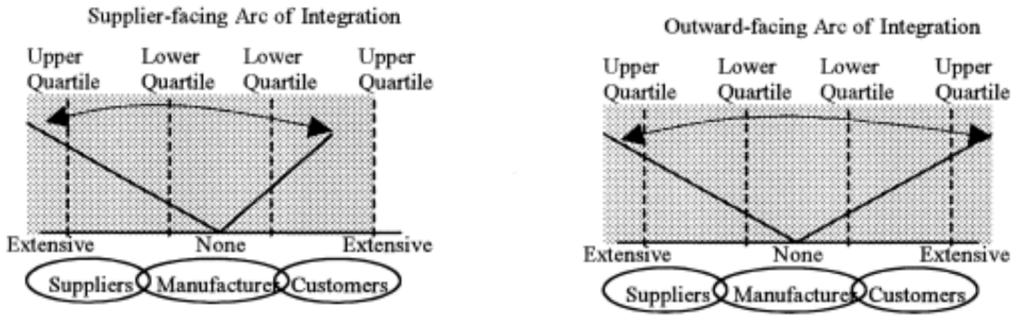


Figure 6 Supplier-facing and outward-facing Arcs of Integration (Frohlich & Westbrook 2001, 191)

As can be noted from the figure above presenting the supplier-facing arc, a firm is interested in integrating its' activities and processes and extending information integration to include several suppliers. In the outward-facing arc, both extended supplier and extended customer side are included. Fawcett and Magnan (2002, 344-345) use a similar kind of characterization in their research. Integration towards downstream is called backward integration and integration directed at customer side is called forward integration. According to Fawcett and Magnan (2002, 345) backward-forward integration (i.e. outward-facing by Frohlich and Westbrook 2001), where both supplier and customer side were included, is considered rather a rare case and more of a theoretical ideal than a real life phenomenon.

2.5 Facilitating information integration with the use of information technology and systems

Firms seek ways to improve their performance and guarantee a smooth flow of information towards their suppliers and/or customers. Understanding information integration context might help firms in setting practical ways to achieve integration as the barriers and drivers for integration are better identified (Uusipaavalniemi 2009, 167). According to Lee and Whang (2000, 373) information integration have greatly been facilitated by the advanced information technology.

To facilitate information integration, the practices behind the actual information sharing process need to be identified in order develop them. Uusipaavalniemi (2009, 151) found that procedures of information sharing and information utilization were the prime cause of problems related to information integration. (Uusipaavalniemi 2009, 151.) Providing a description of information sharing and identifying the development areas related to it was perceived useful among the firms she researched. The lack of common procedures and shared systems clearly restricted the quantity of information shared. In other words, information integration could have been enhanced if information

sharing procedures and practices would have been better identified. (Uusipaavalniemi 2009, 168.) In addition, long-term co-operation is expected to create more commitment and provide more incentives for information integration (Uusipaavalniemi 2009, 136).

Information users were also an equally important cause for problems related to weak information integration. Other problems found were that information was dispersed in different information systems, information did not flow fast enough and information did not reach all. (Uusipaavalniemi 2009, 151.) Information should provide the visibility that is needed for decision making. In order to truly benefit from integrating information, firms need access to the necessary information, they need to collect it and analyze it. In other words, they need to utilize it. (Simchi-Levi et al. 2008, 414.)

Although information systems were seen as a potential solution (development tool) for problems derived from the two previously mentioned factors: information users and information procedures, information systems are still causing problems at many cases. Information systems however reduce the possibility of human mistakes. (Uusipaavalniemi 2009, 150-151.) According to Saeed et al. (2005, 365) inter-organizational information systems (IOIS) facilitate boundary-spanning activities of a firm. These systems enable firms to manage different forms of buyer-supplier relationships. Saeed et al. (2005, 387) found in their study that an integrated inter-organizational information system not only automates processes such as order processing, but it also enables the firms to undertake joint planning and forecasting to gain efficiency benefits by using information technologies and systems.

Saeed et al. (2005, 388) highlight that one good example to integrate information systems and gain benefits from it, is to go beyond traditional supplier relationship management systems. Different supplier Webs are an example of this. Supplier Webs are Internet-based systems which are managed by the focal company wanting to share information. They can be integrated to the focal firms ERP system. Supplier Webs enable suppliers and partners to have access to real-time planning information, purchasing information, material releases, in-transit information, cumulative receipt information, reclamations, purchase approval status and shipments. Depending on the applications and different functionalities, suppliers and partners are also able to share their updated information and shipment information. (Saeed et al. 2005, 388). In addition, Lin et al. (2002, 258; 268) suggest that various extranet technologies facilitate information integration. With some suppliers and/or customers, information is shared on lower levels, whereas, with others on higher levels i.e. more detailed information is shared. (Lin et al. 2002, 258; 268.) Therefore, this indicates that scope, level and direction of information integration can be further extended by using information technologies and systems with selected customers and/or suppliers.

Furthermore, Humphreys et al. (2001, 252) researched inter-organizational information systems. According to them, customers of a focal firm cannot be forced into

using IOIS, whereas, suppliers can be. Customers need to be encouraged into using an IOIS provided to them by the focal firm. The IOIS needs to offer customers specific strategic advantages and useful information (e.g. monitoring of incoming shipments) before they are willing to use it. However, towards upstream and suppliers, the focal firm may have more bargaining power and therefore oblige them into using the IOIS to improve strategic advantages. (Humphreys et al. 2001, 252-254.) In many cases, unprompted and a mutual understanding of common goals might encourage and facilitate both upstream and downstream parties into using IOIS

By understanding organizational and supply chain (context) needs and providing a process description of information sharing practices, firms can be able to achieve higher levels of information integration (Uusipaavalniemi 2009, 167-168). In addition, understanding the role of information technologies and systems, as a facilitator of external information integration, might help firms better develop those information sharing practices and mechanisms that suit for them best and look for industry best practices.

3 INFORMATION INTEGRATION AND LOGISTICS PERFORMANCE

The desired outcome of sharing and integrating information is to improve overall firm performance (e.g. Lee & Whang 2000; van der Vaart & van Donk 2004). Performance, in the field of logistics and supply chain management, is considered a complex concept, mainly due to its multiple goals. There are numerous issues affecting on which performance improvements firms want to achieve first and foremost. The desired outcomes and benefits which firms want to gain by sharing and integrating information and activities are broad. Some of the main benefits of information integration in terms of logistics performance are outlined in this chapter.

The first section of this chapter deals with the impact of information integration and information sharing on improved logistics performance. In the second section, ways of measuring performance will be discussed. The third section of this chapter pays attention to the means of how to enhance logistics performance by sharing and integrating information, especially when the use of information technologies and systems facilitates the process. The fourth section sums-up the theoretical frame of reference.

3.1 Improved logistics performance and competitive advantage

Performance improvements have been considered and observed from wide range of perspectives: from supply chain's perspective, from a single firm's perspective, from a business unit's or from a single plant's perspective. (Fabbe-Costes & Jahre 2008, 139.) What activities and processes firms want to improve, depends highly on an individual firm's position and role in the supply chain and on one's own aspiration. According to Stock, Greis and Kasadra (2000, 545) certain industries achieve improved performance focusing on distribution and outbound activities, whereas for others, inbound logistics and sourcing activities are in the main focus. In addition, competitiveness and intensiveness of the environment or specific industry and the characteristics of manufactured products affect in different ways. According to Sengupta et al. (2006, 13) the extent of information integration could have a greater impact on firms operating in service sector than in manufacturing sector.

Fabbe-Costes and Jahre (2008, 139) acknowledged that researchers have taken different types of performance improvements into account over the recent years when discussing the benefits arising from supply chain coordination and information integration. The improvements vary from *operational to strategic and financial*. Operational performance improvements relate to efficiency and effectiveness within the

firm's internal processes (Stock et al. 2000, 536), and they are contrasted to lower inventory levels, faster response time, better service quality and lower logistics costs. By sharing performance metrics information (e.g. product quality, lead times, queuing delays at work stations and service performance) firms can identify bottlenecks and improve overall performance (Lee & Whang 2000, 380-381). By sharing demand, capacity or inventory information with key suppliers and customers, firms are able to shorten order fulfillment cycles, decrease inventory levels, improve co-ordination of supply chain activities, as well as increase service levels and demand forecasting. (Lee et al. 1997; Chen 2007; Lee 2000). Also flexibility performance can be enhanced by paying attention the scope and level of information integration (van der Vaart & van Donk 2004, 28). Financial and strategic outcomes are more likely to include improvements in competitive position, profitability, growth, customer value and even customer satisfaction. (Fabbe-Costes & Jahre 2008, 139.)

The extent of information integration is acknowledged to have (Lin, Huang & Lin 2002; Sengupta, Heiser & Cook 2006) and not to have potential effects on performance (Fabbe-Costes & Jahre 2008, 139). Several researchers have argued that the higher the level of integration and information sharing are, the better (Frohlich & Westbrook 2001; Bagchi et al. 2005; Stank et al. 2001), whereas, some have argued that the impact is insignificant (Min & Menzer 2004; Fawcett et al. 2007; Fabbe-Costes & Jahre 2008).

Increasing the extent of information integration in supply chains is stated to improve order fulfillment rate and cut order cycle times. Operational performance (speed, delivery, quality) has been positively affected by the greater information integration in a supply chain. Also lower inventory costs can be achieved with greater information sharing (Lin et al. 2002, 267). This might indicate that higher levels of integration are needed in order to achieve more efficient processes and desired performance improvements. Also customer service has been outlined to have potential performance improvement when information integration is extended or has increased (Sengupta et al. 2006, 13).

On the other hand, researchers such as Sahin and Robinson (2005, 592) regard that integration at different levels contributes to enhanced performance, but that the role of information sharing accounts only a portion of this. Sahin and Robinson (2005, 592) argue that: "*the major benefit of supply chain collaboration comes from improved coordination, while information sharing unlocks only a small portion of the potential benefits associated with channel integration*". This interpretation diminishes the value of information sharing but also highlights that human interaction and proper coordination of activities are important factors influencing integration. Also Pagell (2004) has highlighted importance of face-to-face communication.

Whereas several researchers have argued that the higher the level of integration and information sharing the better (Frohlich & Westbrook 2001; Stank et al. 2001; Bagchi et

al. 2005), some implications of empirical studies suggest that there is still a need for a cautious interpretation. Uusipaavalniemi (2009, 16), Fawcett et al. (2007, 358) and Fabbe-Costes & Jahre (2008, 140-142) underline that only a few firms have been able to enhance supply chain performance despite they have integrated information and activities in the supply chain. According to Min and Menzer (2004, 81) the link between supply chain integration and performance exists but the link "*is significant but weak*". (Min & Menzer 2004, 81.) The findings of Stank et al. (2001, 39) reveal another interesting aspect. According to the researchers, intra-organizational (internal) collaboration improves logistics performance, whereas, they argue that external collaboration with suppliers and customers does not improve performance. However, the researchers add that external collaboration is positively influenced by internal collaboration, which in return, improves logistics performance. Therefore, best practice firms focus on both aspects, internal and external collaboration. (Stank et al. 2001, 39.) It can be concluded that achieving enhanced logistics performance by integrating information and activities in the supply chain, can be open to various interpretations.

3.2 Logistics performance metrics

Cost efficient operations are often regarded as a sign of improved performance. Lynch, Keller and Ozment (2000, 48) link logistics competencies and capabilities to overall strategic firm performance and conclude that performance can be measured with operational measures as well as with financial and strategic measures. Fabbe-Costes and Jahre (2008, 136) note that there is a need for a mixture of approaches and measures to be used when measuring logistics and supply chain performance. Therefore, it's essential to include both strategic/financial and operational measures when measuring performance. There is also evidence that larger firms track their performance more than smaller firms. One reason for this is that they tend to be more aware of the SCM concepts than smaller firms. (Bagchi et al. 2005, 288.)

Operational measures of performance relate to measuring efficiency and effectiveness of the internal logistics and manufacturing processes within a firm. Operational measures include for example operational costs, delivery speed, delivery reliability, quality and flexibility. (Stock et al. 2000, 536.) Also measures such as inventory level, response time and service quality are recognized by several researchers (Fabbe-Costes & Jahre 2008, 139).

Financial and strategic measures reflect to factors that impact the firm from outside the firm's boundaries. Therefore, strategic and financial measures include conventional indicators of business performance. These measures are for example market share, return on investment and sales growth. (Stock et al. 2000, 536.) In addition, strategic

outcomes such as improved competitive position, improved profitability, increased customer value and better customer satisfaction can be considered as measurements of improved strategic or financial performance (Fabbe-Costes & Jahre 2008, 139).

To be able to integrate information, firms need to recognize and evaluate the benefits arising from integrating information (Chen et al. 2007, 499; 510). Performance measurement and metrics have an important role when setting objectives and goals, evaluating performance and determining future consequences and actions taken (Gunasekaran, Patel & McGaughey (2004, 333). Gunasekaran et al. (2004, 345) developed a framework for measuring supply chain performance. The framework consists of strategic, tactical and operational metrics. The strategic level measurements influence the top management and firm policies, tactical level measurements deal with resource allocation and measuring performance against objectives, whereas, operational level measurements require data from the firm's different activities and lower management decision-making. (Gunasekaran et al. 2004, 335.) The Table 3 below presents the most important performance metrics of four main logistics activities. Variety of performance measurements for plan, source, make and assemble, and deliver are presented below.

Table 3 Performance metrics (Gunasekaran et al. 2004, 345)

Supply chain activity/process	Strategic	Tactical	Operational
PLAN	Level of customer perceived value of product, Variances against budget, Order lead time, Information processing cost, Net profit vs productivity ratio, Total cycle time, Total cashflow time, Product development cycle time	Customer query time, Product development cycle time, Accuracy of forecasting techniques, Planning process cycle time, Order entry methods, Human resource productivity	Order entry methods, Human resource productivity
SOURCE		Supplier delivery performance , Supplier lead time against industry norm, Supplier pricing against market, Efficiency of purchase order cycle time, Efficiency of cashflow method, Supplier booking in procedures	Efficiency of purchase order cycle time, Supplier pricing against market
MAKE/ ASSEBLE	Range of products and services	Percentage of defects, Cost per operation hour, Capacity utilization, Utilization of Economic Order Quantity	Percentage of defects, Cost per operation hour, Human resource productivity index
DELIVER	Flexibility of service systems to meet customer needs, Effectiveness of enterprise distribution planning schedule	Flexibility of service systems to meet customer needs, Effectiveness of enterprise distribution planning schedule, Effectiveness of delivery invoiced methods, Percentage of finished goods in transit, Delivery reliability performance	Quality of goods delivered, On time delivery of goods, Effectiveness of delivery invoiced methods, Number of faultless delivery notes invoiced, Percentage of urgent deliveries, Information richness in carrying out delivery, Delivery reliability performance

As noted from the Table 3 above, performance can be measured in several ways. Highly important metrics according to the research of Gunasekaran et al (2004, 340-343) were the level of customer perceived value of product, customer query time, supplier delivery performance, percentage of defects, cost per operation hour, capacity utilization, quality performance, on-time delivery of goods and flexibility of service systems to meet customer needs.

Depending on a firm's role in the supply chain, the firm can be more focused on the inbound or outbound activities. This has an effect on the direction of integration and on what activities the firm wants to improve (Frohlich & Westbrook 2001, 190-191). For some firms, it is more suitable to measure performance metrics impacting sourcing and

manufacturing activities, whereas for other firms, delivery activities are in the focus of performance measurements (Stock et al. 2000, 545).

3.3 Enhancing logistics performance and information integration with the use of information technology and systems

According to Simchi-Levi et al. (2008, 408-409) clear links exist between firms' business processes, IT and supply chain performance. By developing more comprehensive and efficient information sharing capabilities, managers are able to improve operational and competitive performance (Fawcett et al. 2007, 359). The use of information systems and latest information and communications technology assists firms in achieving performance improvements (Garrido Azevedo et al. 2008, 7). As a result from the development of IT based systems, supply chain partners have been able to tighten coordination and optimize supply-wide performance (Lee & Whang 2000, 373).

The four elements of information integration (information technology and systems, flow of information, collaboration, and processes and activities) have an effect on firm logistics performance. Some of the potential performance effects achieved by developing information technologies and systems are also benefits achieved by developing a firm's processes and activities. (Uusipaavalniemi 2009, 85-87.) Uusipaavalniemi (2009, 85) summarizes that development of information technology should facilitate sharing of information, as well as harmonize and integrate inter-operable information systems between supply chain partners to increase electronic information integration. The use of IT and information sharing practices serve more as *tools for development*, whereas, collaboration and processes and activities serve more as a supporting functions (Uusipaavalniemi 2009, 125). She adds that there are several potential performance effects which can be gained by utilizing different information technologies and systems in information integration. The potential performance effects are broad and some of them are outlined in the list below:

- Less rework and delays
- Cost and time savings
- Reduced complexity in processes, elimination of unnecessary activities
- Improved information availability and quality
- Increased extent of information sharing
- Increased transparency/visibility in supply chain
- Improved customer service and responsiveness
- Improved collaboration (planning, joint performance and organizational changes)

As can be noted from the list, improving planning (forecasting) and increasing visibility are one of the potential outcomes of using information technology to facilitate information integration. And as Lee and Whang (2000, 376) have recognized, one major benefit arising from using advanced or modern information system technology, is to reduce chronic problems which are associated with volatile business cycles. Van Donk and van der Vaart (2005a, 98) add and emphasize that information integration with key suppliers and customers in an uncertain environment, where especially demand uncertainty is high, is important for the success of the focal firm.

Saeed et al. (2005, 389) found in their research that firms producing standardized products and facing highly competitive environment, can gain process efficiency improvements by using inter-organizational information systems (IOIS) compared to firms producing customized products and facing less competitive environment, especially when higher levels of external integration are needed. Process efficiency improvements can be achieved only if sufficient electronic information linkages have been established that support extensive information flows. (Saeed et al. 2005, 387-389.) Frohlich (2002, 538; 549-551) indicates that information integration and electronic integration (i.e. broad downstream and upstream supply chain integration using web-based technology) lead to closer integration. This is further linked to improvements in performance, productivity, inventory levels and customer service.

Collaboration is considered as one of the main antecedents behind enhanced performance, and by using information system technology collaboration can be increased and facilitated. Lee & Whang (2000, 373) note that a basic enabler for tight coordination and collaboration is information sharing, which has been greatly facilitated by the information technology. According to Fawcett et al. (2007, 360) companies who recognize the need for and invest in both connectivity and willingness should enable higher levels of performance. Fawcett et al. (2007, 362) consider that connectivity and willingness are important antecedents to improved performance.

Utilizing or taking advantage of an information system and creating value with it, are essential if firms want to gain benefits. Narasimhan and Kim (2001; 2002) state that utilization of information systems, that support the firm's infrastructure and create value, has an indirect impact on enhancing supply chain performance and logistics activities. Value is created with the help of IS utilization. The value creation has then a direct impact on SCM performance. In order for the IS to support performance, there needs to be a company requirement for an external integration. Alone, the IS cannot successfully generate improved performance for the firm. (Narasimhan & Kim 2001, 71.) Sahin and Robinson (2005, 588) also add that if the benefits derived from the use of information systems are not shared equally among all supply chain members, systems integration might not reach its' true value.

Sengupta el al. (2002, 13) recognized in their study of manufacturing and service firms, that firms use Internet to conduct a lot different type of transactions. The use of information technology is already so widespread, that it might not contribute to superior performance or performance improvements when compared to a firm's direct competitors. This indicates that it can be harder to gain distinct benefits with the help of information systems and technologies when comparing to direct competitors.

4 THEORETICAL FRAME OF REFERENCE AND RESEARCH SETTING

The use of information technology and information systems have been recognized to extend and facilitate a more frequent communication, interaction and information sharing between a focal firm and its suppliers and customers (Carr & Smeltzer 2002, 22). As a result, by improving and developing information integration, firms can enhance collaboration and integration with key suppliers and customer (Uusipaavalniemi 2009; van der Vaart & van Donk 2004; 2005b). This can lead to potential logistics performance improvements – both operational and strategic (Bagchi et al. 2005; Lee & Whang 2000; Stank et al. 2001; lynch et al. 2000).

The relationship between information integration, the use of information technologies and systems and the outcome, improved logistics performance is complex. Information integration is a wide concept and open to various definitions. In this context, information integration consists of four different elements - information technologies and systems, collaboration (integration of actors), integration of processes and activities and information flow. Information systems and technologies are an important element for integration and coordination of information, and have been in the focus of this study. The elements of information integration (adapted from Fabbe-Costes & Jahre 2008) are closely tied to the frame of reference. The Figure 7 below illustrates the theoretical frame of reference which is formed from three main concepts of this study: information integration, information technology and systems and logistics performance.

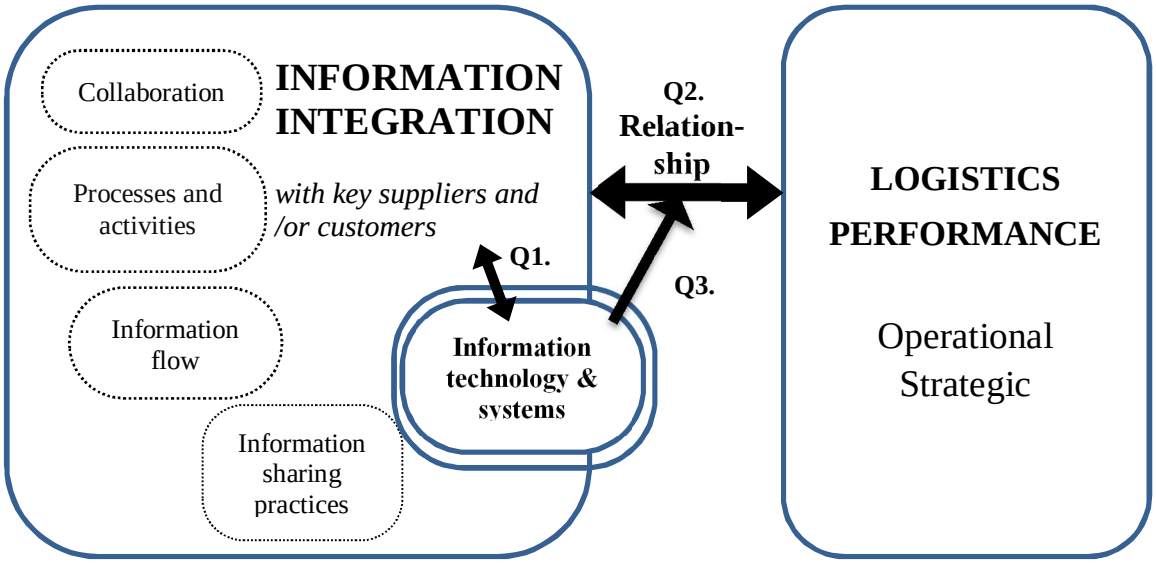


Figure 7 Theoretical frame of reference and research questions

Due to the significance of information sharing practices, they are considered as an important aspect of information integration (e.g. Uusipaavalniemi 2009) and therefore it is important that they are included as one important element in the information integration frame of reference for this study. Their importance for information sharing and integration has been acknowledged by several researchers (Uusipaavalniemi 2009; Carr and Kaynak 2007; Saeed et al. 2005). Information sharing practices were not included in Fabbe-Costes's and Jahre's elements of integration (2008), whereas, especially Uusipaavalniemi (2009) has highlighted their importance for integration of information. However, in many cases information sharing practices are embedded in the IT or IS perspective, due to the fact that actual sharing of information often includes a technical aspect. Information can be exchanged over firm boundaries in several ways: by Email, telephone, EDI, Supplier webs and portals, web-based procurement systems, electronic trading systems, supplier relationship management systems or other software applications (Saeed et al. 2005, 336). Most of these examples include a technical aspect. Uusipaavalniemi (2009, 151) states that in order to develop information integration, relevant information sharing processes and practices need to be identified.

Reasons why firms want to integrate and share information with their key customers and suppliers is to impact on the smooth flow of materials in the inbound and outbound activities of the firm. The two-way arrow between information integration and logistics performance in the Figure 7 illustrates the two-way relationship. By guaranteeing a smooth flow of information, material flow is enhanced. Vice versa by improving operations and processes, information integration can be influenced and increased.

Logistics performance in this context has been divided into operational and strategic logistics performances. Operational logistics performance improvements aim at higher efficiency, whereas, strategic logistics performance improvements aim at improving firm's profitability and operations' continuity. The relationship which logistics performance and information integration form, aims at achieving both strategic and operational improvements for the focal firm, for its key suppliers and customers as well as for the entire supply chain. Information is shared to impact positively for example on firm's profitability (Lynch et al. 2000), on customer service and customer service levels (Stock et al. 1999; 2000; Sengupta et al. 2006), on efficiency and flexibility of manufacturing, warehousing and delivery operations (Gustin et al. 1995; Lee et al. 1997; Lee & Whang 2000; Stock et al. 1999; 2000; Stank et al. 2001; Lin et al. 2002; van der vaart & van Donk 2004) and information quality (Banerjee & Golhar 1993; Closs et al. 1997; Moberg et al. 2002).

By paying attention to extending information integration (by extending scope, level and direction of integration) firms can develop and deepen information integration with chosen suppliers and customers. With the use of information technologies and systems,

focal firms can facilitate and extend a smooth flow of information towards their suppliers and customers. EDI provides basis for establishing order process linkages but its technical aspects alone are not sufficient enough for achieving strategic linkages (Kim & Narasimhan 2002, 4587). The amount of information that is needed to be shared by different supply chain parties has increased over the past decades and continues to do so. Current information technologies and systems have been developed to integrate and provide a solution to tackle the ever growing amount of information. Firms can extent information integration by sharing information through inter-organizational information systems (e.g. supplier portals and extranets) or through other ICT based systems that support the firm's information sharing processes and practices. For achieving higher levels of collaboration and integration, more than an arms-length relationship between firms is needed.

The three concepts of information integration, the use of information technologies and systems and logistics performance form the basis of this study, and are illustrated in the essence theoretical frame of reference in Figure 7 above. The relationships which these three concepts form are in the focus of this study, and illustrated with arrows in the Figure 7. To provide a holistic picture of the research topic, three research questions (Q1-3) have been conducted to test and understand the relationships of these three main concepts. The research questions are also illustrated in the Figure 7 with large Q letters.

The first research question (Q1) aims at testing and understanding the relationship between the use of information technology and systems and information integration with key suppliers and/or customers. The second research question (Q2) aims at testing the relationship between information integration with key suppliers and/or customers and logistics performance - both operational and strategic performances are included. The third research question (Q3) goes deeper and seeks to understand the impact which the use of information technologies and systems has on the relationship of information integration and logistics performance, and what underlying practices, mechanisms and issues impact on the relationship.

1. To what extent does the use of information technologies and systems impact on integrating and sharing of information with key suppliers and/or customers?
2. How much does information integration with key suppliers and/or customers impact on a firm's operational and strategic logistics performance?
3. How does the use of information technology and systems influence the relationship of information integration with key suppliers and/or customers and logistics performance?

The relationships of information integration, the use of information technology and systems and logistics performance are tested by using quantitative research methods. To

provide a better an in-depth understanding of the research topic, the research is extended to include also qualitative research methods. This study is testing the research questions one (Q1) and two (Q2) by using quantitative analysis and SPSS. To provide better understanding of the relationships, qualitative analyses are also performed to understand the relationships. The third research question (Q3) is striving to go deeper and understand the influence which the use of information technology and systems has on the relationship of information integration and logistics performance by using qualitative research methods.

To conduct the quantitative research setting and to test the relationships of the three main concepts, four hypotheses and models were formed and derived from the research objectives to test and understand the research topic. The hypothesis (H1) was formed on the basis of the first research question (Q1) and to test the relationship between the use of information technologies and systems and information integration.

- H1: Use of information technology and systems is positively related to information integration with key suppliers and/or customers

The hypotheses (H2a, H2b) were created to test the relationship between information integration and firm's operational logistics performance. The hypothesis (H2a) is testing relationship to operational delivery performance and the hypothesis (H2b) is testing the relationship to operational flexibility performance. The hypothesis (H3) was formed to test the relationship between information integration and firm's strategic logistics performance. These three hypotheses aim at testing the relationship between information integration with key suppliers and/or customers and logistics performance, and are based on the research question two (Q2).

- H2: Information integration with key suppliers and/or customers is positively related to a firm's operational logistics performance
    - H2a: Integrating information with key suppliers and/or customers is positively related to delivery performance
    - H2b: Integrating information with key suppliers and/or customers is positively related to flexibility performance
- H3: Information integration with key suppliers and/or customers is positively related to a firm's strategic logistics performance

There is a need for further research on this area. Kaipia and Hartiala (2006, 377) point out that research on information integration has mainly concerned a theoretical focus, and that the problem of visibility hasn't been examined much in practice. There

is a need for a better understanding of increased visibility and information sharing practices which lead to improved logistics performance.

5 METHODOLOGY OF THE RESEARCH

5.1 Research design

The scientific research is divided into empirical and theoretical research. An empirical research is based on observations and conclusions derived from the research objects, whereas, the starting point for a theoretical research is in the observations which are totally independent of any senses and measuring devices. (Nummenmaa 2004, 19.) This research is an empirical research and it is based on testing and analyzing two different sets of data: a selected sub sample from the Finnish Logistics Survey 2010 and an interview data.

To form a comprehensive and genuine picture and to enhance the understanding of the relationship between information integration and firm logistics performance, quantitative and qualitative research methods have both been used for conducting this research. Quantitative research refers to testing and explaining cause-and-effect relationships and forecasting, whereas, qualitative research concentrates on describing, interpreting and understanding the research subject. (Eriksson & Kovalainen 2008, 5.) Hirsjärvi, Remes and Sajavaara (2007, 132-133) state that quantitative and qualitative research approaches are not exclusionary but they are more complementary. Especially in this case, when the quantitative research phase precedes the qualitative research phase, and the quantitative hypotheses testing and analyses create foundations for the qualitative interviews later on. This setting enables comparison of observations later on. (Hirsjärvi ym. 2007, 132-133.) The above-mentioned perspective sets foundations for the execution of this research.

By choosing to integrate quantitative and qualitative methods, this thesis follows a mixed research design. The mixed research design of this study consists of *the Follow-up Explanations Design* which is most often used when a quantitative data on its own is not sufficient enough. Therefore the research is expanded by using also qualitative data. In this research design, quantitative findings provide additional explanations which are then explained by qualitative results. The emphasis of this particular research design is usually on quantitative aspects. (Creswell & Plano Clark 2007, 72.) Figure 8 below illustrates the research design of this study.

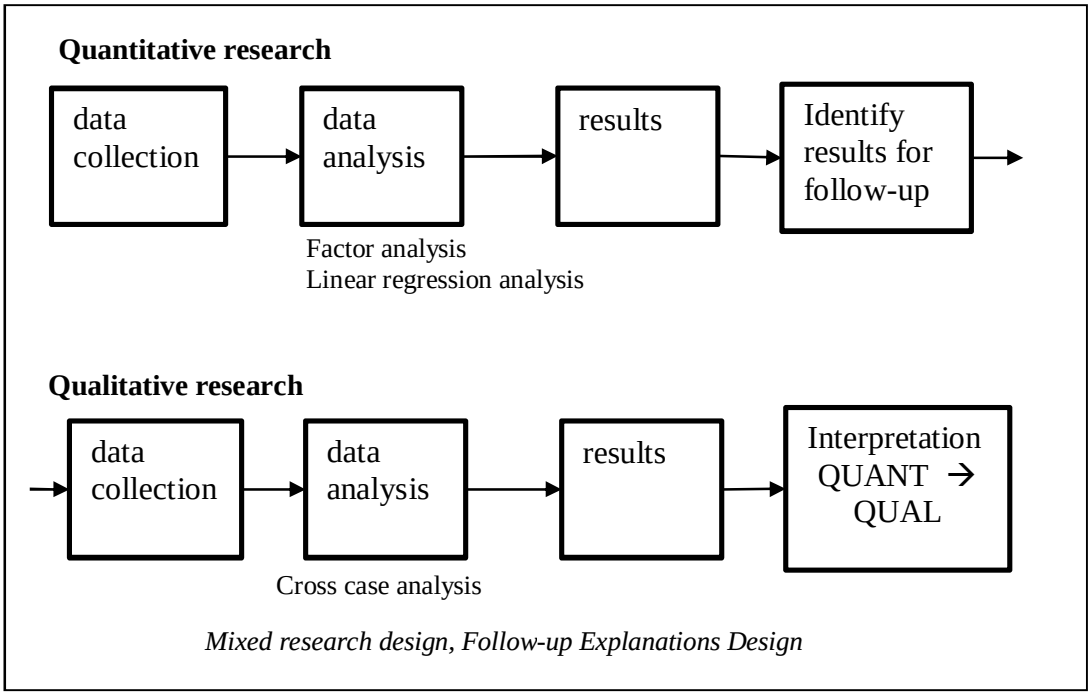


Figure 8 Research design (adapted from Creswell & Plano Clark 2007, 73)

As can be noted from the research design above, quantitative analysis of this study uses correlational research methods (Factor analysis and Linear regression analysis) for testing the selected sub sample. Interviews and a cross case analysis were carried out in the qualitative research part.

It is also essential to discuss the different approaches when creating scientific knowledge and applying both, quantitative and qualitative research methods. According to the positivistic approach, authentic knowledge is solely scientific knowledge when it is founded on observations and measuring them (statistical approach). For logistics studies positivism has been a rather common philosophical approach (Vafidis 2007, 27). On the other hand, when striving to understand how firms describe and identify their information integration and information sharing practices, one also needs to consider approaches such as interpretivism and constructionism (qualitative approach). Knowledge is constructed subjectively and it is interpreted through mutual or shared meanings. (Eriksson & Kovalainen 2008, 18-19.) This suits the qualitative research approach of this study. Although shared information can be or is identical to all receivers and users, people interpret and understand information in different ways and give different meanings to it.

Even though these two methodological approaches (positivistic and constructionism/interpretivism) represent different ways of thinking (Vafidis 2007, 27-32), it is justified that they should to be considered and applied together in this research

context – complementing each other to form a more holistic picture of the relationship between information integration and a firm's logistics performance. The nature of this research makes it possible to apply the above-mentioned philosophical positions together since the research considers quantitative and qualitative research approaches and forms a research triangulation.

This research regards knowledge and interpretations of reality as subjective and constructed in the minds of the respondents. Also Finnish Logistics Survey 2010 (Solakivi et al. 2010, 35) states that the respondents of the survey may not have had all the necessary information or knowledge at hand when answering to the survey. This statement takes into consideration that individual opinions have been or could have been reflected to the answers of the respondents. The answers and opinions of the respondents are considered subjective and present the understandings and interpretations of the respondents.

5.1.1 Quantitative research approach

A quantitative research is concerned with testing and understanding cause-and-effect relationships of certain phenomena, issues or characteristics (Eriksson & Kovalainen 2008, 5). Quantitative research is divided into an experimental research and a correlational research. The first mentioned relates to strict control and observation of the research objects, whereas, in the latter form of study, strict control is not possible but the researcher is still unable to impact the respondents. The opinions exist irrespective of the researcher's actions and intentions. (Nummenmaa 2004, 27-28.)

The quantitative part of this study aims at *testing the relationship between the use of information technology and systems and information integration, and also testing the relationship between information integration and firm logistics performance – operational and strategic performances.* By testing and examining the cause-and-effect relationships, this study aims at assessing to what extent the use of information technology and systems are related to information integration with key suppliers and/or customers, and to what extent information integration with key suppliers and/or customers is related to firm's logistics performance (operational and strategic). Four hypotheses were created to test these relationships (e.g. see Chapter 4). The hypothesis (H1) is testing the relationship between the use of information technology and systems and information integration with key suppliers and/or customers. The hypotheses (H2a) and (H2b) are testing the relationship between information integration with key suppliers and/or customers and operational logistics performance (delivery and flexibility of operations), whereas, the hypothesis (H3) is testing the relationship of information integration with key suppliers and/or customers and strategic logistics

performance. On the basis of the quantitative analysis, main results are identified and then closer followed-up in the qualitative part of this research.

In this research, a sub sample of the Finnish Logistics Survey 2010 (Solakivi et al. 2009) has been used for conducting a correlational research setting. Correlational research measures associations or co-variations of two or more dependent variables and strives to explain why certain characteristics or attributes effect on another's characteristics or attributes. If there is no connection or association between the variables, then there is no causal connection. (Nummenmaa 2004, 28-29.) The conclusions are derived from measuring and testing the variables or research objectives (Nummenmaa 2004, 26-28).

The selected correlational research methods used in this study are factor analysis and linear regression analysis. Factor analysis has been selected to identify whether the correlations between sets of variables form different factors. With linear regression analysis, this study strives to examine if relationships exits between different variables or sets of variables and to what extent certain variables explain other variables.

5.1.2 Qualitative research approach

Basing this research solely on quantitative approach is not sufficient enough considering the objectives of this research. Qualitative research provides an understanding to the research problems which cannot be solved by using quantitative methods or which require more interpreting than measuring (Eriksson & Kovalainen 2008, 5). In this research, the qualitative research approach provides foundations for an in-depth understanding of the relationship between information integration, the use of information technology and systems and logistics performance. The observations and results identified for a closer follow-up from the quantitative research are studied further in the qualitative part of the research. By adding qualitative aspects to this study, a more comprehensive and holistic picture can be reached.

The qualitative part of this study aims at *understanding and interpreting what influences the relationship between information integration with key suppliers and/or customers and logistics performance, and especially when information technology and information systems are used for integrating information.* The qualitative research provides an understanding of how and why information is shared and integrated, what IT/IS practices are used for sharing of information, how often information is shared with key suppliers and customers (intensity), and on what areas (scope) and on what level information is integrated. Also by investigating the facilitating and preventing IT and IS factors that influence information integration and logistics performance (the

desired outcome) are essential for understanding the relationship that the three concepts form.

The method selected for the qualitative research is an extensive case study. A cross case analysis was conducted to analyze the interview answers. The use of extensive case study in business research is mostly to extend prior theory as is the purpose of this research as well. In the extensive case study research, there are several cases under examination. According to Eriksson and Kovalainen (2008, 119) extensive case study and cross case analysis are related to quantitative ideals which emphasize mapping common patterns, mechanisms and characteristics of the research subject. Cases are considered as instruments relating to real life phenomena, and by testing and understanding these cases, generalizations to can be achieved and made. (Eriksson and Kovalainen 2008, 119.) The purpose of the chosen method was to provide a cumulative narrative in which all case companies together added extra to the prior knowledge of information integration, use of information technology and systems and logistics performance. In-depth information and knowledge about the research problem has been obtained by conducting *semi-structured theme interviews* (e.g. see Appendix 9).

5.2 Data collection

The data selected and collected to this study comprises of two sets of data: a sub set of quantitative survey data (Finnish Logistics Survey 2010) and qualitative data collected by conducting interviews. Both data and their collection methods are presented in this section.

5.2.1 Quantitative data – Finnish Logistics Survey 2010 data

The data analyzed in this study is a sub sample from the quantitative data gathered for the Finnish Logistics Survey 2010 (Solakivi et al. 2009). The total number of 1 813 respondents answered to the original survey. The survey data was collected as a web based questionnaire during October to December 2008. The selected survey questions used in this research are presented in Appendix 1.

The selected sub sample for this study included medium-sized and large firms from manufacturing and construction industry and firms from trading industry. The firms were selected on the basis that they fulfilled the European Commission's (EC's) criteria for medium-sized or large firms according to their company turnover. Medium-sized firms had a company turnover of 10-50 million EUR. Large firms had a company turnover over 50 million EUR. Total number of 148 firms were selected and used for

analysis. In total, 95 companies (64.2 %) presented manufacturing and construction industry and 53 trading industry (35.8 %).

5.2.2 Semi-structured theme interviews

The aim of the theme interviews was to provide more in-depth information about information integration and logistics performance especially when information technology and systems are used. An extensive case study was carried out by interviewing two medium-sized firms and four large Finnish firms. To narrow down a sub sample, firms presenting manufacturing of industrial products were selected to the extensive case study.

Firms A, B, C, D, E and F were selected on theoretical grounds. These firms were suspected to regard information integration and information sharing with their key suppliers and/or customers important and active. These firms can also be described as being leading firms in their industry and therefore best practices were sought by interviewing them. Some of the firms were chosen on the basis of convenience and that they were located geographically near to the researcher.

All companies interviewed have global operations and they use variety of different methods to integrate and share information externally. Company D and company F were the largest firms whose corporate turnovers are in billions of Euros. The number of personnel in these firms is substantial. Companies A, C, D and F are exchange-listed companies. Companies B and E represent medium-sized firms, and their company turnovers are between 10-50 million Euros and the number of personnel around 50-250. All the six companies were interviewed about their information sharing and information integration towards their suppliers. Companies A, B and E were also interviewed about their information sharing and integration towards their customers.

Seven interviews were carried out in the spring 2012 (March-May 2012). The interviews were held at the premises of the firms and lasted from 1h 15min to 1h 45min. The interviews were documented by using a voice recorder and then transcribed. Also during the interview, hand-written notes were made by the researcher. Altogether, 12 different persons were interviewed during the seven interviews. The interviewees were selected by first enquiring from the firms who could have best knowledge of the firm's information sharing and integration towards suppliers and on the other hand towards customers. The interviewees represented middle management or employee level of the companies. The interviewees represented a variety of different positions: sourcing managers, category managers, a product manager, a vendor process development manager, a procurement director, a quality manager, a customer service and logistics

manager, a key account manager, a material planning manager, a sales coordinator and an information systems manager.

Table 4 below presents the firms interviewed and their basic company information. Also information sharing practices used by these companies are also shown in brief in the table below.

Table 4 Companies interviewed

Company	**Inter-viewed persons**	**Inter-viewed Supp. (S) / Cust. (C)**	**Industry**	**Turn-over millions €**	**Personnel**	**Information sharing practices**
Company A	2	S + C	Manufacture of machines or equipment	100-500	500-1000	Email, telephone, meetings, letters, EDI, a web portal for suppliers, Sales Tools for customers
(Interviewed Sales coordinator, Material planning manager)						
Company B	3	S + C	Manufacture of machines or equipment	10-50	50-250	Email, telephone, meetings, EDI
(Interviewed: Key Account manager, Customer service and logistics manager, Sourcing manager)						
Company C	1	S	Manufacture of electronic equipment	100-500	1000-2000	Email, meetings, telephone, fax
(Interviewed: Sourcing manager)						
Company D	2	S	Manufacture of machines or equipment	1,1-5,0 billion (corp.)	over 10 000	Email, telephone, meetings, EDI, a web portal for suppliers
(Interviewed: Category manager, IT manager)						
Company E	2	S + C	Manufacture of plastic or rubber products	10-50	50-250	Email, telephone, meetings, EDI
(Interviewed: Product manager, Quality manager)						
Company F	2	S	Manufacture of machines or equipment	1,1 – 5,0 billion (corp.)	over 10 000	Email, telephone, meetings, EDI, a web portal for suppliers
(Interviewed: Procurement manager, Vendor process development manager)						

The interview themes followed the same structure in each interview. All the twelve persons interviewed did not, however, answer all the questions/themes but according to their knowledge. The interview outline was prepared beforehand and sent to the interviewees by Email. The first interview theme dealt with the current information integration of the firm (scope, level, direction) and information sharing practices. The second theme explored the use of information technology and systems for sharing information. The third interview theme summed up the motives for why the firm wants to integrate and share information and what it wants to achieve by it (logistics performance impact). The themes and interview questions are presented in Appendix 9.

5.3 Data analysis

According to Hirsjärvi et al. (2007, 219) quantitative approach most often uses statistical analyses for making deductions, whereas, interpretative approach uses qualitative analyses for making deductions about the research problem. Creswell and Plano Clark (2007, 128) point out that data analysis in mixed research methods consists of analyzing the quantitative data with quantitative methods and analyzing the qualitative data with qualitative methods. Creswell and Plano Clark (2007, 129) however, pose five generic phases which can be followed to analyze both quantitative and qualitative data. These are (1) Preparing the data for analysis, (2) Exploring the data, (3) Analyzing the data, (4) Representing the data analysis, and (5) Validating the data. These phases were followed when analyzing the statistical data and the interview data of this study.

Analyzing the quantitative data. The data analysis was started by choosing appropriate statistical tests according to the research suitability. Factor analysis and linear regression analysis were chosen. SPSS was chosen as the quantitative statistical software program. The answers of medium-sized and large firms in the Finnish Logistics Survey 2010 were selected to the sub sample. First, different hypothesis, models and settings were tried out to resolve how to best describe the research problem. After this, factor analysis was performed to detect necessary latent variables. On the basis of the factor analysis outcome and new latent variable detected, four hypotheses (H1, H2ab, H3) and models (models 1-4), which best described the research problem were formed and analyzed by performing linear regression analysis. The analyses were performed on SPSS.

Analyzing the interviews. Analyzing qualitative data consists for example of coding data, assigning labels to codes and grouping codes into themes or categories (Creswell & Plano Clark 2007, 129). Each interview was first transcribed to form a better understanding of each interview and to improve comparison between the interviews. From each necessary/suitable interview question, a cross case comparison was performed. The amount of information contained in each interview was enormous, therefore a clear structuring of each interview question and drawing a table was found useful by the researcher. A table which included all companies' answers to a particular question was formed. Similarities or identical answers where then colored with a certain color and then further identified, on theoretical grounds, to be part of certain larger factor. The found results were then written to this thesis and constructed in a logical manner.

5.4 Trustworthiness of the research

Reliability and validity are crucial when assessing and evaluating the trustworthiness of the research. Reliability refers to the repeatability of the research results. In quantitative research, statistical procedures have been developed to assist in evaluating the trustworthiness of the research. (Hirsjärvi et al. 2007, 226.) Inadequate reliability can be a cause of insufficient sampling (Heikkilä 2010, 187). In this study, the sub sample of 148 firms provides a sufficient and a rather large sampling. The reliability of the quantitative analysis was also increased by paying attention to the statistical procedures of factor analysis and linear regression analysis. When performing factor analysis, attention was paid to factor loadings, factor rotation methods, eigenvalues, factor model and communalities. When performing linear regression analysis, attention was paid to the fitness of the model, to the variance explained by the model, to the fitness of the selected independent and dependent variables and to the outliers of each model. With the help of these the reliability of the quantitative analysis was strengthened.

The reliability of the qualitative study was increased by paying attention to the following issues: the interviews consisted of a set of same questions and the interviewed firms were selected according to the theoretical aspects of this study. To increase the reliability of the study, the interviews were transcribed.

Validity signifies the ability of the chosen research method or instrument to measure exactly what it is supposed and designed to measure (Hirsjärvi et al. 2007, 227). Validity can be divided into internal and external validity. Internal validity is concerned with controlling the variation of the independent variables, while, external validity pays attention to the fact that findings should be generalizable to the population. Keeping these in mind, a trade-off exists between internal and external validity: if the research settings are highly controlled, the results might not be generalizable except to the research setting in question. (Lincoln & Cuba 1985, 290-291.)

This research setting was not highly controlled when collecting the survey data or the interview data. The interviews were held at the premises of the firms and consisted of open conversation. The interview questions were performed on theoretical grounds and on issues derived from the research literature. This way, the validity of this research was increased. Also, effort was put on presenting the interview questions in a way that they would be understood similarly by all the respondents. The final deductions of this research are justified and derived from the results of quantitative and qualitative analyses. Some generalizations can be made with regard to this study due to the large number of interviewees and the large survey data used. Validity of the quantitative analysis suffers slightly due to the fact that the survey questions were not originally designed to the purposes of this study. This lack has been tried to diminish by performing a mixed methods research design in this thesis.

However, data triangulation further improves the trustworthiness and especially the validity of the research. Denzin (1970) has introduced four triangulation types. Of the four triangulation types, methodological triangulation and data triangulation are strengthening the validity of this study. Triangulation improves the credibility of the findings and interpretations. (Lincoln & Cuba 1985, 305.) According to Hirsjärvi et al. (2007, 228) methodological triangulation consists of using several methodological approaches in the same study. In this research, quantitative and qualitative approaches were combined to form a more comprehensive and holistic picture. As a result from the methodological choices of this study, quantitative data and qualitative data have been used and a mixed research design formed.

6 TESTING THE RELATIONSHIPS WITH QUANTITATIVE METHODS

In general, measuring and establishing a causal relationship between actions undertaken and performance is considered problematic in the management science and business administration (Fabbe-Costes & Jahre 2008, 135). In the first section of this chapter, descriptive statistics of the selected sub sample are presented. In the second section, numerical data is analyzed by performing factor analysis on SPSS. In the third section, linear regression analyses are performed to the data and the results presented.

6.1 Descriptive statistics

The quantitative data analyzed consists of a sub sample originally collected for the Finnish Logistics Survey (Solakivi et al. 2009). Total of 148 manufacturing and trading firms were selected to the sub sample. Manufacturing and construction industry accounted for 64.2 % (95 respondents) and trading industry 35.8 % (53 respondents). Six industries represent total of 64.9 % of the firms in the analysis. These were manufacture of chemicals and chemical products (20.3 %), manufacture of machinery and equipment (12.2 %), manufacture of fabricated metal products (10.8%), manufacture of food (7.4 %), manufacture of basic pharmaceutical products and pharmaceutical preparations (7.4%), and other manufacturing (6.8%). Overall, the data represents firms from 21 different industries and can therefore be considered as a comprehensive sample.

Turnovers of the selected sub sample companies are presented in millions of Euros, and they are shown on the Figure 9 below. Only medium-sized and large firms were selected to study. Majority of the respondents (62.2%) are large firms with a company turnover of over 50 million EUR. The number of medium-sized firms is smaller, counting for 37.8 percent of the respondents.

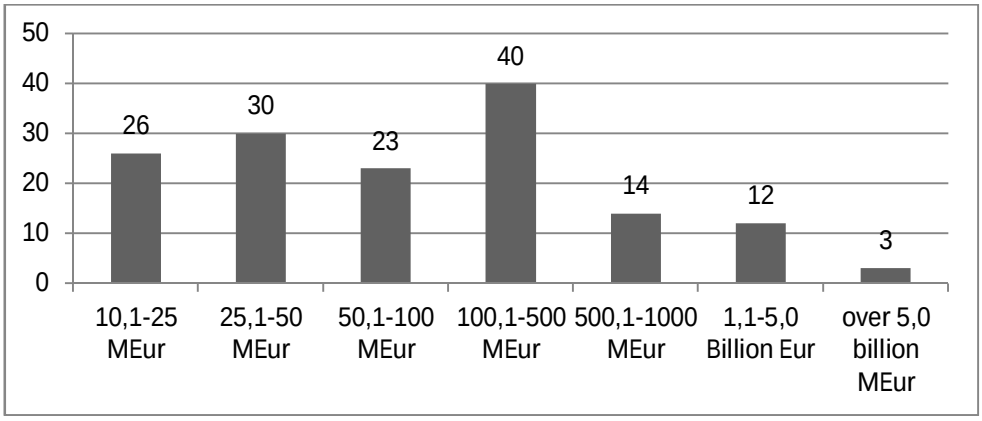


Figure 9 Turnover in millions of EUR

The number of personnel of firms selected to the study is presented in the Figure 10 below. The number of personnel of the respondent firms is slightly divided to the left. The category presenting personnel of 50-249 employees accounted for approximately 1/3 of all respondents.

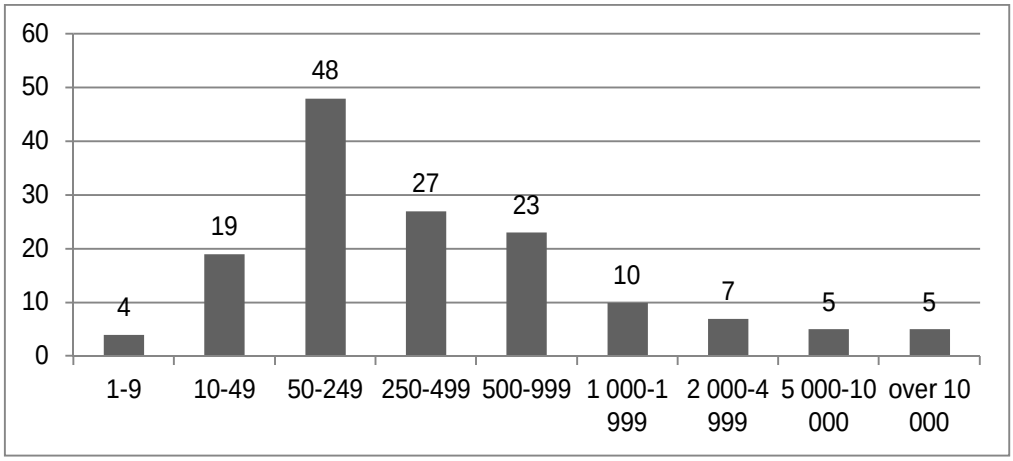


Figure 10 Personnel of the companies selected

Regarding the objectives of this study, it is interesting to notice that almost 2/3 of the respondents (65.5%) considered that they share operative information efficiently with their key suppliers and customers (respondents partly agreed or totally agreed). For many respondent firms, their information systems (IS) enable the exchange of information between suppliers and customers (downstream and upstream information integration). 60.1 % of the respondents considered their company information systems enable sharing of operative information with their suppliers (partly agree or totally agree). Aside, 56.7 % regarded that the company IS enables sharing of operative information with key customers. Figure 11 below presents the findings of efficient information sharing and the sufficiency of company information systems.

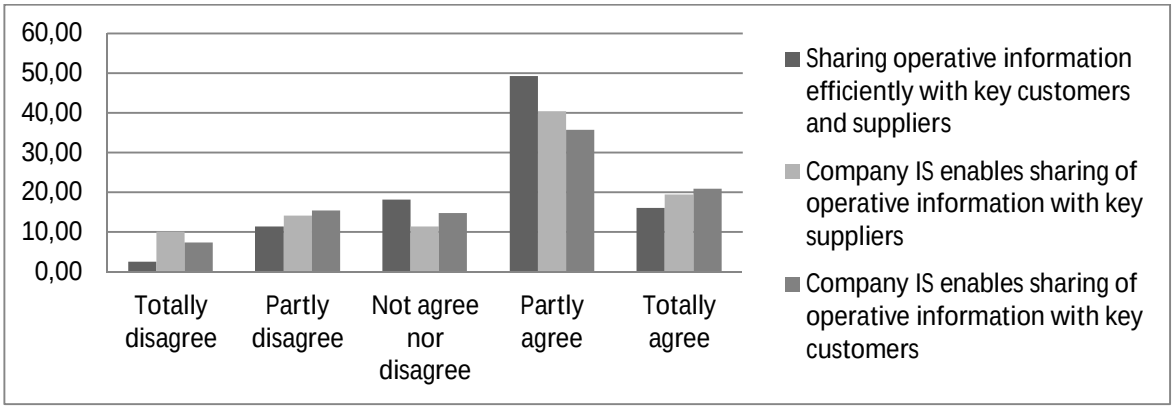


Figure 11 Comparison of sharing information efficiently and sufficiency of company information systems in percentage

As can be noted from the Figure 11 above, sharing information efficiently entails that also company information systems need to enable the efficient exchange of information. The survey questions used in this study also gave an opportunity to examine importance and performance of logistics and production systems, in addition to information systems discussed above. Importance of logistics and production information systems is considered to be important for Finnish medium-sized and large firms. None of the respondents considered the importance of logistics and production systems to be extremely low. Total of 61.0 % of the manufacturing and construction firms regarded logistics and production IS to be highly important or extremely high. Among the trading firms, the number was even higher: 83.1 % of the respondents regarded that the importance of logistics and production IS was either high or extremely high. Figure 12 presents the importance of logistics and production information systems for Finnish firms.

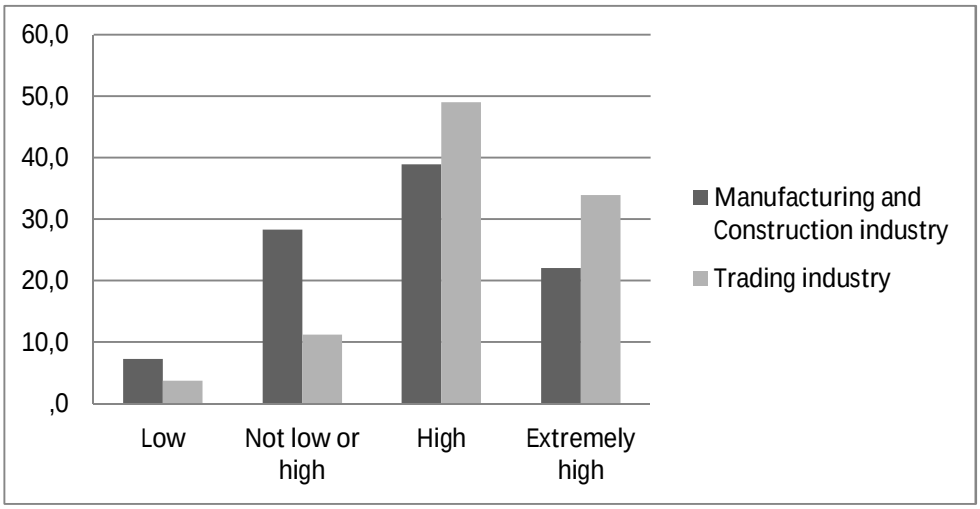


Figure 12 Importance of logistics and production systems in percentage

When discussing the importance of logistics and production IS, their current performance is also essential to review. The respondents felt that the performance of the current logistics and production systems is slightly lower (Figure 13 below) compared to the importance of the logistics and production systems (Figure 12 above). The respondents were asked to compare performance of their logistics and production systems against their competitors systems. 68.5 % of the manufacturing and construction firms and 69.8 % of the trading firms regarded that the performance of their systems is slightly better or either not bad or good. The Figure 13 below presents opinions on performance of companies' logistics and production systems.

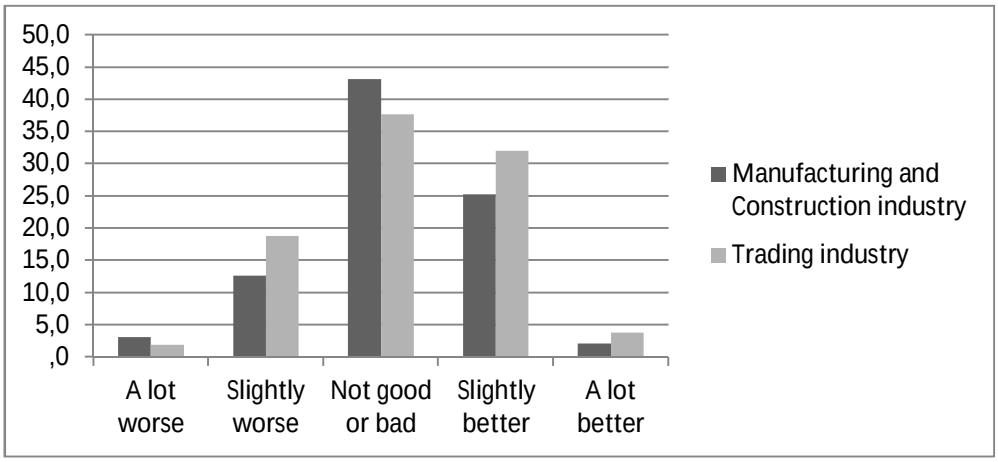


Figure 13 Performance of logistics and production systems in percentage

The importance of using IT and IS for improving information integration and logistics performance is expected to increase in the future. Therefore operability and functionality of information technology and systems need to be enhanced and increased, as the results also indicate.

6.2 Factor analysis

Exploratory factor analysis was performed to extract factors from the data (N=148). Varimax was chosen as the adequate method for this study. The varimax rotation attempts to maximize the dispersion of loadings within factors. It tries to load smaller number of variables into factors which present more interpretable clusters of factors. (Field 2009, 644.) Varimax is also chosen due to the fact that it can be suspected that there are multiple latent variables instead of one single latent variable.

Total of 22 variables were included in the analysis. Absolute values over 0.4 were considered as suitable for interpretation. Components with an Eigenvalue above 1.0 were included.

As a result, five components (new latent variables) were formed by performing a factor analysis. The used extraction method was principal component analysis (Appendix 2). The five new latent variables present the 22 variables included in the analysis. The new latent variables were calculated the sums of top loading variables. The first latent variable presents information systems, the second latent variable presents information integration, the third latent variable presents strategic logistics performance, the fourth component presents relative delivery performance and the fifth latent variable presents relative flexibility performance. The last two latent variables present operational performance. All the five latent variables together explain total of 65,7 % of the variance of the factor (Appendix 4). The Cronbach α was calculated to each of the new latent variables. The Table 5 below outlines the new latent variables and their Cronbach's α. Latent variable 'Information systems' scores the highest Cronbach's alfa (α = 0,908).

Table 5 The new latent variables and their Cronbach's α

	Latent variable	**Cronbach's α**
Information systems and IT	INFORMATION SYSTEMS	0,908
Information integration	INFORMATION INTEGRATION	0,853
Strategic logistics performance	STRATEGIC PERFORMANCE	0,802
Relative delivery performance (operational logistics performance)	DELIVERY PERFORMANCE	0,737
Relative flexibility performance (operational logistics performance)	FLEXIBILITY PERFORMANCE	0,703

The Kaiser-Meyer-Olkin Measure of Sampling for the analysis was adequate and Barlett's Test of sphericity was significant ($p < 0.000$), which indicates that the variables and data used were appropriate for this particular model. The KMO was 0,790. According to (Field 2009, 647) KMO values between 0,7 and 0,8 are considered good. Therefore the KMO of this study is considered adequate. Barlett's Test of sphericity gets result of χ^2 being 1353,256, degrees of freedom (df) being 231 and the significance being $p < 0.000$. The above mentioned values are presented in the Table 6 below.

Table 6 KMO and Barlett's Test

KMO and Bartlett's Test	
Kaiser-Meyer-Olkin Measure of Sampling Adequacy	,790
Bartlett's Test of Sphericity, Approx. Chi-Square	1353,256
df	231
Sig.	,000

Table 7 below illustrates the results from the five new latent variables which were extracted with factor analysis. Factor loadings, total variance of the new latent variables, individual means and standard deviations are presented. The scale of the variables is between 1-5. Rotated component matrix is represented in Appendix 2 and communalities in Appendix 3.

Table 7 Factor analysis - Exploratory

Factor	Factor loading	Expl. variance	Mean (1-5)	Std. dev.
INFORMATION SYSTEMS		29,94 %		
Company IS provides sufficient and real time information about logistics management and planning costs	0,859		3,03	1,274
Company IS provides sufficient and real time information about logistics costs	0,855		3,28	1,159
Company IS provides sufficient and real time information for managing operative logistics	0,847		3,45	1,223
Company IS enables sharing of operative information with key suppliers	0,816		3,53	1,238
Company IS enables sharing of operative information with key customers	0,773		3,56	1,230
INFORMATION INTEGRATION		13,16 %		
Operative processes are developed in collaboration with suppliers/customers	0,839		3,83	0,847
Strategic planning and goal setting is done with customers and suppliers	0,773		3,66	1,075
Operative planning and forecasting is done in close co-operation with customers and suppliers	0,771		3,66	0,981
Sharing operative information efficiently with key customers and suppliers	0,649		3,66	0,999
Preparation to external threats and disturbance	0,596		3,37	1,046
Sharing internal information efficiently	0,501		3,69	1,165
STRATEGIC PERFORMANCE		10,05 %		
Logistics has a major impact on the company's profitability	0,833		4,55	0,830
Logistics has a major impact on costs	0,781		4,23	0,967
Logistics is a key source of competitive advantage for the firm	0,719		4,26	0,909
Logistics is a top management priority in the firm	0,678		3,41	1,357
Logistics has a major impact on customer service level	0,648		4,82	0,506
DELIVERY PERFORMANCE (OPERAT.)		7,29 %		
The ability to meet the quoted or anticipated lead times	0,827		3,77	0,958
The time between order receipt and customer delivery	0,682		3,57	0,965
The ability to notify of delivery delays or product shortages	0,654		3,43	0,879
FLEXIBILITY PERFORMANCE (OPERAT.)		5,27 %		
The ability to accommodate delivery times for specific customers	0,825		3,81	0,815
The ability to mofidy order size, volume or composition during logistics operations	0,691		3,64	0,829
The ability to meet key customer needs	0,544		4,11	0,685

The highest loading is at a single variable “company IS provides sufficient and real time information about logistics management and planning costs” scoring at 0,859. Also other variables included in the ‘information systems’ latent variable score high. In total, the first latent variable extracted (Information systems) explains 29.94 % of the total variance. Information integration explains 13.15 % of the total variance and ‘strategic performance’ around 10 %. The means of each variable are between 3,03 and 2,55.

Variables in the ‘strategic performance’ have scored the highest means. Most of all there is deviation among the ‘information systems’ variables and less among the variables of ‘flexibility performance’. As can be noted, the standard deviations of all variables vary from 0,506 to 1,357.

For the factor analysis to be meaningful, correlation coefficients for the new latent variables were essential to calculate. The Table 8 below illustrates the coefficients for the new latent variables. Information integration is positively related to each of the latent variables. The strength, which information integration has on information systems and strategic performance, is mediocre. For operational performance (delivery and flexibility performance), the strength of the association with information integration is rather weak but it does exist. Information systems are positively related to information integration and strategic performance. Information integration and information systems score a correlation coefficient of 0,477 ($p < 0.01$). Between delivery performance and flexibility performance implies a positive mediocre linear correlation connection ($r = 0,479$, $p < 0.01$).

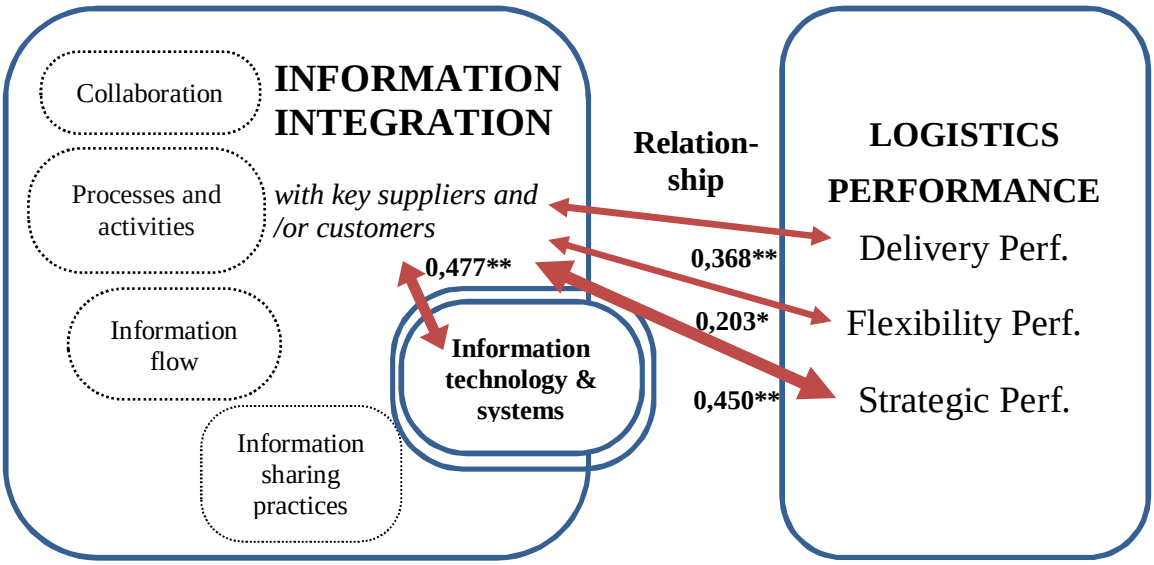
Table 8 Correlation matrix for new latent variables

	Information system	Information integration	Strategic performance	Delivery performance	Flexibility performance
Information systems	1				
Information integration	**,477****	1			
Strategic Performance	,271**	**,450****	1		
Delivery performance	,070	**,368****	,196*	1	
Flexibility performance	,072	**,203***	,123	,479**	1

**significant at the 0.01 level (2-tailed), *significant at the 0.05 level (2-tailed)

Information systems are positively related to information integration, as was suspected according to the research literature. Information integration has a positive relation to delivery performance ($r = 0.368$, $p < 0.01$) and flexibility performance ($r = 203$, $p < 0.05$). The relationship between information integration and strategic performance is positive mediocre ($r = 0,450$, $p < 0.01$). The correlation coefficient between strategic performance and IS positive ($r = 0.271$, $p < 0.01$), whereas, the relationship between IS and operational performance (delivery and flexibility) is statistically insignificant. The essential correlation coefficients and relationships for this research are illustrated in the Figure 14 below with two-way arrows describing the directions of relationships. The

figure is based on the theoretical frame of reference of this study presented in the Figure 7.



**significant at the 0.01 level (2-tailed), *significant at the 0.05 level (2-tailed)

Figure 14 Correlation coefficients of latent variables

The above setting forms the basis for linear regression analysis. Four models (1-4) were created to describe the research problem and hypothesis. Linear regression analysis was performed to each of the models and to the research hypothesis of this study (H1, H2a, H2b and H3). These are represented in the next section.

6.3 Linear regression analysis

The regression analysis was started by calculating an average score to each of the latent variables formed with factor analysis. The average score was calculated from the initial variables' scores included in the same latent variable. To calculate averages were chosen because the results are later on better comparable with each other than if sums of variables were to be used. Empty answers were not included in the averages or in the analysis. This was done to increase the reliability of the study. Due to excluding empty answers, the sample size N is different in all the four regression models below and varies between N=122 to N=129. Four different models (models 1-4) were formed according to the four research hypothesis (H1, H2a, H2b, H3). The analyses were performed by using SPSS. Each model was analyzed by paying special attention to the suitability of the model, to the variance of the model, to the suitability of the variables of the model and to the outliers of the model.

- **Hypothesis 1:** Use of information technology and systems is positively related to information integration with key suppliers and/or customers **(model 1)**

In the first model, 'information systems' is an independent variable and 'information integration' is a dependent variable. The correlation coefficient (R) for information systems and information integration is 0,477 **(N=127)**, which indicates there exists positive mediocre relation between these latent variables.

The model, explaining 'information systems' and 'information integration', is significant and can be accepted with $p < 0.001$ (sig.). The strength of the association in the model is measured with coefficient of determination R^2, which for this model is 0,227. This indicates that 22.7 % of the total variance explained in information integration is accounted for by the variance in information systems. The adjusted R square for the model is 0,221 and the standard error of estimate is 0,6872. Although the independent variable may explain the variation in the dependent variable, this does not necessarily imply causation between the variables (Malhotra & Birks 2007, 581). It can only be noted that relation between these latent variables do exists.

The suitability of the model is estimated with Fischer's F-test. H_0: $\beta_1 = 0$ (the model has no variance) is being rejected, because $H1{:}\beta 1 \neq 0$. Table 9 shows that F = 36,75, df = 1 and $p < 0,001$. Also because $p < 0,01 < 0,05 = \alpha$, the H_0 is being rejected.

Table 9 ANOVA of information systems and information integration (model 1)

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	17.346	1	17.346	36.750	.000[a]
	Residual	59.000	125	.472		
	Total	76.346	126			

a. Predictors: (Constant), Information Systems

b. Dependent Variable: Information integration

The estimated regression for the model is $Y_i = 2,471 + 0,351x_1$. If X_1 (information systems) is increased by one unit, information integration is increased by 0,351 units. The coefficient is statistically significant since the $H1{:}\beta 1 \neq 0$, $p < 0,001 < 0,05 = \alpha$ and therefore the variables suit to the model. The Table 10 below illustrates the estimated coefficients.

Table 10 Estimated coefficients (model 1)

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	2.471	.204		12.139	.000
	Information systems	.351	.058	.477	6.062	.000

The scatterplot formed with SPSS presents the regression standard residuals and regression standardized predicted values of the model. A model fits well to the data, if it relates well to small and large y variable's values (Nummenmaa 2004, 312). The residual values of y variable in the model 1 are scattered over and below zero. The histogram of the model has slightly a positive kurtosis but it is rather close to a normal distribution (e.g. see Appendix 5).

The outliers of model 1 are presented in the Figure 15 below. The linear trend line of large firms is located slightly higher than the linear trend line of medium-sized firms. However, the difference is small and indicates that there is not much difference when comparing linear trend lines of large and medium-sized firms in terms of information systems and information integration. The Figure 15 also reveals that there is slightly more outliers in the data of medium-sized firms.

The model was also performed vice versa, as information integration explaining information systems. The model was significant and could be accepted with $p < 0.001$ (sig.). The strength of the association R^2 was also 0,227, which indicates that 22.7 % of the total variance explained in information systems is accounted for by the variance in information integration. The adjusted R square for this was the same (0,221) as in the other way around. The standard error of estimate was 0,93166 ($p < 0.001$), and estimated regression $Y_i = 0{,}991 + 0{,}646x_1$ ($p < 0.05$). The result of F test was the same as above.

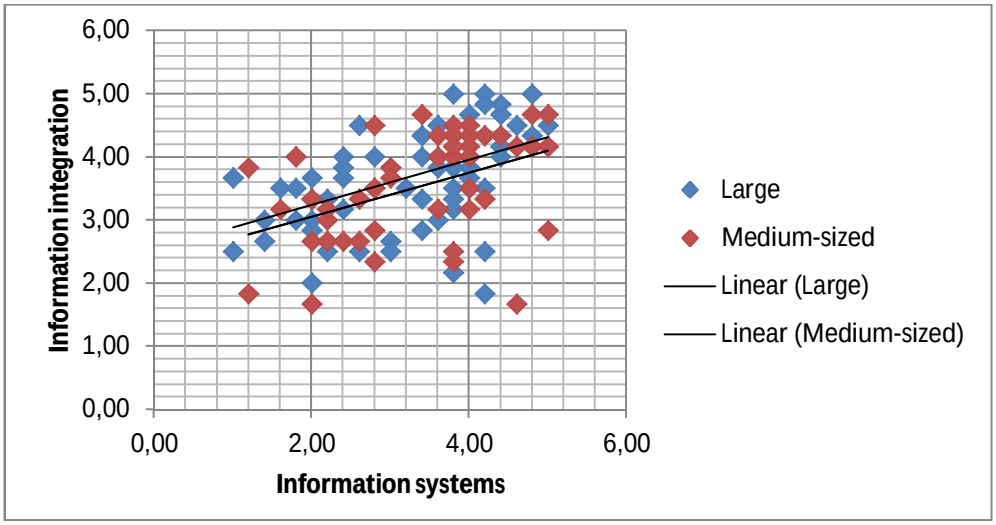


Figure 15 Outliers for information systems and information integration

Hypothesis 2a: Integrating information with key suppliers and/or customers is positively related to delivery performance **(model 2)**

In this model 2, 'information integration' is the independent variable and 'delivery performance' is the dependent variable. The correlation coefficient (R) for delivery performance and information integration is 0,368 **(N=126)**. The coefficient indicates that there is a positive low relation between these latent variables.

The model 2, explaining relationship between 'information integration' and 'delivery performance' is significant and can be accepted with $p < 0.001$ (sig.). The coefficient of determination R^2 is 0,136. This indicates that 13.6 % of the total variance explained in delivery performance of the company is accounted for by the variance in information integration. The adjusted R square for the model is 0,129 and the standard error of estimate is 0,69622. The suitability of the model is estimated with Fischer's F-test. H_0: $\beta_1 = 0$ is being rejected, because H1:$\beta 1 \neq 0$. The Table 11 below shows that F = 19,447, df = 1 and $p < 0,001$.

Table 11 ANOVA for information integration and delivery performance (model 2)

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	9.426	1	9.426	19.447	.000[a]
	Residual	60.105	124	.485		
	Total	69.531	125			

a. Predictors: (Constant), Information integration

b. Dependent Variable: Delivery Performance

The estimated regression for the model is $Y_i = 2{,}326 + 0{,}348x_1$. If X_1 (information integration) is increased by one unit, delivery performance is increased by 0,348 units. The coefficient is statistically significant since the $H1{:}\beta 1 \neq 0$, $p < 0{,}001 < 0{,}05 = \alpha$ and therefore the variables suit to the model. The Table 12 below illustrates the estimated coefficients.

Table 12 Estimated coefficients (model 2)

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	2.326	.294		7.913	.000
	Information integration	.348	.079	.368	4.410	.000

Scatterplot and histogram of the model reveal that the residual values of y variable are scattered over and below zero. The histogram has slightly a positive kurtosis but it is rather close to a normal distribution (e.g. see Appendix 6). The Figure 16 below illustrates the outliers of information integration and delivery performance. The trend lines of both large and medium-sized firms are alike and no differences can be observed.

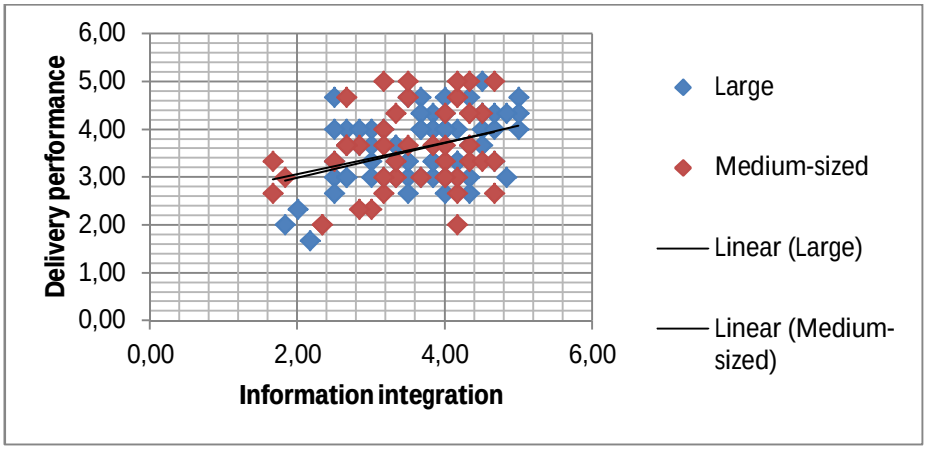


Figure 16 Outliers for information integration and delivery performance

The model 2 was also tested to include two independent variables: information systems and information integration. The model was rejected because it was not statistically significant. The model was also performed vice versa, as delivery performance explaining information integration. The model was significant and could be accepted with $p < 0.001$ (sig.). The strength of the association R^2 was also 0,136, which indicates that 13.6 % of the total variance explained in information integration is accounted for by the variance in delivery performance. The adjusted R square for this was the same (0,129) as in the other way around. The standard error of estimate was 0,73628 ($p < 0.001$), and estimated regression $Y_i = 2,24 + 0,389x_1$ ($p < 0.05$). The result of F test was the same as above.

Hypothesis 2b: Integrating information with key suppliers and/or customers is positively related to flexibility performance **(model 3)**

The model 3 explores the relationship between 'information integration' (independent variable) and 'flexibility performance' (dependent variable). The correlation coefficient (R) for flexibility performance and information integration is 0,203 **(N=122)**. The coefficient indicates there is a positive low relationship between these latent variables.

The model 3, explaining relationship between 'information integration' and 'flexibility performance', is significant and can be accepted with $p < 0.05$ (sig.). The coefficient of determination R^2 is 0,041. This indicates that only 4.1 % of the total variance explained in flexibility performance of the company is accounted for by the variance in information integration. The adjusted R square for the model is 0,033 and the standard error of estimate is 0,59747. The suitability of the model is estimated with Fischer's F-test. H_0: $\beta_1 = 0$ is being rejected, because H1:$\beta 1 \neq 0$. Table 13 below shows that F = 5.158, df = 1 and $p < 0.05$.

Table 13 ANOVA for information integration and flexibility performance (model 3)

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1.841	1	1.841	5.158	.025[a]
	Residual	42.836	120	.357		
	Total	44.678	121			

a. Predictors: (Constant), Information integration

b. Dependent Variable: Flexibility performance

The estimated regression for the model is $Y_i = 3{,}272 + 0{,}159x_1$. If X_1 (information integration) is increased by one unit, delivery performance is increased by 0,159 units. The coefficient is statistically significant since the $H1{:}\beta 1 \neq 0$, $p < 0.05$ and therefore the variables suit to the model. The Table 14 below illustrates the estimated coefficients.

Table 14 Estimated coefficients (model 3)

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	3.272	.261		12.524	.000
	Information integration	.159	.070	.203	2.271	.025

Scatterplot of the model reveals that the residual values of y variable are scattered over and below zero. The histogram of the model follows quite well a normal distribution (e.g. see Appendix 7). The Figure 17 below illustrates the outliers of information integration and flexibility performance. The trend lines of both large and medium-sized firms are similar, however the trend line for medium-sized firms is slightly higher.

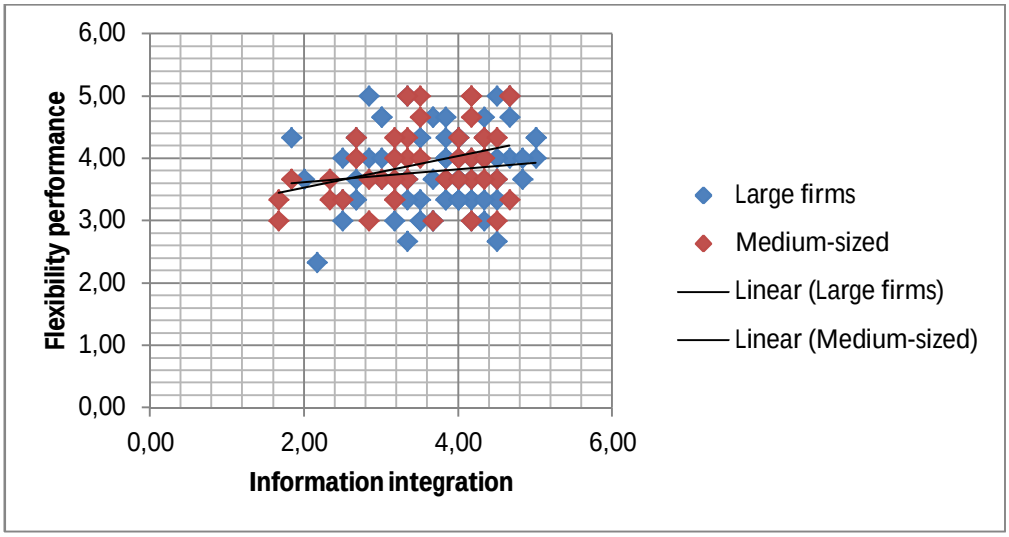


Figure 17 Outliers for information integration and flexibility performance

The model 3 was also tested to include two independent variables: information systems and information integration. The model was rejected because it was not statistically significant. The model was also performed vice versa, as flexibility performance explaining information integration. The model was significant and could be accepted with $p < 0.05$ (sig.). The strength of the association R^2 was also 0,041, which indicates that 4.1 % of the total variance explained in information integration is accounted for by the variance in flexibility performance. The adjusted R square for this was the same (0,033) as in the other way around. The standard error of estimate was 0,76331 ($p < 0.05$), and estimated regression $Y_i = 2{,}654 + 0{,}259x_1$ ($p < 0.05$). The result of F test was the same as above.

Hypothesis 3: Information integration with key suppliers and/or customers is positively related to a firm's strategic logistics performance **(model 4)**

In the final model 4, 'information integration' is the independent variable and 'strategic performance' is the dependent variable. The correlation coefficient (R) for strategic performance and information integration is 0,450 **(N=129)**. The coefficient indicates that there is positive mediocre relationship between information integration and strategic performance. This model scores the highest correlation coefficient compared to the previous three models.

The model 4, explaining relationship between 'information integration' and 'strategic performance', is significant and can be accepted with $p < 0.001$ (sig.). The coefficient of determination R^2 is 0,203. This indicates that 20.3 % of the total variance explained in strategic performance of the company is accounted for by the variance in information integration. The adjusted R square for the model is 0,196 and the standard error of

estimate is 0,65103. The suitability of the model is estimated with Fischer's F-test. H_0: $\beta_1 = 0$ is being rejected, because H1:$\beta 1 \neq 0$. Table 15 shows that F = 32,299, df = 1 and $p < 0.001$.

Table 15 ANOVA for information integration and strategic performance (model 4)

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	13.689	1	13.689	32.299	.000[a]
	Residual	53.827	127	.424		
	Total	67.517	128			

a. Predictors: (Constant), Information integration

b. Dependent Variable: Strategic Performance

The estimated regression for the model is $Y_i = 2{,}724 + 0{,}418x_1$. If X_1 (information integration) is increased by one unit, strategic performance is increased by 0,418 units. The coefficient is statistically significant since the H1:$\beta 1 \neq 0$, $p < 0.001$ and therefore the variables suit to the model. The Table 16 below illustrates the estimated coefficients.

Table 16 Estimated coefficients (model 4)

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	2.724	.273		9.964	.000
	Information integration	.418	.074	.450	5.683	.000

The histogram of the model has slightly a positive kurtosis but it is rather close to a normal distribution. However, due to high sample size this does not cause problems to the model. The scatterplot of the model reveals that the residual values of variable (y) are scattered over and below zero (e.g. see Appendix 8). The Figure 18 below illustrates the outliers of information integration and strategic performance. The trend lines of both large and medium-sized firms are quite alike, although the trend line for medium-sized firms is slightly higher. The trend lines of this model are more sharped than in the previous three models. The figure also reveals that there is slightly more outliers for large firms in the data.

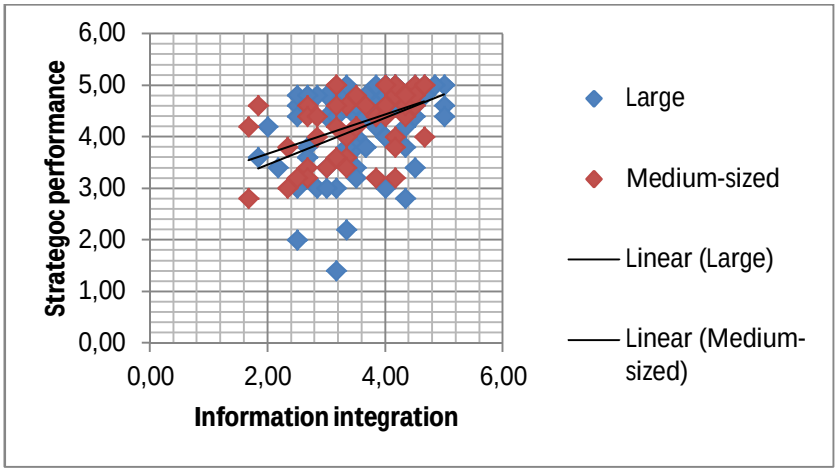


Figure 18 Outliers for information integration and strategic performance

The model 4 was tested to include two independent variables: information systems and information integration. As in the two earlier cases, the model was rejected because it was not statistically significant. The model was also performed vice versa, as strategic explaining information integration. The model was significant and could be accepted with $p < 0.001$ (sig.). The strength of the association R^2 was also 0,203, which indicates that 20.3 % of the total variance explained in information integration is accounted for by the variance in strategic performance. The adjusted R square for this was the same (0,196) as in the other way around. The standard error of estimate was 0,70126 ($p < 0.001$), and estimated regression $Y_i = 1{,}576 + 0{,}485x_1$ ($p < 0.05$). The result of F test was the same as above.

Issues for closer follow-up in the qualitative part of this study:

The results indicate that the use of information systems (and use of information technology) explains a substantial extent of information integration (22.7 %). How does the use of IT and IS impact on information integration, and on the relationship between information integration and logistics performance? These are studied further in-depth in the next section.

Also the relationship between information integration and logistics performance (strategic and operational) requires additional understanding. Underlying issues, mechanism and practices affecting the relationship are studied to form a better understanding of what constitutes the realization of the relationship. Also what strategic and operational performance improvements firms want to achieve are studied.

7 THE USE OF IT AND IS, INFORMATION INTEGRATION AND LOGISTICS PERFORMANCE IN THE CASE COMPANIES

This chapter presents the qualitative analyses and results of this study. First, the use and current sufficiency of information technology and systems is discussed. In the second section, information integration is analyzed from the extent perspective including scope, level and direction of information integration. The elements of integration are closely tied to the analysis. Also the current information sharing practices used in the case companies are outlined. Finally, the relationship between information integration and logistics performance in the case companies is analyzed and discussed. Issues which affect the relationship of information integration and logistics performance are identified and how can the use of information technology and systems facilitate this relationship is discussed.

7.1 The use of information systems and technologies in the case companies

Total of 60.1 % of the respondents of the selected sub sample considered that their company information systems enable them to share operative information with their key suppliers (partly agreed or totally agreed), as mentioned in the chapter 6.1. In addition, 56.7 % regarded that their company information systems enable sharing of operative information with key customers (e.g. see Figure 11).

All six firms interviewed have an enterprise resource planning (ERP) system in use, as well as, other additional information systems and a variety of reporting tools to assist them in decision-making. Two of the companies (Companies D & F) interviewed are using SAP as their ERP system. Most of the respondents were fairly satisfied with their current company information systems, however, all large firms found that the systems could also work better. The two firms using SAP found that the system is rather stiff and inflexible to use. For example, both firms felt that real time or accurate information about forecasts was difficult to get. The two medium-sized firms were satisfied with the functioning of their current ERP system and found the systems sufficient enough for their current needs, whereas, the four larger firms all felt that there could be improvements made to their current systems. Problems associated mostly with the incompetency of the employees to use the systems or in the complexity of the systems.

Advanced communication methods have gained ground, however, traditional communication methods are largely part of everyday inter-organizational communication and information sharing in the firms interviewed. For all the firms, the

most common way to share large amounts of different information was by sending Emails. Most of the information is nowadays shared in an electronic form. Electronic data interchange (EDI) was the second most common way to share information electronically. Some of the firms are also using supplier portals or webs (supplier relationship management systems) to share more information towards the upstream. Only one of three firms, which were interviewed about their information sharing towards customers, has a customer tool/software for receiving orders from customers via a system. Two firms mentioned that they receive customer orders via EDI. From the traditional communication methods, telephone and face-to-face contacts are essential for information integration and information sharing. In rare cases also Fax is used. The Table 17 summarizes information systems and technologies which are used by the firms interviewed.

Table 17 Summary of information sharing methods used by the firms interviewed

	ERP, repor-ting tools	**Data ware-house**	**Supplier portal / web**	**Report informa-tion from EDI**	**Additional software for document management**	**Electronic information exchange**
Company A	**x**	**x**	**x**	developing	Customer order management tool, Documents (purchasing, partner information, technical pictures)	Email, EDI, supplier portal
Company B	**x**	--	--	--	--	Email, EDI
Company C	**x**	**x**	--	--	Documents (sourcing, technical pictures)	Email
Company D	**SAP**	**x**	in test use	--	Documents (technical pictures)	Email, EDI, devel. supplier portal,
Company E	**x**	**x**	--	--	One system for all documents	Email, EDI
Company F	**SAP**	**x**	**x**	**x**	Documents (quality mgmnt, technical pictures)	Email, EDI, Supplier portal

Five firms out of six have EDI connections in use. In Company C, EDI is not in use due to cost-benefit related issues. The cost-benefit relationship of EDI was considered be too low. This made the Company C decide not to implement EDI. In the five other firms, information exchanged via EDI consisted mainly of activities related to order-delivery process: order information, order confirmations, changes in orders, lead times, prices etc. Company F is currently using EDI information to provide additional reports.

Companies A and F have an active supplier portal/web and Company D is testing their new portal in order to share more information electronically towards suppliers. The

selected suppliers have a web-facing and password-protected access to the portals which were most often provided by a cloud service platform. With the help of these portals, the three firms are able to share for example forecast information, claim information, list of open orders, delivery accuracy information, quality information, lead time information, supplier score cards, supplier's commercial information, technical drawing information and other documents. Information which a specific company is sharing via a portal varies slightly. In addition, Company D has built an order management tool for transport purposes to their portal to assist the firm's logistics partners. In the previously mentioned portal, suppliers are also able to receive orders and confirm them via the portal. In company F's portal, the supplier is able to save documents to the portal.

Company A has a customer relationship management tool/software. The system is IBM Lotus Notes-based customer relationship management software. Information is shared on customer preferences, forecasts, pricing, order handling, warranty handling etc. The greatest advantage of the supplier/customer portals was considered to be that information is available at all times and accessible to selected/preferred people. Furthermore, one of the benefits of the portal was considered to be that the information is or would be real time and up-to-date.

Aside to having an ERP system, five firms have a data warehouse from which information can be printed into a report format. These five firms had additional software systems in use - mainly for documentation of drawings and technical pictures, product information, customer information and orders, supplier information, bid information and quality information.

Facilitation of information integration by using information technologies and systems in the case companies

Four firms out of six agreed that their information systems facilitate sharing of different information to their suppliers and/or customers. The two firms using SAP, however, were not able to facilitate information sharing by using their information systems. For these firms, the data needed to be manually handled before sharing it forward.

Almost all interviewed respondents mentioned that although Email is a useful tool for sharing information, it also has its drawbacks. Fast changing business environment requires that large amount of inter-organizational and intra-organizational information needs to be shared. Information was most often exchanged by sending Emails in the firms interviewed. The Quality Manager of Company E illustrated this by saying: *"We have access to a lot of information but most often information is stored behind one person"*. In many cases, information is stored in a person's work Email and therefore inaccessible to those how might need it. In addition, several respondents mentioned that the use of Email for information sharing and communication purposes has resulted in information overload, and employee Email inboxes are filled with unnecessary

information. Three interviewees mentioned that there is clear need for rationalizing or decreasing Email communication and finding alternative efficient communication methods that would assist employees in performing their everyday work tasks more efficiently.

Four interviewed companies mentioned that latest information systems and modern ICT could assist them in improving information sharing and integration. There is a need to have access to relevant information (e.g. forecast, order, product, drawing, bid information), which could be stored in a system or in a portal to which selected people have an access to. Instead of exchanging information by Email, accurate, relevant and up-to-date information could be easily retrieved from a system whenever needed by selected suppliers, customers and partners. The interviewed firms felt that this could further assist them in their external, as well, as in their internal information sharing operations.

According to Company D, for example Microsoft's SharePoint types of software solutions are essential at the moment, and their advantages need to be further researched in the future. SharePoint is a web application platform developed by Microsoft and it provides a shared collaboration environment to which third-parties of supply chain can be integrated. According to company D, these kinds of solutions would help especially in the two-way information integration between a focal firm and its supplier. Currently, information sharing in the company D has concentrated mainly on Email communication and sending messages. According to Company D, in future there is a need to be in more constant collaboration with suppliers, and therefore more than Email/message communication is needed. Especially documents need to be managed properly.

"In general, we need to start thinking more from an 'electronic portfolio of services' approach. We do not want to offer only one tool for sharing information to an individual supplier but to build a combination of standard EDI, and of some other matters that need to be handled in a supplier portal. In addition, we can also be in a third system, for example concerning E-invoicing." (IT Manager, Company D)

If some part of Email communication can be shifted to a portal, requires this new or different kind of internal organization which transfers the information to the system or maintains/ensures its accuracy (Company D, Category Manager). Reciprocally, two firms mentioned that this changes the suppliers' role as well. In future, a more active role is needed from suppliers to search independently for the information that they need.

Aside to having a web portal, several other reasons were mentioned which would further assist firms in sharing information and improving performance by using information technology and systems. Decreasing price of information technology and

systems was mentioned to be an important factor in improving the use of information technology and systems according to three case companies. Also improvements in functionality and ease of use of systems, necessary IT/helpdesk support and taking advantage of ready-made commercial software were mentioned to further assist sharing and integrating information. Information sharing practices were mentioned to assist more efficient information integration by one case company. However, by implementing for example a supplier portal, new information sharing practices become an important part of information integration. In order to successfully implement a new IT system, also new practices and everyday working methods are good to be identified to find the best practices. Also this way the desired performance improvements can be achieved in the long run. The Appendix 10 illustrates the frequency of case company answers about how the use of information technology and information systems would facilitate information integration and performance.

A suitable IT driven environment for implementing new IT has to exist in the entire supply chain, in order to benefit from information systems and technology-based information integration. This was mentioned by several interviewees. Suppliers' limited ability to implement information systems and technology was mentioned by three case companies to prevent them from facilitating their information integration. Supply chain wide technology implementation would create mutual benefits of using information systems and technologies when integrating information. For Companies A,B,D,E and F who felt that information technology and systems would facilitate their information sharing process, the biggest challenges were mentioned to be the limited resources of supplier network to adapt new information communications technology.

"Our suppliers are fairly small and their resources to implement these kind of electronic systems are limited. We do not want to tie the hands of our suppliers into using just one service but to create a flexible environment where to operate. This is also done by lowering their ability and willingness to implement the electronic information services". (IT Manager, Company D)

Also limited or lack of financial resources prevents case companies from using IT and IS in information integration. This was mentioned by four firms. Other issues preventing firms from using IS and IT for facilitating information integration were mentioned to be the lack of necessary human and/or IT resources, employee and management attitudes, economies of scale of all units having same information systems, malfunction of the information systems or other information sharing tools and that often sharing would involve non-disclosed agreement (NDA) information which can be prevented by the focal firm. The Appendix 11 presents the frequency table of the answers of the case companies. According to the case companies, by paying attention to

the above mentioned facilitating and preventing issues, can they tackle the IT and IS challenges and improve information integration and further on performance.

7.2 Extent of information integration and information sharing practices in the case companies

In this sub section, the interviewee firms' responses are analyzed by examining and understanding the extent of information integration (scope, level and direction) with key suppliers and/or customers. Furthermore, the current information sharing practices are outlined to develop a more holistic picture of the current stage of information integration in the case companies. The elements of integration are closely tied to the extent of information integration.

7.2.1 Scope of information integration

Scope can be described as the number of different areas on which cooperation and integration is being developed and information shared (van Donk & van der Vaart 2005a, 99). Several areas of scope were mentioned by the interviewees. One of the most important areas of scope on which firms were keen to share information is forecasts.

Types of information which were mentioned by the respondents can be divided into ordering process information, operational information and strategic information. Figure 19 below illustrates scope of information which is adapted from Van Donk and van der Vaart (2004; 2005a). In the Figure 19, different types of shared information are outlined according to the responses of the case companies (A-F) and located in adequate boxes. As mentioned in the chapter 2.4.1, five dimensions of the scope can be distinguished. These are flow of goods, flow of planning and control, flow of organization, flow of information and product development. The different scopes of information mentioned by the respondents found in this study are placed under each dimension. Each of the five dimensions consists of different integrative practices which add scope to the integration.

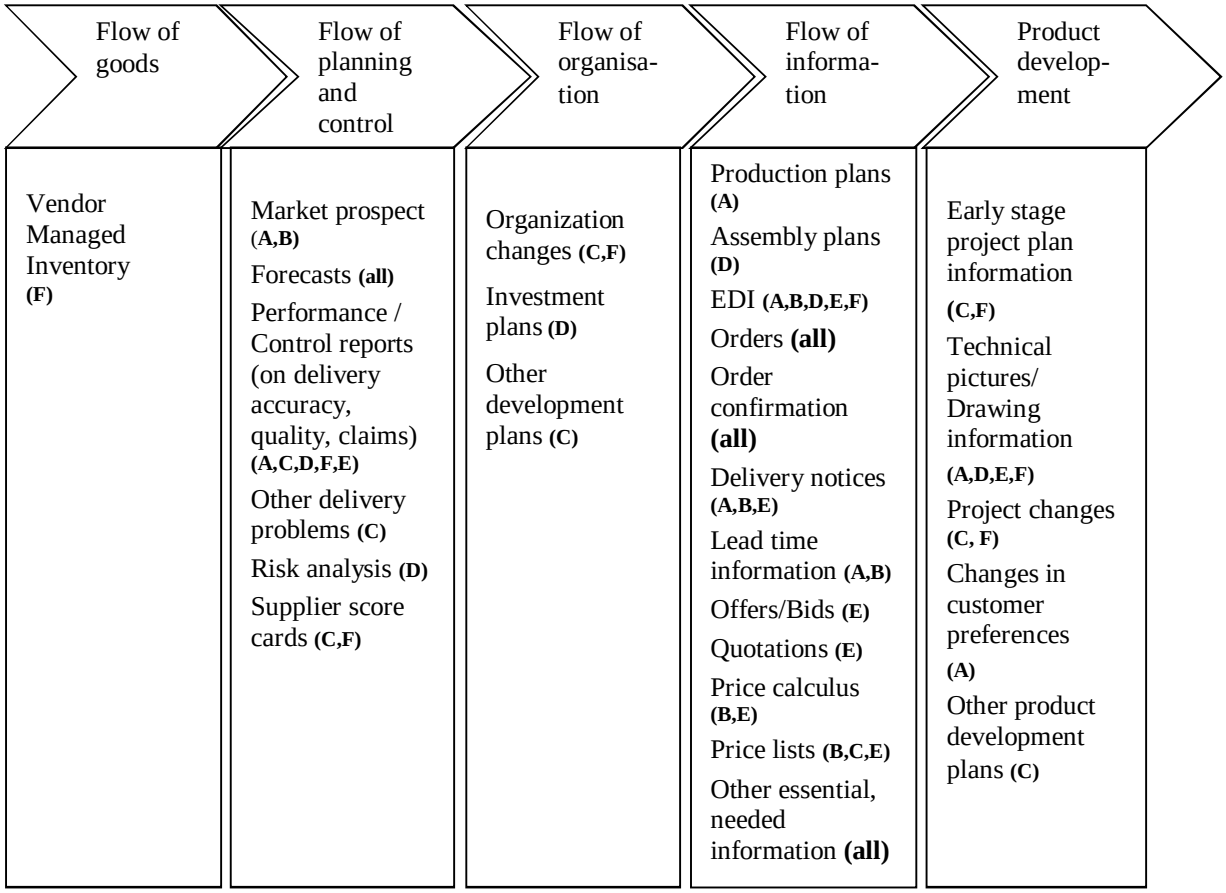


Figure 19 Scope of information integration with key customers and/or suppliers

From flow of goods (1) perspective, information is shared on areas related to vendor managed inventory or to two-box system, in which a vendor or a supplier replenishes the focal firm's inventory automatically. The facilitation of information technologies and system on this area of scope was not discussed in detail by the firms interviewed. One case company mentioned that information about vendor managed inventory and automatic replenishments could be useful if it was placed in a supplier portal. This way the replenishment information would be real time and available to the supplier as well as to the focal firm.

Information related to the flow of planning and control (2) was considered essential in terms of improved performance, both for the focal firm and its key suppliers and/or customers. The respondents identified several areas on which information is shared to improve planning and control. Forecast information was considered extremely important to be shared among supply chain partners. Also sharing control or performance reports (e.g. on delivery accuracy, quality, claims) on was considered important and mentioned by almost all respondents. To improve performance, information was needed to be shared to suppliers for example about how well they are performing. Information was also shared on market prospects, forecasts, special

delivery problems, risk analysis and on supplier score cards. One of the most important reasons for why these were considered essential for information integration was that the focal firm together with its suppliers could tackle the fast changing business environment. Information technologies and systems facilitated and added scope to this area as well. Only company A had real-time component forecasts available to suppliers in their supplier portal. Two other large firms thought that this would be very essential, although their current information systems create a challenge for providing accurate real-time information to be automatically derived from the system. Two of the firms using a supplier portal, have supplier delivery performance and control reports located in a portal. Also companies B, D and E mentioned that they have an access to see their performance reports in their suppliers and/or customer's web portals.

Areas related to the flow of organization (3) consisted of informing of organizational changes, investment plans or other development plans. Company F mentioned that they provide information related to organizational changes to their suppliers by placing it on the supplier portal. This way the information is available to suppliers whenever needed and in a place where it is easy to find. Among other firms, organizational information is shared by sending Emails.

Most of the operative information can be placed into the flow of information (4), and the case companies mentioned many issues relating to this area. Production plans, assembly plans, EDI, orders, order confirmation, delivery notices, lead time information, offers and bids, quotations, price calculus, price lists, other essential or needed information was considered relevant for information sharing and integration with key suppliers and/or customers. Most of the information related to this dimension was found to be useful when provided to suppliers and/or customers by using information technologies and systems. Information placed in this dimension was mentioned, by five out of six firms, to be useful if provided to suppliers and/or customers with the help of a data bank or a supplier portal as well as with EDI.

The fifth scope of integration consists of information related to product development (5). Early stage project plans and information, technical pictures, drawing information, project changes, changes in customer preferences and other product development plans were mentioned to be shared with key suppliers and/or customers. The use of information technologies and systems also could facilitate information integration related to product development dimension. Three firms mentioned that it would be useful to have an access to customer's technical pictures or vice versa, the focal firm's suppliers would have an access to their technical picture via a data bank.

In addition, the respondents identified several areas of scope on which information should be shared even more. Information could be extended to include more of detailed and accurate forecasts, inventory levels, quality analysis or comparisons, lead time information, information about dying products or product families, sudden environment

changes, supplier changes, future R&D projects, the final use of the product, investment plans, risk analysis and suppliers being involved in the focal firm's R&D project from early on. By sharing more information about these, quality of shared information could be increased. Also by informing about future product development projects and special needs from early on, suppliers could assist the focal firm's R&D personnel to conduct cost and time efficient decisions, reduce overall lead times and decrease Email trafficking.

7.2.2 Level of information integration

Van der Vaart and van Donk (2004, 26) described three levels of integration: *transparency stage, commitment/coordination stage and integrative planning stage*, as identified in chapter 2.4.2. The same levels of integration can be identified in the companies interviewed.

The interviewees agreed on that supplier side information is shared primarily with strategic, critical or bottleneck and partnership type of suppliers. Information is also needed to share to volume suppliers, whereas, the need to share information to arms-length suppliers is much lower. As Category Manager in Company D illustrated "*all suppliers need certain amount of information*". For some suppliers, the amount of information needed is significantly lower, whereas, others need variety of different information - of different scope and level. The need depends highly on the nature of the supplier collaboration relationship, which derives from the characteristics of the product that is being purchased from the supplier.

On the contrary, the three case companies (A,B,E) interviewed about their customer side agreed on that all customers and each customer segment are equally important in terms of information sharing and information integration. Therefore, no specific variation exists between the level of information integration towards different customers, and all necessary information needs to be shared with those customers who need it.

All case companies agreed on that all relevant information needs to be shared with key suppliers (strategic, critical, bottleneck and partnership suppliers), and a mutual trust needs to exist between a supplier and a focal firm. Coordination of activities was described to be much more advanced with key suppliers, and the relationship consisted of more than ordering process related activities. This verifies that the second level (commitment/coordination stage) of van der Vaart and van Donk (2004) applies when cooperating and integrating information with key suppliers. In addition, activities related to integrative planning stage can be identified. A more intensive relationship was required if the supplier and its manufactured/purchased products or components were

considered critical to interviewed manufacturing firms, there was joint production planning and manufacturing, there was intensive product development with certain suppliers, and if there was a need for maintaining inventories in control and pursuing just-in-time deliveries. As Bagchi et al. (2005, 283) have described, the level of collaboration with key suppliers, it can be described as medium or high in the case companies.

The frequency of contacts, which the firms interviewed have with their key suppliers and customers can be described as high. Depending on the nature of information shared (ordering process, operational or strategic information), the personnel working in the supplier surface is in close contact with suppliers. In many cases, the key supplier base was contacted daily or weekly, and vice versa. In strategic matters, frequency of contacts or meetings varied from a quarter of a year to a year, or whenever contact was needed. Information is also shared daily or weekly with key customers, and vice versa.

Although information is shared intensively with key suppliers, all firms found that more information integration could be needed or is needed with key suppliers. Especially with suppliers that have a higher supply risk, volumes are greater and the purchased product is more complex. With these, there was considered to be a need for more in-depth level of information integration.

The need to share information electronically or using different information technologies and systems varied depending on the supplier collaboration relationship. Basic ordering process information was exchanged via EDI in five interviewed firms. In these five firms, the amount of order receiving/order confirmation information exchanged via EDI was between 50 - 90 % of order rows or from company turnover. The number is quite high, and is expected to increase further. Two case companies mentioned that their target is to increase the use of EDI in the near future.

The level of information integration is and could be further facilitated with the use of information technologies and systems. In the interviewed companies, ordering process information is already largely facilitated with information technologies and systems. Operational information and strategic information are also crucial for information integration but much more difficult to exchange via EDI than basic ordering process information. These types of information often end up trafficking Email inboxes. The development of supplier portals, available to selected suppliers at all times and most often containing accurate and real time information, offers an advanced communication method that can consist of large amount of information. Especially different level of operational information can be shared via a portal, as already happens in the three firms who have a supplier portal.

The firms felt that implementation of a supplier portal or a data bank would benefit them and enhance their performance, as well as, facilitate internal and external information sharing and integration. Case companies A, B, D, E and F stated that

automation of ordering process activities, implementing data banks or supplier portals and producing clear and accurate reports derived from the systems would facilitate and extent their information integration. Proper and functional information communication systems and technologies could facilitate this and provide performance improvements in the long run.

However, it was not considered beneficial to pursue a close collaboration and extend information sharing towards information integration and to include all suppliers. As stated earlier, information sharing with key suppliers was considered important. Facilitating information integration by using information systems and technologies was considered important with selected/key suppliers. In case company A, a supplier portal access has been given to all larger partnership firms. In case company F, supplier portal has been implemented to include 10 suppliers and in case company D the portal is currently in test use. On the basis of this study, Figure 20 below illustrates a model (adapted from Kraljic's (1983)) to describe with whom it would be beneficial to extend information integration by using information technology and systems. Key suppliers (strategic, critical, bottleneck and partnership) are the essential ones with whom information integration would be beneficial to extend by using information technologies and systems as facilitating information integration.

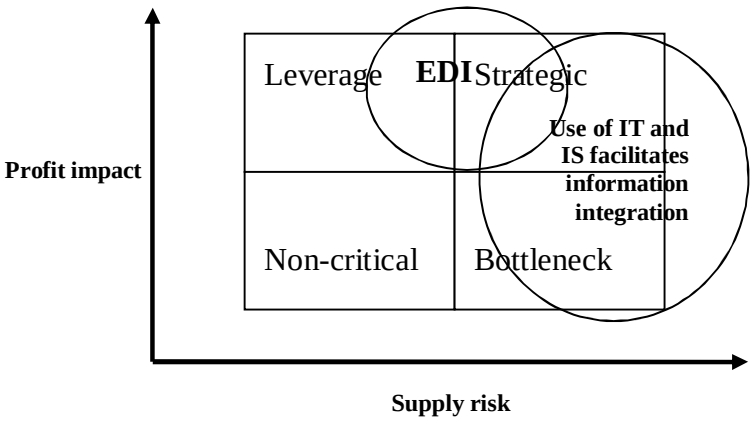


Figure 20 IOIS sharing with selected suppliers and/or customers

EDI is already widely used by most of the case companies, excluding case company C. EDI connections have been implemented mostly to include suppliers and/or customers who have a greater volume of order rows or company turnover. Information systems and technologies (e.g. supplier portals, inter-organizational information systems or data banks) on the other hand would be more preferably used when sharing information (ordering process, operational and strategic information) with key suppliers (e.g. strategic, critical, partnership or bottleneck).

With key suppliers, the level of information integration requires a mutual and constant collaboration, and it needs to meet the business requirements of both the focal firm and the supplier. However, depending on the specific characteristics and types of business, there exists a need for different IS and IT functionalities among different supplier portals. The three firms using a supplier portal have concentrated on slightly different functionalities and share different information in their portals. With regard to the interviewees comments it can be stated that company preferences determine what information is essential, relevant and needs be shared using information technologies and systems to facilitate information integration in a particular company.

7.2.3 Direction of information integration

The direction of information integration was considered difficult to answer by all the respondents interviewed. The main reason behind the difficulty was that in large companies the knowledge about both supplier side and customer side is rarely known by an individual person who is working for in the either supplier side or in the customer side. However, most of the respondents felt that information integration is equally important to both directions in their firm - towards customers and suppliers, and it cannot be easily determined whether a firm is more directed towards one than other. In addition, the respondents considered that the nature of information integration with customers and suppliers is different and therefore comparisons are difficult to conduct. The Category Manager in company D stated that: *"Our customers want most likely the same kind of information from their suppliers e.g. from us, as we want from our suppliers"*. Therefore the chain effect would indicate that same kind of information is shifted in the chain depending on who is acquiring the information.

In this study, the direction of information integration in the case companies is outward-faced. In this direction, information integration is extended to include both wide supplier sides and wide customer sides. As Frohlich and Westbrook (2001, 190-191) have illustrated, this direction consists of high levels of integration.

Instead of observing the case company's direction of information integration, whether it is directed more towards customers or suppliers, the respondents stated that it would be more advantageous to observe the direction of information between a focal firm and suppliers or focal firm and customer. The interviewees agreed on that also suppliers and customers need to share information actively to the focal firm (e.g. buyer). The communication needs to be mutual and flow efficiently towards both directions – the focal firm shares relevant information proactively with its supplier, and the supplier shares information proactively with the focal firm. Case company F mentioned that

information integration towards suppliers is essential especially when the entire production is outsourced.

7.2.4 Information sharing practices

Information sharing practices vary among different customers and/or suppliers, although some similarities can be identified. Focal firm's information sharing practices towards its suppliers vary depending on the position and importance of the supplier. On customer side, two firms interviewed stated that information sharing practices are different within certain customer categories, whereas in case company A, information sharing practices are similar regardless of customer segments.

Within a firm, information sharing practices used or preferred with strategic type of suppliers are quite similar. Consistent and similar information sharing practices are pursued when collaborating within a certain supplier category. The case companies shared information for example with strategic suppliers by using more advanced information sharing practices, whereas, the information sharing practices used with suppliers categorized as arms-length type of suppliers was less advanced due to lower levels of collaboration.

It can be noted from five case companies' responses that larger firms set ground for mutual information integration and to the information sharing practices used. The three larger case companies (A,D,F) used same kind of information sharing practices with their suppliers: supplier portals or webs were used with selected suppliers (e.g. strategic, critical, partnership or bottleneck) and EDI connections were in use with multiple suppliers. Case company D also mentioned that it sends certain reports only to selected suppliers. Email communication was the main method used for communicating with all suppliers (varying from arms-length to strategic partnerships).

On customer side, the two medium-sized case companies B and E agreed on that their customers (most often larger firms) have the power to define mutual information sharing practices and daily working methods. The representative of case company B stated that the bigger the customer firm is, the more they can define how to share information. Practices are most often rather stiff, and suppliers are required to be flexible and adjust to the customer preferences. Also representatives in case company E noted that larger customer firms define the working methods and means to share information. The two firms mentioned that several their customers have an active supplier portal in use. The customer firms require that the portals are actively used. In many cases, implementing EDI connection has been started from the initiative of a larger customer firm. Vice versa, case companies A and B noted that when dealing with

larger supplier firms, the focal company's power to define information sharing methods and practices is limited and the supplier defines the means to share information.

According to the respondents, information sharing practices are most often well-known in the firms interviewed. The practices are consistent, and although information sharing process was not identified in any of the case companies, the respondents felt that their teams and/or employees have found the best working methods to use. Yet, potential improvements or development areas mentioned included improvements in the daily information sharing practices. Improved daily information sharing practices were also identified in chapter 2.5 to facilitate information integration.

"Information which we share to our suppliers is sufficient. How we actually share it needs a lot of improvement. And vice versa, information which we receive from our suppliers is not in a format which we hope it to be. On our supplier side, improvements are needed in the information content, whereas on our side information sharing practices need improvements." (Material planning manager, Company A)

A need to improve information sharing practices is identified for example by the case company A. Case company E emphasized that an important area which needs to be improved is Email communication practices, which form a great part of information sharing practices. The respondents felt that Email practices should to be better instructed. As mentioned in earlier chapters, the usage of Email has increased outstandingly. The use of Email will most likely continue to remain the main method of information sharing, and improved practices are needed when information is shared via Email.

Material planning manager in case company A also pointed out that although information sharing practices should be consistent within a certain factory or a manufacturing unit, can the practices still vary among different business units inside one firm due to the fact that the units are different. This can cause confusion among customers and/or suppliers if different information sharing practices are preferred by different business units or manufacturing units within the same company. In many cases, all respondents felt that the methods which work best for the focal firm and its supplier and/or customer will become constant practice and lay ground for mutual information sharing and information integration.

7.3 Impact of information integration on logistics performance

The desired logistics performance achieved by information integration in the case companies

Performance improvements which the case companies wanted to achieve can be observed from variety of different perspectives as discussed in chapter 3.1. The case companies were observing the potential performance improvements which they want achieve by sharing and integrating information mainly from a supply chain's or from a single firm's perspective. The respondents of three firms mentioned that actions taken place in their supplier field have an impact on their customers' customer in case information is not shared openly and actively. Therefore, the impact reaches the entire supply chain. Performance improvements were not looked at from a business unit's or from a plant's perspective by the respondents.

Three case companies mentioned that operational performance improvements (efficiency and effectiveness improvements) can be seen as means for achieving strategic and financial performance improvements. The respondents felt that by sharing and integrating information with key suppliers and/or customers, firms can improve the efficiency of operative processes and activities, communication and information sharing, the flow of information and add transparency to operations. The strategic and financial performance impacts mentioned by the interviewees consisted of issues affecting customer satisfaction, suppliers' ability to operate competitively and the focal firm's profitability. The Appendix 12 illustrates the desired performance impacts which the case companies want to achieve by sharing and integrating information.

From operational point-of-view, improving transparency of operations, quality of information sharing and material flow, delivery performance, suppliers' operational capability and lowering operating costs are one of the main benefits in terms of efficient information integration. Other reasons for why to share information were to gain what is wanted, to increase understanding about the focal firm's business and its requirements, to improve lead times, to decrease information error, to decrease double work and to create more efficient practices and working methods.

From strategic point-of-view, increasing commitment, openness and in-depth collaboration, increasing suppliers' competitiveness and financial viability, lowering overall costs and improving financial profitability were the most important outcomes of information integration with the key suppliers and/or customers. The case companies mentioned that other reasons for sharing and integrating information were that customer trust is created and maintained, the focal company is competitive in the global competition, the focal company's image is improved, the focal company has competitive prices and that it can increase its profit impact.

Suppliers' operational and financial impact was mentioned to be one important reason for integrating and sharing information in the case companies C, D, E and F. The firms did not want to gain benefits only for themselves but to their partners as well. The case companies considered that it is important to guarantee that also suppliers can operate viably and profitably. All case companies agreed on that the foundation for information integration and information sharing lies in mutual and open collaboration. The respondents mentioned that although they share information to gain their own benefits, they also share information so that the supplier can achieve competitive advantage. As Sourcing Director in company F stated: *"A reason for why to share information is that also the supplier is competitive towards us and itself, and that the supplier can operate and continue its business according to its' own goals"*.

Issues which the case companies experienced to have prevented them from achieving benefits derived from information integration can be identified as being caused by external and internal issues. ***Externally*** - improper utilization of the shared information on the supplier side, indirect information sharing, lack of the entire supply chain to share information openly, rapidly changing business environment and business requirements and human errors were mentioned to influence the relationship between information integration and logistics performance. ***Internally*** - limited time resources of employees, indirect information sharing, improper tools for communication and information sharing, cultural differences in understanding the common company targets, difficulty to forecast accurately, human errors and whether information has been shared too late were mentioned to be the primary causes which affect the relationship between information integration and logistics performance. The list is quite wide and comprehensive. Therefore it can be noted that using improper tools when communicating with customers and/or suppliers is only one issue among several others that impact on potential performance improvements which want to be achieve by sharing information.

Case companies' experienced logistics performance improvements achieved by information integration and information sharing

As mentioned above, there is a great amount of issues that prevent the case companies from achieving what they want. Logistics performance improvements which the case companies want to achieve, have not yet been achieved and work is continued at the companies to improve operational and strategic logistics performance. Although none of the case companies have measured the relationship between information sharing/integration and logistics performance, they experienced that some of the benefits have been achieved. However, many external issues (e.g. rapidly changing business environment and business requirements) and internal issues (e.g. limited time resources of employees) affect the relationship between information integration and

create challenges for achieving improved performance. The case companies agreed on that a situation where no information is shared with key suppliers and/or customers would be impossible and would paralyze all operations. Therefore a positive relationship between information integration and logistics performance is experienced and expected to exist according to the respondents. In addition, how much sharing information actually impacts on logistics performance, is unknown and open for various speculation.

The respondents felt that measuring the direct relationship between information integration and logistics performance is difficult. A reason for why information integration and its' desired outcome is difficult to measure, can be caused by the fact that none of the case companies have identified their information sharing process and how information sharing truly affects the performance improvements they are seeking. All case companies experienced that operational efficiency is achieved by sharing information but to what extent is improved performance derived from information sharing is uncertain.

According to the case companies, information integration can though be observed indirectly by measuring the changes taken place in the potential performance measurements, especially in delivery accuracy, lead times and costs. Directly, the benefits of information integration are not easily measured but indirectly the impact can be identified in the performance improvements.

The measures mentioned by the respondents were mainly tactical (e.g. use of supplier score cards) or operational (delivery accuracy, claims and quality reports) according to Gunasekaran et al. 2004 (see Table 3). Case company C mentioned that they conduct 'supplier scoring' to evaluate the state of the supplier relationship and collaboration. This is followed by an open feedback conversation with the supplier. Company F is using same kind of performance measurement, and supplier scorecards are used for evaluating performance. Company F is currently performing a supplier feedback enquiry.

Operational measures consisted of delivery accuracy, quality reports and faster lead times in the case companies. All case companies are measuring suppliers' or external partners' operations. They are measuring operational efficiency of e.g. suppliers. Flexibility performance measures were not mentioned by any of respondents. Improved delivery accuracy and improved quality of products were mentioned by all the case companies to be better since they have shared information. Case companies use delivery accuracy as the main measurement of whether information has been shared sufficiently enough to the supplier side. The same result was also found in the quantitative part of this study which revealed that delivery performance explains 13.6 % of the variance in information integration.

From information integration perspective, delivery performance also illustrates whether a firm has failed to share necessary information to its suppliers, if the information has been shared too late or it has been incorrect, as mentioned by the representatives of case company F. All these are caused by internal inefficiency of operations. Furthermore, if the supplier neglects to utilize information shared to them (i.e. external inefficiency), the impacts can have enormous consequences on delivery performance of the supplier as well as of the focal firm. In addition, sharing information at an earlier stage can create mutual benefits and increase cost efficiency. The sourcing Director in company F stated that: *"If we share information to our suppliers at an earlier stage, they are able to plan their production more soundly and purchase materials at a lower price. This way, also we can purchase the products from them at a lower price."* The impact is shown on the financial performances of both companies.

Surprising was to notice that the case companies were using more of external efficiency measures (to measure suppliers' operations/efficiency) instead of also measuring and paying attention to inefficiency of internal operations and measuring those. For example limited time resources of employees can have enormous impact on the relationship between information integration and logistics performance if information is not shared on time. Aside to measuring suppliers' operational capability it could be essential to also measure internal issues which prevent information integration and impact on logistics performance.

From the customer side, customer satisfaction enquiries were mentioned to be the main measurement of how well the focal firm has been able to share information to its customers. Company E mentioned that every now and then its customers also perform audits to evaluate their company. The sales coordinator in case company A added that information sharing is dealing with a lot discreet and sensitive issues, and it is important to pay attention to the soft methods how information is actually shared. This relates also to information sharing practices discussed earlier, and how well the firm performs in sharing information to its customers and/or suppliers.

On the long run, information was considered to be shared to impact the strategic targets of the company, e.g. customer satisfaction, trust and profitability of the company. In the short-term, information was shared to impact operational efficiency and operative targets, e.g. ensuring continuous production and deliveries, as well as, lowering operational costs and shortening lead times.

Developing information integration and improving logistics performance

The case companies agreed on that there is a need to improve the use of information technology and systems and to enhance information integration if desired logistics performance improvements want to be achieved. They also agreed on that there is a need to facilitate, simplify and transfer the scarce resources employees have on more

advantageous activities. At the moment, time is considered to be “wasted” on unnecessary information sharing activities and Email trafficking.

According to the respondents, developing current information sharing and information integration can be achieved by paying attention to various different issues. These include for example development of information sharing practices, better utilizing modern ICT and IS, and clarifying the information shared. *All case companies stated that information sharing and information integration could be facilitated with a web portal or a data bank to which e.g. suppliers would have a password and from which they could search for the information they need* instead of enquiring after the information by Email. Especially case companies A, B, D, E and F highlighted the use of a web portal or a data bank. A shared web portal where information is stored was considered to be useful (e.g. a supplier portal, an extranet or a data bank). The Table 18 presents the issues which prevent the case companies from achieving improved logistics performance by integrating and sharing information. On the left side, some of the main internal and external issues which prevent the realization of the relationship betwen information integration and logistics performance are outlined. The right side of the Table 18 below is describing how the use of information technology and systems (especially by using a web portal/a data bank) could influence the relationship between information integration and logistics performance. The facilitating IT/IS issues are mentioned throughout the qualitative part of this research.

Table 18 Developing information integration with IS and IT

Issues preventing the relationship of information integration and logistics performance	**Use of Information technology and systems for facilitating purposes**
Less indirect information sharing	All relevant personnel have access to the information at all times (increase information accessibility)
Lack of the entire supply chain to share information openly	Information is shared downstream and upstream (increase transparency)
Rapidly changing business environment and business requirements	Informing of rapid changes to large amount of suppliers and/or customers when updating information to an IT based system, Automatic changes updated to web forecasts (if synchronized with ERP) (increase quick response)
Human errors	More automation of processes, e.g. order processing (increase information quality)
Limited time resources of employees	More information available in an IS, less Email communication (decrease unnecessary work)
Improper tools for communication and information sharing	Less Email communication (increase quality of information and decrease unnecessary work)
Information has been shared too late	Up-to-date or real time information available (increase timeliness of information)

Using information technology and systems could facilitate the case companies' information integration and lead to potential performance improvements which they are seeking. A web portal or a data bank could help the firms to tackle the issues which prevent them from gaining benefits by sharing and integrating information.

By *increasing information accessibility* (giving relevant personnel an access to relevant information), *increasing information transparency* (integrating information towards downstream and upstream), *increasing quicker response*s (informing of rapid changes to large amount of suppliers and/or customers when updating information to a IT based system and also providing updated changes automatically to web forecasts if systems synchronized with ERP), *increasing information quality*, (increasing automation of processes, e.g. order processing) and *increasing timeliness of information* (providing up-to-date or real time information available in a web portal/data bank), firms can improve information integration, logistics performance and operations.

Three case companies stated that the use of information systems and technologies would most definitely have significant impact on *decreasing unnecessary work time* and reducing the need to send Emails. The respondents acknowledged that one of the main advantages of supplier portal would be that a lot of Email trafficking would be shifted to a portal or a data bank. This way, suppliers would be able to search for the necessary information on their own. On the other hand this indicates that in future, information integration would require more hands-on atmosphere especially from the supplier side, whenever information is needed to be retrieved from a web portal.

The potential performance improvements which the case companies wanted to achieve by using IT and IS, were considered to increase operational efficiency, and that work time would be allocated to more advantageous tasks instead. Respondents in case companies A and C also highlighted that developing information integration would increase a better understanding of the process, and large amount of information would be managed in a more comprehensive manner.

8 RESEARCH FINDINGS AND CONCLUSIONS

8.1 Discussion

The focus of this research has been to test and understand the relationship between information integration and a firm's logistics performance, especially when information technology and information systems are used for integrating information. The quantitative part of this study aimed at *testing the relationship between the use of information technology and systems and information integration, and also the relationship between information integration and firm logistics performance – both operational and strategic.* The qualitative part of this study aimed at *understanding and interpreting what influences the relationship between information integration with key suppliers and/or customers and logistics performance, and especially when information technology and information systems are used for integrating information.*

The quantitative results show that information technology and systems are positively related to information integration, and that information integration and a firm's logistics performance are positively related. The same result was noticed when analyzing the case companies. The respondents felt that by sharing and integrating information with their key customers and/or suppliers, their performance could be and was enhanced or the current level (sufficient enough) was remained. With regard to previous studies and theories, a positive relationship between information integration and logistics performance was expected to exist.

The relationship between information integration and a firm's logistics performance was not, however, found to be as strong as the research literature states. According to the linear regression analyses, if information sharing is increased with certain number of units, this has a mediocre or low impact on the firm's strategic and operational performances. The Table 19 below summarizes the hypothesis created for the quantitative research setting. Evidence to support all hypotheses was found.

Table 19 Summary of quantitative results

Hypothesis		
H1	Use of information technology and systems is positively related to information integration with key suppliers and/or customers (e.g. Uusipaavalniemi 2009; Fabbe-Costes & Jahre 2008; Garrido Azevedo et al. 2008; Fawcett et al. 2007; Boddy et al. 2005; Saeed et al. 2005; Humphreys et al. 2001; Narasimhan & Kim 2001; Gustin et al. 1995)	Positive mediocre relationship, supports previous literature
H2a	Integrating information with key suppliers and/or customers is positively related to delivery performance (e.g. Bagchi et al. 2005; Lee & Whang 2000; Stock et al. 2000)	Positive low relationship, supports previous literature
H2b	Integrating information with key suppliers and/or customers is positively related to flexibility performance (e.g. van der Vaart & van Donk 2004; Stock et al. 2000)	Positive low relationship, supports previous literature
H3	Information integration with key suppliers and/or customers is positively related to a firm's strategic logistics performance (e.g. Lynch et al. 2000; Stank et al. 2001)	Positive mediocre relationship, supports previous literature

The hypothesis (H1) was formed to test the relationship between information technology and systems and information integration. The hypotheses (H2a, H2b) were formed to test the relationship between information integration and firm's operational logistics performance. The hypothesis (H2a) was testing relationship between information integration and operational delivery performance, and the hypothesis (H2b) is testing the relationship between information integration and operational flexibility performance. The hypothesis (H3) was formed to test the relationship between information integration and firm's strategic logistics performance. These three hypotheses (H2a, H2b, H3) aimed at testing the relationship between information integration with key suppliers and/or customers and logistics performance, and were based on the research question two. All relationships are discussed in detail below.

The use of information technologies and systems in information integration

This study found a positive mediocre relationship (r=0.477) between the use of information systems and information integration with key suppliers and/or customers.

Also qualitative part of this study supports this finding. The result is consistent with the previous literature and theory (e.g. Gustin et al. 1995; Narasimhan & Kim 2001; Boddy et al. 2005; Garrido Azevedo et al. 2008; etc.), which emphasize the importance of information systems and information technologies in facilitating information integration and enhancing supply chain coordination. 22.3 % of the variance in information integration is explained by the variance in information technology and systems. Two thirds (4/6) of the interviewed firms considered that their information technology and systems enable them to share sufficient and real time information with their key suppliers, and slightly over a half of all respondents considered that their information technology and systems enable sharing of sufficient and real time information with key customers. According to this research, information systems and technologies have a significant role in explaining information integration. Case companies A, B, D, E and F felt that information technology and systems could facilitate their information sharing process, especially by using a web portal or a data bank to assist in information sharing. Case company C considered that their information systems help them to share information although otherwise more focus is paid to face-to-face communication instead of using information technologies and systems for facilitating information sharing.

Medium-sized case companies B and E were satisfied with their current ERP systems and found that their information systems are sufficient enough for their current needs and real-time information is available. Four large case companies all felt that there could be improvements made to their current information systems and ICT to increase the sufficiency of real-time information. Case companies D and F, using SAP as their ERP, felt that their information system does not facilitate information sharing so much as such, because a lot of manual work is needed to provide necessary reports. Both firms also had difficulties in retrieving accurate forecasts from their ERP system.

The qualitative research also indicates that the use of information technology and systems for facilitating information sharing is increasing. Two case companies A and F are currently using a supplier portal to which development and improvements were mentioned to be needed. Case company D is test using their new portal at the moment. Three case companies which did not yet have a data bank or a portal were highly interested in developing one for their needs. This indicates that there is a lot of interest to use and develop information technology and systems to increase information integration in the future.

The relationship between information integration and logistics performance

The impact which information integration with key suppliers and/ customers has on logistics performance was studied from operational and strategic perspectives. A positive low relationship was found between information integration and operational

performance. Two individual models were created to test the relationship between information integration and delivery performance, and information integration and flexibility performance. Of these two, information integration with key suppliers and/or customers explains more the variance in delivery performance than in flexibility performance. Although a positive low relationship exists between these two performance indicators and information integration, the links are still rather weak. 13.6 % of the variance in delivery performance is accounted for by the variance in information integration (r=0,368). For flexibility performance, the variance explained was only 4.1 % (r=0,203).

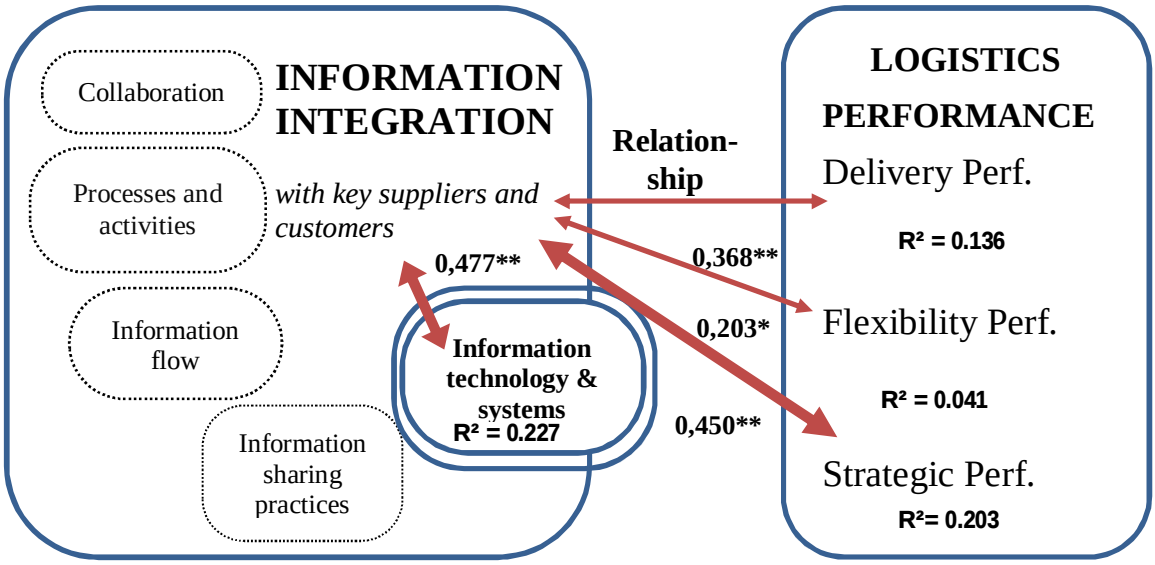
The operational impacts which want to be gained by sharing and integrating information included delivery and quality improvements, improved transparency of operations, efficiency improvements, faster lead times and lower cost related improvements. The number of performance improvements mentioned relating to flexibility performance, were scarce. The low variance (R square) found between information integration and flexibility performance also indicates that the connection is insignificant. Therefore it could be suspected that performance impacts related to increased flexibility were not what firms primarily seek with sharing information. Comparing qualitative and quantitative results of delivery performance, a slight inconsistency can be noticed. Improvements related to delivery performance were mentioned several times to be what is desired to achieve by sharing and integrating information. However, according to the quantitative results of this study, the impact which information integration has on delivery performance is low. It can be therefore concluded that only a few delivery performance impacts have been achieved although information is shared.

The strongest relationship was found between information integration and strategic logistics performance. The relationship is positive mediocre (r=0,450), and 20.3 % of the variance in strategic performance is accounted for by the variance in information integration. This was also expected on theoretical grounds. Integrating information with key customers and/or suppliers is positively related to the firm’s profitability, competitive advantage and enhanced customer service level. The desired strategic logistics performance impacts mentioned by the case companies consisted of commitment and trust issues, competitive advantage, financial impacts and cost related issues.

On the long run, information was considered to be shared to impact the strategic targets of the company, whereas in the short-term, information was shared to impact operational efficiency and operative targets of the company. The experienced strategic logistics performance impacts were scarcely mentioned by the case companies due to the fact that strategic performance improvements were seen in the end of the continuum

after operational improvements have been achieved. The respondents experienced that by sharing information, they had improved their strategic performance as well.

It can be noted that from all the four models created to test the hypotheses, information technology and systems and information integration, as well as, information integration and strategic logistics performance receive the highest scores of coefficients and R squared. Figure 21 below sums up the coefficients and R squared found in the four models tested.



**significant at the 0.01 level (2-tailed), *significant at the 0.05 level (2-tailed)

Figure 21 Coefficients and R squared

The results of this study indicate similar signs as in the research of Yigitbasioglu (2008, 104). Yigitbasioglu studied wider range of activities but regarding a latent variable 'performance output' (incl. inventory turnover, operational costs, stock-out costs, fill rates, on-time deliveries, flexibility to deliver, customer satisfaction) results show slightly similar signs. In his study, intensity of information integration and performance output received a correlation coefficient of 0.486 ($p < 0.01$) and squared R of 0.226. (Yigitbasioglu 2008, 104.)

On basis of the quantitative results, by increasing information integration with key suppliers and/or customers only low or mediocre performance impacts are achieved. How much does information integration truly impact on logistics performance was rather difficult to assess in the qualitative part of the study due to the respondents' subjective opinions. However, the respondents felt that with those suppliers, with whom collaboration is on higher levels, extending information integration impacts on logistics performance. On the other hand, with some suppliers (e.g. arms-length suppliers) the

basic order processing information is sufficient enough and extending information integration does not add value to the focal firm or the supplier.

The results indicate that information integration has an impact on firm's logistics performance, information integration explains logistics performance only slightly. As Uusipaavalniemi (2009, 16), Fawcett et al. (2007, 358) and Fabbe-Costes & Jahre (2008, 140-142) have stated, only a few firms have been able to enhance their performance despite they have shared information and integrated activities in the supply chain.

Although information is shared via traditional and advanced communication methods, all the perceived performance impacts are not yet achieved. Issues which prevented the case companies from achieving benefits derived from information integration were external and internal. External issues influencing on the relationship between information integration and logistics performance were mentioned to be improper utilization of the information shared on the supplier side, indirect information sharing, lack of the entire supply chain to share information openly, rapidly changing business environment and business requirements and human errors. Internal issues which affect the relationship between information integration and logistics performance were experienced to be limited time resources of employees, indirect information sharing, improper tools for communication and information sharing, cultural differences in understanding the common company targets, difficulty to forecast accurately, human errors and that information has been shared too late. To support these findings, additional tests need to be performed to measure how strong the influence of the above mentioned external and internal issues have on the relationship between information integration and logistics performance. With regard to this study, it can also be suspected that the ways in which information is shared still need refining, clarifying and developing.

Use of IT and IS influences on the relationship between information integration and logistics performance

Interesting to notice was that almost all case companies felt that information systems and technologies could facilitate information integration and impact on the desired performance outcomes. The qualitative results of this study give an indication that the use of information technologies and systems influences on the relationship between information integration and logistics performance. By developing the use of IT and IS further, increased utilization could provide firms the necessary assisting tools they need to efficiently share more information with their key customers and/or suppliers. As Saeed et al. (2005, 387) have stated, firms need more than a traditional ordering system or procurement system to enhance their efficiency. With the help and use of inter-

organizational information systems (IOIS) firms are able to undertake joint forecasting and planning activities, and gain efficiency improvements (Saeed et al. 2005, 387).

The biggest challenges for using information technologies and systems to facilitate information integration were mentioned to be the limited resources of supplier network to adapt new information technology **(1).** In order to benefit from information systems and technology-based information sharing, a suitable information technology-driven environment for implementing new systems has to exist in the supply chain. There is a need for constant collaboration in the future, and therefore more than message communication (Email) is needed. Especially documents need to be managed, and by using latest information systems and technologies this could be facilitated. The use of web portals and/or data banks was considered to facilitate information integration. The case companies considered this to be externally and internally beneficial to them. The greatest advantage of a supplier/customer portal would be that information is available at all times - it is easily accessible and up-to-date.

Reasons which would further assist the case companies in sharing and integrating information by using information systems and technologies are employee training **(2),** improvements in information sharing practices **(3),** increasing functionality of a system **(4),** ease of use of a system **(5),** lower price of systems **(6),** necessary IT or helpdesk support is located nearby **(7)** and implementing ready-made commercial software instead of developing one's own software **(8).** Further research is needed to test these issues and their influence on facilitating the relationship between information integration and logistics performance, and whether improved logistics performance can be achieved on the long run.

The Figure 22 below illustrates the final outcome of this study. The figure is based on the research frame of reference presented in the Figure 7. The black arrows illustrate the relationships which have been under investigation in this study. The blue arrows illustrate the underlying issues and their impact on the studied relationships. Issues which influence on the relationship between information integration and logistics performance are outlined. Furthermore, the IT and IS related issues which facilitate the use of information technology and systems to the relationship between information integration and logistics performance are illustrated in the Figure 22 below.

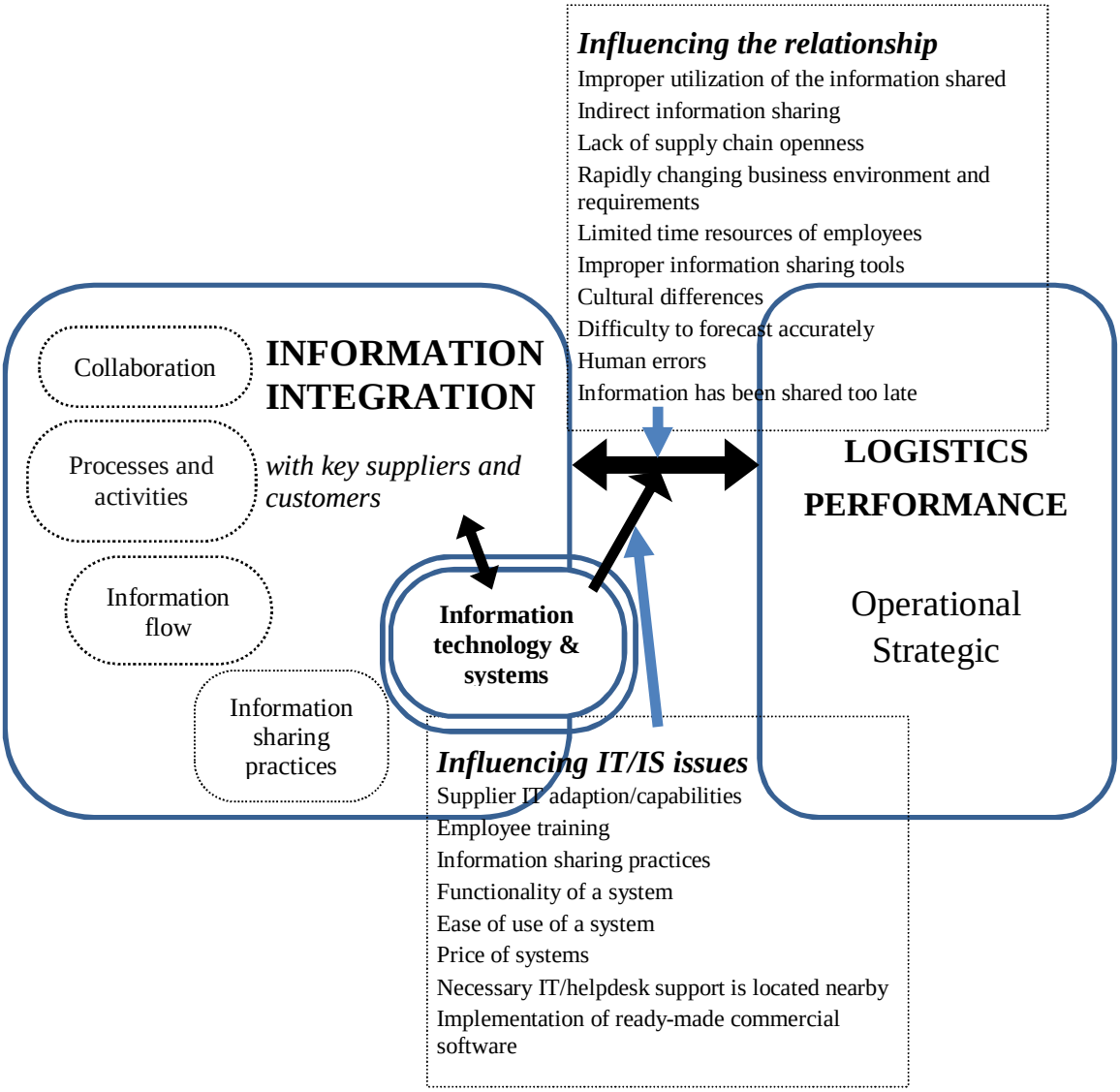


Figure 22 Research findings

The Figure 22 ties closely together information integration, use of information technology and systems and logistics performance creating a multidimensional complexity to which collaboration, external and internal actors and operations influence. By paying attention to the above illustrated influencing issues, firms can identify targets of development and further increase the use of information technology and systems in their information integration.

Extending information integration to involve information systems and technologies in the process is not beneficial to be pursued with all types of suppliers. On the supplier side, extending information integration would be beneficial with key suppliers (e.g. strategic, critical, partnership or bottleneck types of suppliers). If more information sharing is needed, the extension of information exchange should this be pursued with those suppliers with whom collaboration and integration is on a medium or high level.

On the customer side, information integration was considered to be important with all customer segments.

In order to truly facilitate information integration by using information systems and technologies, the information shared needs to be pertinent, accurate and correct. Firms need to be also aware of what information is valuable to its receivers. Attention should be paid to the scope of information shared. With the use of information systems and technologies, information integration can be more easily extended to include a lot of different information – extending the scope of information.

8.2 Contribution

This research has shed some light to the complex subject of information integration with key suppliers and/or customers and what is achieved by it. Due to the variety of different logistics performance and information integration concepts, numerous approaches and theories the main discipline is still in its development stage. This has made the conduction of this research challenging. The theoretical implications of this thesis and research comprise information integration and logistics performance from information technologies and systems approach. Despite that the topic has been widely researched from different perspectives, a holistic understanding of the flow of information towards customers and suppliers by using different information technologies and systems needs further research.

This study has strived to develop practical implications to help managers to include various aspects when considering developing information integration by using information technologies and systems. As Kaipia and Hartiala (2006, 377) have also acknowledged, information sharing and information integration have been research mainly from a theoretical point, and that practical implications have not been fully examined. The recognition of issues which influence on information integration by using IS and IT can give managers ideas which areas need to be taken into consideration when developing information systems and technologies. Further research is needed from the practical perspective in order to make greater generalizations and develop theory. Inter-organizational information systems (e.g. web portals and data banks) and their ability to facilitate information integration require further research on the area.

A comprehensive research has been conducted to examine and understand information integration and logistics performance. The quantitative data consisted of 148 responses and the qualitative research consisted of 7 interviews to which 12 people participated. The broad data analysis increases and improves generalization of the results of this study to a wider population, and generalizations can be made regarding especially industrial manufacturing firms which have been in the focus of this study.

Sengupta et al. (2006, 13) have stated that information sharing and integration could have a greater impact on firms operating in the service sector than in the manufacturing sector. With regard to the results of this study, the impact of information integration is important and essential also to firms operating in the manufacturing sector. Without sharing information, operations would have been more difficult to conduct in the manufacturing case companies interviewed. One reason for this is that just-in-time approach requires firms to share more and more information in order to guarantee a smooth flow of information and materials throughout the entire supply chain.

8.3 Limitations

In all studies, there are limitations. One of the main limitations of this study is the ready-made questionnaire which was used in the quantitative part of this research to conduct statistical analyses. The questions selected to the analyses were not originally designed for the purpose of this study. Therefore the respondents have not necessarily answered to the questions considering information sharing perspective. A new questionnaire conducted on the basis of this study could have improved the measurement error of quantitative analysis and provided better data. However, the entire study is has been a result of a long process and therefore a new questionnaire would have been difficult to conduct.

It would have also been more suitable to examine information integration towards customer and suppliers separately. However, in the ready-made questionnaire these two perspectives were considered in the same questions and therefore both perspectives needed to be included in the study. In the qualitative part of this study, more responses were received concerning supplier perspective. Therefore, greater generalizations towards customer side remain weak, whereas, towards supplier side generalizations can be made.

9 SUMMARY

Today's fast changing environment sets a need for exchanging much more information than traditional ordering process information, in addition operational and strategic information needs to be shared. Collaborating, coordinating and integrating activities beyond firm boundaries are essential for staying competitive (Stock et al. 1999, 224). Information integration with key customers and suppliers is important, and it refers to integration of actors, information flow, processes and activities, and information technologies and systems (Fabbe-Costes & Jahre 2008, 135). Information integration inevitably involves information sharing and use of modern ICT.

The purpose of this research has been to test and understand the relationship between information integration with key suppliers and/or customers and a firm's logistics performance, especially when information technology and information systems are used for integrating information. Special attention has been paid to the scope, level and direction of information (by Van Donk & van der Vaart 2005a, 99) in a limited dyadic relationship. In addition, this research has strived to recognize the underlying issues which influence on the relationship of information integration and logistics performance when information technology and systems are used.

Information integration and information sharing are used interchangeably in the research literature. Jahre and Fabbe-Costes (2008, 135) identified four elements or layers which influence on integration. The elements of integration are integration of flows (1), integration of processes and activities (2), integration of information technologies and systems (3) and integration of actors - structure and organizations (4). The research frame of reference consists of three main concepts: information integration, use of information technology and systems and logistics performance.

Firms share information by using traditional communication methods, such as telephone, fax, Email, written and face-to-face contacts, and by using advanced or modern communication methods such as electronic data interchange (EDI), enterprise resource planning (ERP), web-based procurement systems, electronic trading systems and supplier relationship management systems (Boddy et al. 2005; Saeed et al. 2005; Carr & Kaynak 2007; Garrido Azevedo et al. 2008). Saeed et al. (2005, 387) have acknowledged that adopting new ways of using IT is one important resource for staying competitive on the rapidly changing market. Therefore, creating IT capabilities that suit to the firm's interests and which can improve connectivity with key customers, suppliers and supply chains are essential (Fawcett et al. 2011, 40.) An information system that provides people the information they need for performing their work, will support company performance (Boddy et al. 2005, 26).

The potential performance improvements found in this study vary from operational (efficiency and effectiveness improvements) to financial and strategic (profit,

profitability or customer satisfaction improvements). Information integration has the highest impact on strategic logistics performance, and lowest impact on operational performance (delivery and flexibility). However, the desired outcome of sharing information first and foremost is to impact on issues relating to improved delivery performance (delivery accuracy, quality, etc.). Some of the benefits outlined, have also been experienced to have been achieved in the case companies. The results of this study indicate that although information integration has an impact on a firm's logistics performance, information sharing explains performance only slightly. Also case companies mentioned many issues which are preventing them from achieving performance improvements although information shared. As Uusipaavalniemi (2009, 16), Fawcett et al. (2007, 358) and Fabbe-Costes & Jahre (2008, 140-142) have stated, only a few firms have been able to enhance their performance despite they have shared information and integrated activities in the supply chain. The results of this study indicate the same.

This study found that information technology and systems have a mediocre positive relationship to information integration. The qualitative study reveals that current company information systems are sufficient enough for the current needs, although in the case of large firms, the systems could be improved. Almost all case companies agreed on that information technology and systems could facilitate information integration. Information sharing practices include nowadays a lot more than sending information by Email and using EDI. Information communication technology has increased the use of EDI, web portals, shared communication and software. The idea of a shared portal is around ten years old, although not yet entirely taken advantage of, whereas, the use of EDI is more common. The utilization of different information technologies and systems is expected to increase in the future. The case companies felt that an implementation of a portal or a data bank would benefit them and enhance their performance, as well as, facilitate internal and external information integration. In addition, automation of ordering process activities, developing information sharing practices, and clarifying and improving accuracy of reports would facilitate and extend information integration. Company preferences and level of collaboration define what information is essential and relevant, and needs be shared using information technologies and systems to facilitate information integration in a particular company.

Information integration can be further facilitated and performance improved by paying attention to the influencing IT and IS issues. By considering the ability of supplier network to adapt new IT, employee training, information sharing practices, the functionality of a system, the ease of use of a system, etc. information integration can be facilitated with the use of IT and IS. Further research is needed to test these issues and their influence on the relationship between information integration and logistics performance.

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APPENDICES

Appendix 1: The Questionnaire – Finnish Logistics Survey 2010

M16. Evaluate logistics performance of your company compared to your most important competitors: (1) A lot worse, (2) Slightly worse, (3) Not good or bad, (4) Slightly better, (5) A lot better, (6) No answer
a.) The time between order receipt and customer delivery b.) The ability to meet the quoted or anticipated lead times c.) The ability to meet key customer needs d.) The ability to notify of delivery delays or product shortages e.) The ability to mofidy order size, volume or composition during logistics operations f.) The ability to accommodate delivery times for specific customers

M18. Evaluate the following statements about the significance of logistics in your company: (1) Totally disagree, (2) Partly disagree, (3) Not agree or disagree, (4) Partly agree, (5) Totally agree, (6) No answer
a.) Logistics has a major impact on the company's profitability b.) Logistics has a major impact on customer service level c.) Logistics is a key source of competitive advantage for our firm d.) Logistics is a top management priority in our firm e.) Logistics has a major impact on our company’s costs

M19. Evaluate the following statements about internal collaboration on logistics in your company: (1) Totally disagree, (2) Partly disagree, (3) Not agree or disagree, (4) Partly agree, (5) Totally agree, (6) No answer
a.) We share information efficiently internally

M20. Evaluate the following statements about external collaboration on logistics in your company: (1) Totally disagree, (2) Partly disagree, (3) Not agree or disagree, (4) Partly agree, (5) Totally agree, (6) No answer
a.) We share operative information efficiently with key customers or suppliers b.) We are well-prepared to external threats and disturbance c.) Operative planning and forecasting is done in close co-operation with key customers or suppliers d.) We develop operative processes in collaboration with suppliers or customers e.) Strategic planning and goal setting is done with customers or suppliers

M21. Evaluate the following statements about the information systems in your company: (1) Totally disagree, (2) Partly disagree, (3) Not agree or disagree, (4) Partly agree, (5) Totally agree, (6) No answer

a.) Our company information systems enable sharing of operative information with key suppliers
b.) Our company information systems enable sharing of operative information with key customers
c.) Our company information systems provide sufficient and real time information for managing operative logistics
d.) Our company information systems provide sufficient and real time information about logistics costs
e.) Our company information systems provide sufficient and real time information about logistics management and planning costs

Appendix 2: Factor Analysis - Rotated Component Matrix

Rotated Component Matrix[a]

	Component				
	1	2	3	4	5
Company IS provides sufficient and real time information about logistics management and planning costs	.859	.116	.089	.085	-.066
Company IS provides sufficient and real time information about logistics costs	.855	.134	.086	.165	-.151
Company IS provides sufficient and real time information for managing operative logistics	.847	.173	.067	.118	.035
Company IS enables sharing of operative information with key suppliers	.816	.234	.061	-.160	.105
Company IS enables sharing of operative information with key customers	.773	.237	.063	-.132	.218
Operative processes are developed in collaboration with suppliers/customers	.183	.839	.150	.103	-.054
Strategic planning and goal setting is done with customers and suppliers	.110	.773	.079	-.149	.214
Operative planning and forecasting is done in close co-operation with customers and suppliers	.237	.771	.201	.217	.014
Sharing operative information efficiently with key customers and suppliers	.285	.649	.340	.262	-.033
Preparation to external threats and disturbance	.282	.596	.194	.337	.101
Sharing internal information efficiently	.132	.501	.238	.351	-.167
Logistics has a major impact on the company's profitability	-.047	.148	.833	-.025	.134
Logistics has a major impact on costs	.002	.091	.781	.052	.033
Logistics is a key source of competitive advantage for the firm	.181	.118	.719	.197	.073
Logistics is a top management priority in the firm	.321	.141	.678	.061	-.167
Logistics has a major impact on customer service level	.004	.242	.648	.024	.077
The ability to meet the quoted or anticipated lead times	-.068	.123	.044	.827	.234
The time between order receipt and customer delivery	.175	.026	.118	.682	.279
The ability to notify of delivery delays or product shortages	-.045	.188	.058	.654	.066
The ability to accommodate delivery times for specific customers	-.056	-.057	.042	.119	.825
The ability to mofidy order size, volume or composition during logistics operations	.112	.045	.119	.226	.691
The ability to meet key customer needs	.018	.176	-.020	.442	.544

Notes: Extraction Method: Principal Component Analysis; Rotation Method: Varimax with Kaiser Normalization; Kaiser-Meyer-Olkin Measure of Sampling adequacy = 0.790; Barlett's test of sphericity: χ^2 = 1353,256, df = 231, Sig. = 0.000.

Appendix 3: Factor Analysis – Communalities

Communalities

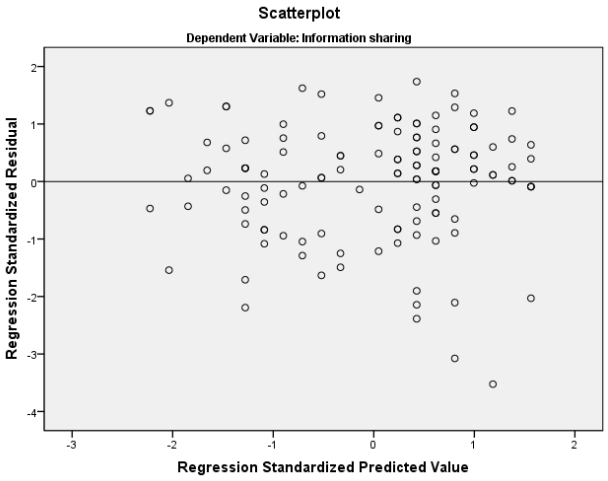
	Initial	Extraction
The time between order receipt and customer delivery	1.000	.588
The ability to meet the quoted or anticipated lead times	1.000	.760
The ability to meet key customer needs	1.000	.523
The ability to notify of delivery delays or product shortages	1.000	.474
The ability to mofidy order size, volume or composition during logistics operations	1.000	.558
The ability to accommodate delivery times for specific customers	1.000	.702
Logistics has a major impact on the company's profitability	1.000	.737
Logistics has a major impact on customer service level	1.000	.485
Logistics is a key source of competitive advantage for the firm	1.000	.607
Logistics is a top management priority in the firm	1.000	.615
Logistics has a major impact on costs	1.000	.622
Sharing internal information efficiently	1.000	.476
Sharing operative information efficiently with key customers and suppliers	1.000	.688
Preparation to external threats and disturbance	1.000	.596
Operative planning and forecasting is done in close co-operation with customers and suppliers	1.000	.739
Operative processes are developed in collaboration with suppliers/customers	1.000	.773
Strategic planning and goal setting is done with customers and suppliers	1.000	.684
Company IS enables sharing of operative information with key suppliers	1.000	.761
Company IS enables sharing of operative information with key customers	1.000	.723
Company IS provides sufficient and real time information for managing operative logistics	1.000	.767
Company IS provides sufficient and real time information about logistics costs	1.000	.806
Company IS provides sufficient and real time information about logistics management and planning costs	1.000	.771

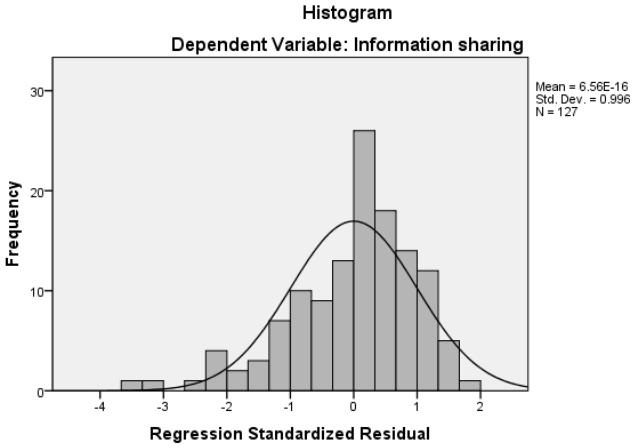
Appendix 4: Factor Analysis - Total Variance Explained

Total Variance Explained

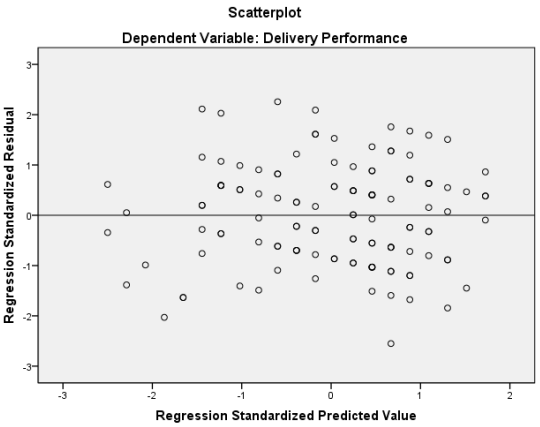
Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	6,587	29,943	29,943	6,587	29,943	29,943	3,921	17,824	17,824
2	2,894	13,155	43,097	2,894	13,155	43,097	3,306	15,029	32,853
3	2,211	10,052	53,149	2,211	10,052	53,149	3,043	13,831	46,684
4	1,603	7,285	60,434	1,603	7,285	60,434	2,361	10,731	57,415
5	1,159	5,268	65,702	1,159	5,268	65,702	1,823	8,288	65,702
6	,985	4,479	70,181						
7	,910	4,134	74,316						
8	,751	3,414	77,730						
9	,719	3,266	80,996						
10	,588	2,674	83,669						
11	,538	2,447	86,117						
12	,515	2,340	88,457						
13	,451	2,052	90,509						
14	,421	1,913	92,423						
15	,310	1,409	93,832						
16	,282	1,283	95,115						
17	,257	1,167	96,282						
18	,208	,944	97,226						
19	,198	,900	98,126						
20	,150	,682	98,807						
21	,133	,606	99,413						
22	,129	,587	100,000						

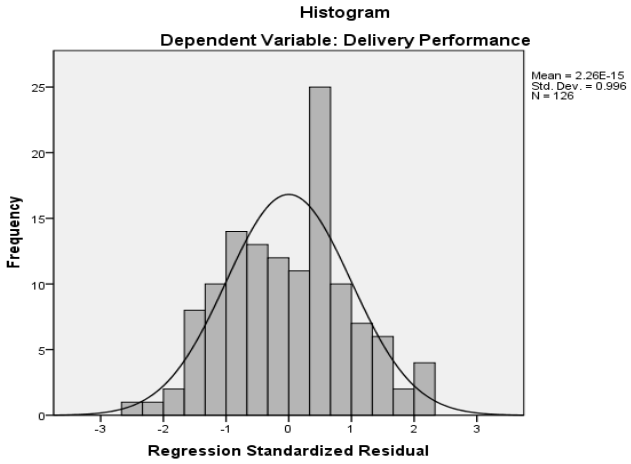
Appendix 5: Scatterplot and histogram for model 1



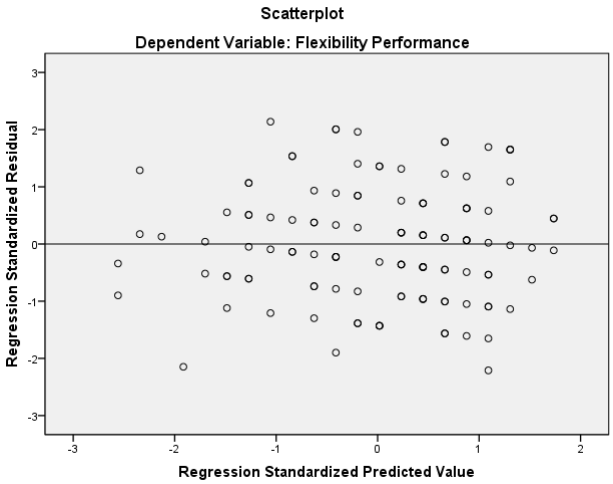


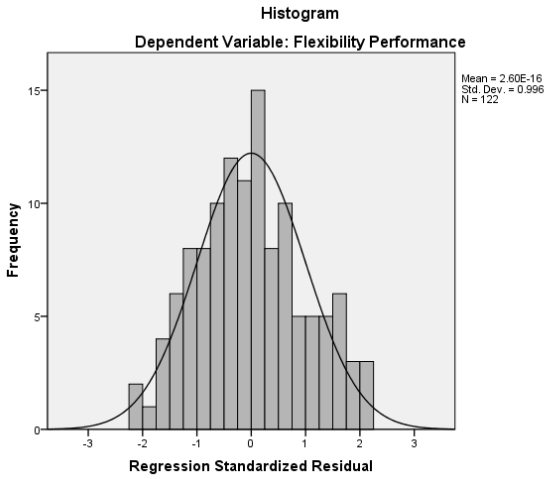
Appendix 6: Scatterplot and histogram for model 2



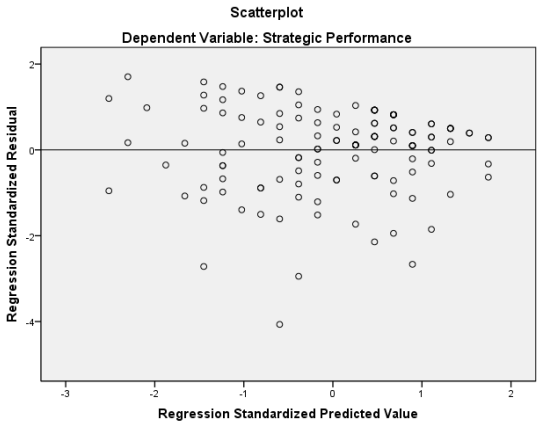


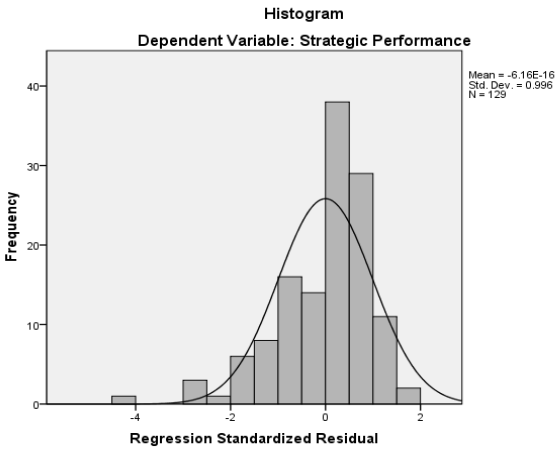
Appendix 7: Scatterplot and histogram for model 3





Appendix 8: Scatterplot and histogram for model 4





Appendix 9: Interview questions

- Interviewee name
- Position in the company
- The industry of the company
- Company turnover (2011), number of employees (2011)
- What departments share information externally to suppliers and customers in your company?
- How is information mainly exchanged in your company?

THEMES	QUESTIONS
(1)INFORMATION SHARING AND INTEGRATION	Describe shortly your external information sharing process (towards customers and suppliers) With what kind of customers and suppliers does your company mostly strive to share information? (criteria, reasons) What kind of information does your company share with its most important customers and how often? How detailed and discreet is the information shared? What kind of information does your company share with its most important suppliers and how often? How detailed and discreet is the information? How does information sharing vary among different customer, and/or among

	different suppliers in your company? Does your company share more information towards upstream or downstream? (reasons) How often do your most important customers and/or suppliers share information towards your company?
(1)INFORMATION SHARING PRACTICES	How well does your company know its concrete ways to sharing information? Describe information sharing practices mainly used in your company How is information shared with customers? How is information shared with suppliers? Do the practices vary depending on with whom your company is sharing information (suppliers, customers)? How? Does your company have mutually agreed and consistent information sharing practices with its most important customers and/or suppliers? (reasons) Would there be a need to enhance information sharing with your most important suppliers and/or customers? On what areas is there a need for developments? What kind of performance effects would these strive to achieve? How should the current information sharing practices be developed in your company?
(1)INFORMATION INTEGRATION, SCOPE	What kind of information would be necessary for your company to share more with its customers and/or suppliers compared to current situation? With whom customers and/or suppliers would your company have a need to increase information sharing? Why? Would your customers and/or suppliers be interested if your company shared more information to them? What kind of information would they be interested in? What prevents your company from sharing more information to your customers and/or suppliers?

	How could your company easiest increase information sharing / what would further assist your company to share more information?
(2) INFORMATION SYSTEMS AND TECHNOLOGY	What information systems and technologies does your company use for collecting and analyzing information? How well do your company's current information systems provide you with real time and sufficient enough information for decision-making? How well do your company's current information systems facilitate information sharing with its most important customers and/or suppliers? What information systems and (ICT) technologies does your company use for sharing information with its most important customers and/or suppliers? To what extent is information shared electronically to customers and/or suppliers? (e.g. via EDI-connections) What processes related to information sharing has your company automated? What factors would assist your company to further utilize information systems in your company? What factors would prevent your company to further utilize information systems in your company? To what extent would it benefit your company to enhance information sharing by using the latest information systems and technologies?
(3)STRIVED PERFORMANCE EFFECTS	What are the most important reasons/motives for your company to share information with customers? What are the most important reasons/motives for your company to share information with suppliers? How / in what ways does your company measure if the desired outcomes and benefits of information sharing have been reached?

	What prevents your company from gaining the desired outcomes, which it wants to be achieved by sharing information? How important is it for your company to follow how do your customers and suppliers utilize information shared to them? How does your company measure if your customers and suppliers utilize information shared to them?

Appendix 10 What facilitates the case companies into using information technology and systems for information integration

	Company A	Company B	Company C	Company D	Company E	Company F
Employee training	●				●	
Improvement in daily information sharing practices	⬤					
Usability and functionality of the IS				●		⬤
Automation of operations		●				
Decreasing price of information systems and technology		⬤	⬤	●		
Necessary IT / helpdesk support	⬤					●
Benefit of commercial software, application, or implement a web portal/data bank	⬤	⬤		⬤	●	
"Portfolio of electronic information integration and services"				●		
Swift from Email communication towards electronic management of documentation	●			●		
Handling of information in an electric form throughout the information flow	●			●		

● Mentioned by the case company

⬤ Mentioned by the case company, high importance

Appendix 11 What prevents the case companies from using information technology and systems information for integration

	Company A	Company B	Company C	Company D	Company E	Compnay F
Supplier limited resources for adapting IT	●			⬤	⬤	
Lack of financial resources		⬤	⬤	●	⬤	
Lack of necessary human resources/IT	⬤				●	⬤
Employee and management attitudes	●	●				
Scale advantages of information systems (syncronizing all business units' systems together)	⬤	●				
Malfunction of IS and tools						⬤
Discrete or NDA Supplier/Customer information (e.g. product drawings)		●			●	

● Mentioned by the case company

⬤ Mentioned by the case company, high importance

Appendix 12 Desired operational and strategic performance impacts of information integration

	Company A	Company B	Company C	Company D	Company E	Company F
OPERATIONAL PERFORMANCE						
Gain what is wanted	●					
Efficient information flow - upstream and downstream		•			●	
Improving transparency of operations	•	●		•	•	
Increasing understanding about focal firms' business and requirements			●			
Improved quality of information sharing and material flow		•	•	•	•	
Improved delivery performance	●			●		•
Lower operating costs		•	•	•		•
Improved and faster lead times				•	•	
Less mistakes in information					•	
Suppliers improved operational capability			•	•	•	•
Decrease of double work Efficient practices and working methods	•					•
STRATEGIC PERFORMANCE						
Commitment, openness and in-depth collaboration	●	●	•	●	●	•
Customer trust	•	•				
Competitive advantage in global markets		•				
Improved company image			●			
Suppliers are equally competitive and financially viable to operate			•	●	•	●
Suppliers are aware of future prospects and focal firm's requirements		●	•			
Lower overall costs		•	●	●		•
Competitive prices						●
Financial profitability					●	●
Profit impact					•	•

• Mentioned by the case company

● Mentioned by the case company, high importance