LAPPEENRANTA UNIVERSITY OF TECHNOLOGY
LUT School of Business and Management
Knowledge Management and Leadership

Laura Granström

INFORMATION FLOW IN THE SUPPLY CHAIN OF PASSIVE MATERIAL FOR FIXED NETWORK CONSTRUCTION PROJECTS

Master's thesis 2017

1st examiner: Markku Ikävalko

2nd examiner: Heidi Olander

TIIVISTELMÄ

Tekijä:	Granström, Laura
Aihe:	Tiedonkulku kiinteän verkon passiivimateriaalien toimitusketjussa
Yksikkö:	School of Business and Management
Koulutusohjelma:	Tietojohtamisen ja johtajuuden maisteriohjelma
Vuosi:	2017
Pro gradu:	Lappeenrannan teknillinen yliopisto
	71 sivua, 9 kuvaa, 3 taulukkoa, 1 liite
1. tarkastaja:	professori Markku Ikävalko
2. tarkastaja:	tutkijatohtori Heidi Olander
Avainsanat:	tiedonkulku, tiedon jakaminen, toimitusketju

Tässä Pro gradu –tutkielmassa kuvaillaan eurooppalaisen televiestintäyrityksen verkonrakennusprojektien toimitusketjuun liittyviä haasteita. Tutkimuksen teoreettinen viitekehys perustui rakentamisen toimitusketjuun, toimitusketjun tiedonkulkuun sekä organisaatioiden välisiin suhteisiin liittyvään kirjallisuuteen. Tutkimuksessa sovellettiin kvalitatiivista tutkimusstrategiaa ja tutkimusmenetelmänä oli tapaustutkimus. Tutkimusmateriaali kerättiin haastattelemalla tarkasteltavan toimitusketjun relevantteja sidosryhmiä teemahaastattelun menetelmin.

Tässä tutkielmassa kävi ilmi, että esille tulevat toimitusketjun tiedonkulkuun liittyvät teemat olivat samanlaisia aikaisempiin tutkimuksiin verrattuna. Haasteet toimitusketjussa keskittyivät tiedon ominaisuuksiin, tietojärjestelmiin, viestintätapoihin ja suhteiden ominaispiirteisiin. Lisäksi havaittiin, että rakentamisen toimitusketjun luonne vaikutti toimitusketjussa esiintyviin haasteisiin.

ABSTRACT

Author's name:	Granström, Laura
Title:	Information Flow in the Supply Chain of Passive Material for Fixed Network Construction Projects
Faculty:	School of Business and Management
Master's Programme:	Master's Degree Programme in Knowledge Management and Leadership
Year:	2017
Master's thesis:	Lappeenranta University of Technology
	71 pages, 9 figures, 3 tables and 1 appendix
1st examiner:	Professor Markku Ikävalko
2nd examiner:	Post-Doctoral Researcher Heidi Olander
Keywords:	information flow, information sharing, supply chain

This Master's thesis describes the challenges appearing in the supply chain of network construction projects in a European telecommunications company. Theoretical framework of this study was based on the literature of construction supply chain, information flow in the supply chain as well as inter-organizational relationships. The study was carried out with qualitative research strategy by using a single case study method, and the research material was collected by conducting theme interviews for relevant supply chain stakeholders.

As a conclusion, this study showed that emerging themes of information flow challenges in the supply chain were similar to previous studies. The challenges in case supply chain were based on information characters, information technology, communication methods and relationship characteristics. Also, it was noticed that the nature of construction supply chain had affected the occurring challenges in the supply chain.

ACKNOWLEDGEMENTS

After many turn of events, here I am. Not only many hours of working with this Master's thesis is behind me, but also five years of studying in Lappeenranta. Five years, which has been one of the most memorable years of my life.

Many thanks to my supervisor Markku, who have supported me with finding the right path for this thesis by answering my questions and guiding me to think like a researcher. Also, many thanks to my supervisor Heidi, who gave valuable feedback for improving this thesis. In addition, I want to thank my colleagues at the case company, who have been helping me to collect and understand the research material. Lastly, many thanks to my friends and parents, who have supported me during this long, sometimes even frustrating, process!

Helsinki, Finland 26.10.2017

TABLE OF CONTENTS

LIST OF ABBREVIATIONS 7

1 INTRODUCTION 8

1.1 Background 8

1.2 Research questions and exclusions of the study 9

1.3 Literature review and theoretical framework 11

1.4 Research methods 14

1.5 Structure of the thesis 15

2 INFORMATION FLOW IN THE SUPPLY CHAIN 16

2.1 Construction supply chains 16

2.2 Information levels 18

2.3 Key factors influencing information flow 21

2.3.1 Information characteristics 21

2.3.2 Information systems 22

2.3.3 Communication methods 23

2.3.4 Relationship characteristics 24

3 RESEARCH METHODOLOGY 26

3.1 Research strategy and methods 26

3.2 Data collection 27

3.3 Analyzing the data 31

3.4 Reliability and validity 32

4 CASE OVERVIEW 35

4.1 Case company 35

4.2 Supply chain stakeholders 35

4.2.1 SCM –team 35

4.2.2 Project Managers 36

4.2.3 Logistics partner 36

4.2.4 Constructor companies 37

4.3 Fixed network 37

4.4 Fixed network construction materials 38

5 FINDINGS 40
5.1 Supply chain processes 40
5.2 Information characteristics 44
5.3 Information systems 45
5.4 Communication methods 47
5.5 Relationship characteristics 49
6 DISCUSSION 51
6.1 Information characteristics 51
6.2 Information systems 53
6.3 Communication methods 54
6.4 Relationship characteristics 56
7 SUMMARY AND CONCLUSIONS 60
REFERENCES 64
APPENDICES 69
APPENDIX 1. Interview questions. 69

LIST OF ABBREVIATIONS

EDI = Electronic Data Interface

IOS = inter-organizational information system

MRT = media-richness theory

MTO = make-to-order

SCIS = supply chain information systems

SCM = Supply Chain Management

TCM = traditional communication media

1 INTRODUCTION

In supply chain, both information and material flows are essential for supply chain efficiency. The impact of material and information flows were identified already in the 1950s when Forrester created a theory regarding the interactions between five flows, which were information, materials, money, manpower and capital equipment. According to Forrester, companies could become more successful by managing these five flows. (Forrester 1958)

1.1 Background

Supply chain management (SCM) has been characterized as inter-organizational coordination, where companies are working together with their customers and suppliers to integrate activities along the supply chain, and that way, to deliver products effectively to customers (Hill & Scudder 2002). When it comes to information sharing and communication, it could be assumed that intra-organizational relationships are easier to coordinate, because the relationships are usually closer inside a firm. However, because the relationships in supply chain usually are inter-organizational, it creates special situation for the coordination of activities and information flow along the supply chain. On the other hand, it has been found, that intra-organizational relationships can have lower level of collaboration when comparing to inter-organizational relationships, even when it has originally been assumed other way around (Mena et al. 2009).

In addition to close collaboration within inter-organizational relations, the relationship between inter-organizational ICT and supply chain performance is found out to be stronger than with intra-organizational ICT (Zhang et al. 2016). The impact of digitalization is reflected in the supply chains, and especially in a company in telecommunications industry. Information is expected to pass on quickly and reliably from place to place. Therefore, information systems are in a big role in information flow between supply chain actors, but it is not always the high rate of usage of information systems that brings efficiency in the supply chain. If people are not feeling comfortable and confident towards the information systems, the systems are not supporting the operations (Childerhouse et al. 2003). When there are information breaks in the systems, other, more traditional, ways of communication might become more important. Even though there are modern tools for communication nowadays, the traditional communication methods should not be

forgotten. Wognum et al. (2002) has suggested that advanced communication technologies do not replace face-to-face communication, but instead, they provide additional opportunities to share information.

Information sharing and information transfer in supply chains are topics, which have been studied increasingly especially in recent decades, when information and knowledge management have started to become more studied subjects. However, the concept of information flow occurs less frequently, especially in the literature related to supply chains. According to Demiris et al. (2008), information flow is the access, exchange and documentation of information. Information flow has also been characterized as sharing information with partners, and therefore information sharing is also an important aspect of information flow (Demiris et al. 2008; Durugbo et al. 2014).

The results of many studies have found information sharing beneficial for supply chain performance. De Treville et al. (2004), on the other hand, found out that lead-time reduction improves supply chain performance more than information sharing. However, it can be assumed, that information sharing is an important part of the lead-time reduction as well. It has been quite popular to study the benefits of information sharing to the organizational performance, but the associated costs or resources haven't been considered as much (Kaipia 2009). Although there are many claims that information sharing in supply chains is affecting performance, there is also critical analysis by Kembro and Näslund (2014) claiming that there are no such studies that proves the affection to performance.

1.2 Research questions and exclusions of the study

Unit of analysis in this thesis is information flow in the supply chain environment. The case company, where the study is conducted, is a telecommunications company, which operates widely in Europe providing both mobile and fixed network services. The focus of this thesis is at the supply chain of fixed network construction and maintenance projects at the case company. The scope of this study is limited to only one procurement process of the supply chain, which is consumption of the passive components for network construction. Passive components include cables, ducts, cabinets, fiber optics and copper wire as well as some other accessories needed to build fixed network. Therefore, passive materials are all materials that don't process data, but are needed to build a functioning

network. Compared to fixed network construction, mobile network construction has different supply processes at the case company, so that is why that process is excluded from this thesis.

The objective of this study is to identify the main information flow challenges of the supply chain, and create some possible solutions for solving these information flow issues. In addition, the goal is to reach understanding of the information flow characters and influencers, which support the supply chain performance and material flow in the most effective way.

Based on the objective of the study, the following main research question was formed:

> *"What are the main challenges regarding information flow in the supply chain of fixed network construction projects?"*

Also, two sub-questions were formed to support and specify the main research question:

a) *What kind of information is going through the supply chain stakeholders, and by which channels is the information being transferred?*

b) *How are the existing information systems and communication methods supporting information flow between stakeholders?*

Sub-question A is answered through research data only, because for empirical analysis of the supply chain, it is relevant to concentrate on the case supply chain. Sub-question B is answered based on the research data as well, because the objective is to understand the information systems and which are used in the case supply chain. The main research question, on the other hand, is answered based on both relevant theory and answers found for the sub-questions.

Based on the features that information has, information can be divided into three different levels, which are data, information and knowledge. The form of information is different according to the level of how much the simplest form of the data is processed and used. At some level, the terms data, information and knowledge are near the same, and therefore, a strict division between the terms is not always necessary (Sanders 2016). On the other hand, the difference between these three terms has argued to be crucial. One common definition is that data is the simplest form of information, which can be transformed into information, which again transforms into knowledge. (Boisot & Canals

2004) While knowledge is not the main topic in this thesis, it cannot be outlined completely, because there is always knowledge bounded into supply chain actions also. The main interest is, however, on information and data, which are more unstructured and unprocessed forms of information.

Multiple different concepts have been used in supply chain related literature when describing information movements between stakeholders. Madenas et al. (2014) use information flow and information sharing for same meaning in their review of supply chain information flow articles. Also, Kaipia (2009) has been using information "flow" together with "sharing" in her study of material and information flow coordination. Moberg et al. (2002) have studied the antecedents of information exchange in the supply chains, so also "exchange" is a concept used to describe information movement between different parties. In addition, information "transfer" has been appearing as a concept together with supply chain information studies. However, information transfer has in many studies been used to describe electronic information (e.g. Inkinen 2009; Kim et al. 2006). Therefore, it is not always relevant which of these terms has been used, rather than what has been the context. In this thesis, the chosen term is information flow, but proper information flow requires information sharing within each partner firm in the supply chain (Titus & Bröcher 2005), and that is why the both terms are involved in this thesis.

1.3 Literature review and theoretical framework

Talking about supply chain management (SCM) can be misleading at times, because actually companies are managing individual supply processes and relationships with some individual partners instead of the whole chain (Hsu et al. 2008). Therefore, there is no universal definition of the supply chain management, but instead, different emphases depending on the particular supply chain under observation. There is a wide range of different definitions of what is seen as a concept of SCM. The used definition depends, of course, of the supply chain definition. In different industries and business operations, the definition of the supply chain varies as well.

The basic definition of the supply chain management includes raw material suppliers, warehouses, factories and stores, where the finished products are sold (Davis 1993). That is a definition, which is easily applied into manufacturing businesses. In construction business, however, supply chain management (SCM) includes management of the

construction materials, information, and financial flows in a network, which consists of contractors, subcontractors, suppliers and distributors (Titus & Bröchner 2005). Kaipia (2009) has been studying supply chain planning (SCP) mechanisms and their effect on finding the balance between information flows and material flows within supply chain. The study represents ideas for better information sharing for improving supply chain performance.

Information has an important role in both preconstruction and implementation periods of the construction environment (Titus & Bröchner 2005). Titus and Bröchner (2005) define construction procurement as “the process required to supply equipment, materials and other resources required to carry out a construction project”. They define procurement as an integral part of construction projects, which is required every time when external resources are needed to provide supplies or services (Titus & Bröchner 2005). In the telecommunication industry and network construction, there is little research done regarding supply chain and its’ information flow. However, in the construction industry, there are multiple studies of the information sharing factors, which can be, to some extent, applied to supply chains of network construction projects also.

For timely construction, materials must be delivered on time to the constructor. This requires information sharing between customer, suppliers, transportation companies and constructors. Durugbo et al. (2014) have studied “delivery flow integration”, which is a term used to describe how information flow can be managed for delivery reliability. Delivery reliability is a metric for measuring the ability of companies to meet delivery dates with correct quantities and specifications (Lin et al. 2012). In the article of Durugbo et al. (2014), the management of integration strategies of traceability, transaction costs and vertical integration, which shape information flow, is examined. Their study proposed that in order to effectively manage delivery-related integrated information flow, the interplay of vertical integration, market relations and long term, voluntary relations, is required. (Durugbo et al. 2014)

Information flow can be defined as a part of a transaction, which is committed at the same time than seller delivers appropriate goods to the buyer (Durugbo et al. 2014; Wang & Das 2001). In this thesis, information flow is viewed in the supply chain and logistics point of view, and therefore most of the chosen literature is supply chain related. It is noticeable, that many of the studies regarding information flow in the supply chain are about information sharing in inter-organizational relationships. Usually, in supply chains, the

examined inter-organizational relationships are buyer-supplier relationships (Cheng 2011). Kim et al. (2010) have studied the buyer-supplier relationship and found out the differences between what are the most significant determinants of the relationship for each party; while inter-organizational trust was important to the buyer, for the supplier the determinants were technological uncertainty and the reciprocity of the relationship. Also, Hsu (2011) have studied buyer-supplier relationship, and found out that the relationship has positive affect on both information sharing capability and performance.

In recent years, the management of supply chains has been aiming towards more automated and standardized information transfer, in which information technology (IT) has been in a major role. An important IT for inter-organizational information transfer has been electronic data interchange (EDI), which has been defined as a "computer-to-computer transmission of standardized business transactions" (Hill & Scudder 2002), and as an inter-organizational system (IOS), which exchanges business documentation in structured and machine-readable form. The use of EDI enables inter-organizational collaboration and reduces transaction costs between operating parties. In addition, some organizations have reached improvements in their performance. (Hill & Scudder 2002; Kyu Min & Sang Jun 2016) On the other hand, the negative side of increased electronic communication is that when visual and physical communication is not present, relationship between parties might become less trusting and cooperative, and therefore confidential information is shared more reluctantly. (Leek et al. 2003)

In the literature, there are multiple studies examining and categorizing factors which are influencing information flow. It is important to pay attention to these factors, as they might be the same factors from where problems regarding information flow are created. Therefore, when identifying the key influencers of information flow in the supply chain, also the problem origins can be identified. In the research of Moberg et al. (2002), the antecedents of information exchange have been divided to three categories, which are information, organizational and relationship characteristics. These all three groups have their effect on both operational and strategic information exchange in the supply chains. Also in the study of Li and Lin (2006), important factors affecting information sharing and information quality are introduced and divided into three groups, which are intra-organizational, inter-organizational and environmental characteristics. Childerhouse et al. (2003), on the other hand, have studied barriers, which are in the way of improving performance in the automotive supply chain information flow, and in their opinion

information flow challenges are related to technology, culture, finance or organization itself.

The framework (Figure 1) for this thesis was formed by the most relevant concepts of this study. Different categories of information flow influencers were combined into three groups: information characteristics, technology and relationship characteristics, which are visualized in the framework.

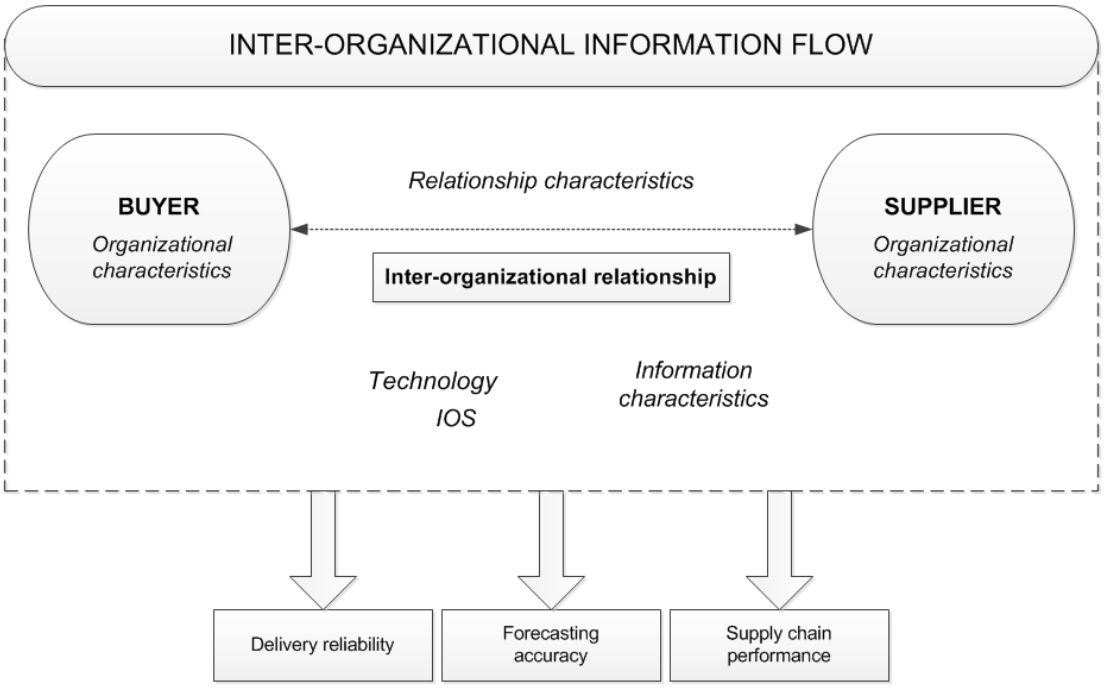

Figure 1. Theoretical framework.

1.4 Research methods

This thesis is a qualitative research where supply chain information flow is examined with empirical analysis of a case. The chosen research strategy is case study research, which is an approach to study phenomenon with a real-life context (Yin 2009, 2) and gain a deep understanding of them (Laine et al. 2015, 9; Yin 2009, 4). There is only one case studied in this thesis, and therefore the research can be characterized as a single case study.

The primary material for empirical analysis is collected with interviews, which are conducted within the most important stakeholders of the case supply chain. The objective is to collect data from different operations and companies along the supply chain, so the amount of knowledge of the supply chain actions would be comprehensive. Also, secondary material, such as documented information about the supply chain, and data from the information systems of the companies is used. In addition, observation is in a major role to forming an overall picture of the supply chain actions as well as to create understanding of the primary data.

The analysis method used in this research is thematizing, which is a method where research data is examined by repeatedly occurring features, which are pointed out along the research process (Hirsjärvi & Hurme 2015, 173). After the interviews, the collected material is divided into themes, after which the material is analyzed according to those themes.

1.5 Structure of the thesis

There are three main parts in this thesis, which are theory, empirical analysis of the case and conclusions about the case study. First, in chapter 2, a review of the existing theory in the field of supply chains, information flow and different levels of information is created. Also, the main factors affecting information flow in the supply chain are examined.

In chapter 3, research methods are described by explaining the research strategy, data collection practices and data analysis methods which were chosen to be used in this thesis. After that, in chapter 4, a brief introduction of the stakeholders in the case supply chain is created, as well as introduction of fixed network infrastructure and construction material types.

Chapter 5 concentrates on the main findings collected from the interviews. First, the order- and delivery processes are explained by describing the supply chain actions. After that, the main findings regarding information flow, including information systems, communication tools and supply chain stakeholder relationships, are described. In chapter 6, the discussion of the findings is created by viewing and comparing the findings with relevant literature. Finally, in the chapter 7, the conclusions of the study are presented by answering to the research questions, which were posed in the beginning of this thesis.

2 INFORMATION FLOW IN THE SUPPLY CHAIN

In this chapter, according to the relevant literature, the concept of information flow is examined in the supply chain point of view. First, the concept of construction supply chain is introduced in order to create an understanding of how its' characteristics are affecting information flow. After that, the concept of information flow is introduced, and the division of different information levels is made. Lastly, the main factors affecting information flow are introduced by dividing the factors into categories, which are information characteristics, information systems, communication methods, and lastly, relationship characteristics. In addition to introducing these influencers of information flow, also the impacts of these factors, such as problems they are causing, are discussed during this chapter.

2.1 Construction supply chains

According to Lee and Billington (1993), supply chain is "a system of suppliers, manufacturers, distributors, retailers, and customers where materials flow downstream from suppliers to customers, and information flows in both directions". The term supply chain has also been defined as "a system of suppliers, manufacturers, distributors, retailers and customers where material, financial and information flows connect participants in both directions" (Fiala 2005). There should be transparent information flows in both order-generating and order fulfilment channels of the supply chain (Childerhouse et al. 2003).

The nature of supply chains is different according to the operations of the company. In construction projects, it is typical, that the projects are unique processes where something is created from the incoming materials. In contrast to manufacturing systems where multiple products are made and distributed to many customers, in construction supply chain there is usually only single product under process (Vrijhoef & Koskela 2000). Construction supply chain has been characterized as a project based temporary supply chain, where there is a large number of participants, which keep changing from project to project. When the number of participants is large, it can make the supply chain more complex and complicate information sharing between the participants. (Titus & Bröchner 2005)

The construction supply chain usually is a make-to-order (MTO) supply chain, where every project is creating some new product of prototype, for example. The creation of similar projects with same processes is of course possible, but the basic idea usually the rate of repetition between different construction projects is low. (Vrijhoef & Koskela 2000) In MTO supply chain, the end products usually are relatively expensive and built according to the needs of an individual customer. The construction supply chain can prepare the procurement of materials only after the customer has approved the project or design plans for the project has been made, which means, that only the raw materials and standardized components can easily be forecasted. Therefore, the lead-time for MTO supply chain is sometimes longer compared to other types of supply chains, because the components may not be ready to be used when the project design has been made. (Stavrulaki & Davis 2010)

Vrijhoef and Koskela (1999, 2000, 2001) have studied supply chain in the construction industry and identified special features of construction supply chain as well as important roles of supply chain management in construction. The roles are different depending on whether the focus is on the supply chain, the construction site, or both. According to the focus point, there are also different objectives that are pursued by SCM, and different actors that may adopt these certain objectives.

Focus of SCM	Supply chain actor	Objective
1. The interface between the supply chain and the construction site	Contractor	• reduce costs and duration of site activities • ensure dependable material and labor flows to the site
2. Supply chain itself	Material and component suppliers	• reducing logistics, lead-time and inventory costs
3. Transferring activities from the construction site to the supply chain	Suppliers or contractors	• reduce total costs and duration
4. Integrated management and improvement of the supply chain and the construction site	Clients, suppliers or contractors	• site production is subsumed into SCM

Table 1. SCM objectives in construction supply chain (Vrijhoef & Koskela 2000).

Ala-Risku and Kärkkäinen (2006) have studied material logistics management in construction projects. According to their study, there are two major problems regarding material deliveries in construction projects: inventory transparency and material availability. To find a solution to the main problems, they suggest that material deliveries have two requirements: transparency of material availability and short response times in supply chain. Their solution to material deliveries included a shipment tracking-based approach to provide inventory transparency, and a pro-active material delivery approach for timely material availability. (Ala-Risku & Kärkkäinen 2006)

2.2 Information levels

According to Durugbo et al. (2014), information flow implies for two-way communication, involving contents, channels and systems (Figure 2). Systems are containing and managing information channels and contents. (Durugbo et al. 2014)

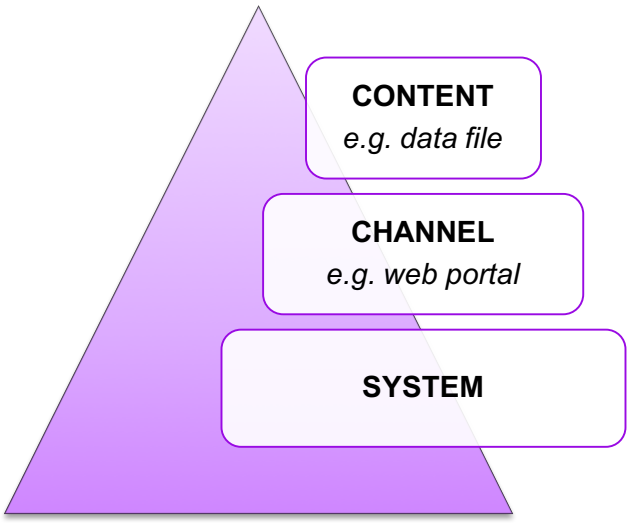

Figure 2. Information content, channel and system (Durugbo et al. 2014).

Titus and Bröchner (2005) have studied information flow in construction supply chain and categorized information interaction types into three groups, according to whether the interaction is between human or a system:

Human ⟷ System

Human ⟷ Human

System ⟷ System

Therefore, there are three interactions to be noticed, when information flow is viewed within a supply chain. Timely information is valuable for procurement, as it provides a base for decision making. The decisions are made either by machines or people, and that is why both parties are important in information transfer. (Titus & Bröchner 2005)

Supply chain information can be shared at three organizational levels, which are operational, tactical and strategic levels. At all of those levels, different kind of information is shared and different benefits and barriers are faced through sharing the supply chain information. (Kembro & Selviaridis 2015) Also Hsu et al. (2008) has divided shared information into different levels: tactical (e.g. purchasing, operations scheduling and

logistics) and strategic information (e.g. long-term objective, marketing and customer information).

	What information is shared	Benefits of information sharing
Operational level	• Order information • Delivery schedule	• Supporting the daily physical flow of products through the supply chain
Tactical level	• Forecasts of the production within next 12 weeks • Monthly meetings	• Attempt to predict and match supply with demand in distribution to better synchronize production and logistics capacities
Strategic level	• One-year demand forecasts and production changes • Five-year plans concerning planned expansion and required investments • Joint business plan	• Strengthened relationship and increased trust between partners • Shared view of the future and potential growth to ensure that sufficient production capacity is available

Table 2. Supply chain information sharing on different organizational levels (Kembro & Selviaridis 2015).

Another way of classifying exchanged information is to divide the information into transactional and managerial information. As listed in the study of Choe (2008), transactional information is the information needed to perform purchase or supply transactions, such as information related to orders and delivery, receipts, transportation or inventory. Managerial information, on the other hand, is regarding decision-making and

controlling of business activities, and it can be related to i.e. costs, quality, and profitability or manufacturing technology. (Choe 2008)

2.3 Key factors influencing information flow

Information sharing between trading partners allows organizations to access data across their own supply chains, which enhances collaboration in multiple different activities of the firm, as well as reduces uncertainty due to improved visibility (Hsu et al. 2008). In addition to these benefits, there are many different factors that are related to supply chain information flow effectiveness. By reviewing these main influencers of information flow, also the reasons to effectiveness, or lack of it, can be identified.

2.3.1 Information characteristics

Kembro and Selviaridis (2015) have found several information related characteristics that are causing barriers within information sharing between dyadic relationships in the supply chain. In their opinion, the problems related to information are that information is dis-aggregated, misinterpreted or incomplete. One issue related to information qualification which is often brought up in the literature, is information quality, which has been defined as the degree to which the information meets the need of the organization. It is an important factor, which affects the performance of the supply chain and whether material deliveries arrive on time. (Kaipia 2009) Other than meeting the requirements of an organization, the quality of information may be related to multiple factors, such as accuracy, timeliness, credibility or proper formatting of the information (Kembro & Selviaridis 2015).

Lack of information has been identified to cause unnecessary costs in the supply chain (Childerhouse et al. 2003). Insufficient information is a challenge for decision making in the supply chain – both in daily operations and long-term decision making. Also, having real-time information available at any time can reduce lead-time as well as increase accountability for tracking purposes. However, real-time availability is not an easy task, because information is not always so easily accessible in the supply chains. (Titus & Bröchner 2005) Especially if there are multiple different organizations and actors in the supply chain, finding real-time information might be difficult.

Information visibility, i.e. the availability of relevant information, has been named as an important enabler for making decisions in the supply chain environment (Goswami et al. 2013). According to Viswanathan et al. (2007), there has been interest among practitioners to concentrate on information visibility factors within information sharing. Especially demand information is regarded as important to share in the supply chain, because sharing it can lead to reduced inventory costs (Viswanathan et al. 2007). Dis-aggregation of demand information in the supply chain is due of insufficient information sharing of the demand amounts, which would help the supply chain partners to plan their actions and material consumption according to them. (Kembro & Selviaridis 2015)

The forecasts of the material quantities and delivery dates must be well estimated to ensure the efficiency in the supply chain. If forecasts are inaccurate, the risk for bullwhip effect increases, which means that there are swings in inventory as the customer demand changes. Li (2013) has studied bullwhip effect and connection to constrained information flow. The conclusion of the study was that both an appropriate order adjustment strategy and information sharing are indispensable in reducing the fluctuations in inventory replenishment and improving supply chain performance. According to Fiala (2005), information asymmetry was the most powerful source to cause bullwhip effect. In addition, Kembro and Selviaridis (2015) identified the problem of incomplete information, which can lead to making incorrect production and distribution decisions.

2.3.2 Information systems

There are many found benefits of using information technology for information flow integration, and one of the benefits is reduced transaction costs, which can be related to e.g. coordination of product information exchange or delays in communication channels (Durugbo et al. 2014). In supply chains, information technology has also been affecting the functionality of the procurement by causing shorter lead times and allowing smaller batch sizes. In addition, information is more centralized in the supply chain. (Fiala 2005)

Bowersox and Closs (1996) have defined three main drivers in the logistical system, when physical distribution and electronic information transfer are combined. The first driver is customer interface, because customers need to have timely information about their product locations and transport schedules. Second, good information resources reduce warehousing needs and help to provide more “on demand” service. The third driver is that information resources add flexibility to the process and help to adapt to new situations if

unforeseen events take place in the process. (Bowersox and Closs 1996; Inkinen, Tapaninen & Pulli 2009)

A concept that often appears in the literature of supply chains, inter-organizational information system (IOS), is a system where information is digitally transmitted between two separate organizations (Kauremaa & Tanskanen 2016). When inter-organizational relationships are present at the supply chain, information has to be able to be shared through information systems. Connecting inter-organizational information processes with information technology systems have been identified as a possible barrier to information sharing in the supply chains. Usually, in an inter-organizational relationship, all of the members do not have the access to same systems, such as ERP systems. (Kembro & Selviaridis 2015) That is why it is important, that also common systems for information sharing are in use between the actors of supply chain, or at least the information transfer between different systems has to be affective.

The incompatibility of information systems is a major factor when discussing information transfer challenges. Usually there are more than one information systems used in the supply chain, because there can be different systems used in different companies. Even when there is a same information system used throughout the supply chain, there can be problems of the information content, because the information can be in different format compared to some other supply chain participant (Daves 1996).

2.3.3 Communication methods

In their study, Carr and Kaynak (2007) have examined communication methods used by buyers to communicate with their suppliers, and they have been categorizing the methods into traditional and advanced communication methods. Traditional methods include the use of telephone, e-mail, written and face-to-face contact in communication, whereas communication methods including computer-to-computer links, electronic data interchange (EDI) and enterprise resource planning (ERP) systems are referred to as advanced communication methods. Choe (2008) has proposed that inter-organizational information systems (IOS) have been replacing traditional communication media (TCM). On the other hand, it has been also studied, that usually both traditional and advanced methods are used in combination and new technologies have not been replacing more traditional ways of communication. (Carr & Kaynak 2007; Leek et al. 2003)

Face-to-face interaction between supplier and buyer is considered an important medium for information exchange (Carr & Kaynak 2007), and it is often proposed as most effective type of communication because of the richness of information (Choe 2008). Media richness theory (MRT) has posited that different types of media have different capacity to convey messages and cues along them. According to MRT, the effectiveness of communication depends on the match between capacity of media and task requirements. (Otondo et al. 2008) Email has therefore seen as a lean medium for communication, as it does not convey rich information, such as face-to-face communication (Choe 2008). Using electronic communications methods has its' impact on the relationships. Relationships are becoming more depersonalized and less collaborative, which leads to decreased trust and openness among parties. In result, confidential information is also exchanged less than before. (Leek et al. 2003)

2.3.4 Relationship characteristics

Relationship characteristics are the factors, which are appearing in inter-organizational relationship, such as in buyer-supplier relationship, and affecting information flow between trading partners. Whereas supply chain information sharing within an organization, i.e. intra-organizational relationships, is defined as the sharing of critical information between departments and operations of one company, inter-organizational information sharing is happening between different firms, such as between companies of buyer and key suppliers. The information to be shared should meet the firms' requirements by being detailed, frequent and timely enough. (Carr & Kaynak 2007) Despite the noticeable role of these inter-organizational relationships creating sustainable value, due to inability, unwillingness or lack of knowledge, many firms have failed to realize the benefits of these relationships (Hsu et al. 2008).

One of the widely identified factors affecting information flow is also trust between supply chain partners, and especially within inter-organizational relationships, such as buyer-supplier relationship. According to Viswanathan et al. (2007), lack of trust and willingness between partners has been known factors that are preventing efficient information sharing in the supply chain. Trust is an important factor especially when confidential information is shared between trading partners. Hsu et al. (2008) has defined, that information sharing in a supply chain context refers "to the extent to which crucial and/or proprietary information are available to members of the supply chain". Companies have to, therefore, balance

with the amount of information shared, because if too much confidential information is shared, there is a risk of information leakage, which means that information ends up to unintended recipient. Therefore, it is not always best that all of the information is shared to the trading partner, but that all of the relevant information is shared, which can be done by finding the balance between completeness and partialness of the amount of information shared in the supply chain. (Durugbo 2014)

Choe (2008) developed a framework for identifying different types of inter-organizational relationships, and as a result of the study, four types of relationships were defined according to the usage level of media and types of information exchanged: traditional links for coordination, strategic alliances, electronic links for coordination, and virtual organizations. The findings of the article showed, that both transaction and management information enhanced inter-organizational business activities, and both IOS (inter-organizational information systems) and TCM (traditional communication media) were actively utilized. Therefore, all of the inter-organizational relationships found out to be “hybrids” of different levels of usage of IOS and TCM. (Choe 2008)

3 RESEARCH METHODOLOGY

In this section, there is a description of the methods this thesis was carried out with. First, the research process and research methods are described together with relevant literature of subject. Then, there is a description of data collection methods, followed with describing the methods used for analyzing the collected research material. Finally, the reliability of the study is discussed at the end of this chapter.

3.1 Research strategy and methods

The chosen research method for this thesis was case study research, which is an investigative approach for describing complex social phenomena and gain a deeper understanding of them. Case study research is not actually method itself, but consists of different methods. Therefore, case study research is more of a way to do research, i.e. research strategy (Laine et al. 2015, 9). The purpose of case study research is to examine single instance in great depth. Therefore, it is the opposite from survey research methods, which seek to gather broad surface-level data about a topic of interest. (Laine et al. 2015, 12; Lapan et al. 2012, 243-244; Yin 2009, 4) The focus in a case study is usually on contemporary phenomenon, where there is a real-life context (Yin 2009, 2). In this thesis both the activities and human interactions were being examined, which is usually typical for a case study research.

Case study research methods can be divided into different categories according to the amount of incidence they contain. This thesis was a single case study, because there was only one incidence as a case (Lapan et al. 2012, 247). Although there were different stakeholders examined in this thesis, only one specific process in the supply chain of network construction was as a phenomenon of interest. Therefore, there was only one incidence, which included one supply chain and its' procurement process.

In case study, it is common to design the study and its' research questions in ways that are meaningful to stakeholders. (Laine et al. 2015, 12; Lapan et al. 2012, 243-244) The relevance for using case study as a research method can be evaluated by observing the research questions placed to guide the research. The more it can be known to be relevant, when there are many "how" or "why" questions to be answered. (Yin 2009, 2-4) In this thesis, the research questions were chosen to be descriptive and explanatory,

because the objective was to gain understanding of the one case, rather than measure some phenomenon.

3.2 Data collection

In case study research, the primary data is usually broad and qualitative data about the different dimensions of the case (Laine et al. 2015, 12). According to Yin (2009, 124), data collection for a case study can be more complex compared to other types of research, as in a case study, methodological versatility is important and certain quality control of the results during data collection is required. For using multiple sources of evidence, Yin (2009, 98, 101-102) proposes six choices of different ways to collect research data for a case study: documentation, archival records, interviews, direct observation, participant-observation and physical artefacts. Also, according to Eisenhardt (1989), different data collection methods, such as archives, interviews, questionnaires and observations, may typically be combined in the case study.

Most case studies involve human relations and behavioral events, and it can set a challenge for how to capture those relations most accurate way. Interview is one of the most important ways of collecting information for a case study, as it is a way to find out opinions and attitudes of the interviewees, which can help to understand behavioral aspects (Yin 2009, 108-109). In this thesis, the research subject involved relations between stakeholders and also individuals' actions, so interviewing found out to be the most effective way to collect data for this research. Also, it was important, that opinions and attitudes of the interviewees were brought up, as it was important for understanding the case under observation, and to find out which were the weak points of current actions in the supply chain information flow.

Yin (2009, 107) proposes in-depth interview, focused interview and survey as alternative interviewing methods for a case study research. From these methods, focused interview is a semi-structured interviewing method, where a person is interviewed for a short period of time, for instance an hour. Focused interview allows the interview questions to stay open ended and the whole atmosphere of the interview is usually conversational. Although, it is usual to have a set of questions to be followed during interviews, but not to follow them as punctually than in structured surveys. (Yin 2009, 106-108) Compared to structured interviews, in semi-structured interviewing the dialogue of the researcher and respondent

is allowing the interviewee to bring up whatever angle he or she considers important, even if it is slightly off topic (Brinkmann 2013, 21).

In this thesis, the interviews were conducted as semi-structured interviews and according to pre-defined themes, which were same for all respondents. The method can therefore be named as *theme interview*, which Hirsjärvi and Hurme (2015, 47-48) have defined as a semi-structured interview method, where the themes of the interview are same for all respondents, but the form and order of the questions are not strictly chosen beforehand. In this study, it was important that interviewees could present their own ideas about the research topic and researcher could present questions that came up in the interview situation along the answers. Therefore, semi-structured theme interview was the most suitable strategy for collecting the research data for this research.

In qualitative research, the research sample is typically chosen according to the studied case (Hirsjärvi & Hurme 2015, 58-59). In this thesis, the research sample was seven interviewees, who were chosen according to their current position in their organizations and their experience regarding the subject of this thesis. The interviews were carried out among the most important supply chain stakeholders, which were in this case logistics partner, constructor companies and SCM-team and Project Managers at the operator. The purpose was to conduct interviews for each of these stakeholders in order to collect data from different phases of the order- and delivery process.

According to the research questions, it was possible to identify five themes, which wanted to be investigated through interviewing:

- order and delivery process
- the content of supply chain information
- information flow and the quality of information
- information systems and –channels
- development ideas and future

These themes were used for defining and grouping the interview questions (Appendix 1). In addition to these themes, some background questions were posed in order to get insight for the interviewees' job tasks and career history at the current and previous jobs.

Interviews were carried out in two parts; interviews B, C, E and F were held in July 2016 and the rest of the interviews, A, D and G between September and November 2016. As

the interviews were held as theme interviews, interview questions were not posed in the same order in different interviews, but the same themes were discussed in every interview. For interviewees A, D and E, interview questions were showed before the interview, so that the interviewees were able to get an overall picture of the subject before the face-to-face interview. Interviewee A was answering all of the questions by email before there was face-to-face interview held, where the answers from the email interview were specified. Interviewing by email found out to be an effective way to get more specified answers to the questions, so the last interview, G, was held only by email. Most of the interviews were held face-to-face, except interview B, which was held with skype call. All of the interviews were conducted in Finnish, as it was the mother tongue of the interviewees and researcher. Each interviewee was given its' own mark between letters A and G (Table 3), which were used as references when research findings were organized and described in this thesis. This was helpful for separating the interviewees from each other, because the names of the interviewees were not used in this thesis.

After the first interviews (B, C, E and F), the final number of interviews wasn't decided yet. Those first four interviews were acting as a starting point, after which the required number of interviewees was planned. According to Eisenhardt (1989), one important issue for reaching closure in a case study, is to observe when theoretical saturation is reached. It means, that more cases shouldn't be added once the "incremental learning is minimal", i.e. the observations made from new cases are already seen before. In this thesis, the ideal number of interviews was reached, when there was seven interviews total. At that point, the held interviews included respondents that represented all of the most important stakeholders in the supply chain under observation.

Reference	Job function	Company
A	Purchaser, SCM-team	*operator*
B	Purchaser, SCM-team	*operator*
C	Project Manager	*operator*
D	Project Manager	*operator*
E	Sales Manager	*logistics partner*
F	Constructor	*constructor*
G	Project Manager	*operator*

Table 3. Interviewees.

As it has been recommended for conducting a case study, multiple sources for data collection were used in this thesis. To support the primary data, there was some relevant documented information of the company utilized during this study. In addition to the qualitative data collected from the interviews, there was numeral and other documented information about the procurement and information systems collected from the ERP system, material delivery systems and other internal channels of the case company. Quantitative data can be used to support the primary data in qualitative research (Eisenhardt 1989; Laine et al. 2015, 12) and it can provide some additional view to the qualitative results.

Also, observation of the stakeholders was in a big role of understanding the case supply chain. As Yin (2009, 110) has pointed out, observational evidence is often useful for reaching additional information about the studied topic. Therefore, observation was not used as a method to collect research data in this thesis, but instead, to achieve more in-depth understanding to the primary data.

3.3 Analyzing the data

All of the interviews were recorded so that the researcher was able to transcribe them afterwards. Transcribing can be seen as a part of the analysis (Brinkmann 2013, 61), and it is in a way a starting point for analyzing the research data. Transcribing can be done in many different ways according to the purpose of the study, and that is why it should be planned already early in the process. (Brinkmann 2013, 61) Detailed transcriptions, including for example gestures and volume of the speech, were not necessary to the purpose of this study, and therefore the transcribing was done in more loosely manner, capturing the main points of the interviewees' answers. However, the transcripts were tried to keep in the original form of the interviewees' answers, so that the meaning of the answers did not change. One of the main differences between quantitative and qualitative analysis is, that in qualitative analysis, the data is analyzed close to the data and its context. Therefore, in qualitative research it is typical that the research data is kept in its' original linguistic form. (Hirsjärvi & Hurme 2015, 136)

In qualitative research, researcher can go through the research material with either inductive or abductive reasoning, depending on the role of the research data. With inductive reasoning, researcher uses the data as a center of the research and there might not be certain hypotheses for the research findings. (Hirsjärvi & Hurme 2015, 136) The focus in examining the research data was on the content of the interviews, and the target was to see where the data leads the research. In addition, there was a target to construct some comparison between different respondents according to the similarities and differences noted in the interviews.

Eisenhardt (1989) has proposed, that often in theory-building case research, data analysis is overlapping with data collection. Therefore, as a result of this overlapping, researcher can take advantage of flexible data collection, and make adjustments during the data collection phase, if needed. In this thesis, analyzing of the data started right after the first interviews were held and transcribed. The interviews were held according to the specific themes, so interview data was in most parts already in the order of these themes. Therefore, the same order of the themes made it possible for researcher to observe the appearance of reoccurring of differing interview answers. That way, the analyzing started already during the interviews.

One of the strategies to analyze qualitative data is thematizing, which is a concept that has also been used together with the phase of the study where the whole theme of the study is formed (Kvale 1996; Hirsjärvi & Hurme 2015, 173). In this context, however, it is a way to observe repeatedly occurring features, which stands out from the data. Often these features are based on the same themes that are defined in the theme interview. However, it is normal that some new themes arise from the data, and those themes might be even more interesting for the study than the original ones. (Hirsjärvi & Hurme 2015, 173) The analysis in this thesis was conducted by going through the transcribed research material and marking different themes into interview documents. Themes used during the analysis were the same ones, to which the interview questions (Appendix 1) was grouped into.

The method of thematizing allowed the data to be handled theme by theme, which was a basis for grouping the information and starting to seek for answers to the research problem. While themes were important for the research, also the original transcribed interviews were viewed at the same time. To find comparisons and similarities between different interviews, it was necessary to view the interview documents in their original forms. Both of these ways to survey theme interviews were necessary, as the main objective was to form conclusions to the research problem, and at the same time, find some occurring problems in the supply chain actions.

3.4 Reliability and validity

The aspects of reliability and validity towards chosen research methods are important factors to evaluate during a study, because on the basis of them, it can be seen if the study is conducted with suitable research strategy and if the study is consistent and understandable to its' readers. Yin (2009, 40-45) presents some tests that can be used to evaluate the quality of a research: construct validity, internal validity, external validity and reliability. Those four tests can be used to observing the quality of this case study and the methods chosen.

Construct validity is a measure for if correct operational measures for the studied case have been used (Yin 2009, 40). The way to ensure construct validity in a research is to use multiple sources of evidence. In this thesis, the data collected included mainly information collected through interviews, but in addition, some secondary data including documented company information and observation daily operations was used for

supporting the collected data. The other way of ensuring construct validity is, according to Yin (2009, 98, 122-124), that the chain of evidence is maintained throughout the study. That means that the reader of the study must be able to follow the process of research, i.e. follow the “evidence” from the research questions all the way until the conclusions of the study. The research process must therefore be consistent and clearly reported.

External validity is an aspect to be investigated whether the findings of a research are generalizable beyond the studied case. In this thesis, there was a single case to be studied: a supply chain of passive material for network construction. Therefore, it cannot be stated that the results of this study could be applicable to other supply chains, because the characteristics of that specific supply chain affect the results. Case studies have often been criticized for the lack of generalizability, especially when only single case is studied. Whereas surveys aim to statistical generalizability, case studies rely on analytic generalizability, which means that the results of a case study are generalized to some broader theory. (Yin 2009, 43) If there would have been multiple cases to be studied in this thesis, the results of each case could have been compared to each other. In that case, as a result of these comparative findings, there could have been more generalized finding for describing different supply chains. However, in this thesis those generalized results were not the main purpose, but to gain as deep as possible understanding of the one case under observation.

The matter of reliability means to test if the study is documented in a way, that some other researcher could perform the same case study later again and arrive to the same findings and conclusions (Yin 2009, 45). Although the method of interviewing is usually an essential way to collect data in a case study (Yin 2009, 108), it is important to notice that the weakness of interviewing as a data collection method is reflexivity, which means that interviewee gives the type of answers he or she thinks the researcher wants to hear (Yin 2009, 102). Therefore, the material collected with interviews might not always be reliable as a result of the interviewee unintentionally or intentionally answering as opposed to what he or she really thinks. In addition, the replies of the interviewees are always subjective, as they are opinions of the specific interviewees in that specific time of the interview. Thereby, in another setting, different time or place, the answers of the respondent could differ from previous ones. If the same study would be repeated with same research methods, it would not be guaranteed that the results and findings would be same that before.

Also, the researcher is able to “manipulate” the data by guiding the answers of the interviewee. It is important, that the researcher doesn’t pose leading questions, from which the interviewee can easily notice the opinion of the researcher, but instead, stay naïve about the subject and let the interviewee provide the answers (Yin 2009, 107). This impartiality of a researcher was an important factor in this thesis, as the researcher was working in the case company and already had her own knowledge and opinions of the subject. Therefore, it was important to pose the interview questions as objectively as possible to avoid the manipulation of the results.

4 CASE OVERVIEW

In this chapter, the case company and the operations of fixed network construction are introduced. First, the main stakeholders of this thesis are introduced. After that, there is an introduction of the different fixed network materials, which are procured from the logistics partner.

4.1 Case company

A case company for this thesis was a European telecommunication company, which provides mobile and fixed network communication services. This study was conducted under Deployment –department, which is responsible for the construction and maintenance projects of the network. In this thesis, case company is called “operator”.

The construction project types vary depending on the end customer. Typically, the construction projects with a shortest lead time are projects, where the end customer is a private company. In addition, a big portion of the projects include construction projects, where the end customer is a public institution, i.e. universities, cities and other public facilities. The construction projects include also own network construction projects of the operator as well as maintenance and modernization of the existing network.

4.2 Supply chain stakeholders

In the case supply chain, there are four main stakeholders under observation, which two of them, Project Managers and SCM-team, are in the case company, the telecom operator. Other two stakeholders are logistics partner and constructor companies. In this chapter, these stakeholders and their main activities regarding the studied supply chain are introduced.

4.2.1 SCM –team

SCM-team at the operator is responsible for Supply Chain Management -functions of network construction and maintenance. In this thesis, the term “SCM-team” is used when referring to purchasers, who are working with the orders and deliveries of passive material, which are procured from logistics partner.

The tasks of SCM-team include procurement of fixed network construction material, which includes making orders for the logistics partner, other suppliers and own warehouse. Tracking the deliveries and solving material delivery problems are also part of the daily tasks, and those tasks include solving these issues with suppliers, logistics partner, transportation companies as well as constructors, who receive the materials. Purchasers of the SCM-team are in charge of the daily cooperation with the logistics partner, when material order and –delivery issues are being solved. Inventory management of the warehouses of operator is also on the responsibility of the SCM-team.

4.2.2 Project Managers

Project Managers are in charge of the construction project implementation at the operator by discussing the requirements of projects with the constructors and monitoring the schedules of the construction. After the constructor has made the plans for material requirements, Project Manager takes care of that those materials are ordered. Other daily tasks include following the status of material deliveries and other issues related to the projects, and this includes communication, especially with the named contact persons at constructor companies. Regarding material problems, Project Managers are solving the delivery and availability issues with SCM-team.

4.2.3 Logistics partner

Cooperation between operator and logistics partner begun in the beginning of 2013, when procurement of the passive materials for fixed network were outsourced to the logistics partner. Logistics partner in this case supply chain means a telecom sales team, which is in charge of all of the orders coming from the operator. Their responsibility is to handle the orders coming from the operator and according to them, direct the orders either for supplier or own company's warehouse. There are over 50 suppliers, from which logistics partner purchases all of the materials. Ten of the suppliers are the most important ones, which includes for example optical cables supplier.

As a main contact person from the telecom sales team, there is Sales Manager, who is responsible for customer relations with the operator. The tasks of Sales Manager include solving material availability problems and coordinating the process by joining all of the meetings and staying informed of all of the issues regarding the cooperation and material orders of the operator. In addition, Sales Manager is in charge of the pricing of materials.

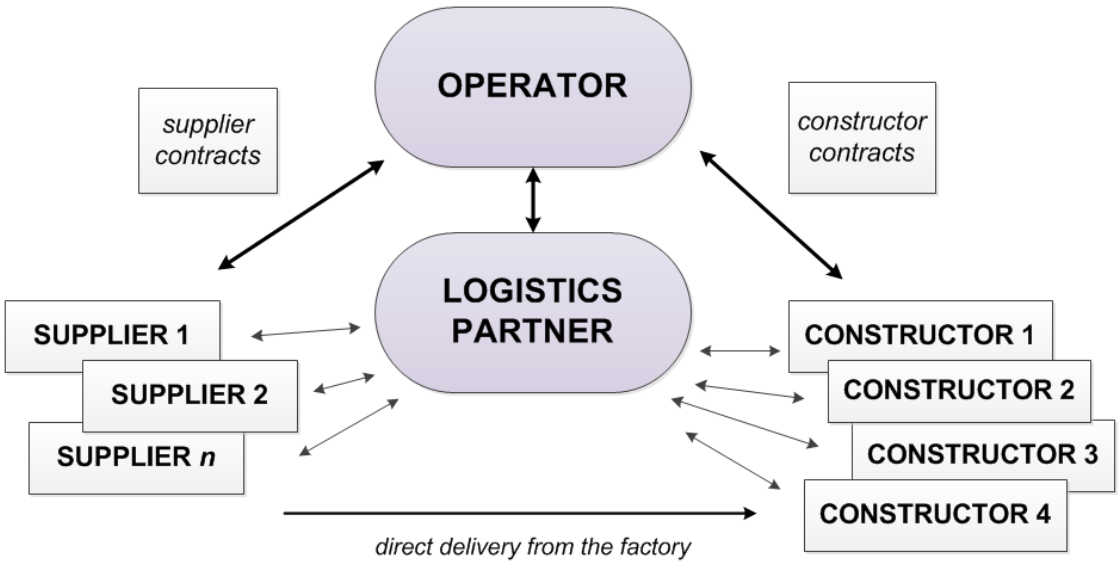

Figure 3. The role of logistics partner in the supply chain.

4.2.4 Constructor companies

There are four main constructor companies, from which all of them carry out both mobile and fixed network construction projects of the operator around Finland. Network designers at the constructors make the material plans according to the requirements for a project that operator has ordered. Construction materials are delivered either straight to the constructing site, or to the constructor's warehouse, until the material is needed at the site location.

4.3 Fixed network

The basic principle of telecommunication infrastructure is that there are three elements needed for information transfer over a distance: *transmitter*, *transmission medium* and *receiver*. The transmitter processes the information to a form that is removable by transmission medium, which in turn, transfers the data finally to the receiver. The receiver has to convert the data into a usable form.

According to these three elements in telecommunication infrastructure, materials used in constructing the network can be divided into two major categories: *passive* and *active* materials. Active materials include all of the devices, which process data, i.e. transmitters and receivers. Passive materials, on the other hand, are needed for transmission medium, and therefore include all the other material needed for data to be transferred.

There are different principles for how the data is being transferred in the fixed network, and that depends on the transmission medium, which can be either copper wires or optical fibres. A telecommunications network has two main parts: *core network* and *local or access network.* In core network, there is large number of buildings connected together by transmission systems, and the most common transmission medium is optical fibre.

The local or access network connects individual customers into the nearest point of core network by copper or fibre cables. The cables are linked to cabinets, from which the connection is continued in smaller cables to the distribution point, which can be sited at the top of a telephone pole or in a large office building. From the distribution point, the connection is again continued with copper wires to the final location.

4.4 Fixed network construction materials

At the operator, passive material for fixed network consists of four major categories, which are cables, ducts and pipes, cabinets and accessories or installation material. A significant part of the passive materials is cables, which in fixed network consists of mainly copper cables and optical cables, which are the main technologies to choose from when building the network. In addition, from the logistics partner, there are some other cables procured, for example for mobile network construction. As seen from the figure 4, the substantially biggest portion of the cables purchased for fixed network construction is optical cables, as it is the most modern way to construct fixed network nowadays.

The other major category, mounting accessories, includes ducts and pipes, which are used for cable installation. Also, other equipment used together with ducts, such as cable wells, is included in this material group. The category of “other materials” in figure 4 consists of other equipment and installation material used for both fixed and mobile network. For mobile network, there are also other passive material suppliers in addition to the logistics partner, so share of the total purchases from the logistics partner is not significant.

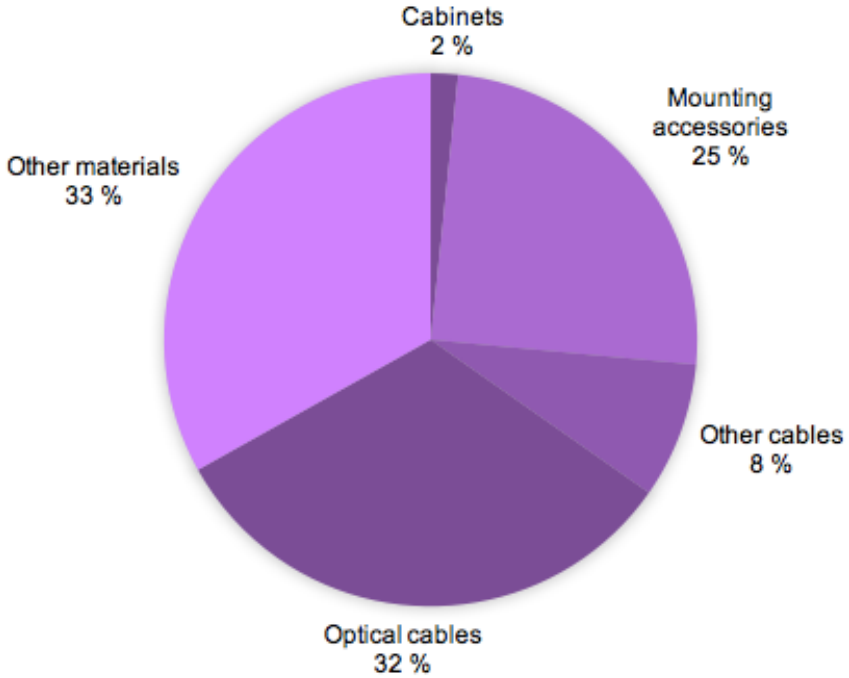

Figure 4. Passive material purchases from logistics partner in 2016 (net value).

5 FINDINGS

In this chapter, the most important findings of the research are introduced. First, the characteristics of the case supply chain are introduced by describing the material ordering- and delivery processes. After that, in the same way than in the theory chapter, the findings of this research are categorized to different themes, which are different factors that are influencing information flow in the supply chain. Of these themes, first the information characteristic as well as communication methods and technology characteristics of the supply chain are described, and after that, the relationships between stakeholders in the supply chain. In result, the overall picture of the findings of this thesis is formed.

5.1 Supply chain processes

The procurement of passive material for fixed network begins by defining the material needs. The operator has an excel sheet, which includes all passive material options, which operator has chosen to be used for fixed network construction. To this excel sheet, constructor selects the materials, which it has been planning to use for construction. After that, constructor sends the excel sheet to Project Managers either by email, or through constructors' server, where Project Managers also have access to.

After the plans of the operator has received, Project Manager checks the material plans and saves all the information into the NCPM system – a web-based system, which transfers the information forward to the ERP system. All of the construction site information is recorded to the NCPM system as well. For material order, Project Manager has to save material numbers and amounts, requested delivery date, network site number and name as well as delivery address and recipient of the materials into the system. If technical information regarding materials is needed, usually those are requested from the logistics partner, who in turn, asks it from their supplier, if needed.

After the information is saved to the NCPM system, a purchase requisition is generated to the ERP system. Depending on the materials ordered, some purchase requisitions are at this point automatically generated into purchase orders, which are transferred in EDI format to the logistics partner through ERP system. However, some purchase requisitions are not automatically generated into purchase orders, and those requisitions are handled manually by SCM-team. The reason for why manual handling must be done is that cables

and ducts have two different prices in the supplier contract, and the ERP system is unable to determine which one to use when it tries to generate a purchase order. The price of the cables and ducts is different depending on where the material delivered from. Normal price is used when material is sent from the logistics partners' warehouse, but if the material is delivered straight from logistics partners' supplier to the recipient, the price is higher than the normal price.

When SCM-team manually handles the purchase requisition, it chooses the right price for the material. Most of the needed information is already in the purchase requisition, but for cables, there must be fees for cutting the cables and cable reels added. Also, if bigger transportation truck is needed (as usually is when there are large amounts of cables or pipes ordered) information about that is added to the order. If these additional fees are not added, the invoice sent from logistics partner doesn't match the order in operator's ERP system. Invoice is then blocked from automatic payment and the order must be changed to match the invoice afterwards.

When the purchase order is created, the system is transferring it by EDI message to logistics partners' ERP system. At the same time, information about the order is also transferring to the material delivery system of the operator. When logistics partner receives the EDI message, it is either going through to their warehouse, or blocked for manual handling. Manually handled orders are those orders, where non-stock products, cables or ducts are ordered. That is needed because there must be a decision about where the material is delivered from.

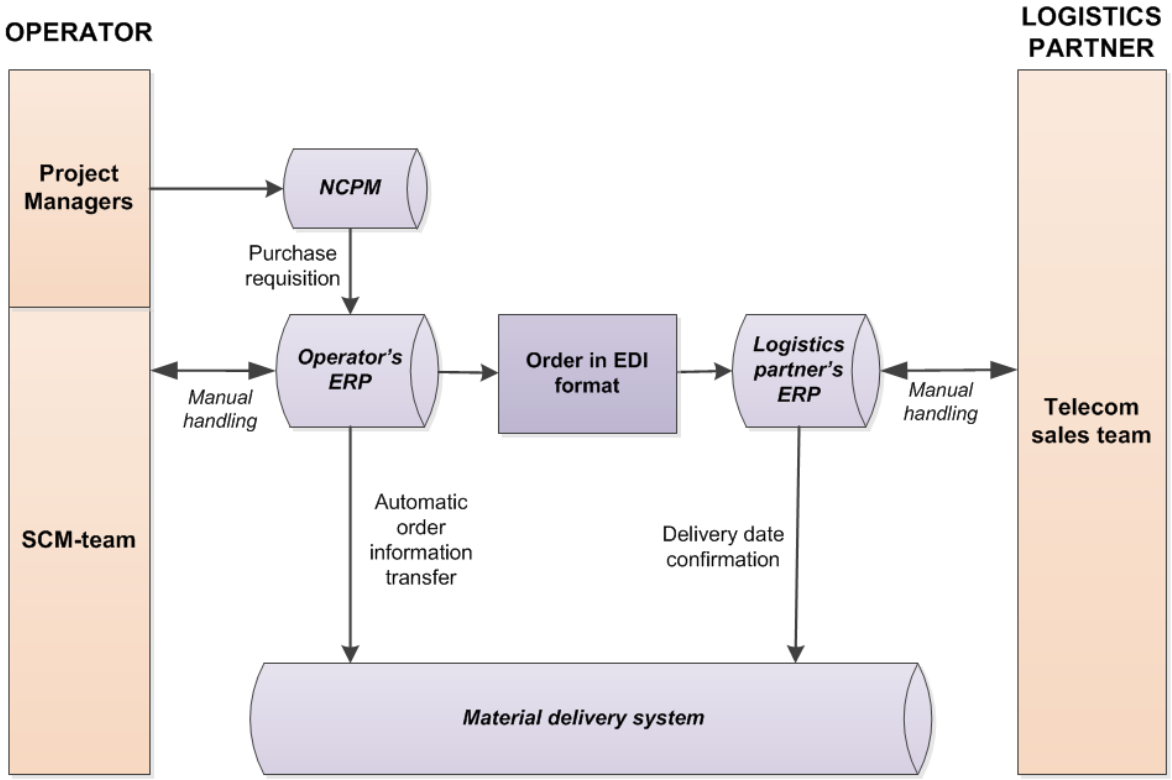

Figure 5. Material ordering process.

If the material is wanted to be delivered straight from the suppliers' warehouse, logistics partner has to make the order to the supplier. If the product is found in own warehouse, order can be approved and transferred forward to the warehouse. Other situations, when order is not automatically going through, is when all of the information in the order is not, for some reason, transferred from the operators' ERP system. Usually this means, that delivery address is missing from the order and therefore, it must be requested from the SCM-team.

All of the delivery information needed is already transferred on the order to the logistics partner, and from them, forward to the transportation company. From the warehouse of the logistics partner, a confirmed delivery date is added to the delivery system, as soon as it can be confirmed. When the order is leaving from the warehouse, a tracking number for delivery is also added, and the system retrieves delivery information from the transportation company's website. Some cables and ducts, which are not delivered from the warehouse of logistics partner, are delivered straight from the factories of suppliers,

and logistics partner is requesting the confirmed delivery date from the supplier, and transfer the date into material delivery system.

Materials are delivered either straight to the construction site, or to the constructor's own warehouse to wait until it is needed at the site. Especially when a large amount of cable or ducts are ordered, they are delivered straight to the construction site, because there is not enough space to storage them. Constructor has to confirm to the material delivery system, when material orders are received. At the constructors' warehouse, a delivery receipt is done by them, who are receiving the material at the warehouse. However, if material is delivered to the construction site, there must be someone from the constructor to check if the material is delivered, and confirm a delivery receipt to the system.

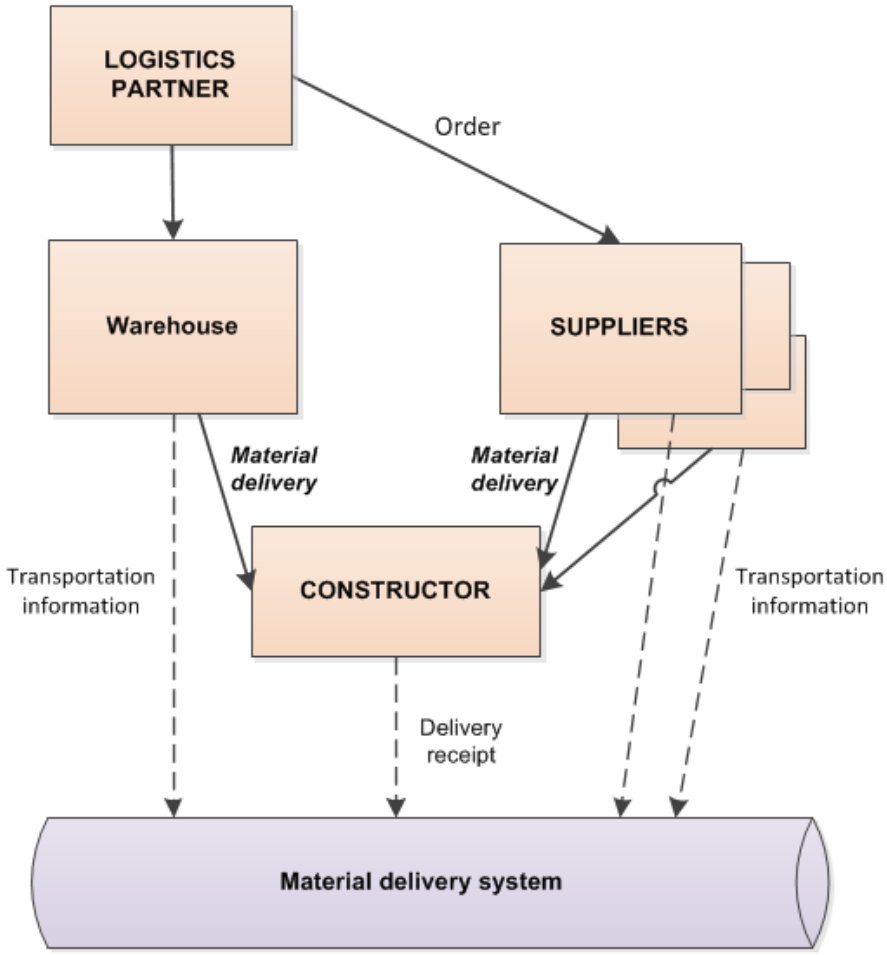

Figure 6. Delivery process.

5.2 Information characteristics

The main information between the supply chain stakeholders is related to material ordering and delivery of the materials. For Project Managers, the availability of material types is important information to get from the suppliers, because it can affect the types of materials that are ordered. In addition, order information, such as network or site information, material codes and required order date are important as well as delivery information for the place that material is delivered to. All of this information is required for Project Manager to be able to place the order into NCPM system. For SCM-team, this same information is required, and it usually already is found on the ERP system if Project Manager has filled the information properly. In addition, SCM-team is usually in charge of updating the contract prices into ERP system, and sometimes the material prices have to be changed according to the latest versions of the contracts. Supplier information is saved to ERP system, so the only thing to know is, which contract number is used in which order, and the supplier information is automatically transferred.

When asking interviewees about the requirements for information in the supply chain, the quality of the information was evaluated as an important factor regarding the information characteristics in the supply chain. The quality of the information, i.e. how accurate the information is, was the most important requirement for information according to the Sales Manager of the logistics partner (interviewee E). Also, SCM-team emphasized the importance of information quality: "*The most important requirement for information is that it is correct, and not almost correct, and that time is not wasted on handling incorrect information*" (B).

Also, the fast availability of the information was emphasized by the interviewees. Project Manager (interviewee D) said: "*The project schedules are usually already late when the projects arrive to us, so there is always rush to get the materials delivered as soon as possible".* Also, the interviewee A brought up the importance of fast availability, and told that there is not much value for secondary, "not so accurate", information, and that is why it is important that the right information is communicated as soon as possible: "*The most important thing about the received information is that there is one correct information at one time and to one place. There are development needs in the fast availability of the information, and also, in the fast responsiveness on the basis of that information*" (A).

5.3 Information systems

Regarding the order- and delivery processes in this research, the most significant information systems in the observed supply chain were ERP system and material delivery system. At the operator, the same ERP system is in use throughout the whole company. At SCM-team, ERP system is used for e.g. material ordering and inventory management. Project Managers are using the ERP system for doing material and work orders. Also, the logistics partner uses similar ERP system of their own, which enables the purchase orders to automatically transfer to the logistics partners' system.

All of the needed material information, supplier information and contracts with prices for materials are found in the ERP system. Interviewees in SCM-team (A, B) both told that most of the required information needed in daily operations is found on the computer, and for that, ERP system is an important source of all information. If additional information is needed, it is found from the logistics partner or constructor companies, depending on the information needed. Although, with a long experience in the SCM-team, there rarely is need for seeking information from many places (A, B).

When materials are delivered somewhere else than warehouse of the constructor, the address of the delivery place has to be described to the order in ERP system. Sometimes the delivery location is an intersection of streets somewhere not in the city area, or a factory area, for example. There is only one text row for an address in the ERP system, when order is made, and in these situations, the delivery location is difficult to explain in only few words. Project Managers (C, D) brought up, that there would be good to have some additional text box for additional address information in the ERP system, when material is delivered to this kind of places, where there is not a receiver waiting all the time (like at the constructor's warehouse there usually is).

Material delivery system is operator's web-based system for tracking material orders and deliveries. The system is in use at the operator, logistics partner, transportation companies and constructors, and it is an important tool for getting information about the deliveries. Constructors make a confirmation to the system, when they have received the material. Also, if they haven't received material in time, or material delivery hasn't been delivered correctly, they can send reclamation to the SCM-team and supplier through the material delivery system. Material delivery system was used by all of the interviewees. For Project Managers (C, D, G), the role of the system was smaller than for other supply chain

stakeholders, as they were only using the system for observing material delivery dates and delays in the deliveries.

In material delivery system, orders can be tracked by purchase order number, delivery code or other information, such as delivery date or material type. This searching feature is in use for the SCM-team employees (A, B), who are using an internal version of the material delivery system, which has more searching functions. Other stakeholders, who are using an external system version, have more limited view of the purchase orders. For example, each constructor company is able to see their own constructing sites and their material orders, and search the orders by their order number or delivery code.

Sometimes there is information missing from the material delivery system. According to the SCM-team (A, B), there was problems with shipping information in the material delivery system. Missing transportation tracking numbers and missing tracking information are problems because information has to be looked from somewhere else, even it should be available in the material delivery system, so for example, the recipient of the materials could follow the delivery. Interviewee A felt that missing or incorrect information in the material delivery system caused difficulties into daily work: "*Material delivery system should support the actions in the supply chain, but instead, it can cause more confusion"* (A).

In addition to non-functionality among the systems, the other named problem was inadequate use of the data, which in this case means that information is not filled properly by users. The most major named example of that was that delivery receipts were not filled to the material delivery system (A, B). Constructors make the receipt into the system at the time when they receive the material delivery, and information about the receipt is automatically transferred to the ERP systems' purchase order. When the logistics partner is sending invoice for materials, the purchase order has to match invoice, or else the invoice is blocked for manual handling. The delivery receipts have to be done before the invoice is paid, and therefore, if the receipt hasn't been made for material that has already arrived, SCM-team has to inquire after missing receipts.

One issue regarding material delivery system is information about changed delivery dates. If logistics partner cannot deliver materials on requested date, the new delivery date is corrected to the system. However, SCM-team and recipient of the materials (constructor) can only see the delayed delivery date if they view the order in material delivery system.

Therefore, unless constructor is checking the status from the material delivery system, they usually are not in any way informed about the delayed delivery. This regarded as a problem at the operator as well as constructors. Constructors must be able to schedule their activities, and for that, it is important to know when material arrives (F). As a solution for this problem, interviewees suggested that there could be automated message or report for these delayed delivery dates from the material delivery system (A, B, F).

The importance of information systems was found out to be major in daily work in the supply chain. All of the interviewees felt that information systems played a big role in daily operations. However, system functionality was not highly rated among the interviewees – many of them brought up, that systems were crashing on regular basis. Interviewee B from SCM-team told that "Information systems play a big role; there is nothing to do at work if the systems are not working … material delivery system is the biggest problem, because it crashes almost every week".

According to the interviewees, there have been system compatibility problems between ERP system and material delivery system. For example, a delivery receipt made by constructor doesn't transfer to the ERP system, as it should. After that, when delivery receipt is missing from the ERP system, invoice from the order doesn't go to payment. As a result of missing delivery receipts, information of delivered materials must be entered manually to the ERP system.

5.4 Communication methods

When operator is communicating with logistics partner or constructors, email is the most often used tool. Both SCM-team and logistics partners' telecom sales team has their own shared email accounts, where most of the order- and delivery questions as well as order reclamations are addressed to. In SCM-team, through that email, information is shared both internally, with Project Managers for example, and externally, with logistics partner and constructors. By using the shared email account, information is instantly available for processing by everyone on the team, and therefore, it is simpler to divide tasks between the team employees. (A) Shared email was experienced as a fast way to find out some questions regarding orders and materials (G).

Skype is used for communicating with audio calls, instant messages and online meetings. Especially in internal communication at the operator, Skype is used daily and it is an

important tool for keeping online meetings. Interviewee A from SCM-team told, that some quickly handled issues are communicated through Skype instant messages or phone calls, but when there are more than one recipients who to contact, email is more useful tool. Constructors are also using Skype for connecting with operator, but it is mostly used with keeping meetings, and not in daily communication, such as material ordering and delivery questions. Also, regular phone calls are used for communication, both in internal and external communication.

Operator has an online shared workspace for collaboration between constructors and other external parties, as well as internal collaboration at the operator. In logistics-related information, the workspace is used especially for instructions regarding material returns or material disassembly. Constructor is returning unnecessary or dismantled material back to operator, and for that, there is different instructions of the return policies. All of those instructions are found at the workspace, where both SCM-team and constructor has access to. Logistics partner does not use the workspace, but the instructions for returning their material is found in shared workspace as well. Still, even the principle has been that the latest versions of the instructions are found in the workspace, the right versions of the instructions have not been used. According to interviewee A, constructors have sometimes been using the old versions of the instructions, and as a result, there are multiple different instructions in use at the same time.

In the interviews, there was little face-to-face communication mentioned happening in the daily communication between supply chain stakeholders. Almost all of the communication was handled through electronic channels, such as email. Especially constructors were found out to be in contact with the operator mostly by email, phone and sometimes by skype meetings. Between SCM-team and logistics partner there was some face-to-face contact in form of meetings which were held especially when it was needed to discuss some development issues of the future. At the operator, some Project Managers and employees of SCM-team were meeting each other daily, so face-to-face communication was closer than with the other stakeholders. Between them, the communication was found out to be mostly irregular, and the interviewee A mentioned that “sometimes we drop by colleague’s desk to solve issues” and interviewee G mentioned that there was face-to-face communication between others, because of the open office, where people were sitting next to each other.

Lack of face-to-face communication was experienced as a weakness in terms of information flow. Project Manager (D) stated that “Nowadays we are faceless here … the constructors do not know who to contact from our company. We are not easily reachable”. There were more face-to-face meetings before, and people could see better who they were dealing with. (D)

5.5 Relationship characteristics

SCM-team has a weekly online meeting with the Sales Manager of logistics partner. It has appeared to be an important way to give feedback and check the current situation of the material availabilities. With constructors, there are different principles on how often there are meetings held. Some Project Managers are keeping regular online meetings with the constructors. SCM-team is having weekly meeting with each constructor company separately, and there are named contact persons from the constructors present at the meetings. The subjects of the meetings are e.g. to discuss the current situation of the material availability and deliveries and to give feedback to each other.

For purchased passive materials, the operator is not usually communicating with suppliers, because all of the orders go through the logistics partner. This is affecting the communication, as there are more steps to find out e.g. delivery information for material orders. However, in many cases, as the material is first purchased into the warehouse of the logistics partner, the deliveries are handled by logistics partner, and there is no need to contact the suppliers (assuming that the material is available in the warehouse of the logistics partner). Then again, when some cables and ducts are done as direct deliveries from the factories of the suppliers, there might be more delays of getting information about the delivery times, because logistics partner has to wait for the information from its’ suppliers.

From logistics partner point of view, advance information for material orders is an important factor in the operation. From the beginning of the cooperation with logistics partner, operator has done annual forecasts of material consumption. In years 2013-14 consumption was over the forecasted, and year 2015 even 30 percent over the forecasted amount. It is important for logistics partner to receive some advance information about material needs, because they have to be able to prepare for orders by informing their suppliers and reserving materials into their own warehouse. According to the Sales

Manager at the logistics partner (E), there seems to be internal problems with the material forecasting at the operator. The required information for forecasting is somewhere in the organization, but it is not utilized at the best way to form forecasts.

The consumption of passive materials is forecasted by Project Managers for the biggest projects (G). Regardless of specific forecasts of consumption from the Project Managers, sometimes the materials are not received from the logistics partner on time. The reason could be that operator has not given enough big forecasts to the logistics partner. (G) Poor forecasting results delays in project implementation, though delays in material deliveries have not been major issue with logistics partner, mainly with some other suppliers (C).

Most of the interviewees evaluated the information flow between stakeholders being at good level at the moment. SCM-team felt that information flow was on a good level inside own company and with logistics partner, but not as good with constructors. They felt that to some questions it was difficult to get answers from constructors. Even if all of the necessary information was shared to constructors, it felt that information was not applied to the use. In addition, sometimes information was staying in the management level and not reaching the field level, where it actually would have been most useful. (A)

6 DISCUSSION

To analyze information flow challenges, in this chapter, the discussion has been divided into same themes than when presenting the findings: information characters, communication methods and technology, and relationship characteristics. These three themes were found out to be the most significant in both this study and current literature of supply chain information flow. Therefore, it was useful to review these themes individually, and observe how the factors under those themes are affecting information flow in this study.

6.1 Information characteristics

Most of the network construction projects in this supply chain are demand-driven, which means that the projects are launched based on the customer orders. Every project is somewhat unique, which means that material consumption can be designed after the specific needs of the project. Therefore, the supply chain under observation is, as usually construction supply chains, make-to-order supply chain, where lead-times can be longer compared to the basic manufacturing supply chains. The problem of late material orders was brought up in the study, when interviewee D said, that there are few projects where material is ordered early enough, because the projects arrive so late for the Project Managers.

Because of the volatile material demand, it is important to be able to have forecasts of the materials to have them on time to the construction sites. The role of forecasting was emphasized by the interviewees, and especially by logistics partner. The rough amounts of the materials have to be able to be forecasted, because otherwise the delivery times of the materials would increase if the logistics partner cannot be prepared for the orders.

Both Childerhouse et al. (2003) and Goswami et al. (2013) have emphasized in their studies that lack of information leads to unnecessary costs and complicated decision making in the supply chain. It is not only the amount of the information that counts, but the availability of the relevant information, i.e. information visibility, that acts as an enabler for decision making in the supply chain (Goswami et al. 2013). The same requirement came up in the study, especially by the Sales Manager of the logistics partner (interviewee E), because from the logistics partners' point of view, the information of material amount forecasts was important information to have. Demand information has been identified as

an important subject to share between supply chain stakeholders, as it can lead to reduced inventory costs (Viswanathan et al 2007) and enhanced planning over the actions and material consumption between the partners (Kembro & Selviaridis 2015).

The characteristics of information in the supply chain have usually been associated to information quality, which was also identified as an important factor in the supply chain in this study. In the article of Li & Lin (2006), the role of information quality has been brought up as an important factor that together with information sharing enhances the relationships in the supply chain. Also, Wiengarten et al. (2010) have emphasized that information quality acts as an important performance driver, and information to be shared between supply chain partners should be of high quality. The importance of information quality has been associated to the high use of inter-organizational systems, because by using them, information is often automatically transferred and therefore the risk of weak information quality to affect performance is serious (Wiengarten et al. 2010). In this study, major amount of the information was found out to be shared through IOS and other electronic communication channels, and because of that, it is natural that the expectations for information quality was on a high level.

Regarding information quality, there are characteristics that in this study were found important regarding supply chain information: accuracy and fast availability. This finding seems similar to the study of Moberg et al. (2002), where information-related antecedents for information exchange were found out to be accuracy, timeliness and proper formatting of the information. The matter of fast availability of information is undoubtedly an important requirement for many areas of work, but especially, in a telecommunications company that is advanced in information technology. In addition, all of the interviewed Project Managers pointed out that network construction projects schedules are often already late when projects arrive on their tables, so it is natural that fast availability and fast transfer of information become crucial in order to get materials to the construction sites and projects progressing as quickly as possible.

Information delays and accuracy of information has been discovered important information quality factors also in the study of Hai et al. (2012), where it was stated that because of the large amount of information from varying members in the construction supply chain, managing information is difficult which leads to information errors and delays, and finally to conflicts and disputes between supply chain partners. Any conflicts were not mentioned in this supply chain per se, but it was noticed that some of the respondents were not

happy about how quickly they got answers to their questions from the other members in the supply chain. For example, interviewee A pointed out that information flow between SCM-team and constructors could be improved; sometimes there was no answers to the questions from constructors, or constructors were not filling the delivery receipts to material delivery system. Information error was not mentioned to be a challenge in the supply chain, even though it is an important factor of information quality, which was experienced as an improvement issue.

6.2 Information systems

All of the interviewees were emphasizing the role of information systems in the daily work. The most important systems for all of the interviewees were material delivery system and ERP system, except for constructor, who was not using the same ERP system. All of the interviewees from operator stated that the systems were crashing quite often, which created difficulties into daily work, because the systems were needed in almost every task. In the supply chain, there were problems experienced in both ERP system and material delivery system functionalities. Both systems had their own individual problems, but in addition, there were problems in the information transfer between the two systems.

The level of information systems usage found out to be high in the supply chain under observation, which created a situation where everyone was dependent on the systems. The level of information system usage has not been found out to be always enhancing factor for firm performance, and instead, the focus should be on internal knowledge and skill accumulation and administrative innovations (Kim et al. 2006). Therefore, the focus in enhancing information flow should also be in people and their activities, and the role of information technology to support relationships and the information flow between the supply chain partners.

As a result, it feels that ERP system supports the processes in the daily work, unless there are problems with network or other issues that leads to systems crashing. The most dissatisfied to the ERP system were Project Managers (C, D, G), who hoped that the system would be more flexible with the amount of information to be able to fill to the orders. The material delivery system, on the other hand, was in the worst case considered even complicating the daily work, because the users couldn't be sure if the information was found in the system or if it was correct. As interviewee B stated, *"There are problems*

with both non-functionality of the information systems and inadequate use of the data", and therefore, the problems were focused partly for technical issues and partly for users. As a technical problem, it was found out that information transfer from the ERP system was in some cases insufficient. In addition, the interviewees felt that data was filled inadequately to the system, which is a problem that has to be dealt among the users of the system.

Availability of the information in the systems was not experienced as a problem, and the interviewees felt that all of the required information is found in the systems. The long working experience at the operator could have influenced this finding, especially in SCM team, and for example interviewee B told that: *"All of the needed information is in the systems … there is no other information needed unless there are some problems. If additional information is needed, it is coming from own head, because I remember the materials from the experience".*

6.3 Communication methods

According to the division made by Carr and Kaynak (2007), the communication media used in the supply chain can be categorized into traditional and advanced communication media. When evaluating communication media effectiveness, it is important to evaluate also the richness of the media, as stated in media-richness theory. In MRT theory, there are differences between communication channels according to the effectiveness of the communication as well as capacity to convey messages and cues (Otondo et al. 2008). Therefore, the communication media used in the supply chain are divided into categories according to these criteria (Figure 7). In terms of affective information flow, it is noticeable to observe the communication tools in use, and to rate how those tools are supporting the actions in the supply chain.

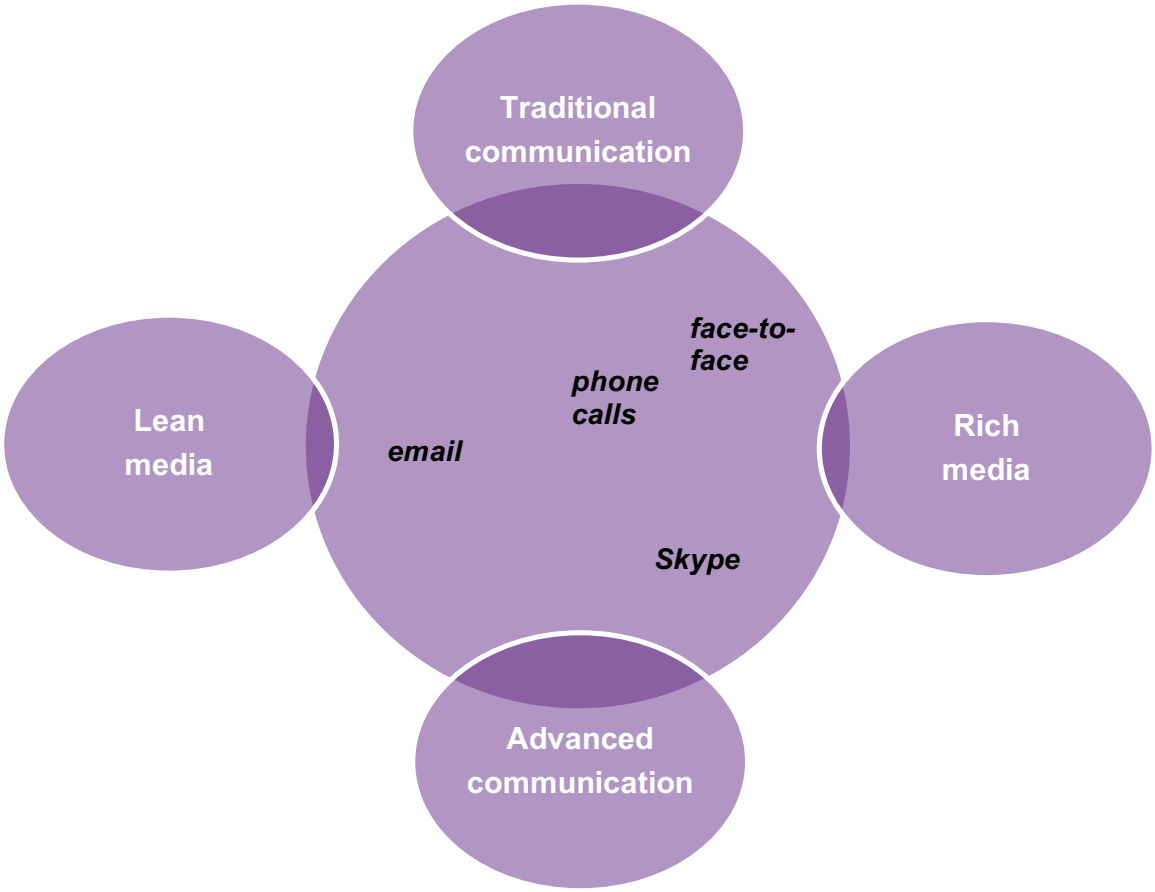

Figure 7. Communication methods in the supply chain.

Interviewee C told, that the used communication method in communication between operator and constructor was depending on the closeness of the relationship with the other person. Communication between Project Managers and SCM-team was found out to be quite regular, and happening mostly through email. Even though there was face-to-face communication present between some Project Managers and SCM-team employees, it was mostly informal meeting at the office, and solving occasional problems. Any scheduled meetings, however, were not mentioned to be held between Project Managers and SCM-team employees. This affected the knowledge of current regulations of with which information to order materials. Interviewee C told, that it would be beneficial if Project Managers would get feedback from the SCM-team, if there are continuous errors in material orders they enter to the system: “we might have learned some old ways to do

things, because it depends who have been teaching us when we came to this job … it would be nice to know where everything affects, when we fill the orders to the system".

Face-to-face communication was not mentioned to be frequent between supply chain stakeholders. Especially in inter-organizational relationships, i.e. operator-constructor- and operator-logistics partner –relationships, the amount of personal meeting between stakeholders was relatively rare. Even though different communication tools and especially electronic channels and information systems were experienced as important ways to communicate, it is often stated in previous studies that face-to-face communication convey trust (e.g. Otondo et al. 2008) and because of that it should not be underestimated (e.g. Petersen et al. 2005). Even between people working in the same building (interviewees A, C, D and G), the meetings were in most of the time held through Skype.

As it was found out in the study of Durugbo et al. (2014), using multiple communication channels for delivery information was recommendable. Also, they stated, that firms could improve their delivery documentation strategy by structuring delivery-related information in a way that is intuitive and user-friendly to customers or suppliers. (Durugbo et al. 2014, 645) The variety of different information channels was good, because there were specific needs for every way of communication between the stakeholders. Although, as mentioned before, the frequency of face-to-face communication, which is the most "rich" way to communicate, was too low.

6.4 Relationship characteristics

There is a found conflict in the level of information to be shared in the supply chain, because at the same time companies are eager to share information with supply-channel partners in order to have operating efficiencies, but at the same time, every partner wants to maintain some information asymmetry to manage other partners' behavior (Kim et al. 2006). This was also mentioned in the interviews, and interviewee A stated that some people knowingly doesn't share information to each other. With this lack of trust in supply chain partners, there is a risk of creating a situation, where stakeholders only share the most "necessary" information to each other and therefore, doesn't maintain enough close relationships to each other.

It is found in the study of Li & Lin (2006), that information sharing is impacted positively by trust in supply chain partners and shared vision between supply chain partners. Similar findings were established in this study, because trust was seen as an important factor regarding information flow in the supply chain. On the other hand, in the study of Li & Lin (2006), it was found, that top management support was positively impacting information sharing, and this was not established in this study. The importance of trust has also been brought up in the conclusions of the study by Petersen et al. (2005), where it was found out that the degree of trust between buyer and suppliers enhances collaborative planning and in that way, improves supply chain and firm performance. Interviewee A emphasized the role of trust by noticing the importance of keeping promises to other stakeholders: *"The key to affective operator-constructor –collaboration is keeping promises to each other, and that is one factor that should be developed and improved in this relationship."* (A)

Construction supply chains have been widely characterized as a temporary or short-term supply chains (Hai et al. 2012; Titus & Bröchner 2005), but on the contrary from that, on this study the stakeholders in the supply chain were quite permanent. The relationships were more of long-term partnerships, which affected the nature of the cooperation. According to Hai et al. (2012), partnering has been identified as a successful procurement strategy to handle the challenges faced in the construction supply chain, such as problems caused from make-to-order and short-term supply chain. According to Titus and Bröchner (2005), construction supply chain usually has multiple participants, making the supply chain more complex and complicating information sharing. In manufacturing supply chain, it is typical that there are components that are purchased from a supplier, and then a company manufactures the product which is further distributed to the customer. However, the construction supply chain has a constructor, which makes the installation work, so all of the material is delivered to them. Therefore, the project design and installation is not made in the same company.

Overall, supply chain relationships were found to be on a good level, reflecting the fact that relations in the supply chain were quite tight. Especially with operator and logistics partner, the relationship was stated to be on a good level, which was probably due to that there were only few people to communicate with, and there was sometimes face-to-face communication between them. It is easier to create a tight relationship, when people know each other, when communicating regularly with each other. As interviewee E stated,

"*operator has understanding of what information is important to tell us, and on the other hand, we also have an understanding of what to tell operator*", so information asymmetry didn't seem to be an issue between operator and logistics partner. As the cooperation between operator and logistics partner started in 2013, there has only been few years of working together, during which the practices have been defined and redefined together (E). Therefore, in the beginning of the relationships, there presumably has been special attention to create a close relationship with each other.

On the other hand, the relationship between operator and constructor companies was more complex compared to the logistics partner. There were multiple different constructor companies in many different locations in Finland, and therefore, there were so many different people to communicate with that naturally the information flow became more difficult and it was more difficult to maintain close relationships. What seemed to be the main problem in the opinion of constructor, there has not been enough information of delayed material deliveries. As stated by interviewee F, notifications of the delays could be something to be improved: *"I just had an example of this, we didn't get any information that there were material delivery problems. The delivery date had been moved further without any notice. It was only seen from the material delivery system. It would be beneficial that we would get information about the status of the materials about where they are going."* The same issue was noticed at the operator though, where interviewee G stated that the person who ordered materials should have an automated notification of the material delays.

As it was mentioned regarding information systems, there was a problem in the supply chain, that information was filled out inadequately or incorrectly into the information systems. The problem with this is, that different stakeholders has somehow learned different ways to do things, and there is lack of knowledge of the correct ways to fill out information. This problem occurred in both internal and external supply chain relationships of the operator. As the interviewee C argued, it is not always clear what is the current way to mark order information in ERP system. By understanding where everything affects when filling the information in ERP system, it would help to understand what would be the most sensible way to do things. Having some common instructions or training sessions would help with this problem, and in the future, the information would be more coherent throughout the whole supply chain.

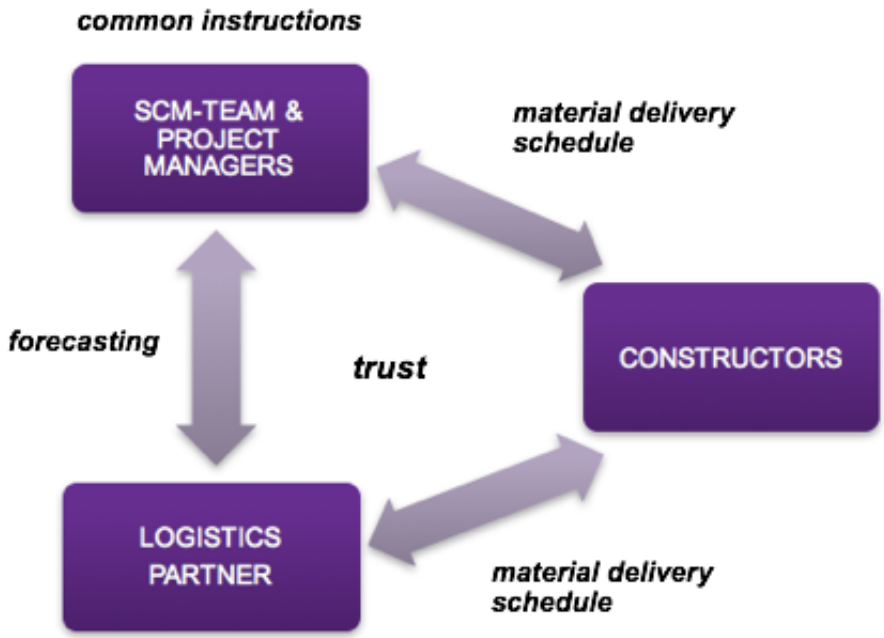

Figure 8. Relationship characteristics in the supply chain.

7 SUMMARY AND CONCLUSIONS

In this thesis, the objective was to find out the main challenges regarding information flow in the supply chain context. The case company was a telecommunications company and the supply chain under analysis consisted of fixed network construction passive materials, which included materials such as cables, ducts, cabinets, fiber optics and copper wires. The most important stakeholders of the supply chain were SCM-team and Project Managers at the case company, and logistics partner and constructors. The objective of the study was to identify the main information flow challenges of the supply chain, and to evaluate, from where these challenges originated from.

Finally, after the analysis of the theory and empirical research, it is possible to answer to the research questions. First, two sub-questions of the research are answered, and after that, the main research question. The first sub-question was: *"What kind of information is going through the supply chain stakeholders, and by which channels is the information being transferred?".* In the interviews, there were questions about how is the order- and delivery processes functioning in the supply chain under investigation. As a result, according to the interviews, it was possible to visualize those processes (Figure 5, Figure 6). At the processes it is seen, which are the stakeholders, information characteristics and channels in the supply chain.

The second sub-question was: "*How are the existing information systems and communication methods supporting information flow between stakeholders?*". According to the interviews, there were challenges with the current information systems, and in the worst case, sometimes the system difficulties made information flow more challenging than it would have been without the systems. Dependence of the systems has led to the situation, where at the time of system breaks, almost nothing can be done. Other communication methods, such as email and phone calls, as well as face-to-face communication were appreciated by the interviewees, and the traditional communication channels were experienced beneficial for information flow.

The main research question was: *"What are the main challenges regarding information flow in the supply chain of fixed network construction projects?"* Regarding supply chain information, a main challenge was information quality, which was in this study characterized as fast availability and accuracy of the information. Also, the availability of

relevant demand information to create accurate forecasts was experienced as a challenge especially by logistics partner.

There were two main factors regarding information systems, which were causing problems in information flow between stakeholders: information system non-functionality and inadequate use of data. ERP system was, for the most parts, experienced as a supportive and necessary channel for daily work, but the problem was, that it was collapsing quite often, and therefore complicated daily work. Also, interviewees felt that the system was not flexible enough to fill enough order delivery information.

The material delivery system, on the other hand, found out to be one major problem in information flow between stakeholders, because it had both technical problems, such as information transfer from ERP system and other sources, and the information found in the system was not trusted to be correct or sufficient. Lack of face-to-face communication found out to be the main problem regarding communication methods in the supply chain, although the variety of communication tools and information systems was sufficient to be able to support the information flow in the supply chain.

Supply chain relationship problems were caused by the nature of construction supply chain, where supply chain is complex because of multiple participants in the supply chain. Due to the complex relationships, lack of trust was experienced as an issue to affect information flow in the supply chain. In addition, both constructors and Project Managers stated that material delay information was insufficient in the supply chain.

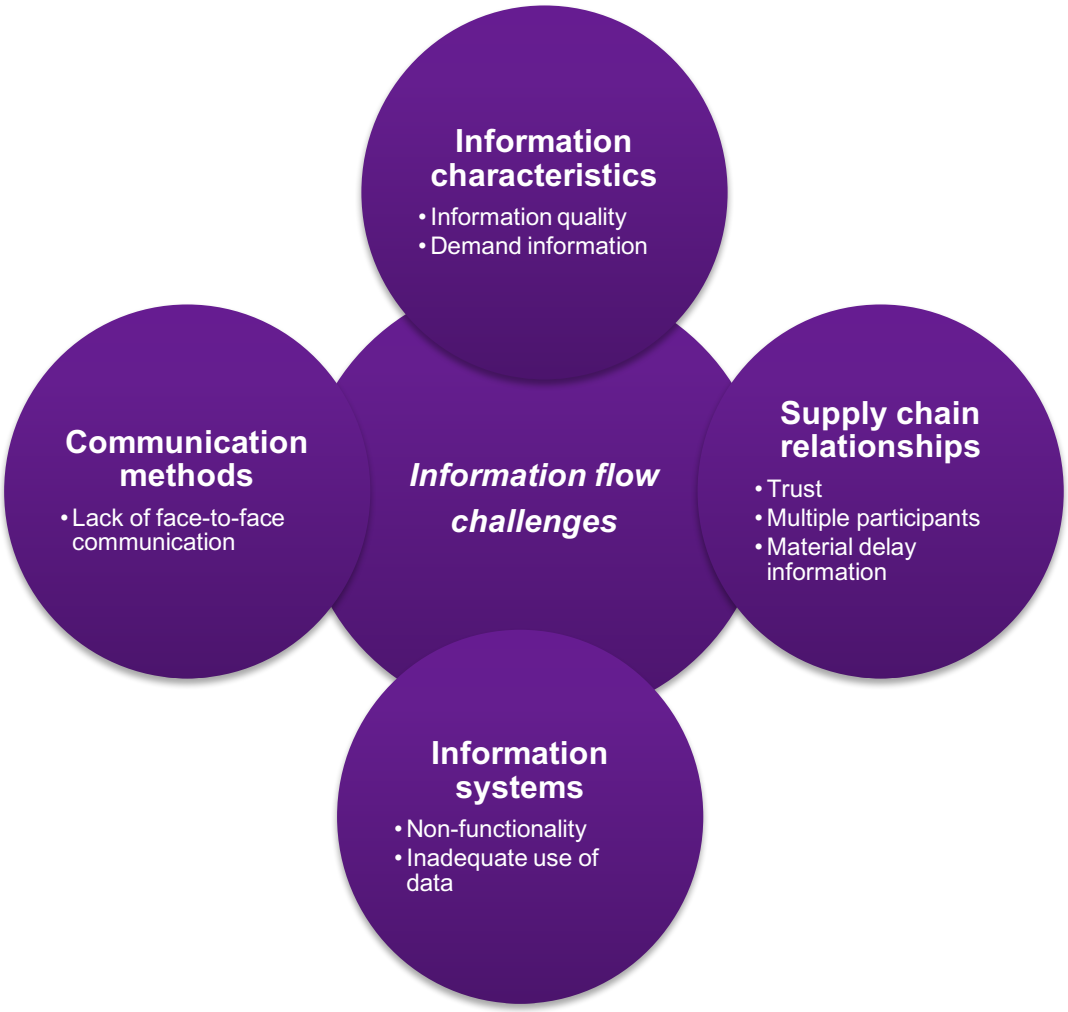

Figure 9. Summary of the results.

Although the research sample was covering different stakeholders, and therefore, different opinions between the respondents were discovered, the total number of the respondents could have been bigger to ensure more variety for the interview data. However, usually the main purpose of the case study research is to become familiar with one specific case thoroughly, and not necessarily to have a wide research sample with dozens of respondents.

It was found out both in theory and interviews, that to some extent, companies want to maintain some information asymmetry between trading partners in order to be careful not to share too much information with each other. At the same time, also a close relationship

is beneficial for having an effective supply chain processes. Therefore, in inter-organizational supply chain there is always balance to be maintained between having a relationship with trust and high level of information to shared, and with being careful of what information is shared to the trading partner. This balance would be an interesting topic for future research, as well as to finding out what problems can follow from sharing too little information with trading partners. As mentioned in this thesis, lack of trust meant that information was not shared easily, but it would be interesting to investigate, if it also means that lack of trust is an issue that follows from limited information sharing in the supply chain. Also, there still is a question remaining of what does it mean for the supply chain if there is lack of trust between trading partners.

All in all, in this thesis there was multiple information flow challenges found out under the themes of information characters, information technology, communication methods as well as supply chain relationships. By investigating each theme, several information flow challenges emerged, and it was possible to form an understanding of the problems present in the case supply chain. In this thesis, each theme was somewhat apart from each other and analyzed individually. However, to go even further with this study, a more comprehensive analysis could be done of the correlations between these different themes. This analysis could show, if there is a trend between what factors emerge from each theme, and in addition, if the factors under each theme correlate to each other.

REFERENCES

Ala-Risku, T., & Kärkkäinen, M. (2006). Material delivery problems in construction projects: A possible solution. International Journal of Production Economics, 104(1), 19-29.

Boisot, M., & Canals, A. (2004). Data, information and knowledge: Have we got it right? Journal of Evolutionary Economics, 14(1), 43-67.

Bowersox, D.J. and Closs, D.J. (1996), Logistical Management: The Integrated Supply Chain Process, McGraw-Hill, London.

Brinkmann, S. (2013). Qualitative interviewing. Oxford University Press.

Carr, A. S., & Kaynak, H. (2007). Communication methods, information sharing, supplier development and performance: an empirical study of their relationships. International Journal of Operations & Production Management, 27(4), 346-370.

Cheng, J. H. (2011). Inter-organizational relationships and information sharing in supply chains. International Journal of Information Management, 31(4), 374-384.

Childerhouse, P., Lewis, J., Naim, M., & Towill, D. R. (2003). Re-engineering a construction supply chain: A material flow control approach. Supply Chain Management, 8(3), 395-406.

Choe, J. M. (2008). Inter-organizational relationships and the flow of information through value chains. Information & Management, 45(7), 444-450.

Davis, T. (1993). Effective supply chain management. Sloan Management Review, 34(4), 35.

Demiris, G., Washington, K., Oliver, D.P. & Wittenberg-Lyles, E. (2008). A study of information flow in hospice interdisciplinary team meetings. Journal of Interprofessional Care, Vol. 22, No. 6, pp. 621-629.

De Treville, S., Shapiro, R.D. & Hameri, A. (2004). From supply chain to demand chain: the role of lead time reduction in improving demand chain performance. Journal of Operations Management, Vol. 21 No. 6, pp. 613-27.

Durugbo, C., Tiwari, A., & Alcock, J. R. (2014). Managing integrated information flow for delivery reliability. Industrial Management & Data Systems, 114(4), 628-651.

Eisenhardt, K. M. (1989). Building theories from case study research. Academy of management review, 14(4), 532-550.

Fiala, P. (2005). Information sharing in supply chains. Omega, 33(5), 419-423.

Forrester, J.W. (1958). Industrial dynamics: A Major Breakthrough for Decision Makers. Harvard Business Review, Vol. 36 VAI 38, pp. 37–66.

Goswami, S., Engel, T., & Krcmar, H. (2013). A comparative analysis of information visibility in two supply chain management information systems. Journal of Enterprise Information Management, 26(3), 276-294.

Hai, T. K., Aminah, M. Y., Syuhaida, I., & Wei, L. F. (2012). Reviewing the construction supply chain challenges and construction supply chain management strategic management. *International Journal of Civil Engineering and Structures*, *1*(1).

Hill, C. A., & Scudder, G. D. (2002). The use of electronic data interchange for supply chain coordination in the food industry. Journal of Operations Management, 20(4), 375-387.

Hirsjärvi, S. & Hurme, H. (2015). Tutkimushaastattelu: Teemahaastattelun teoria ja käytäntö. Gaudeamus Helsinki University Press.

Hsu, C., Kannan, V. R., Tan, K., & Leong, G. K. (2008). Information sharing, buyer-supplier relationships, and firm performance. International Journal of Physical Distribution & Logistics Management, 38(4), 296-310.

Inkinen, T., Tapaninen, U., & Pulli, H. (2009). Electronic information transfer in a transport chain. Industrial Management & Data Systems, 109(6), 809-824.

Kaipia, R. (2009). Coordinating material and information flows with supply chain planning. The International Journal of Logistics Management, Vol. 20 Iss 1 pp. 144 - 162.

Kauremaa, J., & Tanskanen, K. (2016). Designing interorganizational information systems for supply chain integration: a framework. The International Journal of Logistics Management, 27(1), 71-94.

Kembro, J., & Näslund, D. (2014). Information sharing in supply chains, myth or reality? A critical analysis of empirical literature. International Journal of Physical Distribution & Logistics Management, 44(3), 179-200.

Kembro, J., & Selviaridis, K. (2015). Exploring information sharing in the extended supply chain: An interdependence perspective. Supply Chain Management, 20(4), 455-470.

Kim, K. K., Umanath, N. S., & Kim, B. H. (2006). An assessment of electronic information transfer in B2B supply-channel relationships. Journal of Management Information Systems, 22(3), 293-320.

Kim, K. K., Park, S. H., Ryoo, S. Y., & Park, S. K. (2010). Inter-organizational cooperation in buyer–supplier relationships: Both perspectives. Journal of Business Research, 63(8), 863-869.

Kyu Min, H., & Sang Jun, L. (2016). How Does Electronic Data Interchange (EDI) affect the Competitiveness of a Firm's Supply Chain Management?. Journal Of Marketing Thought, 3(2), 13-18.

Kvale, S. (1996). InterViews. An introduction to qualitative research interviewing. London: Sage.

Laine, M., Bamberg, J. & Jokinen, P. (2015). Tapaustutkimuksen taito.

Lapan, S. D., Quartaroli, M. T. & Riemer F.J. (2012). Qualitative Research: An Introduction to Methods and Designs.

Lee, H. L., & Billington, C. (1993). Material management in decentralized supply chains. Operations Research, 41(5), 835.

Leek, S., Turnbull, P. W., & Naude, P. (2003). How is information technology affecting business relationships? Results from a UK survey. Industrial marketing management, 32(2), 119-126.

Li, S., & Lin, B. (2006). Accessing information sharing and information quality in supply chain management. Decision support systems, 42(3), 1641-1656.

Li, C. (2013). Controlling the bullwhip effect in a supply chain system with constrained information flows Vol. 37, Iss. 4, 15 February 2013, p. 1897–1909.

Lin, Y., Ma, S., & Zhou, L. (2012). Manufacturing strategies for time based competitive advantages. *Industrial Management & Data Systems*, *112*(5), 729-747.

Madenas, N., Tiwari, A., Turner, C.J. & Woodward, J. (2014). Information flow in supply chain management: A review across the product lifecycle. CIRP Journal of Manufacturing Science and Technology, vol. 7, no. 4, pp. 335-346.

Mena, C., Humphries, A. & Wilding, R. (2009). A comparison of inter- and intra-organizational relationships. International Journal of Physical Distribution & Logistics Management, Vol. 39 Iss 9 pp. 762 – 784.

Moberg, C. R., Cutler, B. D., Gross, A., & Speh, T. W. (2002). Identifying antecedents of information exchange within supply chains. International Journal of Physical Distribution & Logistics Management, 32(9), 755-770.

Otondo, R. F., Van Scotter, J. R., Allen, D. G., & Palvia, P. (2008). The complexity of richness: Media, message, and communication outcomes. Information & Management, 45(1), 21-30.

Petersen, K. J., Ragatz, G. L., & Monczka, R. M. (2005). An examination of collaborative planning effectiveness and supply chain performance. *Journal of Supply Chain Management*, *41*(2), 14-25.

Sanders, J. (2016). Defining terms: Data, information and knowledge. In SAI Computing Conference (SAI), 2016 (pp. 223-228). IEEE.

Stavrulaki, E., & Davis, M. (2010). Aligning products with supply chain processes and strategy. International Journal of Logistics Management, 21(1), 127-151.

Titus, S., & Bröchner, J. (2005). Managing information flow in construction supply chains. Construction Innovation, 5(2), 71-82.

Viswanathan, S., Widiarta, H. & Piplani, R. (2007). Value of information exchange and synchronization in a multi-tier supply chain. International Journal of Production Research, 45(21), pp.5057–5074.

Vrijhoef R. & Koskela L. (1999). Roles of supply chain management in construction. Proceedings IGLC-7, 26-28 July 1999, 133-146.

Vrijhoef, R. & Koskela, L. (2000). The four roles of supply chain management in construction. European Journal of Purchasing and Supply Management, 3(4): 169-178.

Vrijhoef, R., Koskela, L. J., & Howell, G. (2001). Understanding construction supply chains: an alternative interpretation. In Proceedings of 9th International Group for Lean Construction Conference, 185-199.

Wang, G. & Das, A. (2001). Models and protocol structures for software agent based complex e-commerce transactions. Lecture Notes in Computer Science, Vol. 215, pp. 121-131.

Wiengarten, F., Humphreys, P., Cao, G., Fynes, B., & McKittrick, A. (2010). Collaborative supply chain practices and performance: exploring the key role of information quality. *Supply Chain Management: An International Journal*, *15*(6), 463-473.

Wognum, P. M., Fisscher, O. A., & Weenink, S. A. (2002). Balanced relationships: management of client–supplier relationships in product development. Technovation, 22(6), 341-351.

Yin, R. K. (2009). Case study research: Design and methods (4th Ed.). Thousand Oaks, CA: Sage.

Zhang, X., Van Donk, D. P. & Van der Vaart, T. (2016). The different impact of inter-organizational and intra-organizational ICT on supply chain performance. International Journal of Operations & Production Management, Vol. 36 Iss 7 pp. 803 – 824.

APPENDICES

APPENDIX 1. Interview questions.

1) TAUSTATIEDOT

- Nimi, yritys ja titteli
- Aiempi työkokemus muissa ja nykyisessä yrityksessä
- Nykyinen työtehtävä ja työtehtävien kuvaus

2) TILAUS- JA TOIMITUSPROSESSI

Miten laajakaistan rakentamisen passiivimateriaalien tilaus- ja toimitusprosessi etenee?

- Keitä siihen osallistuu missäkin vaiheessa?
- Mitä tietoa tilauksiin liittyy?
- Mitä tietoa toimituksiin liittyy?
- Mitä kautta mikäkin tieto siirtyy?

3) TIEDON SISÄLTÖ TOIMITUSKETJUSSA

Mitä tilaus- ja toimitustietoa tarvitset työssäsi päivittäin?

- Missä muodossa tieto on?
- Mistä tai keneltä tieto löytyy?
- Joutuuko tietoa etsimään monesta eri paikasta?
- Onko tieto helposti saatavilla ja hyödynnettävissä?

Mitä tietoa jaat muille työssäsi?

- Missä muodossa tieto on?
- Minne tai kenelle tietoa jaetaan?
- Jaetaanko tietoa eniten oman yrityksen sisällä vai ulkopuolelle?
- Kenen työskentelyyn jaettava tieto vaikuttaa?

4) TIEDONKULKU JA TIEDON LAATU

Keiden sidosryhmien (SCM-tiimi, projektipäälliköt, logistiikkakumppani, urakoitsija) kanssa olet päivittäin tai lähes päivittäin tekemisissä?

Millaiseksi arvioisit tiedonkulun sidosryhmien välillä tällä hetkellä?

Mikä on tärkein vaatimus saamallesi tiedolle: tiedon oikeellisuus, nopea saatavuus, ajantasaisuus vai riittävä määrä?

- Miksi? Missä näistä olisi vielä eniten parannettavaa?

Miten tiedonkulkua on ohjattu ja kehitetty päivittäisessä työnteossa?

Millaiseksi arvioisit tiedon laatua tilaus-toimitusketjussa?

Mitkä ovat suurimmat ongelmat tiedonkulussa ja missä nuo ongelmat ilmenevät?

- Onko kommunikoinnin puutteeseen liittyviä ongelmia?
- Onko ongelmia liittyen ristiriitaisiin toimintatapoihin?
- Onko muita tiedonkulun ongelmia?

Mikä sen sijaan toimii hyvin tiedonkulkuun liittyen tällä hetkellä?

5) TIETOJÄRJESTELMÄT JA MUUT TIEDONKULUN KANAVAT

Mitä järjestelmiä ja ohjelmia käytät työssäsi päivittäin tai lähes päivittäin?

Millainen on tietojärjestelmien ja muiden ohjelmien rooli työssäsi?

- Missä asioissa ne tukevat tiedonkulkua sidosryhmien välillä?
- Milloin ne eivät tue tiedonkulkua sidosryhmien välillä?
- Mitä ongelmia niiden käytössä on ilmennyt?

Minkälaisia välineitä tai ohjelmia käytät kommunikointiin?

- Miten kommunikoit oman yrityksen sisällä?
- Miten kommunikoit oman yrityksen ulkopuolelle?
- Poikkeavatko kommunikointitavat käsiteltävästä asiasta riippuen?

Minkälaisia ongelmia olet kohdannut järjestelmien ja ohjelmien käytössä?

6) KEHITYSIDEAT JA TULEVAISUUS

Mitä tilaus ja toimitusprosessiin liittyen pitäisi parantaa, jotta työn tekeminen sujuisi helpommin?

Mitä muutoksia nykyiseen tilaus- ja toimitusprosessiin on odotettavissa seuraavien 5-10 vuoden sisällä?

Millaisia muutoksia on odotettavissa nykyisiin toimintatapoihin liittyen?