Digitalization & Transactional Information Flow Analysis of a Pulp Supply Chain

Case Anonymous Finnish Forest Industry Enterprise

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Abstract

The research objective was to analyze the transactional information flow in the assignor's supply chain and to investigate the risks and benefits involved in shifting from manual processes to a digitalized supply chain. The research scope was on integrations with the logistics partners. The assignor was a Finnish raw material supplier operating in the forest industry.

The theoretical basis provides the theory necessary for understanding the research topic and the used research methods. The theoretical basis begins by defining the used data collection methods.The theory continues by explaining the terms supply chain, supply chain management and logistics and the roles of information technology and information flow coordination in them. The theory proceeds to digitalization and finally to theory about blockchains.

The research was executed as a qualitative case study. The primary research method was participative observation which concluded with a current state analysis of the assignor's supply chain transactional information flow processes. Actual textual description was accompanied by corresponding process charts.

The research results were verified through triangulation by reflecting the author's observations against the executed excursions, conversations and related meetings and seminars on digitalization and supply chain development. In addition, other research and data acquired by other specialist was used. During the actual research process, various issues and barriers for information flow were solved. The study concluded with a risk analysis of supply chain digitalization as well as with development recommendations for the digitalization process and the assignor's supply chain .

Keywords/tags (subjects)
Supply chain management, logistics partner, information flow, digitalization, blockchain

Miscellaneous (Confidential information)
Appendix 1-9 are confidential and have been removed from the public version. Chapter 5 is confidential and have been removed from the public version. Other confidential information, including figures have been censored from the public version.

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Tiivistelmä

Tutkimuksen tarkoituksena oli analysoida transaktionaalisen informaation kulkua toimeksiantajan toimitusketjussa ja tutkia toimitusketjun manuaalisten prosessien digitalisoimiseen liittyviä riskejä ja hyötyjä. Tutkimus keskittyi erityisesti integraatioihin logistiikka partnereiden kanssa. Toimeksiantaja on Suomalainen raaka-ainetuottaja, jonka toimiala on metsäteollisuus.

Opinnäytetyön teoreettinen perusta antaa välttämättömät valmiudet ymmärtää tutkimuksen aihe ja siinä käytetyt tutkimusmenetelmät. Teoreettinen perusta määrittelee ensin käytetyt tiedonhankintamenetelmät. Teoria jatkaa määrittelemällä termit toimitusketju, toimitusketjun johtaminen ja logistiikka, sekä määrittelemällä informaatiotekniikan ja informaatiovirran koordinoinnin merkityksen edellisille. Teoria siirtyy tästä digitalisaatioon ja lopulta lohkoketjuteknologiaan.

Tutkimus toteutettiin kvalitatiivisena tapaustutkimuksena. Ensisijaisena tutkimusmenetelmänä käytettiin osallistuvaa havainnointia, joka johti nykytila-analyysiin toimeksiantajan toimitusketjun prosesseista. Varsinaista kirjallista kuvausta tukevat kuhunkin prosessiin liittyvät prosessitaulukot.

Tutkimuksen tuloksia vahvistettiin triangulaatiolla, joka toteutettiin peilaamalla omia havaintoja digitalisaatio- ja toimitusketjun kehitys -aiheisiin ekskursioihin, keskusteluihin, tapaamisiin ja seminaareihin. Tarkoitukseen käytettiin myös muita tutkimuksia ja toisten asiantuntijoiden hankkimaa tietoa. Tutkimuksen aikana ratkaistiin useita toimitusketjun tiedonkulun ongelmia ja esteitä. Tutkimus johti toimitusketjun digitalisaatioon liittyvään riskianalyysiin ja toimeksiantajan digitalisaatioprosessiin liittyviin kehitysehdotuksiin.

Avainsanat (asiasanat)
toimitusketjun johtaminen, logistiikka partneri, informaation kulku, digitalisaatio, lohkoketju

Muut tiedot ***Liitteet 1-9 ovat salassa pidettäviä, ja ne poistetaan julkisesta työstä. Kappale 5 on salassa pidettävä ja se on poistettu julkisesta työstä. Muu salassa-pidettävä informaatio on sensuroitu julkisesta versiosta. Salassapidon peruste Julkisuuslain 621/1999 24§, kohta 17, yrityksen liike- tai ammattisalaisuus. Salassapitoaika viisi (5) vuotta, salassapito päättyy 1.2.2024.***

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1 Introduction

The study begins with an introduction, the objective of which is to give a brief insight into the forest industry and supply chain digitalization. The introduction is followed by the research basis defining the research and limiting the research problem.

1.1 Digitalized Supply Chain is the New Black

Corporations based in the first world are playing a game of deathmatch where the choice is to either change with the changing world and consuming habits or slowly pass away. The desire and pressure to develop sales and marketing processes in order to match the age of e-commerce has been conspicuous in the public conversation. The well-informed part of the public knows the stories of industries and global corporations that rejected the change and lost a prominent part of their turnover or even went bankrupt. Tales of the winners and more flexible, early adopters are as well known. In 2018 even the most stubborn, old fashioned industries have realized the exigency to change.

What has received less public attention are the forces responsible for bringing the products to our shops and post boxes: logistics and supply chain managent, terms that are still unfamiliar to most of the public. Globalization has made the world one big market, and digitalization has made it possible for any company to deliver any product anywhere on the globe, and the final customer is able to follow up the process in real-time. These two megatrends have made the competition between enterprices into competition between supply chains. Digital processes are already in use at some level within all globally operating supply chains. The problem is that those painfully implemented “cut and glue together” IT-systems are already becoming obsolete and not capable of handling the enormous amount of information transferred and processed within the supply chain. Furthermore, the multitude of promising but still developing information technologies do not make the objective any easier. It is hard to even keep abreast with all the hyped new technologies and their possiblities.

Early adopters have considered the risk worth taking and started developing technologies either with succesful or fatal outcomes. On the other hand, some less adventurous and conservative adopters have opportunistically preyed for the technologies first tested in practice and been able to choose an already mature, safe option.

The Finnish forest industry, and especially the pulp industry, have been pictured as one of the most conservative industries holding back, watching and slowly reacting to change. This is not entirely true. During the last few years, the pulp industry has faced a turning point and reformed completely. The demand of printing paper has significantly decreased, but pulp, as its fundamental component, has been found again as a component of multiple new products and solutions. This has transformed each pulp bale from a nameless unit into an ecological and unique product, able to be customized for many purposes.

Meanwhile, as digitalization has completely changed the forest industry for good, it has also made it possible to deliver very detailed information not only about the product but also with the product. Logistics and supply chain management have already gone through some reforms through digitalization. However, it is still far away from reaching its full potential regarding information flow in the supply chain.

With the development of pulp into a globally interesting product due to the present megatrends, the interest in an even more streamlined pulp supply chain has also arisen. Digitalization plays the part of the conductor in this process of increased efficiency and responsiveness.

1.2 Finland Literally Lives of the Forest

The Finnish forest industry started to develop during the last decades of the nineteenth century. Mechanized sawmilling had paved the road by harnessing the rapids for an industrial revolution in the rural northern wilderness. Sawmilling was shortly accompanied by inventions to process the leftover wood refuse not suitable for shaping planks. The processes of groundwood and sulfite pulping were adopted and applied to utilize some of the enormous forest resource covering most of the area that later formed an independent country. Industrial plants and mills were built in suitable locations mostly with foreign capital. Infrastructure advanced beside the industry, and poor peasants seeking stable income found it in the industrial communities next to the mills in their search for a better life. The evolution of machinery, chemicals, logistics and research created a cluster to support the needs of forest industry. The whole nation benefitted from this because in less than 150 years a poor rural country turned into an export driven economy with one of the highest standards of living in the world. (Diesen 2007, 19)

Forest industry, consisting of pulp, paper and mechanical wood working, is still one of the cornerstones of the Finnish economy. However, the global macrotrends of the late 2000 and the monetary crisis of 2008 crushed the export volumes and led the industry to a decade of decrease and stagnation. Outsourcing of production to lower cost countries and decreasing consumption of paper led the public conversation refer to “the death of the Finnish forest industry”. The conventional industry whose personnel was constantly on strike was seen by generation X as something ancient and unattractive. However, after a couple of hard years of trimming the production and expenses the winds began to change. Trends in demand and consumption suddenly began to rise, and they are still rising. Ironically, the rise is driven by the very same phenomena that were said to kill the entire industry only a decade ago, namely digitalization and globalization. Aided by the increasing demand for biodegradable consumer packaging, the global macrotrends are again favoring the Finnish forest industry. In 2017, the value of pulp exported from Finland was 2 billion euros. In 2018, the forest industry is still responsible for 20% of the value of the nation’s export. (Metsäteollisuus Ry 2018, Tilastoja). Moreover, the strong upward trend seems to continue (Berg & Lingvist 2017).

1.3 Pulp Production in Finland

Although some of the subjects dealt with in this thesis can be considered general, the focus is on one of the Finnish forest industry´s main products: pulp. Pulp, or sometimes referred to as cellulose, is a chemically, mechanically or with a combination of both ways produced fibrous material that can be made by segregating fibers from peeled wood, wood chips, waste pulp bales or waste paper. Most of the pulp made in Finland is chemical or semi-chemical pulp, which is made by cooking. By cooking, the lignin binding the wood fibers together is removed (Ahtiainen 2010).

After cooking, pulp is normally bleached to improve its brightness and cleanliness. Pulp production is a complex chemical-mechanical process that requires a large, capital-intensive infrastructure. In order to be transported long distances, pulp mass must be first dried and pressed into sheets, which piled and tied together form pulp bale units. Pulp that is sold and transported outside the production plant and not consumed by an integrated paper mill is referred to as market pulp. (Ahtiainen 2010)

Pulp is baled to different types of bale units depending of the need of the client. Several forest industry companies in Finland produce market pulp in various pulp mills in different parts of the country. Crudely, pulp types are divided into hardwood pulps and softwood pulps. Most of the pulp made in Finland is bleached softwood or bleached hardwood pulp.

Softwood and hardwood pulps have different fiber properties and serve different kinds of purposes. Northern softwood and hardwood pulp both influence the strength and optical properties of the final product. There is some variation in the methods and processes used by different pulp mills, which tends to affect the properties of the product. Usually, the used bleaching method (ECF/TCF), trademark and the used raw material are labeled on each pulp bale unit. Other important pulp quality properties include brightness, impurity level and fiber length. Different final products require different quality and properties from the pulp used. The hardwood and softwood pulp trademarks produced in Finland are referred as NBHK and NBSK. (Knowpulp Portal 2015)

- Northern Bleached Hardwood Kraft Pulp (NBHK)
- Northern Bleached Softwood Kraft Pulp (NBSK)

Most of the Finnish pulp production is consumed inside the country by paper and cardboard mills. The pulp sold outside the country is first transported to a port to be exported via a vessel if not loaded directly into a truck trailer heading for Northern or Central Europe, the Baltic countries or western Russia. In the port, pulp is either loaded into a lo-lo break-bulk vessel or first containerized and loaded onto a container-vessel.

Pulp bales still face from one to several value adding stages by the consumer. Mostly, it is used as an ingredient of paper, tissue or cardboard. Until the recent years, the global pulp production was also decreasing with the weakened printing paper demand struck by digitalization and other megatrends disfavoring the use of paper and forest products. However, the variety of different uses for pulp is ever widening as the global trend is towards more ecological and biodegradable products and packaging materials. Pulp as a material is even compared to plastic in terms of multifunctionality. Simon Mathis writes in his article that there is a growing pressure towards prohibiting the use of plastic in the developed countries (Mathis 2018).

Economic development and the rise of the middle class in the BRIC-countries has supported the consumption of tissue products whose main ingredient is pulp. The growing E-business and online shopping is dependent on cardboard boxes that also require pulp. Currently, also the medicine and food industry favor pulp as a filler, which puts pressures on the health regulations of the whole pulp manufacturing and transportation process. Global megatrends really seem to create opportunities for pulp.

Possible and new uses for pulp are invented constantly, and the global demand is growing mostly driven by developing markets of China, Eastern Europe, Latin America and other parts of Asia. Figure 1 below presents the forecasted distribution of the demand for various forest industry products regionally. In the figure below, the red square represents stagnancy or decreasing demand, yellow stagnancy to small growth of demand and green significant growth in the demand for the product group in the market area (Berg & Lingqvist 2017, Article).

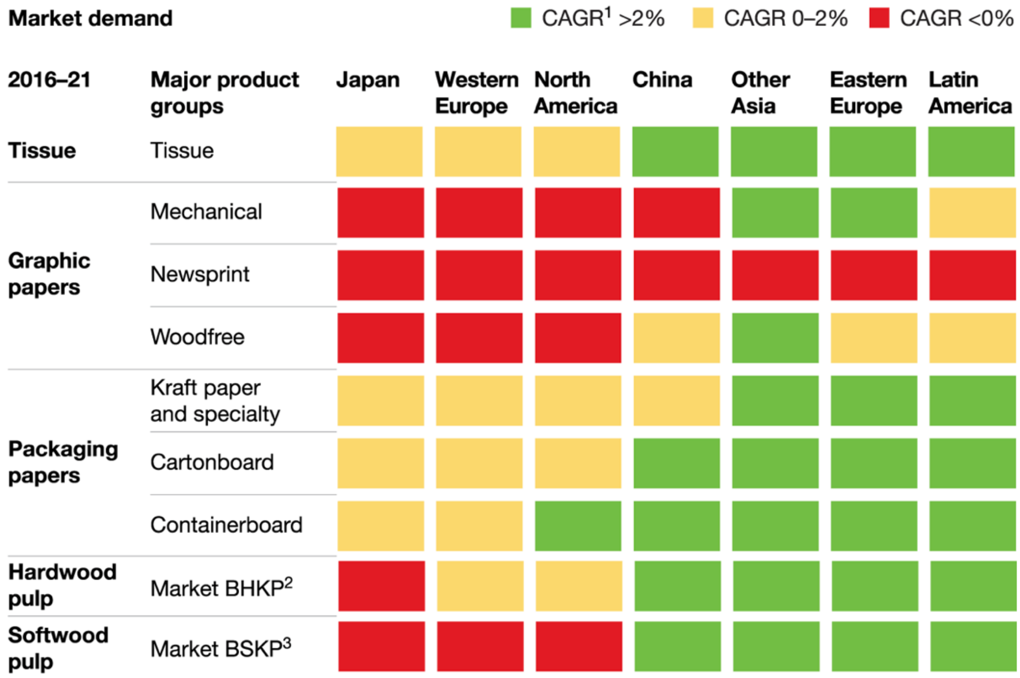

Figure 1 Forecasted growth prospects of various segments grouped regionally (Adapted from McKinsey)

1.4 Pulp Supply Chain

According to Diesen (2007, 12), the Pulp industry is cyclical. As with other raw materials, pulp market price is dependent on the current supply and demand rates. Although part of the demand is fixed, historically the demand has had high variation, and the market price has been volatile. Pulp production cannot react quickly to rising trends in market demand. Pulp mills are characterized as high investments taking several years from the investment decision to the beginning of producing sellable product. Market price fluctuations often trigger simultaneous investment decisions, which leads to overproduction. Higher supply rates, again, lead to a drop in the market price. Customer inventory speculation during expected rising price cycles tends to boost market price fluctuations even further. During a high cycle, customers buy larger amounts of pulp to stock expecting to avoid price peaks (Diesen 2007, 13). During a decreasing cycle, the mechanism is reversed causing a quicker and exaggerated market reaction (See Figure 2 below).

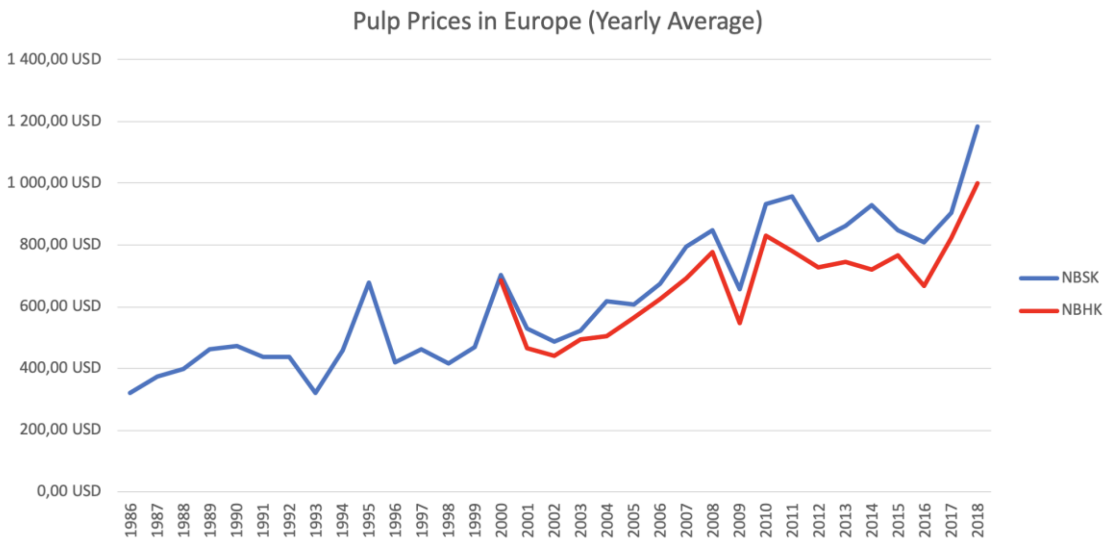

Figure 2 European pulp price fluctuations 1986-2018 in USD (Price data from RISI)

Pulp production is steered by annual, quarterly and monthly forecasts that are updated frequently, as changes occur from time to time for unpredictable reasons. For example, such changes can be sudden mill shutdowns, trade barriers to certain markets or rapid changes in market price.

The forecasts are based on paper mill operating rates, supplier information, fixed orders, mill shutdowns, retailer bookings and market price forecasts. This said, the pulp supply chain is a highly push-oriented system. However, recently there has been some shift towards a push-pull boundary moving closer to the supplier as the customers require products with more tailor-made properties. (Diesen 2007, 13)

A push-oriented supply chain is characterized by a long reaction time to market changes. Building a single new major mill can affect the market price significantly because production batches are large and product variety is small. Excessive inventories are another attribute of the pulp supply chain. The nature of the pulp supply chain leads to high inventory levels, as the lead time from the producer to the final customer can be long, with various warehousing and transportation stages on the way. The bullwhip effect commonly leads to inefficient resource utilization in the pulp supply chain.

Paper mills are required to have safety stocks for securing the paper mill operation. This is due to the opposite role of the paper supply chain as a system, where the push-pull boundary is close to the client and the last transportation leg lead time is shorter, making the system fragile to drags. Paper producers' business intelligence and market analysis specialists monitor the market situation constantly. When the market indicates high price volatility, either buy or halt signals are triggered. When price drops are foreseen, pulp purchases are decreased or halted and safety stocks gathered around the supply chain are used instead. When reverse signals forecasting pulp price peaks are seen in the horizon, the level of the paper mill safety stock is increased within the supply chain. When even one major pulp producer has all their supply chain inventory capacity in use, the inventory has to start moving towards the customers. This causes a rapid price decrease, as when one producer decreases the price, others in the same situation have to set an even lower price in order to be able to make their excess inventory move within the supply chain. This market logic, or game, is the cause of the cyclical nature and extreme price fluctuations that have been seen in history and that will be seen in the future.

2 Research Basis

2.1 Background of the study

Kananen (2015, 35) lists factors that affect the lead-through of a thesis process positively. The factors include the substance- and method skills of the author, the attraction and controllability of the subject, the importance to self and to the discipline and finally, the availability of information.

The assigning company's business unit is currently going through a rapid digitalization process including several wide scale projects. Especially the organizational units tied to the supply chain management and its information flow are facing major process and organizational changes. Moreover, the author was seeking for an interesting topic for a bachelor's thesis.

It could be seen from the very beginning that the topic of the study had potential and benefit both for the assignor and the author. The study gave the author a significant cause to explore the interesting and current theories and applications related to the digital technologies involved in supply chain management and logistics. The topic had a connection to the author's previous work experience and practical knowledge acquired during the years spent employed for tasks with and around the products of the Finnish forest industry. The study also gave the author a reason to meet and discuss with notable persons and visit sites of interest. The research, when successful, could also create value for the assignor, fellow colleagues and even students or graduated logistics engineers.

Availability of information was never a problem when writing the theoretical basis. In fact, there was so much information available that staying within the scope proved to be difficult. Moreover, the fast obsolescence and dependability of the information was also a problem. Digitalization and the internet give easy access to infinite amounts of information much of which is also unreliable.

2.2 Research objective

A study always serves a reason or a purpose. The reason guides the selection of the used research strategies. However, it is important to note that a study can also serve several purposes and that the purpose of the study can change during the research process. (Hirsjarvi et al. 1997, 134)

The objective of the present research was to study why and how the digital communication between the stakeholders involved in the pulp supply chain should be developed in order to reach the best functionality and added value of the supply chain. In order to reach the research objective, the research methods must be carefully chosen and justified.

The main desire behind the present study was the assignor's need to digitalize the supply chain. The objective of the digitalization was to develop the supply chain information flow transparency and reduce manual work. The final objective was an integrated system for transferring transactional information within the corporation and to the external partners. The available benefits had to be examined, without forgetting the possible risks involved in converting from manual to digital.

The most important research questions were as follows:

1. What is the current state of the supply chain information flow?
2. How should the supply chain information flow be developed?
3. What are the possibilities, risks and benefits involved in digitalization and developing the supply chain information flow?

2.3 Scope of the Research

After deciding on the research topic, it must be delimited in order to have a focused idea of what the researcher wants to know, point out and what should be left out. (Hirsjärvi et al. 1997, 81)

Quantitative and qualitative methods have different approaches to the limitation and scoping of a study. As a qualitative research problem should be distinctly limited, the qualitative research methods are often chosen due to the flexibility of the uncharted and unpredicted nature of the research. (ibid., 83)

The research focus of the present study was on the content of the information transferred within the pulp supply chain as well as on the information flow between the logistic partners and the producer, in other words, transactional information within logistics. The information content included logistics documents necessary for the material flow, for example, customs documents, cargo documents and other such materials. The research does not focus on the technical implementation of the information flow. The study included surveying the risks, benefits, possibilities and new aspects that digitalization would bring.

2.4 Scientific Research Methods

All research, which bachelor thesis also is, has to be scientific (Kananen 2008, 14).

Success in research is result of ending up with valid, useful conclusions. Valid conclusions are largely dependent of choosing and using suitable research strategies and methods to conduct the research. Research strategies are wider principles or guidelines aiding to choose correct theoretical and practical methods (see Lähdesmäki et al. 2012, Tutkimuksen suunnittelu [Planning Research])

In this chapter different research strategies and methods are generally presented and their feasibility for this study briefly explained. The most important chosen methods are reasoned and described in detail.

Methology

According to Kananen (2008, 16) method is a technique to gather, analyze and interpret material. Methods result to approval or rejection of existing theory or to creation of a new one. The examination of the validity of a study is based on the documentation collected throughout the research. Precise documentation is one of the most important criteria of a successful scientific research.

Even though different categorizations are used, the most simplified and clear is a rough division of research methods to quantitative and qualitative methods. Whichever is chosen defines how the research material should be acquired and analyzed. (Kananen 2008, 18)

Quantitative Research Methods

Quantitative research is a scientific method that approaches the research objective by describing it with numbers and statistics. Using quantitative research methods requires the occurrence to be quantitively measurable. Quantitative research methods include variety of different tools to analyze collected data with statistics and calculus. Quantitative research uses categorizing, comparison, classification and cause-consequence rationalization. (see Lähdesmäki et al. 2012, Määrällinen tutkimus [Quantitative research])

Using and testing hypothesis is peculiar for quantitative research. Hypothesis are presented as arguments. Hypothesis are then tested and validated with reasons acquired from previous researches or theory. (Hirsjarvi et al. 1997, 154)

Qualitative Research Methods

The research objective of qualitative research is to comprehensively understand the properties, quality and significance of the studied subject. Depending on author and the point of view, qualitative research is either seen as a pair or opposite to quantitative research. Quantitative and qualitative research methods can be used in a same study to explain research objective(s) through different viewpoint. There is not one correct way to design and execute a qualitative research. Qualitative research methods are multiple but common factors are included. The research methods are characterized by the aspect to describe the background, importance, meaning and expression of the object (see Lähdesmäki et al. 2012, Laadullinen tutkimus [Qualitative research])

Complete objectivity cannot be accomplished through qualitative research methods and the results are always conditional. That is though, a property of qualitative research which’s aim is not to prove facts or statements, but to find them. (Hirsjarvi et al. 1997, 157)

Case Study

Case study can be executed either by using quantitative or qualitative research methods (Hirsjarvi et al. 1997, 186).

Case study is especially used to examine processes. Case study doesn't necessarily aim to test hypothesis nor explain connections between different phenomenon. Case study as a term is very versatile and is used within wide scale of different scientific disciplines. Project, development and evaluation studies can also be seen as case studies. Although case study focuses on specified single case it should be adjusted and seen as part of larger entity or phenomenon. (see Saaranen-Kauppinen & Puusniekka 2006, Tapaustutkimus [Case study])

Chosen Research Methods

The research will be implemented as a case study. Case study suits well the objective of gathering detailed, intensive information about the subject and using the acquired material to systematically and accurately describe the phenomenon. Case study uses several methods to gather information relating the research object (Hirsjarvi et al. 1997, 130-131).

The majority of the used research methods are qualitative. Qualitative research methods suit the study better than quantitative research methods. According to Hirsjarvi et al. Qualitative research aims to understand the research object (1997, 176). The study is more about describing and finding facts and results either than proving existing hypothesis.

The functionality, quality and value of the information are abstract facts that are dependent of the sender and receiver. Hence, creating or acquiring a value system and converting the value of information within this study case into measurable units does make little sense for reaching the research objective. However, raw numbers and statistics acquired and analyzed in quantitative research grant provable facts to be leaned on. Qualitative research doesn't contain this ability and the view and conclusion reached with qualitative research is never completely objective. However, to have scientific value, a research cannot be completely subjective. To avoid this and to gain veracity for the research, the triangulate research methods are used.

2.5 Design of Data Collection

To archieve the research objective the current state of the information flow and system of the company's supply chain must be first identified and analyzed. The current state analysis is based on observation. Observation is participating, as during the research process the authors job description and success in duties is based on handling the supply chain information within the assignors supply chain. Researcher’s own interpretations are distinguished of the actual observations and the analysis is done from as neutral point of view as possible.

2.6 Observation

Observation as a method is one universal cornerstone of scientific research. Data acquired through the method is straightforward information about behavior and properties of the objective of observation. Observation functions well as a research method for qualitative research. Information obtained through queries and interviews focuses on the subjective view of the object persons thoughts whereas observation focuses on what really happens. Method is especially suitable for describing interaction. However, observation is time consuming and always involves the risk of the scope becoming subjective view of the researcher. Observation techniques vary by the level of participation the researcher takes and how systematically the observation is planned and implemented. (Hirsjarvi et al 1997, 207-209).

Hirsjarvi et al (1997, 212) point out it is important to keep in mind that researcher distinguishes his own interpretation of the observations. Triangulation should be considered when observation is chosen as a research method. Researcher’s own history, lines, assumptions and prejudices always affect the registered observations (see Saaranen-Kauppinen & Puusniekka 2006, Ei-osallistuva havainnointi [Non-participating observation]).

Triangulation refers to paradigm approach of combining various methods, theories, sources and researches in a study to enwiden the view to the research and hence increase reliability of the results. Methodological triangulation is a type of triangulation that includes usage of different data acquisition methods. Using a single data acquisition method to implement a research doesn’t necessarily prove wide enough view of the objective. Researcher can for example use a combination of queries, observation and interviews to enlarge the view to the research subject. (see Saaranen-Kauppinen & Puusniekka 2006, Triangulaatio [Triangulation]).

The triangulation is based on the researchers participating observation of the studied phenomenon and interviews of persons of importance. This creates enough veracity for the results and enlarges the perspective to the phenomenon.

2.7 Interview

Interview is one of the main research methods and typically used in qualitative research as the principal method. Interview is direct linguistic interaction with the research subject. Interview is a flexible method for data acquisition as it can be adjusted to match the requirements of the situation and interviewee. Interview is very suitable for the research topic for three reasons:

1. Within the research topic, human is an active party that sends and receives information within the supply chain. Hence, the person should be able to express himself without unnecessary restrictions. The research emphasizes the fact that person is a subjective within the study situation.
2. The answers related to the research topic will be complex and meandering.
3. The desire is to deepen understanding of the research topic and the stated arguments should be validated.

(Hirsjarvi et al. 1997, 199-200)

The data acquired with interviews is further analyzed and studied to gain answers for the research objective. The issue with interviews is the fact that human always have a certain perspective or viewpoint to how they see the subject. This applies to both the interviewer and interviewee. Hence the sources of error accumulated through previous reasons should be taken to consideration before making conclusions based on the facts obtained though human interaction. The researches approach to interview is evermore necessary to adjust not to manipulate the interviewees answering if not included and essential for the approach. Preparation and careful planning is always necessary for the interview occasion to result for usable data. (see Saaranen-Kauppinen & Puusniekka 2006, Haastattelu, [Interview])

Interview is a large concept including differently constructed interviews suitable for different researches and research objects. In research study literature different groupings and names are used to categorize the ways to implement research interview. Basic categorization is to divide the interview types depending of the freedom given for the interaction situation. Two opposites are a completely free interviewing situation, where the interviewee only defines the topic under which the discussion is done and completely structured interview in which the prepared questions are presented in certain order and even with defined answers to choose from. Between these two extremes falls themed interview or half-structured interview, which consists of beforehand planning and structuration of the themes discussed (Hirsjarvi et al. 1997, 203).

Structured interview

Structured interview is a method which is conducted with a carefully structured application form framing and limiting the situation. Each interview is executed in the same order with same questions and answer options given to interviewees. (Hirsjarvi et al. 1997, 203). The fast analysis of the collected data is the advantage of using structured interview. The downside is the construction and planning of the application form, which is time consuming and can fail if not done correctly. Fail in planning the application form can lead the data reflecting more the researcher's point of view than the interviewees. Structured interview is most suitable for studies where a certain hypothesis or previous qualitative study results are tested with easily quantitated data and implementing a query is expected to produce small percentage of answerers. (Hirsjarvi & Hurme 2001, 45)

Open interview

Open interview is also referred to unstructured interview, deep interview or conversational interview. Open interview is very similar to a common conversation with just a theme given and no script built in advance. The situation is led by the given answers and even the theme can change during the conversation. Open interview requires skill from the interviewer to guide the situation. Open interview is time consuming and may require implementation of several interviews. (Hirsjarvi et al. 1997, 204).

Half structured interview

Half structured interview is an intermediate form of structured and open interview. The interviewing situation is not strictly planned in advance, but certain questions have been decided. Questions can be modified and presented in order not defined in advance. Ready answers have not been made and the interviewee can answer the questions freely. Half structured interview is a general term holding variety of slightly different ways to plan and implement an interview. (Hirsjarvi & Hurme 2001, 47)

Themed interview

Themed interview (teemahaastattelu in finnish) is a form of half structured interview expound by Hirsjarvi and Hurme in their guide for themed interview. Themed interview is based on the focused interview presented by Merton, Fisk and Kendall in their book *The Focused Interview* first released in 1956. Second edition was published in 1990 (Hirsjarvi & Hurme 2001, 47). Themed interview can be used in both qualitative and quantitative researches as the data acquired can be analyzed in multiply manner (Hirsjarvi et al. 1997, 203). The original focused interview bears the following properties unique and different of other research methods.

- It is known the interviewees have experienced certain situation
- Researcher has tentatively researched important parts, basis, processes and entity of the researched phenomenon
- Researcher has ended to certain postulate based on the tentative research

After the preliminary analysis the researcher constructs a structure for the interview and focuses the interview on subjective experiences the interviewees have of the occasion tentatively analyzed.

Themed interview is based and modified of the original focused interview thus it doesn't require to conduct a common experience with the interviewees like the original. Themed interview doesn't require certain level of intensity nor amount of interviews conducted but focuses executing the interviews within essential themes that are same for all the interviewees. The focus of the themed interview is on the interviewee's subjective interpretation of the studied phenomenon. Using certain themes instead of single questions brings this interpretation pure, liberating the interview of researches perspective. Themed interview is more related to open interview than structured interview. However it cannot be categorized as open interview due holding certain level of structuration by conducting all interviews within the same theme (Hirsjarvi & Hurme 2001, 47-48).

Interview is applied to the research to gain valuable and necessary external point of view to the research subject hence leading to increased veracity of the research results. Examining different interviewing methods to find the most apposite discipline resulted in themed interview. When planned and implemented correctly, themed interview combines partially the profundity and resiliency of open interview retaining the scope to the subject. Themed interview doesn't retain the inapplicable experimental characteristics of the original focused interview that would have been unnatural for the research. Significant benefit of the themed interview is also its terminological neutrality which doesn't take a stand on the necessary amount of executed interviews nor the required deepness of each interview.

Single, Group and Pair Interviews

Interviews differ also by the amount of people interviewed within a session. Group interview involves more than two interviewees. Pair interview involves two and single interview only one. Pair and group interviews suit researches when the research is especially tightly scheduled and as interviews are time consuming, the problem is partly avoided by interviewing multiple people on one session. Researcher can also benefit of implementing of group or pair interviews when there is a change, that one on one interview would produce short answers and or the situation would be considered scary for the interviewee. This is especially relevant when interacting with children and people considered shy and tight-lipped. Interviews executed with multiple people at one session can produce oriented answers if there is a dominant person leading the conversation or if there is pressure within the group to produce or avoid certain opinions. (Hirsjarvi et al. 1997, 205-206).

The interviews applied to this research are realized as single interviews. The target group doesn't include children nor professional groups that are reputed of being shy and hard to interact with. Personnel operating within the tasks of the target group are necessary to have personality traits supporting social skills and extensive, clear self-expression, requisites for reactive and profound interviews.

2.8 Process Analysis

Due the large entity of the research subject the current state is modeled by process analysis applied for the research. The aim of the process analysis is but to describe the information flow of the supply chain, also to objectively state, why it must be altered.

According to Martinsuo & Blomqvist (2010, 4) process is a run to create added value to the customer. Enterprise inputs resources into the process to gain certain output. Different processes can further be divided to core- and support processes, which have different roles. Core processes connect to external clients whereas support processes are internal and function to aid core processes.

Process Thinking & Analysis

Process thinking is a method to model, develop and improve processes in business and production. Process thinking involves picturing functions as processes for further analyzing to rationalize them and to remove unproductive work. Processes are first modeled to demonstrate the current or desired process to visualize the possible errors and development targets. Tools, information technology and documentation are important remedies to harmonize and automate stages and often highlighted in process thinking and processes description. Processes are often described when new information technology is being implemented (Martinsuo & Blomqvist 2010, 3).

After the current state is modeled and described with the applied process thinking method, SWOT-analysis will be used to describe risks, strengths, opportunities and weaknesses involved in developing the assignors supply chain information system. SWOT-analysis is a quite simple tool that can be utilized widely for reviewing internal strengths and weaknesses and external opportunities and threats affecting the subject. SWOT-analysis can be used to deepen results of the current state analysis (OAMK n.d., PK-Yritysten kehittämistyökalut [Development tools of small and medium sized businesses])

3 Theory of Supply Chain Management & Logistics

The theoretical basis begins by explaining and defining the terms supply chain, supply chain management and logistics. The main focus of the theoretical basis is on the flow of information and the importance of information flow for the overall performance of a supply chain.

The function of a theoretical basis is to deepen the research scope by presenting and explaining the phenomena tied to the research problem (Kananen 2015, 112). The information for the theoretical basis was obtained by familiarizing with the focal literature written about supply chain management, logistics and digitalization. This also included reports and case studies including bachelor and master theses. Internet based articles and more recent studies were viewed for the theory concerning the recent progress

3.1 Supply Chain & Porters Value Chain

The term supply chain management can be traced back to the 1980's, when companies discovered and implemented various new manufacturing strategies and technologies allowing them to produce better quality faster and for a cheaper price. These new technologies and ideologies, such as just-in-time manufacturing, lean, Kanban and six sigma, and the development of early IT-systems, led to reduced manufacturing costs and higher profits. To increase their market share and margin, companies had to take the next step and reduce the costs of transportation. Terms, such as *logistics management* and *value chain* began to spread within the specialists and academics. (Simchi-Levi, et al. 2009, 7; Mangan et al. 2009, 4).

An academically recognized economist, Michael Porter, was the first one to present the term *value chain* in 1985. Porter described value chain as a sequence of activities making the product more valuable for the final customer. These activities, called value adding activities, included logistics, operations, sales, marketing and services (Hsuan et al.2015, 41). However, information can also be considered a value adding attribute (Hsuan et al. 2015, 18). Porter also envisioned the term *value system*, an inter-organizational chain of companies, linked together as a larger chain, aiming to eliminate irrelevant activities and to shift vital activities between and within the stages. A conventional supply chain can be found in Porter's value system. Porter's value chain is presented in Figure 3 below (Hsuan et al. 2015, 41-42).

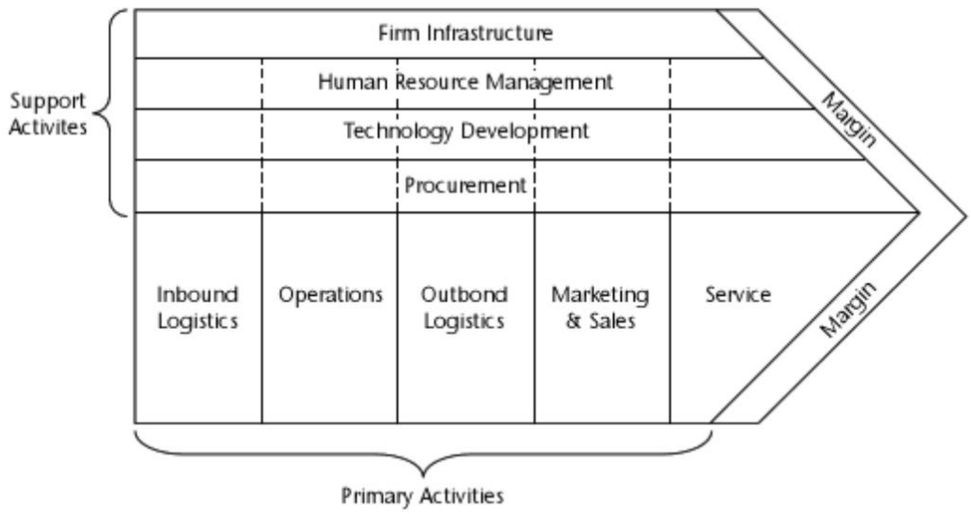

Figure 3 Porters Value Chain (Hsuan et al. 2015, 17)

Supply chain management is a relatively new concept, which still lacks an exact and widely adopted definition (Hsuan et al. 2015, 18). Supply chain management has gained further interest and importance within enterprises during the last thirty years. As always with relatively new terminology, different schools of thought occur, and especially the older related literature refers either to terms logistics management or supply chain management. Confusion with the terminology is common as an exact description for the abstract, undefined concept of supply chain lacks. Supply chain management and logistics are commonly mingled with each other. According to Mangan (Mangan et al. 2009, 12), the traditionalist view sees supply chain management as an add-on to logistics. Perspectives vary with the terminology. In this thesis the approach adopted was determined as a *unionist view*. The unionist view sees logistics as a crucial part involved in the movement of materials within the inter-organizational, larger entity of supply chain management. (Mangan et al. 2009, 12)

Handfield and Nichols (2002, 8) define the supply chain as follows: "The supply chain encompasses all organizations and activities associated with the flow and transformation of goods from raw materials stage, through to the end user, as well as the associated information flows. Material and information flows both up and down the supply chain."

Supply chains and supply chain management exist everywhere where organizations interact with each other sharing and transferring physical and financial resources, services and information both upstream and downstream the supply chain. The source of the stream starts from the supplier end of the supply chain and ends at the final consumer. In between, there is the value adding process of various activities linked with each other. During the process the product gains more value from the point of view of the final customer. The activities can consist of procurement, inbound logistics, production, outbound logistics, retailing, marketing, sales, reverse logistics etc. The boundaries of the chain or the stream are not always clear, meaning that sometimes it is necessary to draw an arbitrary line to be able to focus on the primary interest. (Waters 2009, 15; Hsuan, et al. 2015, 17-19). Figure 4 below presents logistics and supply chain boundaries.

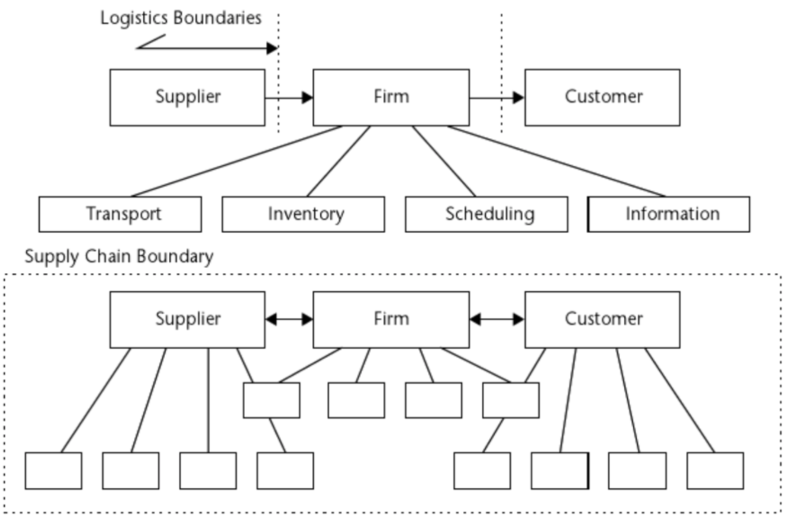

Figure 4. Logistics and Supply chain boundaries (Adapted from Hsuan et al. 2015, 22)

3.2 Logistics

Logistics is a vital process involved in moving the physical product towards the customer in the complex and somewhat abstract concept of a supply chain. Logistics and supply chain management often cross terminologically and can involve overlapping activities. However, supply chain and supply chain management are considered wider entities of which logistics is a part. Especially in older literature, concepts of logistics management and supply chain management are mixed with each other. Logistics also involves the management of physical, information, and financial flows but through a narrower scope, concentrating on specific activities within the supply chain. There is still variation depending mostly on authors or company structures as to which activities fall under the definition of logistics. (Mangan et al. 2009, 8-9, 59-60)

The Chartered Institute of Logistics and Transport in the UK describes logistics as a process of:

"Getting the right product to the right place in the right quantity at the right time, in the best condition and at an acceptable cost." (CILT UK 2018)

Sourcing and procurement of materials, inventory and warehouse management, transportation, material handling, and distribution are the supply chain activities that are considered to be parts of logistics (Mangan et al. 2009, 59).

3.3 Supply Chain Management

"Supply chain management (SCM) is the integration and management of supply chain organizations and activities through cooperative organizational relationships, effective business processes, and high levels of information sharing to create high-performing value systems that provide member organizations a sustainable competitive advantage" (Handfield & Nicholds 2002, 8).

As supply chains consist of networks of organizations performing necessary activities tied to the product value chain, supply chain management aims for the best possible performance of the chain. Globalization, shift in business logics and faster information flow made possible by digitalization have shifted competition between organizations and products to competition between supply chains. Supply chains compete each other to remain profitable hence to have a reason to exist.

Remaining profitable requires constant coordination of the flows of material and information transferred between organizations involved in the network. Each organization involved in the chain is independently managed, making the management of the chain as whole complex. This has put pressure for deeper integration and closer, more open information sharing to both directions within members of the supply chain. As successful coordination of information flow plays ever growing role in competitiveness of the supply chain, the trend is towards more integrated operations and eliminating barriers between organizations. Development of information technologies during the past decades have made it possible to share sales forecasts, inventory levels, marketing strategies, transportation plans, production status, transportation follow up and other supply chain related information in real time with partners and organizations involved in the sc. Integration and inter-organizational co-operation has led to faster lead-time and decreasing inventory levels. (Hsuan et al. 2015, 19-25)

3.4 Role of Transactional Information for Supply Chain Management

Transactions within the supply chain result to supply chain data. Supply chain data is necessary for those controlling the supply chain to plan production to meet customer satisfactory (Murray 2007, 20).

Different categorizations and groupings can be used to distinguish the information related to the physical flow of products within the supply chain. Hsuan and colleagues mention two different ways (Hsuan et al. 2015, 97-98).

Another is to group the data depending on its stability to logistics master data and transaction data. Figure 5 below categorizes these two types of transactional data further.

LOGISTICS INFORMATION

LOGISTICS MASTER DATA	LOGISTICS TRANSACTION DATA
• Article- and order-based data – Addresses – Article numbers – Measures of units – Prices	• Article- and order-based data – Delivery quantities – Delivery times requirements – Number of delivery units – Number of shipping units
• Location-based supplier logistics data – Shipping dock information (number of doors, areas, buffer capacities, shipment control) – Delivery channels • Location-based operation logistics data – Receiving dock information (number of doors, areas, buffer capacities, incoming control) – Shipping dock information (number of doors, areas, buffer capacities, shipment control) – Inventory areas (storage types, capacities and marginal performance of given storage systems	• Location-based supplier logistics data – Delivery addresses – Delivery times, shipment times, operating times • Location-based operation logistics data – Picking information (types, capacities, marginal performances) – Number of used logistics units – Operating times, collection times, standard delivery times
• Logistics unit data – Identification number – Technical-functional name – Measures – Sizes – Weights – Restrictions coding	• Logistics unit data – Number of logistics units and packaging units – Number of loading equipment and transport means

Figure 5 Logistics information Characterized (Adapted from Hsuan et al. 2015, 98)

Hsuan et al. (2015, 97-98) present also another way to group logistics transactional data. Below is an example of this grouping, which bases the valuation on the functionality of the data.

- Transactional information
  - Routine information transmitted in formalized, standardized form recording individual logistics activities and functions
- Management control information
  - Information related on performance measurements
- Decision analysis information
  - Strategic and tactical information for evaluating and identifying logistic alternatives
- Strategic planning information
  - Information for decision making models and wide-range business planning

Information is also divided depending of the direction. Intra-firm information flow is information transferred within the organization, between different departments or units. Inter-firm information flow is information flow to and from external organizations. Due the variety of IT and related languages used, the standardization of electronic messages is an issue in inter-firm information flow. Electronic Data Interchange (EDI) and eXtensive Markup Language have been used as “translators” between different IT software and languages to be able to transfer unaltered information. Internet based standardized applications have quickly overtaken this task improving information flow between organization in supply chains. (ibid., 99)

3.5 Role of the Logistic Partners in Supply Chain Management

Globally operating enterprises have dozens of logistics partners in different countries performing activities on different stages of the supply chain. Partners vary greatly by size and the activity performed. Certain outsourced operations could be best performing with small and flexible company operated by one employee with a laptop and knowledge of specific software, while port and railway operations to mention few, are important employers and require filling complex regulation and legislation with major investments in equipment and infrastructure.

Organization can take various approaches to execute the movement and handling of physical flow of materials in supply chain. Transporting and holding inventory on own account means that the organization handles, stores and transports the freight with its private owned fleet and infrastructure, designed and tailored for the organization’s requirements. Obviously, using own fleet and infrastructure allows certain flexibility and perfect control of the logistics operations due integration and internal communication. (Waters 2009, 380-382, 423-424)

Organization can also choose to use a specialist outside of the company to execute these operations. Transport and cargo handling company offering logistics services for other organizations is referred to as a logistic partner, logistics service provider or 3rd party logistics provider, depending of the wideness of the role. While logistics partner provides normally services related to one or couple of legs of the logistics chain, an external third-party logistics provider (TPL) doesn’t only handle multiple integrated logistic activities, but also provides solutions to logistics or supply chain related issues. (Hsuan et al 2015, 251-254)

Using a logistics partner, or several of them to provide the cargo handling processes has various benefits compared to the usage of own fleet. It allows the company to concentrate on its core business, while the logistics service provider does the exact same. Logistics service provider benefits of economies of scale and of having the expertise in cargo handling, warehousing, transportation or even information technology, being able to offer more efficient service for cheaper cost. It is important to denote, that necessarily the logistic service provider doesn't own the fleet it is using, but it is likely being operated by a subcontractor. Obvious, it is also possible to combine usage of own fleet with outsourcing part of the logistic processes to a logistics partner. (Waters 2009, 380-382, 423-425)

In Global Supply Chain Management, Juliana Hsuan Refers to Berglund et al. (1999) identification of the entrants into the TPL market

1. Asset-based logistics providers
2. Network logistics providers
3. Skill-based logistics providers

Asset-based logistics providers

The logistics partnerships as we know them started to develop in early 1980s and have shaped since then. The first entrants to the market were operators owning or leasing assets and infrastructure necessary to perform logistics operations. Offering wider scale of logistics services straight to enterprises was natural extension for these operators to remain competitive with the declining margins in the tightening transportation market, and sometimes also to secure volumes for their basic services. (Hsuan et al. 2015, 254)

Network logistics providers

Former express parcel and courier companies such as UPS, DHL, TNT and FedEx nowadays expertise in global, reliable, express shipments suitable especially for products such as electronics, pharmaseutics, fashion goods and spare parts that are high-value-density and time-sensitive and require traceability of the shipment. These companies benefit of their formerly built worldwide covering, advanced transportation and communication network, allowing them to provide overseas manufacturers real-time follow up information and e-commerce service. Network logistics providers compete with the traditional asset-based logistics providers in these markets of high margins. (Hsuan et al. 2015, 255)

Skill-based logistics providers

The value skill-based logistics providers add to the supply chain is more based on knowledge, specialization, contact networks and management of assets owned by other providers. They offer solutions and consultancy services for information technology, finances and supply chain management. These are the most recent type of players in the TPL market, first starting or emergence at the end of the 1990s.

Especially enterprises operating globally could benefit of all types of TPL providers depending of the services desired to outsource. Below figure 6 classifies the service providers according to the variability of the customization and competence of the solutions providable. (Hsuan et al. 2015, 255)

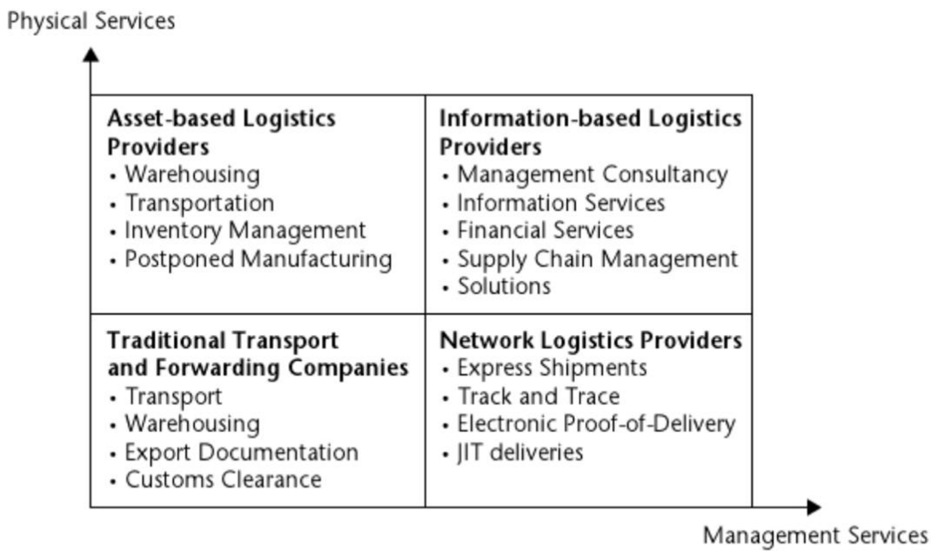

Figure 6 Typology of logistics services (Adapted from Hsuan et al. 2015, 256)

Affect of outsourcing logistics activities

Trend in logistics and SCM has recently been towards outsourcing strategic operations within the supply chain, forming partner organizations responsible of activities that are not part of the organizations core business. (Hsuan et al. 2015, 40). Deregulation and liberalization of the transportation market, complexity and capital intensity of global supply chain management, containerization, globalization and the trend of trimming expenses by outsourcing services and focusing on core business has favored shifting the execution of logistics activities to logistics partners. In the world of tightening resources, organizations cannot expertise in all facets of the business. Outsourcing logistics activities allows the organization to expertise in its core business, while the logistics partner does the same. Globally operating TPL service providers cover wide geographic areas never seen before, creating easy access to new markets for the partner organization. TPL providers do not lack the resources and expertise to implement newest logistics related material handling, delivery and information technology, as it is vital for their core business to keep up with the technology. (Hsuan et al. 2015, 256-257)

Transportation, material handling and warehousing operations are capital intensive. Shifting responsibility and financial risk of owning this capacity to TPL provider frees capital, allowing the company to convert fixed costs to variable costs. Company is free of capacity uncertainty caused by demand fluctuations, and TPL provider can better utilize the capacity by serving multiple clients of crossing demand patterns. TPL logistics provider benefits of economies of scale and acquired knowledge and contracts in logistics management, being able to provide competitive prices and better service. Concentrating stagnant, high volumes through same channels lead to shorter lean times, as documentation and distribution planning simplifies and operators advance in priority with the ship owners and container providers. More stagnant volumes allow utilization of wider distribution channels penetrating to new market areas. Enterprise can instantly enter new markets via TPL provider without investing massive capital in fixed assets in unchartered market territory. (Simchi-Levi et al. 2009, 250-251)

Implementing and building logistics partnership

Outsourcing and building partnerships with logistics service providers are critical decisions causing multiple strategic and organizational consequences. Partners are not only physically in touch with the product, but also handle critical information and can be in straight contact with the final customer. Hence, partners are critical for the reputation of the company in means of brand and service level. Leaking critical information, providing unacceptable service, causing environmental or humanitary damage or simply delivering the product in wrong condition all affect not only the reputation of the logistic partner, but also the brand and reputation of the service buyer. Partnerships have to be based on common values and the partner organization should be properly examined. Outsourcing decisions and new contracts with partners occur often simultaneously with supply chain redesigning processes. This makes evaluation and comparison of new and old systems complex.

Essential part of the process is a proper analysis of the current logistics system aimed to outsource or in case of competitive bidding, the system and real costs of the current partner. Logistics costs can be hard to identify, as they are not always separately shown in accounting systems. Especially within more conservative industries material handling equipment and warehousing infrastructure are often under production costs. Indirect inventory holding costs and capital tied to warehouses are not necessarily identified separately in accounting systems. Sales organization are not necessarily familiar with incoterms, which leads to unidentified transportation costs hidden in purchase price. Logistics performance metrics, service levels, error density and reliability should be examined and measured, and requested also of the new candidate for more precise comparison. (Hsuan et al. 2015, 257-260)

For fluent fluct of information between the organization and logistic partner, information systems have to be integrated. Manual sharing of information using email, fax, or phone is unefficient and time consuming, especially when dealing with frequent, stable volumes with few partners. The digitalization level of the logistics service provider and information systems hence become a selection criteria that cannot be left unexamined. These include the capability of track and trace services of the freight and possibility to implement RFID technology with the partner. Integration of information systems include datalinks such as EDI, XML, portals or internet based systems, data coding, software and computer systems. Especially the desired way to implement datalinks is crucial to examine further and merge jointly between the two organizations, as correctly done it reduces significantly manual work, and enables fast and accurate data transmission of orders, invoices and other documents. Data links can also be used for real-time inventory status monitoring and tracking shipments. (Simchi-Levi et al. 2009, 250-252)

3.6 Push, Pull & Push-pull boundary

Standard categorization of supply chain processes has traditionally been dividing them into push or pull strategies, which could be seen as opposites of each other.

With contemporary global supply chains, such a strict categorization does not always apply anymore. Organizations have developed approaches combining the advantages and avoiding the disadvantages of these two strategies. A supply chain combining both strategies is called either a hybrid or push-pull supply chain. When discussing these approaches the push-pull boundary is the interface between these the strategies where the strategy or system converts. (Simchi-Levi et al. 2009, 190-191)

Properties of a Push-based supply chain

The decisions of a push- supply chain are based on the speculative long- and short term forecasts of the customer demand. The forecast accuracy is dependent of the time horizon window, used forecasting method and the information the forecast is based on. A push-based supply chain is under constant uncertainty as demand forecasts are never perfectly accurate. The process cycles including procurement of raw materials, manufacturing and transporting start long time before the point of sale. Push-based supply chain reacts slowly to changes in market and often face the problem of obsolescence of inventory, as demand for certain products can suddenly disappear. Especially globally operating push-based supply chains are complex, utilize long lead time and require more planning and management. Long lead time and complexity lead to excessive inventories and inefficient resource utilization, especially because of the bullwhip effect. Production, transportation and inventory management costs are high due to failing demand forecasts, which cause emergency changeovers in processes. Overall expensiveness and ineffectiveness describes a push oriented supply chain, as it often fails to have the right amount of the right products available on the right time at the point of sale. Raw material supply chains are often push oriented. (Simchi-Levi et al. 2009, 188-189)

Properties of a pull-supply chain

In a pull-based supply chain the final customer demand is known and the product is pulled towards the customer. The execution of processes is initiated to respond a customer order and the order can be configurated to match the customer desire. In theory, a pure pull-oriented supply chain doesn’t hold any inventories, and there is no uncertainty as the process responds only to a specific customer order. (Simchi-Levi, Kaminsky, & Simchi-Levi 2009, 189) In practice the inventory levels do decrease due the shorter lead time, and the resource management is more efficient compared to equivalent push-system. On the other hand, the irregularity and lack of planning ahead make it hard to take the advantage of economies of scale in procurement, manufacturing and transportation. It is often impractical to implement a pull system to a long lead time system. A pull-system requires flexibility, close integration of the supply chain partners and fast and accurate information flow upstream and downstream the supply chain. The point of sale data needs to be transferred to the organizations participating the supply chain. In general it is almost impossible to implement a pure pull strategy, as even the most responsive system must have some prediction of the overall direction of demand to arrange capacity and supply network. (Hsuan et al. 2015, 128-129; Simchi-Levi et al. 2009, 189-190)

Boundary Between Push & Pull Systems

Push and Pull strategies have their advantages and disadvantages, and suit for different kind of processes and product cycles. Companies have found an efficient way to combine both systems employing push-pull strategy. In a push-pull strategy, processes of certain stages of the supply chain operate according to planned forecasts, whereas rest of the processes are triggered by customer order. The interface where the system changes from push-based to a pull-based system is referred as push-pull boundary. (Simchi-Levi et al. 2009, 189)

The location of the point on the supply chain where push strategy converts to a pull strategy is dependent of the characteristics of the industry, length and complexity of the supply chain and desired customer service level. In raw material industry the push-pull boundary is located further in the supply chain, as there is very scarce differentiation of the product variety and the supply chain lead time tends to be long. The customer order cycle can for example take place as late as in a distribution center located on other side of the world, where to the product has been on transportation for 60 days. Quickly obsolete electronics products industry is an opposite example, where the execution of processes doesn’t take place until customer order is received. Hence only the procurement cycle is considered push strategy, transferring the uncertainty to the suppliers. Below figure 7 represents the push/pull boundary.

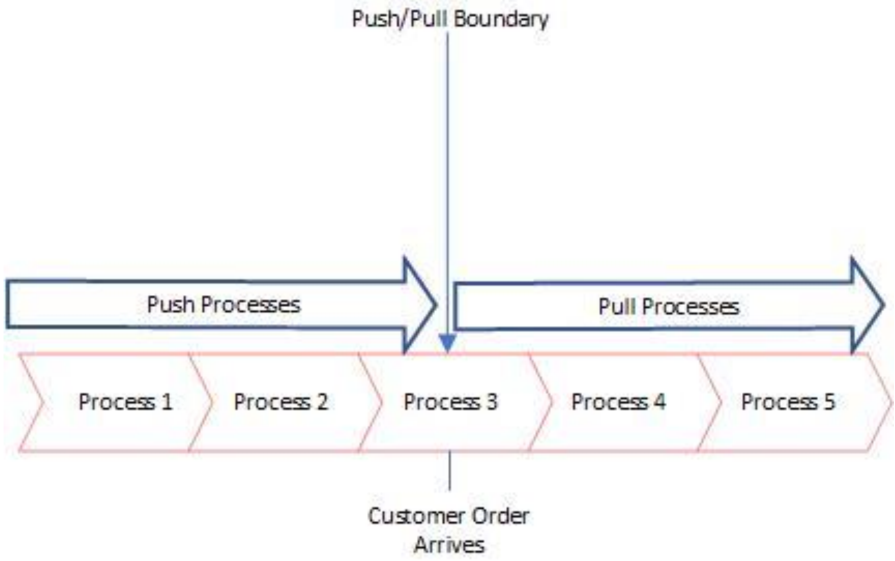

Figure 7 Push/ Pull Boundary (Adapted from Chopra & Meindl 2013, 22)

Trend in supply chain management has been forwarding the push-pull boundary towards suppliers, shifting the expenses of inventory management and capital tied to inventory from the manufacturer. Manufacturers processes become more pull-oriented and less dependent on forecasting, making the bullwhip effect occur less n supply chain. Development of information and tracking technologies, enabling fast and real-time information on point of sale and inventory status has enabled this change to more order executed supply chains. In other means, producers processing raw material further have become more aware of the possibility to produce more customized product patches with specifications more suitable for their final product. This can create inventory management and sorting problems with mass production manufacturers, as with part of the production the push-pull boundary is right after production line, while with other part it is at the distribution center on other side of the world. (Chopra, & Meindl, 22, 24, 64; Simchi-Levi et al. 2009, 188-191)

4 Role of Information in Supply Chain Management & Logistics

4.1 Information Flow and Visibility

As physical flow in supply chain significates the movement of freight and financial flow the flux of capital, information flow is for managing, supporting and triggering the previous flows. Contemporary fast paced global market is information intensive and has created the need for accurate, timely information. Availability of accurate real-time information of demand and supply reduces overstocking and understocking propability of inventory. (Mangan et al. 2009, 150-151)

Fluent flow of information within the organizations involved in the supply chain is a key component for an efficient and highly responsive sc. (Chopra & Meindl, 500). According to Mangan, information visibility or transparency is the ability to see information at the various points across the supply chain as and when required, which can help to manage the complexity. (Mangan et al. 2009, 151)

Information technology and internet have changed the transmission and availability of information within SCM. Accurate and complicated information is fast and easily accessible across organizational boundaries and distance. IT but boosts efficiency, also enables new opportunities. The complex operations in uncertain environment the SCM has to operate with are better tackled with increased supply chain visibility IT brings. (Hsuan et al. 2015, 95)

Visibility of information is desirable and leads to competitive advantage. Accurate information regarding the value chain should be transparent and available for all parties involved in the sc. Effective and efficient information sharing and availability requires integration, mutual trust and collaboration. Simply said, hardly implemented. Financial, technical, organizational and cultural barriers affect information flow, especially in interorganizational, global supply chains. (Mangan et al. 2009, 151-153)

Supply chain information technologies are expensive to implement and support. It is not financially reasonable to implement integrated information systems with all partner organizations of the supply chain. This denotes for *financial barriers*.

Within partner organizations the information systems should be either the same or at least be able to communicate with each other. Agreement of the information transparency within the partner organizations have to be made also, mutually accepting what data is available for whom and when. These come for *technical barriers*.

The supply chain of global, multinational companies involves various nations and cultures, which all differ in openness and availability of information. *Cultural barriers* are important to explore before implementing information technology within multinational corporation.

Organization involves separate departments or micro-organizations responsible for different tasks, possibly involved in processes of divergent goals. Alignment of these processes is complex and requires sophisticated coordination. *Organizational barriers* stand for these intra-organizational barriers.

To benefit maximally of implementing information technologies into supply chain, each of these barriers should be charted and addressed to. (Mangan et al. 2009, 151-153)

Information Technology

Investing on right information technology increases visibility across the supply chain. Coordinating decisions and transactions becomes more efficient, when information is easily shared and accessible throughout the parties involved in decision making. (Chopra, & Meindl 2013, 63, 500)

IT glues together organizations involved in a supply chain. Supply chain partners can share and access common data easing the decision making. Organizational boundaries of an enterprise extend with the network of data sharing IT provides. Managers can base their strategic decisions considering the market requirements of the whole system bringing it closer to the borderless company, a network of separate organizations redefining the concept of an enterprise. (Hsuan et a l.2015, 96)

As important as visibility is the right amount of information. Relationship between efficiency and amount of information is not rising linear. Beyond a certain point additional information benefits supply chain coordination only marginally, whereas the costs for handling the additional information increase. (Chopra, & Meindl 2013, 64)

Information sharing is crucial for the success and profitability of a supply chain. Supply chain coordination is an art based on shared information between different stages of the supply chain. Coordination aims for optimal usage of resources and surplus (ibid., 64) Lack of coordination within the chain results to each stage only optimizing its local objective, resulting to lower performance of the entire supply chain. Successful supply chain coordination requires constant charting of the impacts each action may result to on other stages of the supply chain. (ibid., 262)

IT enables SC coordination regardless of geographic location. Routine internal and external information, documentation, and orders can be automatically processed without human intervention. Automation without human supervision however creates the danger of going out of control. Data errors tend to amplify over time, causing havoc. IT also holds the danger of rapidity of changes occurring. The creation of supply chain as they are now, have been swift and the inter-organizational supply chain information system is in still in temporary state. With further development of IT Supply chains and supply chain management will change into more flexible networks easier to alter. (Hsuan et al. 2015, 95-96)

4.2 Information Technology in Supply Chain Management

The development of information technologies (IT) have been the most shaping and reforming single factor of supply chain management and logistic during the past decades. IT has broken boundaries of the information flow by integrating organizations involved in the supply chain. IT has automated labor consuming processes and made it possible to control operations of a global firm over a distance. Development, rapid spread and wide adoption of internet has made it possible to share complicated information in real time across the world and organizations. Possibilities of IT and internet technologies cannot be ignored by any business searching for efficiency and future opportunities. (Hsuan et al. 2015, 95)

The first IT-applications for production, logistics and supply chain management were material requirements planning (MRP) developed in 1970s, followed by more complex manufacturing resource planning (MRP II) developed by Oliver Wight in 1983. Developed in the early 1990s, enterprise resource planning software (ERP) were the next stage of evolution and the first specific IT tool for information and resource management of supply chain. (ibid., 107)

During and after 1990s the development of IT has been rapid and variation of software available for managing business and supply chain immerse. It does not make sense to present all possible applications for management. Next the most important ones for this thesis are briefly explained.

Enterprise Resource Planning (ERP)

Organizations have adopted Enterprise Resource planning software for monitoring and managing transactions of financial, human and material resources throughout functional and departmental boundaries of an organization and supply chain. ERP provides possibility for real-time tracking and visibility of the processes, aiding the supply chain to improve operational decisions and quality. (Chopra, & Meindl 2013, 65)

ERP collects and stores the data created from operations and executed transactions for documentation, reporting and analysis. This helps to minimize and even eliminate the paper documentation of an organization. Contemporary ERP systems are compatible with other systems and IT applications for supply chain management making it possible to electronically transfer documentation and transactions beyond organizational and technological borders. This requires connections to external applications able to convert and fix the data transmitted from different data system and format. (Hsuan et al. 2015, 107-108)

Implementing and maintaining an ERP system is time and resource consuming and requires significant financial devotion. To success with the ERP implementation it is sometimes necessary to adjust the organizational structure of the enterprise. ERP systems are not commonly used within small and medium sized enterprises. (Mangan et al. 2009, 155)

ERP system is always tailored for the requirements of the company. However, ERP system alone is normally not enough for handling and coordinating processes involved in supply chain. SAP, Oracle, i2, PeopleSoft and Microsoft Dynamics are nowadays the most known standard ERP vendors. (Hsuan et al. 2015, 107)

4.3 Communications

According to Hsuan and colleagues (2015, 117), supply chain management is distinguished from the earlier supply systems by the potential to instantaneous communication, presentation of data and the ability to react rapidly to changing situations.

Hsuan and others (ibid., 117) list four tasks the ability to manage a supply chain consist of:

1. The Capacity to handle the volume of individual transactions
2. The speed with which these transactions and their accompanying data can be processed
3. The visibility of operations to participants
4. The complexity of communication

The role of information to success of supply chain management will expand due the development of technology and the increasing need to handle the tasks affecting the capability to manage supply chain (ibid.,117). The following technologies have been developed to manage transactions and ease and automate the communication within supply chain.

Electronic Data Interchange (EDI)

EDI was developed as early as in 1970s for handling instant, paperless purchase orders with suppliers (Chopra & Meindl 2013, 65).

EDI is still used as a meta-term for different electronic standards enabling low-error transmitting of standardized messages between different IT-systems and organizations involved in supply chain. EDI could be described as a programmable translator, able to automatically crypt, translate and forward transactional messages between different IT-systems. Due to these reasons, EDI is commonly used for inter-firm information flow. (Hsuan et al. 2015, 118)

EDI operates automatically at the background delivering data and invoices when certain programmed factor launches the command. The launching factor could be a certain date or time, or a AIDC-technology trigger. Linked with an AIDC technology such as RFID, EDI can send electronic transactions automatically when the RFID-tag passes certain location. For example, an invoice can be sent automatically to the customer when a RFID tagged delivery truck passes factory gates equipped with a RFID-reader. (Mangan et al. 2009, 154)

eXtensible Markup Language (XML)

XML was introduced by World-Wide-Web Consortium in 1998 and was recommended as a standard for electronic information exchange over the web. XML is used similarly as its ancestor HTML (Hypertext Markup Language) for processing website content. The benefits of XML are its flexibility and standardized open code securing that the data is uniform and vendor-neutral. As EDI requires coupled business applications to be integrated in carefully planned complex endeavors, XML integrates applications more loosely and cost-effectively. (Soh 2004, 21) Contemporary XML is used for web-based closed networks designing like extranets and intranets containing corporate specific information only accessible with password or similar identification. (Hsuan et al. 2015, 119)

Internet based applications

The generalization of internet has created uncountable possibilities for transferring information. Internet has become the dominant for communicating between organizations and within supply chain. Internet provides tools for communication and information especially between suppliers and customers (CRM) and other different stages of the supply chain not being able to send standardized information between each other. Internet based, tailored portals and applications can be used to imitate or replace some of the standardized information shared between supply chain stages and parties, when it is not reasonable to build expensive EDI or XML conveys. Internet based applications and portals are a good alternative for more efficient information sharing to small and medium sized businesses and volumes. These applications can be easily adjusted when there is shift in volumes, relations or frequencies. (Chopra & Meindl 2013, 500)

4.4 Automatic Identification and Data Capture (AIDC) technologies

Automatic identification is a passive information technology to identify and follow up and track deliveries. It is passive in the means that the data needs to be interrogated by a radio frequency transmitter or a scanning device to be read. Bar codes and radio frequency identification are the two most used technologies. Both have their pros and cons. (Hsuan et al. 2015, 119)

Barcodes

Barcode is a passive, machine-readable tag created of high and low reflectance regions containing information about the product attached on. Barcode system was created in 1973 by Universal Product Code (UPC) and are still widely used to provide a common information system for the supply chain. Barcodes are an inexpensive, accurate and reliable system to follow deliveries and identify products. The disadvantage is the requirement of a clear line of sight to be read and that a regular device can read only one barcode symbol at a time, which can be time and personnel consuming. Barcodes can also contain only sparse amount of information, especially compared to RFID tags. The information cannot be altered, which can be both benefit and disadvantage, depending of the case. (Hsuan et al. 2015, 120)

RFID (Radio Frequency Identification)

The basic idea of RFID is to provide a similar follow up system as barcodes do without the requirement for a line of sight, which alone gives various advantages. RFID technology provides also several other benefits and new possibilities compared to barcodes. Even though the technology gives new opportunities, RFID technology hasn't yet broke through widely. (Hsuan et al. 2015, 120) Earlier tags had readability and reliability issues and the functioning rates used to be as low as 80 %. There is still privacy and cybersecurity issues remaining unsolved. (Simchi-Levi et al. 2009, 448) Compared to bar code system, RFID is expensive to implement and maintain, as even the cheapest tags of the market are far more expensive than barcodes, and the follow up system is more complicated and technologically advanced. Implementing RFID requires consultation and adjustment of the whole physical and information flow of the supply chain. For the best possible profit, benefit and transparency of the supply chain it is not enough to just implement RFID technology, but the whole complexity of organizational, technological and business processes have to be adjusted. (Simchi-Levi et al. 2009, 449; Hsuan et al. 2015, 120)

RFID tags emit radio signals usually on one frequency band. Reader defined for the same frequency picks up the signal, showing information, status, or location of the product. Different frequencies suit for different products and environments and affect the reading distance largely. Reader can be fixed, mobile or hand-held. As there are different types of readers for different uses, there are also different tags. (Simchi-Levi et al. 2009, 448)

Passive tags are the cheapest type of tags. They can be stickers or hard-tags. Passive tags respond only when queried by a reader and are normally not rewriteable. Passive tags contain usually a small memory and no power source (Pesonen 2017, RFID).

Active tags are the more expensive type of tags that have an internal power source making them able to broadcast information (Pesonen 2017, RFID). Active tags are reactive to the environment and the data can be altered and updated (Simchi-Levi et al. 2009, 448).

This creates also risks, as the cybersecurity of the tag must be solved somehow. Active tags can be reused several to multiple times. Active tags provide the same time a track-up system, as with GPS-chip they can provide location data. Active tags can also gather information related to the prevailing conditions the product faces during the transport. Analyzing this data can be used to prevent the damage caused to product by condition or inapproriate handling. (Hsuan et al. 2015, 120)

Precisely implemented, RFID provides a flexible, transparent and intelligent tracking system for logistics and supply chain management. RFID can provide real time information of the product location and status independently, without human intervention. This could shorten lead times and trim inventory management processes resulting to higher inventory turn rates and hence reduced capital tied to inventory. Inaccurate manual counting and labor consuming barcode scanning processes can be changed to semi-automatic scanning procedures. The whole shipment can be scanned at once, leaving no change for human error to occur. The tracking system can be implemented throughout the supply chain stages, providing complete visibility of the physical flow from the production line to the consumer. Complete information regarding specifications of each product or production batch can be coded to the memory of the tag and read at any point of the supply chain. Mass customization could reach so a new level as the information of the product is physically attached to it and don't have to be tracked back to the manufacturer. Easily accessed information regarding the product can be valuable for the consumer, resulting to value added and better customer service level. RFID technology has multiple possible applications that could be turned to more responsible, transparent, flexible, cost-effective, accurate and customer-oriented supply chain. The technology itself is still developing and especially issues regarding the cybersecurity, privacy and handling of the big data gathered have to be solved before the technology can widespread across the industry. In the contemporary pace the new technologies are developed and adopted it seen as a problem that this quite old technology isn't still complete and widely adopted. Before being even ready, new communication and follow-up technologies can drive past RFID and make it obsolete. (Simchi-Levi et al. 2009, 452-456)

4.5 Digitization and Digitalization

Conceptual terms digitization and digitalization can be traced back to the early development of computer science in 1950's. Terms are closely associated and due lack of a widely adopted official and exact definition, often not segregated of each other in associated literature, causing misunderstandings.

In Oxford English Dictionary digitization refers to "the conversion of text, pictures or sound into a digital form that can be processed by a computer" (Oxford English Dictionary 2018, Digitization).

Hence, digitization could be described as conversion of analog or manual processes, objects or things completely or partially to electronical or digital form. Digitization occurs on both consumer and business process -level. (Ilmarinen & Koskela 2015, 22) Illustrating examples of digitalization are:

- LP's-> CD-Roms -> Spotify
- Photos -> digital photos -> cloud services to store photos
- Mail -> Telefax -> e-mail
- Document -> Word document

Digitalization meanwhile doesn't have a definition in OED. In context, digitalization is used to determine the increasing use and adoption of digital and automated computer technology by individuals, organizations, industries and countries. (Brennen & Kreiss 2014, Digitalization and digitization)

It is common to refer to digitalization with examples, without a complete idea to determine it. Digitalization is ever widening and covering new innovations as technology advances rapidly. Digitalization has been a topic being discussed of since 1990s, with the promise to reform business, industry and the world as we see it. (Ilmarinen & Koskela 2015, 22-23)

Digitalization doesn't only limit to converting processes from manual or physical form to electronic form, but also converting services and whole business processes to digital or electronical form. Banking and sales industry have lately digitalized and automated their service and business processes, which has led to decreasing need of personnel hence increased profit margins. In highly digitalized nations it is not uncommon to process and adjust civil services such as tax clearances and contact information completely via internet portals, instead of going to solid state bureaucracies. With banking, even mortgage applications are processed completely automated, the only human participation on process being the final checking for errors and validity and signing the form. (ibid., 22-23.)

Relationship of Digitalization and Technology

Digitalization requires technology, but the technology itself doesn't create digitalization. Digitalization drives change in human behavior, market dynamics and business core operations in both macro and micro level. In macro level digitalization affects and changes society, market dynamics, human behavior and economy. In micro level it affects and reforms strategy, services and business models of a single enterprise. Macro and micro levels naturally interact with each other.

Society can enable and encourage digitalization or slow down and disable it from evolving. With its digitalization and innovation a single enterprise can also affect the whole industry, society or even the way of how a customer sees a product or service. One remarking example of revolutionary digitalization strategy is Uber, which rapidly reformed the whole worldwide taxi industry, the vantage point to see a taxi service and the regulations related to human transporting around the world. Uber is also a perfect example of active digitalization. Enterprise using digitalization to change its strategy and the way to earn profit uses digitalization actively. Passive digitalization is adaptation of digitalization to adjust to the transformation of the industry. Uber, for example has forced traditional taxi operators to create applications to order taxi to satisfy the customers and to adjust to the new business environment. Uber has also forced governments to react to change. The business logic of Uber isn't as transparent to tax authorities and in some of its market areas it circulates the regulations and duties protecting accessibility to regular taxi market. This can cause unfair competition, when a party can benefit of remising regulatory responsibilities. With Ubers case it has led to conflicts between traditional taxi drivers and to ban of the company operating its services in some countries, states or cities. (Ilmarinen & Koskela 2015, 23-24)

Difficulty of timing in Adopting and implementing a new technology

With previously presented Ubers case, early adoption of digitalization and new technologies and effectively converting them to functioning business model led Uber to be globally operating company worth of billions in just couple of years. This is an example of disruption and market digitalization (Ilmarinen & Koskela 2015, 51, 65). New innovative companies seem to appear "out of the blue" disrupting business and profit models of traditional players in the market with new out of the box approaches to answer the consumer desire. Competitors play the game with rules of the new digitalized era, not necessarily being tied to old rigid structures, large organization and conventional business logic and -strategy. These new players challenge the old mammoths unable or unwilling to accept the bitter pill to swallow: the rules of the game have changed. (ibid., 65-69.)

In contemporary globalized world technologies do not only spread rapidly, but also develop so rapidly, that it is difficult to make the decision, when to adapt. Especially within large enterprises the digitization of manual processes are usually long and painful projects of months or years, depending of the rate of desired digitalization level and the processes digitized. This causes the problem of being always behind of the newest innovations and technological progress. Implemented digital technologies may even become obsolete during or soon after the project being completed, leading to wasted time and capital, or even lost technological support. (Ernst & Young 2011, The digitization of everything)

Wireless Application Protocol or WAP- technology is one example of technology that was hyped up in early 2000, but unsuccessful due to backwardness of enabling technology. Consumers abandoned WAP because of the slowness of mobile internet and difficulty of using web-browser with mobile phone. The protocol lost its importance in couple of years with companies depending on it losing capital or going bankrupt. WAP was later to be replaced with more successful, effective and integrated technology. Touch screen, development of small, powerful and cheap microprocessors and 4G-technology enabled the usage of mobile internet technology to explode in in 2010’s. Now mobile internet is one of the driving forces and enablers of digitalization. (Ilmarinen & Koskela 2015, 30-31, 61)

On the other side, too slow adoption or denial of obvious need to adopt and implement new technologies or to digitalize and convert business dynamics has put once dominant enterprises on their knees. H&M invested on basis network of stores while the clothing and fashion industry was going online. H&M’s revenue, profit margin and stock trading price nosedived. Something between two last examples is an opportunistic company observing and waiting for the right time and technology to invest on. Watching how competitors success or fail with new technologies. Why to invest today when tomorrow there can be something better on market? This kind of strategy is obviously also risky and dangerous, as the technologies develop all time, and there is never exactly perfect time to adopt them. Waiting and observing for too long may lead to falling so much behind competitors, that getting back on track requires expensive and easily failing adoption with haste. Slow adoption can also lead to consumer dissatisfaction as clients quickly adopt new, benefitting services and technologies as essential part of the product. (Ilmarinen & Koskela 2015, 29-31)

Frameworks for Right Timing

The rapid pace of technological development thus obsolescence creates the urge for right timing when adopting a new technology. Failure in timing can cause but troubles in implementing the technology, significant losses for business. The most important properties to consider of are the maturity of the technology, the risks involved and the competitional advantages involved. Several frameworks have been created to ease the decision making and timing. The S-Curve of Innovation, Technology adoption Life Cycle, The Hype Cycle and ultimately the Gartner’s Hype Cycle are presumably the most used ones. The Gartner's Hype Cycle of Emerging Technologies is used by companies to help in decision making whether it is a good time to invest to a new, emerging technology. The methology created annually by research and advisory company Gartner combines elements of the previous three frameworks. It adjusts innovations to the phase the technologies are on the cycle, helping to evaluate the maturity of a technology for real beneficial business scenario and to point out overhyped technologies facing unrealistic expectations. Information spreading fast among business and consumers, new promising technologies and innovations do gather often unrealistic expectations and hype around them. Even and especially when the technologies are just being explored and developed further. This is the Peak of inflated Expectations in Gartner's hype cycle. During this stage, huge commercial promises being made and early success stories and breakthroughs published. This is the stage, when it is better to observe than acquire. During the Through of Disillusionment the expectations become more realistic and the loudest hype has already shifted towards something newer and more interesting and "promising". Technology is gaining maturity and being developed by considerable producers. The producers with false promises and without real potential have already petered out. Slope of Enlightenment is reached when the technology is becoming standardized and lost its glamour. On Plateau of Productivity the technology is fully mature and harnessed for maximum benefits. (Hector 2018, When to Invest in Warehouse Technology)

Gartner's Hype Cycle is a good framework for evaluating risk factor involved in emerging technology or innovation. Early adoption is always riskier but the payoff and added value can also be significantly better. Waiting longer for the technology to mature is reasonable approach to avoid the minefields involved and to see valid proof for the eloquent commercial speaks typical for new "revolutionary" innovations. However, waiting and observing for too long may turn costly also if the connectivity or accessory to the technology becomes a new essential for clients, partners or for competitiveness. All technologies tend to become obsolete with time and implementing one when it is already close to discontinuity phase may turn costly for a company averse to change. (Ilmarinen & Koskela 2015, 29-31) See below figure 8 of

Gartners Hype Cycle of Emerging Technologies for developing technologies of different phases.

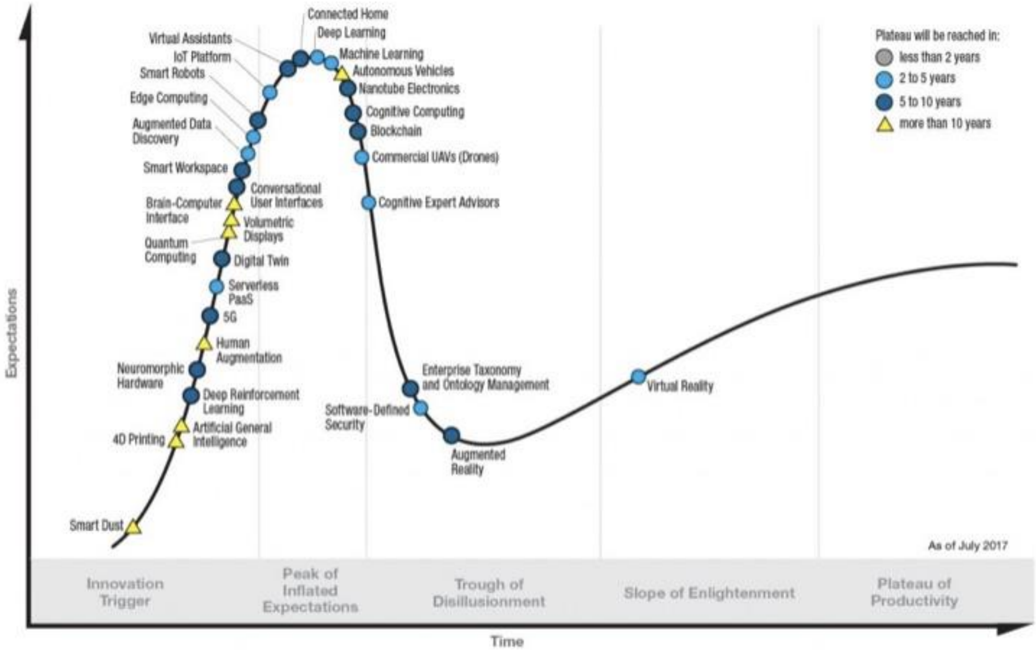

Figure 8 The Gartner Hype Cycle of Emerging technologies 2017 (Panetta 2017)

The Era of Digital Supply Chain Management

The developing digitalization of supply chain processes and activities holds but many different names, lots of potential. The era and state of technological development we are living on is referred to with different names, including third generation of digitalization Ilmarinen and Koskela use (2015, 29) or industrie 4.0 commonly used by German companies. The development of the linked technologies holds the promise to revolution manufacturing, engineering and supply chain management completely. Phenomenon’s are spoken of with eloquent names: Internet of things, Internet of Everything, augmented reality, autonomous logistics, smart warehousing, the blockchain, procurement 4.0 etc. (Strategyand.pwc.com, Industry 4.0). Some of the technologies are already in use within the most modern facilities and digitalized enterprises. According to Gartners studies, 65% of surveyed supply chain professionals agreed that technology is a competitive advantage in the supply chain industry. (Beadle 2017, Gartner) The author has picked the technology seen to hold most potential for supply chain management and coordination applications.

4.6 Blockchain

Blockchain technology came to interest and attention of publicity during and after the Bitcoin gained public interest. The public conversation has focused on blockchains financial opportunities. However, blockchain could have enormous potential if and when the technology is ripe, regulated and proven. Blockchain holds promises to change industries by providing a decentralized, shared and tokenized ledger allowing untrusted parties to exchange transactions. Blockchain could remove business friction by being independent of individual applications and participants (Panetta 2017). Bitcoin and blockchain are often misunderstood and seen as the same thing. Bitcoin and blockchain are not the same. Blockchain is the enabling technology behind Bitcoin, providing the means to record and store Bitcoin transactions. Blockchain technology provides much wider uses and possibilities than just bitcoin. Blockchain provides a digital, shared ledger for recording transactions of any asset whether it is tangible, intangible, or digital. (Gupta 2018, 6)

Blockchain holds the promise to provide a better functioning solution for the exponentially growing transaction volumes worldwide. Contemporary occurring electronical transactions are complex, inefficient and vulnerable. According to Gupta (2018, 4) this is due the following limitations:

1. The time between transaction and settlement can be long.
2. Cash being only useful in local transactions and in relatively small amounts.
3. The need for third-party validation and or presence of intermediaries to verify transaction.
4. Fraud, cyberattacks, simple mistakes, cost and complexity of doing business and the compromise of exposing all participants to a central system.
5. Cost of transactions provided by credit card companies.
6. Requirement of parallel payment system to conduct transactions as half of the worlds population do not have an acces to bank.
7. The limited transparency and inconsistent information hindering efficient movement in the shipping industry.

Conventional transactions require duplicated effort as participants of the network each have their own ledgers and each transaction is verified by authority, intermediate or central system. This creates also delays in agreement execution. The need for a central system (for example a bank) creates the risk of occurring cyberattack, fraud or a simple mistake affecting the whole business network involved. (Gupta 2018, 6)

According to Gupta (2018, 5) Internet of Things will even further explode the transaction volumes globally, when autonomous objects such as refrigerators refilling itself by buying supplies become common. The need for collective bookkeeping solution for ensured transparency and trust, requiring no specialized equipment and no monthly fees is immense.

Blockchain doesn't require a central system, intermediates nor each participant holding own ledger. Blockchain architecture holds the build in ability of giving each participant updated replication of the ledger each time a transaction occurs. Within Blockchain, each node, or participant acts as a publisher and subscriber in the network. Each node or participant is also able of sending and receiving transactions to other nodes and able to view recording of the transactions as each one is synchronized across the network. This is called peer-to-peer replication. The change to conventional transaction systems is that the record is available to all parties, making them all able to see the change in ownership of an asset. All participants must also agree on the validity of the transaction for it to occur. Once a transaction is validated and recorded to the ledger, no participant can tamper with it. (Gupta 2018, 7)

How Blockchain Works

The name derivates of the way Blockchain actually consists of blocks, linked together to form a chain. A blockchain grows with the number of occurred transactions. The network participants agree to the rules how the blockchain records and confirms the sequence of transactions. The recent validated batches of transactions are recorded to hashes, which are digital fingerprints containing a timestamp and the hash of the previous block. The hashes link blocks together, preventing any manipulation of a block or insertion of a block between existing blocks. Each subsequent block of the chain strengthens both the previous and the following block from being tampered (Gupta 2018, 14). Below figure 9 is graphical expound of blockchain.

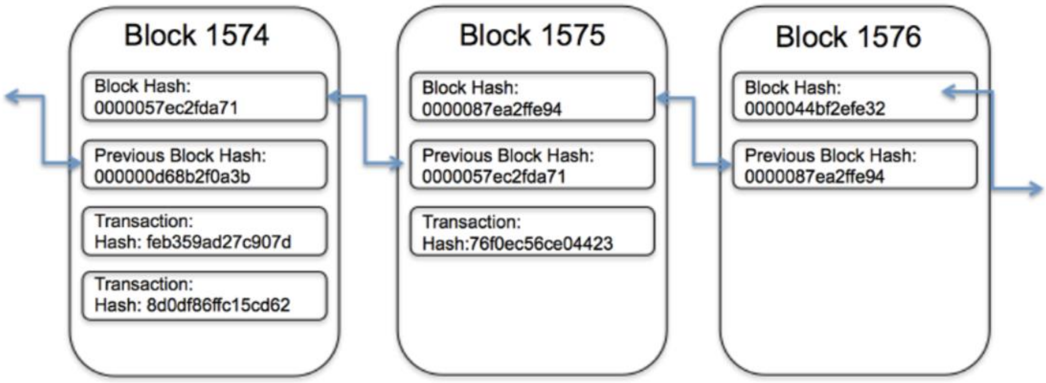

Figure 9 Blockchain blocks and hashes (Gupta 2018, 14)

Blockchain for business

Blockchain can also be built to be private and permissioned platform of known identities, instead of being a public exchange platform of anonymous users like with Bitcoin (Gupta 2018, 14). Blockchain's four main concepts further explain the potential it holds.

Shared Ledger

Compared to traditional ledgers, the shared ledger cuts away the need for duplication effort. A Single shared ledger records all transactions of the business network and is shared and replicated to each participant of the network. Participants are linked to transactions via their identifications and are identified and authorized to view only transactions permissioned to them.

Permission

Permissioned blockchain holds participants each having a unique identity. Each identity is constrained to access only certain transaction details creating the possibility of storing more detailed data in the blockchain. Different authorization groups can be created to prove users broader or narrower range of transactions to view. This is called digital certification. For example: party A and party B can see transaction of an asset they transferred between each other, while party C can only see that party A and party B have transacted between each other, but they cannot see the details of the transaction. A party given auditor or regulator authorization can see the full detail of transactions occurred in the network.

Consensus

Consensus is an agreement, how transactions in a business network are verified and committed to the ledger. There are various mechanisms to implement this. Proof of stake requires certain percentage of the networks value to be held by a validator. Proof of stake makes it expensive to execute attacks and reduces incentives for it. Multi-signature is a mechanism that requires majority of validators to agree on the validity of a transaction. PBFT or Practical Byzantine Fault Tolerance settles disputes among the computing nodes, making the one node in a set to generate different output.

Smart Contracts

A smart contract is a set of rules that executes as part of the transaction on a blockchain. For example, a smart contract can be an algorithm defining conditions on which travel insurance is activated automatically when a flight is delayed more than six hours. (Gupta 2018, 14-17)

Reducing Market Friction

Market friction is anything that impedes the exchange of assets. That can be a cost or a delay. According to Gupta, taxes, bureaucracy, involvement of intermediaries, delays in executing contracts and regulations are all friction. Friction affect different industries in different ways. Blockchain is capable of alleviating the friction. Gupta (2018, 20) mentions three kinds of friction that disturb and slow down market and development. One of a particular interest for Supply Chain Management is information friction. Information friction is a result of following:

Imperfect Information:

All participants involved in a transaction do not have access to the same information. Information isn’t necessarily correct or inclusive, leading to bad decisions.

Inaccessible Information:

Sharing, storing, processing and analyzing data and information is known to hold potential, but technical challenges lead to inefficient and incomplete collection and accessibility to it.

Information Risks:

Hacking, cybercrime and privacy issues are on rise, growing costs and holding the risk for damage to brand reputation. Blockchain could significantly reduce information friction by following properties it contains:

Shared ledger

Information is not held by single owner but shared with lifetime history regarding an asset or a transaction. Ownership, transactions and identities can be validated by participants without the need for third-party intermediate. Access privileges and roles define each participant's access to information relevant for them.

Permissions:

In a closed business network blockchain, each participant has unique identity and to conduct transactions, they must meet certain criteria. Each participant can be sure the person they are dealing with are who they claim to be.

Cryptography:

Permissions and encryption prevent unauthorized access to transaction details and block frauds.

Consensus:

The blockchain doesn't append transactions that are tampered, as the transactions must be validated by checking the previous and following hashes. (Gupta 2018, 20-22)

Blockchain for Supply Chain Management

Blockchain has great potential for the art of supply chain management. Blockchain could make documents, data and information more visible in near real time without the need to reveal ownership or identification related sensitive information. Documents used for importing, like bill of ladings, could be processed much faster. Although a document is accessed by any participant, each party involved in viewing the document could only review and add information regarding on the role and permission rights. (Gupta 2018, 24)

Terminals could so plan and execute their processes earlier, improving efficiency. Terminal authorities could for example only review and process the weight and departure time of a container, not having to worry about privacy issues regarding the ownership. Paperwork would never again be missing, and the delays and additional costs regarding it could be forgotten. (ibid., 24)

Blockchain could revolution logistics sharing and exchanging. Truck fleets, warehouse space, and shipping containers could always roll with optimized fillment rates, as sharing and exchanging space is secure, and information regarding it could be viewed and shared without privacy concerns. Demand forecasting between retailers and manufacturers could be improved for better stock replenishment. Supplier reliability track record could be viewed from the conducted transactions and raw material sources and specifications could be tracked to the point of source. (ibid., 24)

Each year, more than 4 trillion dollars worth of goods are shipped, which of 80% are carried by the ocean shipping industry. It is estimated that the cost for handling trade documentation will reach 20% of the costs for handling the actual physical transportation costs. This is due the variation of different systems for processing transactions each supply chain participant has. Manufacturers, shippers, insurers, banks, customs, border agents each have different systems for processing transactions. This also significantly slows down the movement of physical goods. (ibid., 30)

It is obvious that the shipping process requires streamlining, as multiple legal authorities need to approve a transaction of goods across borders, each individually and usually by using manual, time consuming, conventional methods such as email or paper documentation. The documentation circles between and across customs, port authorities, transportation companies, port operators, bookers, senders, receivers, etc. Figure 10 below demonstrates the circulation of documentation in supply chain management as it is now. (White 2018)

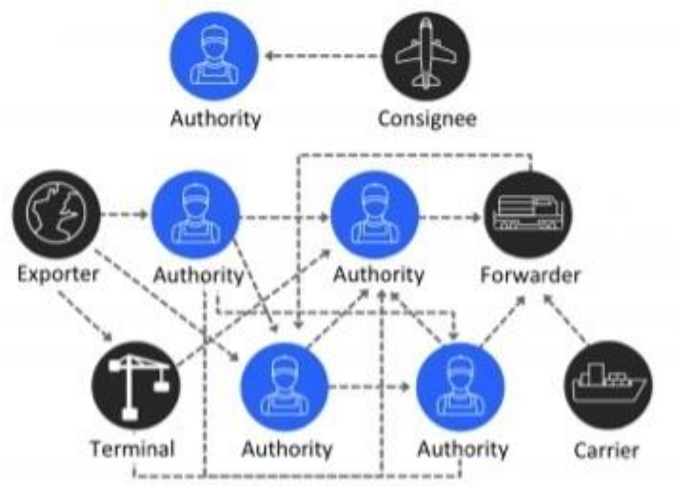

Figure 10 Transferring of Documentation within Supply Chain (White 2018)

The Contemporary Process Holds several disadvantages

1. The complication of the process and the requirement to send same documents and approval statuses on and forth creates long settlement times, delays, errors and disputes.
2. Time consuming manual handling of paper based processes.
3. The inconsistency of the information transferred across organizational boundaries leaves blind spots throughout the supply chain, affecting efficient flow of goods.
4. The messaging involved in the process is cumbersome, time consuming and costly peer-to-peer messaging.
5. The administrative costs of handling a container is comparable to the cost of handling the actual physical transport.

Blockchain could simplify the complex processes into one single process for obtaining multiple approvals from legal authorities, paperless and digitally. This could be done for example with its inbuilt abilities such a creating a single shadow ledger each authority could view and sign for approval. Capital would move more freely, as not being stuck with long settlement times involved in export and import processes. Accountability and trust among enterprises, customers and regulators would also increase with the decreased friction and higher transparency and visibility. (Gupta 2018, 26) The supply chain visibility could reach end-to-end transparency. In future, after adopting blockchain, the process for handling shipping documentation could be more like in the following figure 11. (White 2018)

Figure 11 Blockchain enabled documentation verifying (White 2018)

IBM and A.P. Moller-Maersk have created a co-operation joint called TradeLens to apply blockchain to the global supply chain. The platform is already in use by selected partners that share the interest of developing a smarter trade process. The platform aims to reduce global trade barriers and increase efficiency among global supply chains by connecting the entire supply chain ecosystem via Blockchain. (White 2018)

In the beginning of November 2018 the Chinese port operator Hutchison Ports announced a new project named Global Shipping Business Network (GSBN). The objective of the project is to create a transportation system based on blockchain technology for streamlined processing and handling of shipping documentation. The system will be founded on the principality of distributed ledger system. The international logistics system provider CargoSmart will be responsible of the software. In addition to Hutchison Ports, The CargoSmart GSBN Consortium consists of five vast container shipping companies and four port operators. The names of the companies are worldwidely known: CMA CGM, Cosco Shipping Lines, Evergreen Marine, OOCL, YAng Min, DP World, PSA International Ptde LTd and Shanghai International Port. (Marinov 2018)

5 The Company X Presentation

Confidential.

6 Current State Analysis

First part of the research defines and explains the main processes of the current state of the supply chain from the information flow perspective. Certain points of interests within the flow are highlighted. The transactional processes explained in detail with related process charts are limited to shipments leaving the mill warehouse. However, the research results based on current state analysis cover larger entities of digitalization, traceability and information flow.

Modified process analysis tool is used to aid to demonstrate the system with figures. Data acquired to build the current state analysis and structures has been gathered but by participating observation, also by acquainting to relevance documentation and data already gathered by other professionals and colleagues. Observation also consisted of several visits to enlarge the perspective for understanding the supply chain better.

Author is currently employed as a supply chain coordinator with Pulp Mill 1 as a primary location and Pulp Mill 2 as a secondary location. Author is also responsible for arranging straight deliveries to European mainland from Mill 1 and Mill 2 and responsible for developing logistics processes of the new Port 1 terminal during the ramp up phase. The current state analysis concludes information and knowledge adopted via being involved in the actual position. Authors previous work experience include also working as a stevedore in Port 1 and as a pulp loader in Mill 1's warehouse. Author's wide-ranging view of pulp delivery process can be considered perspective enlarging, and previous work experience as a factor for better understanding of the entity from physical material flow point of view.

During the visits author but participated to daily activities and duties, had tours and discussions with personnel working on the sites. The data obtained through observation, visits and discussions was commit to notes and the learned results led into a journal of a kind. The complete data inventory, further explanation and the sources of data are described in the conclusion chapter more accurately and in detail. In the next chapter the limitation to the research is defined. Also, the differences and unique elements of the Finnish pulp mills are briefly described and their properties compared.

6.1 Limitations of the Research

The current state analysis scope is on Mill 1 supply chain. Mill 4 overseas is completely left out of the study. In the detailed analysis Mill 2 and Mill 3 and their supply chains are referred to in the study mainly for comparison. The reason for this is that each of the three Finnish pulp mills have their unique elements regarding production, product portfolio, warehousing and overall supply chain. Bachelor thesis is quite brief study and it cannot successfully describe supply chain from all three mills perspective in detail.

Mill 1 was chosen for the most precise analysis for several reasons:

- Mill 1 is author's primary working location
- Of the three Finnish pulp mills, author has the longest experience and widest knowledge about the supply chain of Mill 1
- Mill 1 supply chain can be identified as considering most diverse range of differing processes from supply chain perspective as it serves:
    - Integrate's paper mill's two paper machines
    - Domestic customers via trucks
    - Domestic customers via rail
    - European customers via straight trailers
    - European customers via stock transport orders
    - Break bulk volumes from Port 2 and Port 3
    - Far eastern and new market's containerized volumes from Port 1
- Mill 1 has the shortest history of selling out baled production, hence the supply chain has been digitalized since the beginning of production of high amounts of market pulp
- Mill 1 product portfolio is the narrowest of the Finnish mills
- Mill 1 supply chain coordinator processes the most diverse and complex amount of supply chain information due the wide variety in supply chain lead time

Producing and selling out market pulp at the current volumes is quite recent phenomenon for the organization. The only Finnish pulp mill where market pulp has been exported in grand volumes before the rapid growth of export volumes during last five years is Mill 3. Mill 2 used to produce grand volumes of market pulp heretofore but basically only to domestic customers.

From the taken perspective, it is certain that Mills 1 and 2 have more in common with each other than with Mill 3. In Mill 3 far wider range of different grades and baled unit types are produced. Portion of the final products are made only to order.

Mill 3 is located only two kilometers away of Port 4. Mill 3 stock is immediately transported from the baling line to the port stock by a tailor-made skid. Completely excluding mill warehouse put-away process, mill storage stage and pre-delivery from mill stock to port stock is an exclusive benefit for Mill 3 supply chain and especially it's supply chain traceability.

However, as there are differences there are obviously also similarities in the supply chain informational flow within all the mills. Furthermore, certain transactional flows from separate mills, particularly of Mill 1 and Mill 2, unitize during the downstream of the supply chain. The results of the current state analysis are meant to benefit the supply chain on wider scope.

A single bachelor thesis cannot describe the related informational processes satisfactory. Hence it is blatant that the uncharted areas of the last legs of transportation and supply chain transaction and information flow could be studied further in a continuation research. This research also highlights issues not in the scope of the thesis to be examined or researched further.

Before the recent investments of 260 Million euros and effort on debottlenecking, Mill 1 previous function was mainly to provide slush pulp to the integrates two paper machines. See below figure 15 to have better picture of the ratio of baled and slush production change over the last four years.

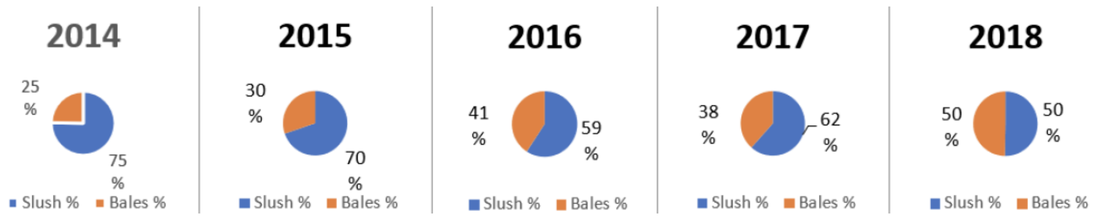

Figure 12 Mill 1 slush bale ratio

From 2014, bottlenecks of the pulp production have been one by one removed. Turning point was the last quarter of year 2015, when the investment on company's most modern pulp drying machine turned into operational production. Culmination point was the year 2018 when final guarantee tests succeeded and the new pulp drying machine was proven to be able to dry the whole production capacity of x t/a of the pulp mill. See below figure 16 for production volume development considering both softwood and hardwood fiber lines.

Figure 13 Mill 1 production development (confidential)

As characteristic to a global push-based supply chains of raw materials, also Company X's supply chain is extensive, complicated and consider wide range of differing, both push and pull-oriented processes and variation in length of the lead time. Especially the long lead time supply chain involves various transportation methods and legs, stock locations, handling of various parties and constant, complex information flow between the sending, receiving and other involved parties involved in the material and informational flows within. Physical flow within the supply chain include all transport modes except airfreight. Below figure presents the information flow relativity in simplified form and roughly states which parties exchange information with each other. The point of the below figure 17 is to show the existing logic and hierarchy behind the information flow process. A deduction can be made that certain parties involved are not to exchange information with each other. Naturally exceptions occur.

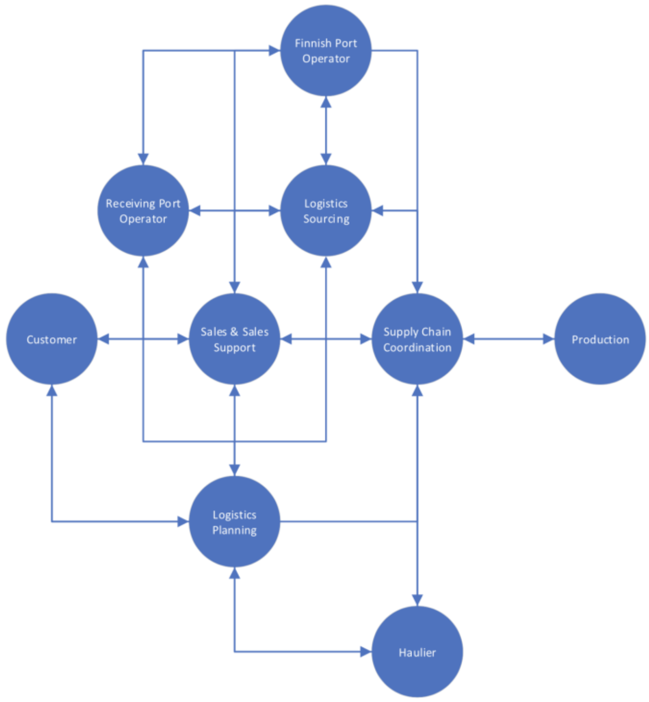

Figure 14. Roles and relations involved in the information flow of this thesis scope

6.2 Supply & Demand Planning and Steering

Pulp is a raw material and the supply chain is driven by speculative short- and long-term forecasts of the customer demand. Sales and operations planning contribute for the forecasts and balancing. Business support managers steer and harmonize the complexity on higher stage for the best mutual contribution and benefit. The forecast frameworks are annual and monthly. The Annual forecast is likely to go through various changes during the year and is more of a guideline to production and sales. The last years the annual forecast has been oversold because the global pulp demand has been higher than the global production capacity. For a push-based supply chain this is the favorable situation. Overselling has lifted the pulp price to new records in all markets on 2018.

On monthly basis the stock level is monitored and balanced. Actions are taken if the stock seems to be rising or decreasing beneath acceptable level. In addition to the annual and monthly forecasts, weekly skype-meetings are held to discuss the development of stock levels for different grades within the supply chain. Weekly meetings function also as a forum for the global supply chain and sales professionals to debate and keep up with the recent actions in the market and production. Pulp supply chain can never completely accurately success in forecasting. This leads to constant general uncertainty within the supply chain and creates the following attributes characteristic to a push-based supply chain:

- Bullwhip effect
- Supply chain inefficiency
- Lack of transparency
- Hidden inventory levels (customer stocks)
- Excessive inventory levels
- Long lead time
- Extreme complexity of the supply chain
- Rapid and exaggerated changes in market

The current supply/demand balancing tool is Integrated Business Planning tool. The IBP is a excel based cloud interfering tool and has been taken to use on December 2018. IBP would be extremely interesting and valid topic for this thesis also to discuss, but as the implementation has occur quite recently, IBP is left for very little consideration within this research. However, the affect IBP has on the organization's supply chain transparency and effectiveness, could be studied further when there is more data available of the affect. Currently Both sales and production professionals use the IBP which's objective is to:

- Internal supply chain transparency
- Supply/Demand balance adjustment on weekly level
- Visible effect of the made adjustments through heuristics
- Provide common, internal tactical planning tool for production, supply chain coordination and sales

6.3 Production process and Integrate Information Flow

Pulp mills make the product to stock. Production is continuous regardless of the market situation. Production shut downs are costly and to be avoided. But the physical flow of the products, also the informational flow of transactions from the mill must be continuous. Issues and unpredicted maintenance occur but the production rate and the quantity of tons the pulp mills are able to produce daily are more or less stable on the big picture. Friction to normal productional amounts lead to need of rescheduling and redirecting deliveries. Plans, calculations and the information shared to the external partners is based on stable production.

The amount of baled production though can vary greatly depending of the integrates pulp consumers. This occurs especially on Mill 1. When the both of the integrate paper machines are running they consume approximately 50 % of the mills pulp production capacity. The rest is baled. However, the transparency to the running rates of the internal client's paper machines is not transparent and the communication with the neighbor is complex and indirect due organizational barriers. Shutdowns of the paper machines are commonly informed to supply chain coordinators within short time window. Shutdown of both integrate paper machines double the daily production of baled units. The total warehouse capacity of Mill 1 is limited. Hence, paper machine shutdowns create a bullwhip effect on small, local scale, as the push process from the mill must be tuned up as suddenly there is an urge for extra transportation and stock handling capacity. The opposite affect occurs when a paper machine prepares for producing heavier wood free paper qualities. Within these situations baled pulp production drops or baled units have to be pulpered from pulp mills warehouse. Supply chain coordinators receive this information normally one to three days before the planned production.

It is important to denote that the warehouse is never empty as there are customers to be served directly from mill warehouse. With these cases a make to order supply chain can be identified within the push- based supply chain. Mills with integrated paper mill have the responsibility to keep a safety stock to secure the run of the paper machines. Mill 1 has to hold the integrates pulp safety stock for the situations when the pulp mill cannot support slush pulp to the paper mill. During these situations baled units are pulped and delivered to the paper mill to keep the paper machines running. Paper supply chain is pull-based making it priority what it comes to following the production plans.

At Mill 3 the external integrated paper machine consumes around 25 % of the pulp daily pulp production. However, the transparency to the operating rates is significantly better as the company buying Mill 3 slush is an external customer. Transparency is also necessary within Mill 3 case as the whole supply chain from Mill 3 is more of a pull-oriented supply chain and the push-pull boundary is closer to the production. Due the wider product portfolio and significantly different supply chain Mill 3 produces greater amount of the production to order instead of to stock.

At MIll 2 the integrate single papermachine consumes approximately 5-8 % of the pulp production making the production fluctuations a minor issue. Mill 2, however, holds pulp buffer stock for other internal paper mills.

Each of the mills have different product portfolio and the amount of different baled units vary per mill. Mill 1 and Mill 2 are more similar also in this perspective. Mill 1 product portfolio consists mainly of four different primary class baled units. which are:

- Hardwood pulp domestic bale
- Hardwood pulp wrapped standard bale
- Softwood pulp domestic bale
- Softwood pulp wrapped standard bale

At Mill 1 there is only one pulp drying machine which dries both soft wood pulp and hardwood pulp. Which type of pulp is dried changes in cycles. When the level of the container storing the pulp mass of corresponding wood type reaches certain level, the drying machine starts taking mass from that container, adjusts the drying process and starts to produce corresponding bales. At Mill 2 there is one pulp drying machine for soft wood and hardwood pulps. At Mill 3 there is one pulp drying machine for soft wood and one drying machine able to dry both softwood and hardwood pulps. The cycles of which pulp type is produced create its own management process at Mill 1 what it comes to production and supply chain coordinating.

Daily Production Planning

Supply chain coordinators plan the daily baled production with the support of the mill personnel. Supply chain coordinators plan and make bookings for the pre-transportation from the mill. Due the differences in product and customer portfolio there is variation in the planning processes and especially in the planning timeline length. Roughly Mill 3 can plan and implement monthly planning, Mill 2 weekly planning and Mill 1 daily planning. The large variety is result of various differences:

- The differences in production processes
- The difference in infrastructure
- Mill specific product and customer portfolio
- The difference of the supply chain lead time

The length of the possible planning time horizon is a two-sided blade. Whereas possibility to plan only short period of time in advance creates ambivalence of the delivery processes, it also adds flexibility. Especially tight planning made on long time horizon is more fragile to sudden productional issues and delivery issues. As long as logistics partners have transporting and warehousing capacity available on short notice the uncertainty can be managed.

The core reasons leading to the uncertainty at Mill 1 occur due mill warehouse and railroad infrastructure and inter-organizational barriers. At Mill 1 the possibility to plan the production for longer periods of time in advance could be arranged with better transparency to the paper machine operating rates and production cycle planning with investments to development of warehousing and material handling capacity.

6.4 The Finnish Ports and Port Operators

Port’s play crucial role in the pulp supply chain. This is natural result of Finland’s geographical location. Generally speaking, all Company X's Finnish pulp export volumes flow through seaports at some point of the supply chain with deliveries to Russia being an exception. However, the Russian market is marginal at the time written. The volumes of Mills 1 & 2 are pushed to Port 1 and Port 2 and from the corresponding port to the next leg of transportation. Port 2 is used for break bulk volumes and Port 1 for containerized volumes.

Mill 1 and Mill 2 port operation is to be completely centralized to new Port 1 terminal. The new terminal is designed for pulp storage and handling right from the beginning. A supporting pier for break bulk loading is under construction. Concentration of volumes to a single port is a strategic move and will significantly streamline the supply chain complexity and information flow. However, Port 2 will be used for break bulk volumes until the new terminal is completed.

Currently Mill 2 delivers production volumes via road transportation whereas Mill 1 uses both rolling stock and road transportation. In Port 2 generally one storage location is used. Certain spot volumes are stored to another warehouse, but these volumes are irreregular. Mill 3 uses the Port 4 located only two kilometers of the mill. Port of 4 is currently only capable of handling break bulk volumes. Volumes to be containerized are transported to the Port 5.

6.5 The Transaction Flow Architecture and Current IT-tools

The current information system architecture operating behind the pulp supply chain is complicated and the complexity causes issues from time to time. The system landscape and the tools supporting the information flow have been built when the pulp transaction flows were significantly lower. Various of the communication components and applications have been originally planned for other business segments such as paper and plywood. These applications have been then tailored for pulp supply chain information flow. As not originally planned for pulp hence push oriented supply chain, these tools are not the most functional for current use. Below figure 18 shortly explains the functions of these applications most important for understanding this research.

Figure 15. Pulp IT applications and tools (confidential)

Below figure 19 gives a better view to the system landscape chart. The chart is currently up to date and in use until the new ERP-system is integrated to use. The figure's purpose is to demonstrate the complexity and the amount of different routing applications operating behind the scenes.

Figure 16. System integration Landscape (confidential)

The operating IT-system and tools available for supply chain coordination do not support the current transaction flow. The results are frequently occurring, hardly tracked and manually corrected errors, which often require IT-professionals interference. The supply chain informational flow leans on manual information sharing, executed via email, skype and mobile phone. The current transaction flows are too high to be functionally supported by manual information sharing.

The production and sales ERP-system for pulp is SAP-based. The current warehouse management tool is still functional, but rigid and certainly it is not made for the current amount of transactions. It converses with the ERP-system and is used for warehouse management purposes and to design information printed on waybills and to create loading orders and loading instructions for mill warehouse personnel. Warehouse Management tool has also a visual view of the mill warehouse layout. Recently also a new layout for Port 1 warehouse was created. See below figure 20 warehouse management tool's Mill 1 and storage bin batch view and figure 21 for warehouse management tool's loading order view.

Figure 17. WM-tool's mill warehouse and storagebin view (confidential)

Figure 18. WM tool's loading order view (confidential)

The created loading orders are visible in loading platform. The Loading platform is ERP terminal used for mill warehouse storage transactions, inventory management and for creating pulp shipments in ERP system. Shipments are manually created in loading platform which forwards the deliveries and waybills to logistics systems and to logistics partners with existing EDI-connections. It is also used to print the waybills. See below figure 22 for loading platform terminal view with the same loading orders visible that are opened in warehouse management tool.

Figure 19. Loading order view (confidential)

The current IT-tools in use do not provide a functional tool for supply chain coordination to manage and book transportation, to follow up the port stock, STO allocations nor existing customer orders to be fulfilled from the port stock. Due inexistence of supporting tools for stock and transport management, supply chain and sales professionals use Microsoft Excel based ledgers for port stock level and order execution monitoring. The excel ledgers are manually updated. Inserting and updating information has to be extremely careful to avoid human error. Each mill and sales team have developed their own way to plan and follow up the supply chain operations and designed their own ledgers for the purpose. There is no harmonization of the information flow process towards logistics partners and each mill team have their own manner to coordinate supply chain information.

Pulp supply chain professionals do not have a transport management system (TMS) in use. Transportation is booked either via email, phone or with rolling stock, via external portal. However, electronic data flow towards logistics partners and the port operators exists. Data is transacted from sales ERP-system via master data base (MDB) with parameters converting the message readable for the receiving party's WM- or TM-system. Waybills and invoicing information flow through EDI- connections and to System Y, which is operated by Logistics Sourcing professionals. Standard costs and routes, hence master data is also updated by the same team. See appendix 8 & 9 for a more detailed information flow. See figure 23 below for detailed information of invoice and package data flow between pulp-ERP and logistics systems.

Figure 20. Logistics invoice and package data flow (confidential)

The current automatic electronical message flow of EDI-messages to receiving systems is sensitive to human error. The error frequency is high and the errors are informed and fixed manually. Most of the errors in invoicing or disrupt flow of information are caused by incorrectly typed information in the very beginning of the delivery process. This beginning is loading platform terminal, which is operated by mill warehouse personnel on a laptop integrated on forklifts.

6.6 Process Categorization

From supply chain informational point of view, the following different processes can be identified. Execution of the below processes involve but various different internal specialists, logistics partners, and transportation modes, a complex exchange of information between these parties. The below processes bolded are each described on devoted chapter with corresponding process chart. The process charts have been added as appendix to the end of this thesis. The process charts are examples and hence simplified generalizations. The related process chart to the serial 2 is an example of stock transport order for APAC-sales order. In addition to this, there are multiple different variations of stock transport order process flows. Processes marked with red color are not described due the fact, that implementation of IBP-tool has made changes to the information flow of planning the implementation of these processes. These processes are hence currently under constant change, the objective being more fluent communication and information flow when executing these processes. The descriptions focus on supply chain transactional flow and to exchange of information. The function is to highlight current problems and barriers for information flow. Occasional issues out of the research scope are also highlighted if seen valid. Furthermore, some problematic parts of a process flow are described with proper charts.

Table 1 Delivery process Categorization

Serial	Process	From	To	By	Appendix
1.1a	**Sales Order**	**Mill**	**Domestic customer**	**Rail**	**1**
1.1b	**Sales Order**	**Mill**	**Domestic customer**	**Truck**	**2**
1.2	**Sales Order**	**Mill**	**Customer on European mainland**	**Truck**	**3**
2.	**Stock Transport Order**	**Mill**	**Port**	**Rail Truck**	**4**
2.1	Sales Order	Port	Customer	Vessel	
2.2	Sales Order	Port	Customer	Container	
3.	Stock Transport Order	Port	European port	Vessel	
3.1	Sales Order	European Port	Customer	Rail/Truck/Barge	

6.7 Sales Order and Stock Transport Order

The informational flow processes when and after the pulp is loaded to a transportation vehicle at a stock location are of the most concern of this study. From information flow and material flow perspective two different main process categorizations can be identified.

Table 2 Delivery process generalization

Process	Abbreviation	Standard Categorization
Delivery for sales order	SO	Pull oriented material flow Push/Pull boundary close to production
Delivery for stock transport order	STO	Push-based material flow Push/Pull boundary close to customer

Both SO's and STO's are created in the sales ERP-system. In general sales support co-ordinators create SO's and supply chain coordinators STO's. SO's are deliveries to customer from a stock location. SO's result to actual invoices hence financial flow. See below figure 24 for a simplified view of delivery for sales order.

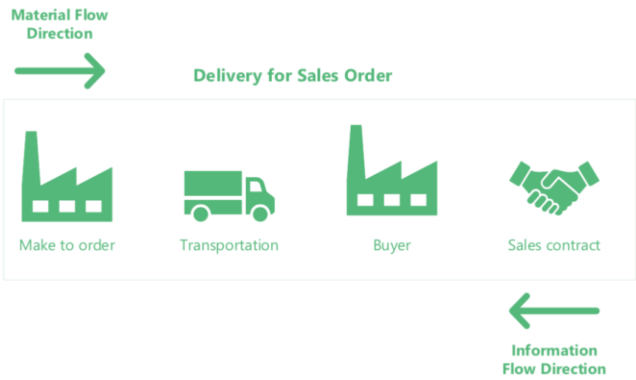

Figure 21 Delivery for sales order

Stock Transport Order

STO's are used to transfer stock in system from a storage location to another, hence information flow only. Mainly STO concerns delivery from mill warehouse to port stock via rail or road transportation and from sending port stock to receiving port stock via break bulk vessel. STO's are then divided from stock location against customer orders. Below figure 25 is a process example in which the first stock transport order is delivered from mill to port stock, second is created and shipped from sending port to receiving port and finally allocated for single or various sales orders.

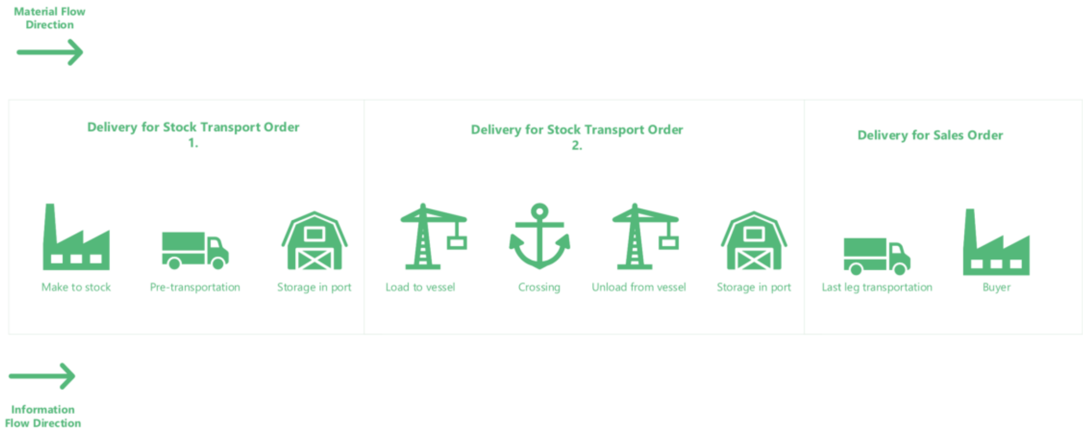

Figure 22 Stock transport order

In the ERP-system and warehouse management system a stock transfer order (STO) is a sub process to be able to follow up the delivery, to have information of the production batches delivered and to have a manageable amount of product to be allocated for the next delivery leg. It functions the same way as a sales order, but instead of a customer the receiving party is a port operator or external storage location and hence no financial flow is included in the process.

Road and rail transportation are the possible methods to deliver the pulp to port stock. The transportation method used has to be known when creating the STO. Only either method can be used for each created STO. Each STO contains only one type of pulp and is delivered and stored into predefined harbor and stock location. If the STO is delivered to stock without knowing yet for which customer it is allocated the amount for the STO is created depends of the size of the receiving party's warehouse bin. Standard process is to fill each storage bin with a single STO. This is to avoid mixing of STO's for better traceability and information handling. If there's already an existing customer order for the STO it simplifies process to create the STO for the desired amount of the order.

STO's are always created for a certain amount of pulp bales or tons. The amount and properties of the STO depend on several factors:

- Transportation method (truck, train, vessel or container)
- Pulp grade
- Receiving harbor
- Receiving warehouse bin
- Delivered to stock or delivered for order
- Transportation method of the following transportation leg

STO could be seen as a creational informational handling unit containing specified amount of pulp units to ease communication and to have a manageable informational unit in the system. In the system STO has an identification number of six digits. It is important to denote that each STO exists only as long as it is in the port stock. When further transported within the supply chain a certain amount of units or the whole amount of the STO is allocated for customer orders. If the whole amount is allocated the traceability is extended as if the STO is divided, the pulp units delivered physically and transacted in the system do not necessarily match. As neither the ERP-system nor warehouse management tool provide functional tool for warehouse management and order allocation, all external stock inventory levels and allocations for sales orders are managed with Microsoft Excel based ledgers. Microsoft Excel is a functional tool for stock management and allocation when there are only few, well communicating users updating the same ledger and the complexity and amount of transactions flown is decent. However, with the current volumes, supply chain complexity and necessity for various users inserting information in tandem, Excel based ledgers are outdated and not capable for handling the information.

6.8 Information Flow of the Stock Transport Order to Port Stock & Delivery by land to Customer

The informational processes of the so called predelivery to external stock location and a straight delivery against SO via land transportation are very similar with each other. Hence it would be irrational to explain the same processes repeated. This chapter explains the informational flows of serial 1.1a, 1.1b, 1.2 and 2.0. However, for each process, a proper process flow chart is made.

There are some exceptions, but generally the delivery process involves only one transportation mode. Integrate slush pulp is delivered via pipe systems. For bale deliveries the transportation mode is either delivery by rail or delivery by truck. With domestic customers, all three modes of transportation are used whereas all straight deliveries from mill to European mainland are implemented by truck.

Stock Planning

Mill 1 produces only four different products regularly and the production planning is rather simple. After the customer order is taken the production is planned to respond the demand. Usually the customer order is anticipated as the domestic demand per customer is highly constant and there is corresponding pulp available in stock. For several customers a stagnant safety stock of baled domestic units is kept in Mill 1 warehouse. Even though constantly keeping an excessive inventory on hand increases costs tied to the stock, currently this is the only possible solution.

The approximate anticipated volumes to be delivered from port stock are input to the sales forecast by the sales managers and sales support coordinators. Supply chain coordinators use the sales forecast for rough estimation of the volumes to be produced as export units and to be delivered to stock in port. Only minimal amount of export units is kept on the mill stock due the limited warehousing capacity. The export stock is pushed to harbor warehouses at as early stage as possible due the mill warehouses lacking capacity, equipment and the role of serving domestic customers only. Warehouses at the port function as actual storage locations except with domestic volumes.

Information Flow of the Daily and Weekly Order Volumes

Proportion of the domestic customers are internal. However, the information flow is mostly manually processed hence time consuming, even with the internal customers. The daily and weekly orders are placed and informed to supply chain coordinator by email, skype or by phone.

Especially phone is problematic as it doesn’t leave any track nor evidence, if errors or misunderstandings occur. In this instance email is better as it at least leaves some concrete evidence. At Mill 1 the arrangements made by phone are confirmed via email afterwards just for this instance. Both manors are however obsolete considering the current transaction flow. These manual manors are also inefficient, time consuming and sensitive to misunderstandings and human error.

After the customer has placed the weekly or daily consumption plan, supply chain coordinator confirms the feasibility. Generally, if there isn’t major productional issues and or very low stock the plan is feasible. If the corresponding mill cannot answer to the demand the volumes are allocated to another mill able to satisfy the customer demand. Corrections are often made to the placed daily delivery orders, as customers also commonly lack sufficient warehousing capacity for raw materials and use pulp from several sources.

Changes in placed orders of daily and weekly volumes always have to be informed manually via email or phone call to the haulier and the mill's warehouse personnel. Changing occurring plans is time and resource consuming, includes manual information sharing and may cause extra expenses. The culture is that changes made by the customer representative are always accepted, if still feasible to implement. Though resource consuming, this is good service level towards customer and necessary, as stock outs of raw material are out of question with paper, tissue and cardboard mills. However, it might be irritating towards logistic partners as they have the information last and have to react to demand change with the least time to reschedule.

Delivery to a Domestic customer

The delivery process for a straight land delivery to a domestic customer is the simplest and possesses the shortest lead time. The domestic orders to ERP-system are created either as scheduling agreements or as normal customer orders. Sales support coordinators create the orders to ERP-system and inform the order references to supply chain coordinators via email. When order reference is received from sales support coordinator, the loading order is created in warehouse management tool. See appendix 1 & 2 for the corresponding process charts.

Delivery to a European Customer

The straight deliveries to European mainland are created to ERP-system as consignment stock orders or normal customer orders. The European customers taking their order via land transportation normally place their orders at least one week in advance. For the European customers buying market pulp without special requirements, there are basically always a decent amount of hardwood and softwood wrapped standard bales available at Mill 1 warehouse. This is due the fact, that all market pulp production can never be loaded straight from the conveyor into rolling stock wagons. The benefit is that it makes it possible to respond even to customer orders placed on very short time of notice. See appendix three for the corresponding process chart.

Delivery to Port Stock

Delivering pulp from mill to stock in port is a frequent process of the push-oriented pulp supply chain. Mill supply chain coordinator plans the implementation of the pre-delivery of a STO via rail or road transportation to port stock. With SO's the delivery point of the SO has been agreed to with the customer when the contract has been made. Delivery terms are based on incoterms 2010. The agreed incoterms determine the implementation of the transportation. See appendix four for an example to stock transport order delivery and allocation.

Road Hauliers

The Company X doesn’t own any road transport equipment and has outsourced all road transport services to external hauliers. The Company X doesn’t rely only on few service providers, but instead uses variety of them.

Within Company X regular volumes the service providers are monitored using key performance indicators and tendered by management every two years. Irregular spot deliveries are tendered from market with more flexibility, and spot deliveries are invited to bid by specialists or managers. Both domestic and international shipments are implemented via road freight. International road freight is mainly intermodal. Straight road deliveries to European mainland are loaded to trailers at mill or in special cases at port by the port operator. Road transport haulier takes care of the multimodal transportation of the trailer.

Supply chain coordinator makes the query for transportation based on the agreed delivery terms of the sales agreement. Transportation is inquired and booked either via email or mobile phone considering road transportation. The right amount of trucks is requested from the logistic partner assigned for the route. Currently most of the domestic routes are assigned to single haulier.

The Finnish Railroad haulier

The Finnish railroad freight has been opened to competitors various years ago. However currently a single railroad operator is still in principle the only Finnish railroad operator capable of handling massive freight volumes via rail. The Company X and forest industry in general have long history of co-operation with the railroad operator as forest industry relies on efficient and cost-effective transportation method to deliver massive volumes to and from its mills from a distance.

For rolling stock deliveries the empty wagons and the shunting-operation is ordered via a external portal provided by the railroad operator. The delivery schedule and delivery point for loaded wagons is also input to the portal.

Warehouse Personnel Instructions

After the query has been confirmed the delivery plan is written to loading instructions to be sent to the warehouse and baling line personnel. The loading instructions are delivered either via email, via internal portal (pulp diary) or printed and delivered to the personnel. It is also common to share acute and more detailed instructions via mobile phone. Loading and production instruction is made daily and normally delivered to the mill personnel within the last office hour. There is variation how to implement daily printed work instructions between Mill 1 and Mill 2. For weekends and national holidays the loading and production instruction is made for all corresponding days when the supply chain coordinator is out of office. At Mill 1 and Mill 2 the loading instruction is made on a excel sheet. Mill 2 instruction is more standardized but relentless whereas Mill 1 instruction is more flexible and adjustable for current situation on hand.

At Mill 1 the production instruction is more of a guideline as the production cycles of hardwood and softwood pulp are irregular and the insight to the quality changes is informal. Furthermore, the railroad wagon shunting doesn’t function on agreed schedules, which makes it impossible to plan wagon loading on detailed level. The reasons affecting the issues are complicated and there is not a single factor, but several. This is not on the scope of the study but should be further studied. The inefficiency however affects the pulp supply chain functionality and information sharing by implication, making the supply chain planning insecure.

Informational Flow of Loading and Delivery Process

Each bale transported physically must be transferred in the system also. Direct SO's are created by SSC's. SCC's create STO's for each pulp quality grade in ERP-system. All pre-tranportation flow in the system as shipment as works (SAW). For direct truck delivery SO's invoicing information flows to OTM and is processed either manually or via e-invoicing within logistics sourcing team. STO waybill information flows as EDI-messages to OTM for invoicing and to receiver as package information. For each directly delivered SO and predelivery STO delivered from a mill stock, a corresponding loading order and instruction has to be created in WM-tool.

The created loading instruction is then shown in loading platform terminal. The supply chain coordinator adds the storage bins to the loading order and writes instructions how to execute the loading to be shown also on the terminal. These instructions concern normally the amount and grade of baled units to be loaded per delivery and how the unloading is done in the receiving warehouse. Some special info can also be added, but the space to write instruction is short. Normally special instructions are either written on the daily updated loading/ manufacturing plan or told to the warehouse personnel via telephone. Supply chain coordinator inputs the information shown on the waybill to be printed after each delivery is finished.

Warehouse personnel select the according loading order of the list on loading platform when loading pulp to a transportation unit delivering the pulp. Within the loading platform the pulp loader manually inputs each bale loaded on vehicle independently. The unit batch number is read from the edge of the pulp unit with sight. Vehicle register-plate or wagon identification code is written to the terminal manually. Current time is updated from the system. The transport company is either chosen manually from a list or automatically updated. Automatic input occurs if the vehicle identification number has been previously been loaded at the warehouse and transported cargo for a transportation company. In these cases, the ERP-system remembers the registration number and connects it with a transportation company for which the current truck has been driving for. However, lease trucks tend to serf for various companies hence creating frequent errors in invoicing and waybill creation. If automatically filled from the system, the pulp loader has to be sharp-eyed to notice the error and correct it manually.

With railway wagons the identification number of a wagon have to be inserted correctly to the terminal for fluent flow of the EDI-message. If the identification number is written incorrectly the EDI-message doesn't flow between the systems and requires manual intervention. If the waybill isn't corrected the transaction of the pulp units doesn't flow in the system to the receiving party with whom an EDI-connection has been created with. Furthermore, invoicing cannot be done, and in some cases the railway wagon cannot even be delivered from the railroad-yard. Especially the HAINS-wagon's identification numbers are long and complicated consisting of 12 digits, making the errors occur constantly.

All errors within waybill creation have to be later corrected manually in ERP-system by supply chain coordinators for valid invoicing information flow at latest by the end of the month. Errors are often hard to trace and fix when time have already passed. Each corrected error has to be manually informed to logistics invoicing, haulier, and the receiving party. Fixing error the pulp loaders have made in the ERP-system consume significant amount of a supply chain coordinators work time reducing time to do tasks that could create added value.

Information Flow After Completed Delivery

After the vehicle or railway wagon is fully loaded physically and in the system the delivery is completed on loading platform the electronical waybill is created to system and printed physically. In the system the waybill transaction is sent to logistics invoicing and to partners with whom an EDI connection has been created. Surprisingly with internal customers there is no electrical data exchange. Internal customers request information regarding deliveries and this is sent to them manually via email. There is variety on the requested information depending of the customer. Several customers require each waybill to be sent to them. Some request also a delivery report to be printed from ERP-system and sent to them. Some request both. Waybills have to be sorted, scanned and sent to customers each morning the day after delivery. For deliveries executed during weekend the waybills and delivery reports are sent on Monday. Supply chain coordinators deal with this manual, laborious and time consuming effort.

Printed waybills are also scanned and sent via email to various customers of European mainland. Customers request waybills to be able to better anticipate the arrival of the delivery, as there are no automated tools to follow up deliveries. Hauliers delivering intermodal freight to European mainland also constantly fail to deliver the original waybill to the customer and the waybills are requested later via sales support coordinators. Certain European customers also request quality information report from the ERP-system to be sent to them via email.

Informational Flow to the Port Operator

During normal situation both the physical and informational flow to and with the port is constant and continuous. When a new STO is created and the deliveries against it are about to start, the port operator is informed via email. The email contains information of the port stock warehouse location used for storage, the grade of the units delivered against the STO, the transportation method, the size of the STO and the approximate volumes and arrival dates. When the STO is finished, port operator is informed of the actual tonnages delivered in system and the matching of actual physical tonnages is checked. Even though the information flow is mostly manual, the information flow works pretty well as it is when there are no errors. There is also automated data transmission between the Company X and the port operator's systems, but the interference isn’t always seamless. The waybills and the delivered bales flow to port operator's system also. However, problems occur often and especially problematic are the errors in typing wagon identifying numbers to loading platform. An error of one digit causes the leaving ERP message to get stuck.

Traceability

The friction begins from the baling line conveyor. The connection between the productional system and the ERP-system doesn’t function as it should, which creates cumulative error in inventory accuracy. See appendix five for the issues leading to inaccuracy of the packing list and actual bales delivered to customer. The current state of traceability is problematic, as customers are more aware of traceability and receive it from other producers.

Especially the best paying customers are constantly more aware of the fraud in the packing list and the actual delivery. These customers use pulp for more fragile and demanding final products and have special requirements for the pulp quality and specifications, such as impurities or the brightness grade. Consumer market is getting more diverse and new uses for pulp are being constantly researched and tested for. Certain final products require pulp batches especially produced with certain properties not produced as mass production. Instead of a mass product, these customers buy a premium tailored product. Naturally making more tailormade products is a shift towards pull-oriented environment.

Customer paying for premium product naturally wants to be sure to also receive a premium product. If the packing list containing pulp property specifications fails to prove this, customer cannot be sure he gets the product he has paid for. Customer pays the premium price to be able to adjust the process recipe to the be most suitable for their final product, hence gaining savings by having decreased need to adjust the process and add filler materials.

Current Model to Support Traceability

Currently a certain state of traceability and reliability of a delivery can be reached by time consuming micromanagement, constant communication and monitoring and laborious manual information processing. See appendix 5 for the current process of added traceability of the pre-delivery. Important to denote that the process is still fragile to the possibility of human error. As can be seen, from the process chart this model is more of an exception how the actual delivery process is implemented. The process is a pure make to order process, and as the whole supply chain and supply chain information system has been made for make to stock product, there is a conflict.

As significant amount of the pulp is transported in masses to port and divided for orders there, the traceability issue must be tackled also when delivering from the port warehouse. See appendix six for the issue within delivering from port. The distortion presented in appendix six, caused by randomly nominated units in the port operator's system, was examined further and solved during the implementation sessions with co-operation of the stevedoring foreman and forwarder.

Mill 3 is an exception to traceability due completely different process for putting the final product to stock. For Mill 1 and Mill 2 instead the possibility to support both push and pull oriented systems from the mill warehouse is complex and requires significant amount of manual work and information sharing. Within make to stock process there is naturally an effort to try to match the packing list, but this is barely a theoretical attempt. The manual work consumes resources and reduces the cost-efficiency, decreasing the benefit gained of better paying customers. RFID or a similar tool with supporting IT systems is a necessity for the business to be able to provide the traceability on the level the market requests. And this is only one small portion of the benefits traceability brings. More will be stated in the conclusion chapter.

7 Research Results

7.1 Digitalization

The development of the technologies made to support and digitalize the supply chain information flow has been tremendous during the last decade, and the pace of this development is invariably becoming more rapid. Not so long ago, the question used to be whether to invest in digitalization or whether to continue processing information manually.

Now the questions are when to invest, to which technology, how much it will cost and what the project schedule is. Moreover, the implementation costs are underestimated, and the results and benefits vary.

Currently various developing technologies, such as the blockchain, IoT and 5G technology have gained incredible amounts of interest within various business and technology segments, including supply chain management. According to business and technology publications and consultants, all of these technologies hold the promise of significantly improving the supply chain information flow, coordination, transparency and of even making the supply chain information flow highly automated without the need of human interference. However, when the interest in the emerging technologies is extremely high, it is easy to go along with it and forget that these technologies still have various issues to be solved before being able to benefit supply chain management, for instance.

Furthermore, Company X's supply chain information system is going through enormous changes in processing the supply chain data. The rapid growth of the pulp business, which has turned the segment into the best part of the whole company has made it both possible and necessary to build a completely new digital core. The taken direction seems correct, and the project teams behind the digitalization projects have been gathered from different stages of the supply chain, giving a wide perspective for considering the crucial elements of a digital system for a streamlined supply chain information and transaction flow.

The business unit has decided to invest in technologies that have already bypassed the phase of unrealistic expectations and that can already be considered mature technologies with empirically proven benefits for cost efficiency and added value. For example, other pulp producer decided to implement the RFID technology with their pulp supply chain already five years ago, working as a pioneer in this respect and paving the road for other pulp producers.

It is clear that the other pulp producer and Company X are significant players in pulp production worldwide. When implemented successfully and beneficially also in Company X's case, RFID could develop into the new standard of identification technology for the pulp supply chain and mutually benefit companies with their expertise and steady connections with their partners. RFID or a similar identification technology is extremely important for the business and supply chain in the current market environment.

Successful timing in adaptation is crucial for gaining full profit throughout the life cycle of the technology. Being a late adopter is a safe, less risky strategy than being the road paver because problems occur far less often with already matured and tested technologies. Technologies that have already become widespread and proven to be operable and profitable are naturally also cheaper to implement after they have lost their novelty value. However, the pressure from internal and external partners and customers may lead to flail in the implementation process. At the time of the writing of this thesis, there were various important digitalization and supply chain development projects on different phases of implementation:

- Confidential

7.2 Considerable Risks and SWOT Analysis

Based on the results of the current state analysis and the development plan of the supply chain informational system, a SWOT analysis was made considering the greatest internal weaknesses and strengths as well as the considerable external threats and opportunities. The internal analysis focused on the strengths and weaknesses of the company and the business unit. The strengths in this case were capabilities as well as both tangible and intangible resources aiding in the successful digitalization and development of the supply chain information flow. Weaknesses were related to major internal factors that could be considered risks for the successful development and shift from manual processes to digitalization.

The external analysis focused on the opportunities in the operational environment and industry and the threats affecting the desired result of the successful execution of a digital development. These could be considered attributes of the competitive environment, the current trends and the technological development, in other words, the bigger picture, on which the company's own actions have only a marginal effect.

The conclusions of the analysis are first presented in a SWOT-analysis chart and then the most important of them considering this thesis are explained more in detail. The description concentrates on the risks related to the digitalization process and transformation from manual to digital. See Figure 26 below for the SWOT-analysis conclusions.

	Positive affect to archieving the objective	Negative affect to archieving the objective
Internal	**Strenghts** -Skilled and experienced, multicultural personnel -Management's innovative and positive attitude towards change -Motivated project teams -Project teams consider wide range of professionals of different stages and responsibilities within the organization SC -Existing knowledge of digitalization - Customer service attitude - Hard working, motivated personnel -Synergies of the other businesses of the globally operating parent company - Highly profitable business - Change management	**Weaknesses** - Communication between the projects - Seamless co-operation towards mutual goal regardless of organizational limits - Running over project schedules - Hiring consultants lacking specified knowledge of the business -Changing too much too fast - Failing to build user friendly system and tools -Clear boundaries of responsibility - Internal information flow between organizations - Human resources pushed over limits during change process - Training personnel to use the new digital tools - Cultural differences in information availability and transparency
External	**Opportunities** - Strong and long history of co-operation with the logistic partners -Customers and logistics partners strong interest towards digitalization and traceability - Good reputation within customers and partners -Development of long lasting, deep partnerships through digitalization - Favourable global megatrends - Late adopter benefits (RFID) - Competitor role of early adopter (RFID), paving road for UPM	**Threats** - Wrong timing with the chosen technologies - Cyber security issues - Losing customers during the painfull process -Failing to response to customer desire towards improved traceability - Failing to develop functional digital connections and SC transaction flow with logistics partners -Tightening legislation of cyber security e.g. GDPR - Possible technological breakthrough of developing technologies such as blockchain and IoT not taken seriously enough - Shift in megatrends

Figure 23 SWOT Analysis

It is important to emphasize that two persons with the same information regarding the organization and its operational environment would very rarely make the same conclusions about the analysis. Hence the SWOT-analysis can be very subjective, and the results should be considered only approximate guidelines and notes (See reference SWOT-analyysi, Opetushallitus).

Digitalization processes always contain risks. The sphere of interest in the projects related to the current digitalization and supply chain information flow has an influence on the whole business unit. The most common internal risks in digitalization and ERP-projects are related to failing in communication, keeping the schedules and staying inside the budget frames. All these risks were also present in this case. Almost 50 percent of the ERP-projects failed or exceeded the budget significantly. The presence of these risks was considerable especially because there were several wide scale imbricated projects being executed at the same time. The ongoing digitalization projects have to be well steered in order to support each other seamlessly. Communication with the leaders of different projects has to be fluent and transparent. Furthermore, the responsibility areas have to be explicit. Successful change management is extremely important throughout the whole organization considered, all the way from the warehouse floor to the management.

The external risk of wrong timing is a considerable threat even with the older, tested technologies. The implementation is a lengthy, slow process within such a large organization and complex supply chain. As the implementation takes several years, in the current environment where technological development is rapid, there is always a risk of the technology becoming obsolete during or shortly after the implementation process.

During the digitalization process, the customer relationship management has to be extra careful, as it is certain that customer service level through supply chain reliability will face challenges particularly during the ramp up phases. Crucial for the usability of a new digital system is the strategic co-operation with the logistics partners during the whole construction phase. The partners have to be tied to the process right from the beginning. The desires of the most significant logistic partners must be heard. The system and its preferences designed together serve best the purpose of the strategic supply chain transparency. Stubbornly pushing the partners to connect and use systems significantly differing from the solutions of their other customers might lead to the transparency project quickly turning against itself. If a solution only adds extra work but provides very few benefits for the partner, it might become degenerate as well as unused and obsolete.

The company and business unit retain a strong and long culture of co-operation with the logistics partners. Through digitalization the partnerships can be even deepened. The parent company's other business areas benefit the business organization considered. The business unit also benefits from the synergies and the existing knowledge of digitalization and conversion from manual to digitized processes inside the parent company.

The digital systems have to designed so that the interface and usability is user friendly and so that reporting and transactional data is logically available to aid in making better strategic decisions. The digital environment has to support the supply chain information flow of and between different internal organizational stages. The environment must also be cross-organizationally transparent and available for analysis from any point of the supply chain. The key performance indicators of the logistics partners and even internal material handling the personnel should be available in real time. Crucial for the usability and transparency of the new digital system is also complete avoidance of manual interference with the transactional flow and keeping personally designed excel ledges.

When shifting from manual processes and information flow into digitized processes, cyber security issues become even more important to take into consideration. The digital heart of the business may become vulnerable to the risk of a cyber-attack. In the current digital environment, it impossible to stay completely out of range of these attacks. The backup system for being able to operate manually in case of serious collapse of the digital systems has to be available.

A thoroughly built, secure, decision supportive and transparent digital system for supply chain management and transactional information flow is a tremendous project where compromises must be made, schedules and budgets checked repeatedly and issues found and solved still years after the system’s launch. However, the business unit leans on the present model and system for supply chain transactional flow until the new digital system is launched. The information flow is processed manually via email, and the current system is not transparent nor the right information available in real time. The IT-landscape is pushed to its limits with the current amount of transactions flow, and errors in the transaction flow create chaos and costs. The reasons for errors are difficult to trace, and fixing them requires resources.

7.3 Notices and Improvement Recommendations

Information and data can be also considered as a final customer value adding attribute. Today's customers and external stakeholders are more and more aware of the value of information. However, the intra-firm information flow towards internal and the inter-firm flow towards external parties leans on manual work, and email, depends on personalized manual information sharing and customized Microsoft Excel based ledges. Information that could be transferred completely automatically is instead handled and forwarded with human interference. The best and worst example of this are the printed waybills and ERP delivery reports daily scanned and sent via email to both internal customers and external customers and logistics partners. Outstandingly salience is the requirement to provide the delivery information manually to internal customers as described in chapter 6.9. This daily handling and forwarding waybills and quality information to customers and logistic partners consume significant amount of supply chain coordinators daily working hours.

Coincidently, the Intranet Team sites and the Microsoft Sharepoint pages in intranet represent the current state. These databases contain enormous amount of information, proportion of which could provide personnel useful instructions how to make better use of their current IT-tools in use. Also, curios people could understand their operating environment better. However, the information is scattered around various sites of sub-organizations, mixed with obsolete information and hard to find and access as it hasn't been organized rationally.

Currently notable share of the information processed by supply chain coordinators consists of laborious handling of manual information and correcting errors caused by human error. Manual copying and sharing of long and complicated series of numbers and digits is extremely risky for human error. As supply chain coordinators have hence less energy and time to concentrate on value adding planning and optimization tasks the result is a chain reaction leading to less cost-efficient supply chain. Investing on human resources would allow the current supply chain personnel to put their skill and knowledge for better use creating value and finetuning the supply chain. Portion of the manual information could be more effectively processed by blue collar warehouse personnel, if they had sufficient IT-skills. Supply chain team could also benefit of recruiting university students to aid with the simpler tasks not requiring long working experience nor wide knowledge of the pulp supply chain. This would benefit both the company and the students, functioning as a test environment to tie future professional to the company and function as a recruiting channel to pick summer trainees with already some experience of the actual work. The business unit could also provide more research subjects for suitable future professionals and benefit both parties.

Currently email is Supply chain coordinators most important tool and the amount of information processed daily via email is enormous. Without question, email is an excellent way to process supply chain information. However, great share of the current information processed via email could be also processed automated, without human interference. Fortunately, the ERP-project aims to create functioning tools to shift this manually processed data to be transferred automatically.

In a multicultural, globally operating company with complex organizational structure, cultural and organizational barriers for information flow and coordination certainly occur. Information flow for planning APAC volumes turns occasionally chaotic and confusing, causing complexity and increased costs. This is not exceptional within a supply chain of such a long lead time, but definitely from time to time there are unnecessary micromanagement from customer side. The micromanagement and last minute changes cause trouble especially for the supply chain coordinators of Finnish mills, and the overseas specialists of logistics sourcing. Another platform for communication should be investigated. Email and personal ledgers create too immerse risk for human error. Contributed ledgers in sharepoint or even a Social media platform (Yammer) could be one possible easily adopted short term solution to be studied for usability.

Organizational barriers occur especially in communication with Mill 1 integrate customer. The communication is necessary to be as open as possible in case of such an important factor affecting short- and long-term supply chain planning. Open communication would make it possible to avoid constantly occuring sudden production fluctuations which lead to small scale bullwhip effect for Mill 1 supply chain.

The information flow towards and from logistics partners, especially port operators, functions adequate the way it is now but is also fragile to human error. However, the information flow systems with logistics partners do not support traceability. Traceability is discussed in a chapter nominated for it only. Logistics partners performance is hard to follow up effectively as there are no supporting tools for it. Certainly, the new digital environment will provide functional tools for logistic partners KPI followance. The tools should also consider how internal warehouse personnel performance could be monitored.

The Finnish railroad operator though is an exception in this instance. The weak performance level provided by the railroad operator is a constant issue for Mill 1 supply chain. The weak performance considers especially the lacking capacity of the railroad yard operations of Mill 1, delay in rolling stock change, daily issues with broken wagons, lack of rolling stock capacity, low level of transparency and the "lost connection" of the shipment during the railroad transportation.

Transparency to the rail operator's behavior and performance is almost inexistent. Rolling stock deliveries could be described as a tube, where the information regarding the shipment disappears when the wagons are brought from mill warehouse and the shipment remains invisible until it comes out from the tube in Port or in customer warehouse.

The recently adopted IBP is great leap towards better internal transparency and will definitely benefit the internal visibility to supply chain balance. However, it has no affection towards transparency between Company X and external stakeholders such as logistic partners. Neither it has affection towards the communication and transparency between different internal organizations.

7.4 Traceability and Automatic Identification Technology

As digitalization has advanced the matching of the packing list has become more and more important for the customers, especially for the customers paying the best price hence expecting the best quality of the service and best quality of the product. There is desire from customer point of view that the batch numbers for each delivery would match perfectly. This is due the fact, that even though pulp is considered as a raw material and a mass product, each production batch, or even each bale holds slightly or significantly different properties. For the customer a certain type of pulp with stable properties is the most suitable and reduces the need to adjust production process.

The current delivery process relies on human sight and manual input of the loaded bales to the system. The reliability of the packing list is currently an issue. This causes major problems for the transparency of the supply chain and is a major issue for the strictest customers requesting complete reliability of the quality report and the actual delivery.

With the current information system, infrastructure, material handling capacity, and especially without an automatic identification technology a perfect match with the bales delivered in system and actually delivered bales is impossible to execute on larger scale. The friction starts already at the beginning of the delivery process. To fix this, proper resources are required to correct the error leading to BQM bridge transferring incorrect amount of pulp units to the production ERP-system's conveyor storage bin on both Mill 1 and Mill 2. The error causes constant inventory level errors and cumulatively affects traceability of the deliveries.

At the moment the only possible way to reach almost perfect certainty of the match of the packing list and actual delivered bales is time consuming, exact and manual process. Improved reliability would require an automatic identification technology such as RFID. However, the service level, inventory accuracy and shipment accuracy have to be improved immediately to provide desired customer service level and avoid losing business with profitable core customers. Steps towards this have been already taken and the bachelor thesis research has aided in this.

It is important to denote that some of the competitors on the market are already able to provide service for agreeable traceability. The competitors have implemented traceability to their supply chain either though RFID or bar code technology, which both are trustworthy and rather old and technologies. Both have been used within other industries and even within other forest industry products for years to be able to execute delivery follow up and realize point of sale information. Especially the cost for implementing RFID technology has decreased significantly during the couple of last years, making it a reasonable option to implement. Fortunately, during the time this bachelor's thesis has been written, the internal RFID project is advancing. It is certain the implementation of RFID to the pulp supply chain will improve the supply chain's traceability and provide added value.

Better traceability doesn't benefit only the customer service level, but it could have also significant affect to supply chain reliability and cost efficiency. There are various researches and studies concentrating on benefits of implementing RFID to supply chain of a mass product of high volumes. Furthermore, there are studies concentrating only on implementing RFID to pulp supply chain. For example Sini Nurmi's master thesis (e-Business and collaboration: A case study of pulp supply chain, 2014) concerns the integration and benefits of RFID supported pulp supply chain in more detail level.

With RFID's increased point of sale data and inventory level followance, significant cost savings could be gained through decreased capita involved in inventory. RFID accelerated supply chain would enable vendor managed inventories (VMI), which would bring supply chain cost efficiency and increased customer service. Especially implementing VMI to internal domestic customers pulp supply model would significantly benefit all parties of the involved supply chain. RFID would also enable real time data of the pulpered units for optimized paper making recipe and improved process steering.

Traceability of the supply chain isn't only requested by the customers, but the pressure is also coming from logistic partners. The logistic partners serve also other forest industry enterprises, whom have already made investments to the supply chain traceability. The infrastructure and methods are already familiar to the logistics partners and the benefits have been noticed.

7.5 Pulp Blockchain and IoT Vision

This chapter considers future vision of blockchain, 5G and internet of things (IoT) boosted pulp supply chain. The vision is completely fictional and considering the current issues these both technologies have, impossible to implement the time being. However, if and when the build in issues of blockchain are fixed and the technology made possible to be widely used for supply chain purposes, combining these technologies could revolutionize supply chain information systems and supply chain management. Something related to the below vision could be possible considering the next generation of digitalization which is commonly referred to as Industry 4.0. Particularly the laborious and complicated exchange of documentation within a globally operating supply chain could become obsolete with the shared ledger blockchain provides. The figure 27 below gives an overall view of the vision.

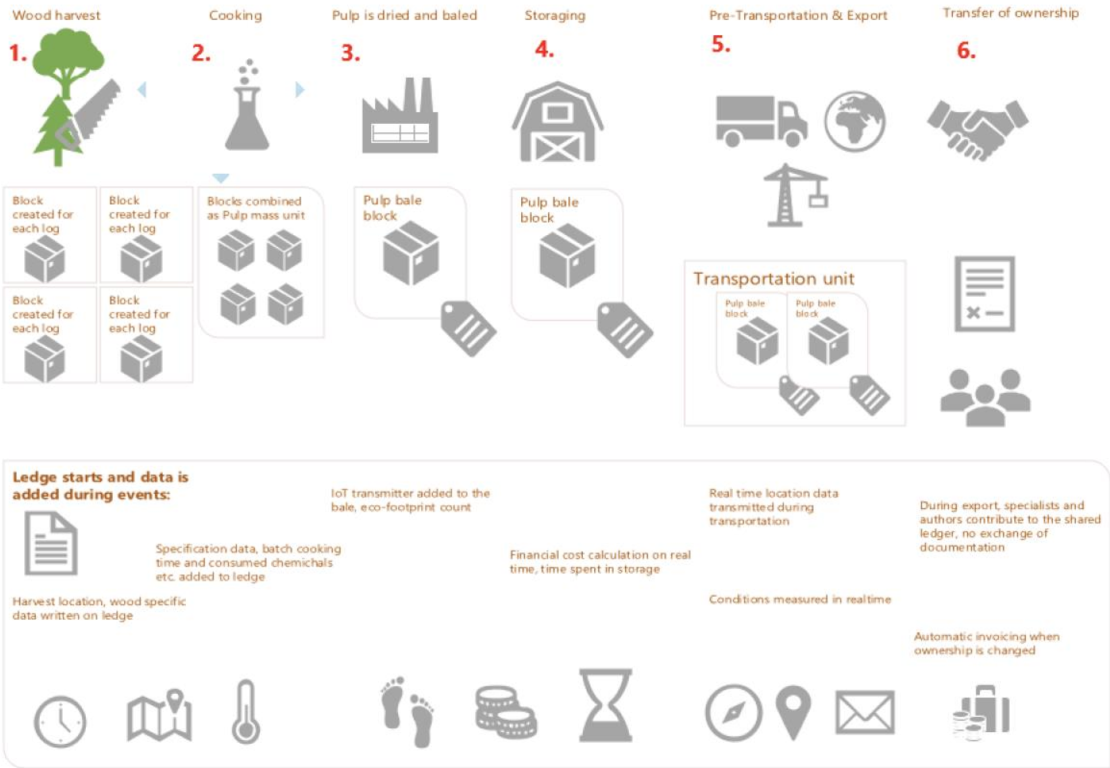

Figure 24 Blockchain Vision

In phase 1. the wood is harvested and transported to mill. A block for each log is created and the shared ledger started for data to be added on each event and during the life cycle of the unit.

- Harvest location, time, conditions and wood-specific data added to the ledger
- Financial cost calculation begins
- Eco foot-print calculator created and counting started

Phase 2. The actual wood processing starts at pulp mill. Block are combined as pulp batch slush unit.

- Batch specifications added
- Takt-time and lead time of the process calculated to the ledge
- Added and consumed chemical data written to ledge

Phase 3. Pulp is dried and baled. Pulp bale block is created in system and IoT-transmitter attached to the bale. The transmitter contains block data and is connected via 5G-connection, continuously measuring conditions and providing real-time data for supply chain coordination.

- Complete specification added to the ledge containing all information customer is interested of.

Phase 4. Pulp is stored in warehouse. Transmitter measures warehousing conditions and storage time, transmitting data to WMS and ERP systems continuosly.

- Transmitter measured data written to the ledge

Phase 5. Bales are loaded into a vehicle for transportation. Transmitters react to each other and connect, creating united transportation block to system. Transportation block contains shared delivery document, which is readable and contributable by all stakeholders involved in the supply chain. No manually interfered information flow is needed. Invoices are sent automatically when bales are unloaded from vehicle. Stock time calculation starts to count again in port stock. Transmitters measure transportation conditions continuously. Location data is transmitted and can be followed in real-time.

- Delivery document ledge contains all documentation regarding the delivery and is contributed by specialist, port authors and customs during the transportation

Phase 6. Customer receives the shipment and physical ownership of the bale and informational ownership of the data considering the bale is transferred. Financial flow and invoicing transactions flow automatically after the block and the contributed ledger ownership is changed. Customer can read and analyze all contributed and measured data written on the block during the transportation and lifecycle of the pulp bale.

The development for considerable blockchain-based applications for supply chain management are currently still on early research phases. However, the increasing interest towards blockchain application development from logistic mammoths is certain signal of the potential the technology holds for future supply chain information systems.

8 Conclusion

The research focus was on Company X's supply chain and it's digitalization and informational flow. The research concentrated on considering the possiblities and threats of digitalization and describing the current issues in the informational and transactional flow of the supply chain, highlighting also other possible barriers and issues if acknowledged.

The observational data resulted to a current state analysis describing quite extensively the transaction flow of predelivery and delivery processes. Actual textual description was accompanied by corresponding process charts. The final results and data analysis of the research were primarily based on data gathered during the nine months of participating observation through daily work. The original purpose was to have blockchain, digitalization and supply chain information flow application related themed interviews with professionals of various interest groups after finalizing the current state analysis.

However, the actual research phase begun on last quarter of 2018 and was timed so that it was impossible to execute the originally planned time consuming data collection method. In the time being there were several prospectios seminars, company, partner and consultant visits relating to the current state and development of the supply chain. New warehouse in Port 1 was taken to use and digitalization related projects shifted to their next phases. The new sales and operations planning tool was implemented to daily use. The Project x was launched. On the other side, these huge supply chain considering changes, launches and shifts of projects and seminars for discussion made excellent forums to imbibe information and meet and discuss with the whole scale of professionals and stakeholders involved, about the themes considered in this thesis.

The data of the formerly described events was gathered into a journal, used for reflection and avoidance of too narrow perspective. Notes to the journal were also made during intra-firm and inter-firm meetings and internal and external visits to various nodes of the supply chain. The visits were naturally included to the daily operations but opportunistically also used for the purposes of the thesis to enlargen the view by discussing and changing opionions with colleagues, professionals and specialist of various stages of the supply chain. Dozens of documents, presentations and process charts found from multitude of locations in intranet were ploughed through. Several current and research considering accurate master's thesis and bachelor thesis were read and result validity considered for this thesis' purposes. The journal and the events triangulate the results made by researchers observations. These data collection methods should provide sufficient realibility and validity for the results and conclusions made. The evaluation of the validity and realibility of this thesis however requires also experience in the considered fields of research.The amount of data processed and evaluated for this bachelor thesis is enourmous. The below research data inventory was made to conclude sources of data used for current state analysis and reflection and triangulation purposes.

Table 3 Research data inventory (confidental)

Ultimately the overall picture of the research resulted quite different than the original vision was. The theory does not support the research as it was planned to. If written now again, the theory supporting the research ought to have different emphasis. Particularly RFID and more conventional supply chain transactional informational tools such as ERP, TMS and WMS would be highlighted. Also interview as a data collection method was presented in the supporting theory but never used such. However, the theory still supported the triangulation even though not used in exact form, as digesting into themed interview theory provided valuable lessons on using and littering data gained through discussions.

The theory of blockchain considers conspicious portion of the theoretical basis related to the brief insight taken to future applications and possiblities in the end of the actual research. It was a conscious decision to still include the theory about blockchain to the thesis. It reflects the situation and hypothesis of the time when the thesis was still a draft. Blockchain was not yet current considering the topic and the input and effort was put to more current and sensible technologies. If proven to have actual benefits for supply chain management in the near future, blockchain might be current topic when the pulp supply chain considers the next generation of digitalization.

The research itself turned to consider substantially wider scope than originally planned and the results were more practical than ought to. The original focus was too abstract and it should have been constrained. Various other important issues out of the research scope were also emphasized and highlighted forthe purpose of serving the assignor better. Various issues highlighted in the thesis have also already been remedied and taken under development. The authors purpose was not to wait until publication of the thesis but to immediatly bring up the noticed issues and process them further.

9 Reflection

When the thesis was assigned to me in the end of april 2018, the digitalization projects were on completely different phase. During the past nine months the business segment and the market situation has also faced several interesting phases and currently indicate more stabile environment. From both physical and informational point of view the object supply chain has had several turning points during the time this research has been in the making. The original research scope became obsolete and shifted and changed within the development of the digitalization projects of the assigning company. Ironically, a narrowminded approach taken it could be said that I had wrong timing in starting and doing the research on the subject.

However, saying that would mean not seeing the forest for the trees. My current state as a logistics and supply chain professional was also completely different when I started as summer trainee and begun to view the object supply chain through lenses of learning and ideal in the beginning of may 2018. Back then I considered myself as an almost complete logistics engineer having incredible confidence of my skills and of everything I've learned in the university.

However, I was still a student and a complete novice from professional point of view. Professionally the growth during this process has been tremendous and I've absorbed colossal amount information. Hopefully the authors growth process can also be read between the lines. After this learning process I'm at least now aware of the fact that within this profession, there is always space for learning and professional growth.

I've also noticed something valuable of myself, that the reader of this thesis might've learned already within the first pages of the research: I have remarkable issues of presenting myself or a subject of mine briefly.

The most important learning conclusion I have made is that as a supply chain and logistics professional, I still have a long path to take.

"The only true wisdom is in knowing you know nothing" (Socrates, 460 BC).

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Appendices

Appendix 1. Confidential

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