PULP LOGISTICS: CURRENT PRACTICES, CHALLENGES, AND DEVELOPMENT

Lappeenranta–Lahti University of Technology LUT

Industrial Engineering and Management, Master's thesis

2025

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ABSTRACT

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Outbound logistics plays an important role in the overall supply chain of pulp, putting a strong emphasis on cost optimization due to the high transportation volumes involved. It is therefore in the interest of companies within the industry to try and minimize their costs regarding the function. The complexity of logistics, however, makes the act of balancing costs with flexibility and resilience difficult.

This master's thesis explores how the practices in operations and decision-making can be developed in the focal company, providing clear recommendations and reasoning for total cost optimization. The research for the thesis is conducted as a single-case study, with the primary data source for the empirical research being semi-structured interviews conducted on personnel of the focal company from relevant business functions.

The findings of the study include insight into the current practices, as well as challenges faced within the logistics operations of the focal company. The main challenges were found to revolve around cross-functional communication, and differences in priorities between different functions. Based on the findings of the interviews, a framework for improving the decision-making processes to achieve better total cost optimization is suggested, along with other relevant recommendations for the operations within the logistics function.

TIIVISTELMÄ

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LUT Teknis-luonnontieteellinen

Tuotantotalous

Santeri Nuottamo

SELLULOGISTIIKKA: NYKYKÄYTÄNNÖT, HAASTEET JA KEHITYS

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Lähtölogistiikan rooli sellun toimitusketjussa on merkittävä, korostaen kustannusoptimoinnin tärkeyttä suurien kuljetusmäärien vuoksi. Toimialan yrityksillä on siten tahto minimoida kyseisen toiminnon kustannuksia. Logistiikan moniuloitteisuus tekee kuitenkin kustannusten, joustavuuden ja resilienssin tasapainottamisesta haastavaa,

Tämä diplomityö tutkii, kuinka toimintoja operaatioissa ja päätöksenteossa voidaan kehittää kohdeyrityksessä. Tutkimus on toteutettu tapaustutkimuksena, ja sen empiirisen osion ensisijaisena aineistona toimivat puolistrukturoidut haastattelut, jotka on toteutettu kohdeyrityksen henkilöstölle asiaanliittyvistä funktioista.

Tutkimuksen tulokset tarjoavat tietoa nykyisistä toimintatavoista, sekä haasteista kohdeyrityksen logistiikan toiminnassa. Keskeisiksi haasteiksi havaittiin funktioiden välinen viestintä ja eri liiketoimintafuntioiden väliset prioriteettierot toiminnassa. Haastattelutulosten perusteella päätöksentekoprosessin kehittämiseksi ja paremman kustannusten optimoinnin saavuttamiseksi esitetään viitekehys. Lisäksi tuodaan esiin muita olennaisia suosituksia logistiikan toimintojen kehittämiseksi.

Acknowledgements

The submission of this thesis marks the end of my years as a university student. These years have been filled with both joy and struggle, and even though I am happy to take the next step in my life, I will always cherish the memories created at LUT.

I want to thank everyone who has been a part of my journey, especially my family and friends, who provided much-needed balance to studying. Special thanks to my thesis advisors as well; I am very grateful for having had the opportunity to put my studies to use.

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Santeri Nuottamo

Abbreviations

AHP	Analytical Hierarchy Process
BB	Break Bulk
CDP	Common Data Platform
DEA	Data Envelopment Analysis
DMU	Decision-Making Unit
EDI	Electronic Data Interchange
EPIS	Exploration, Preparation, Implementation and Sustainment
FMEA	Failure Mode and Effects Analysis
FST	Fuzzy Set Theory
IBP	Integrated Business Platform
KPI	Key Performance Indicator
LARG	Lean, Agile, Resilient and Green
MCDA	Multi-Criteria Decision Analysis
QIF	Quality Implementation Framework
TOPSIS	Technique for Order Preference by Similarity to Ideal Solution
SCOR	Supply Chain Operations Reference

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1 Introduction

The concept of logistics is not new. However, its complexity and importance make it extensively studied even today, and it could be argued that with some recent technological advancements and the interconnectedness of global markets its role has become even more apparent. From the simple situation of just having to choose the best method of transport between places, to multi-variable decision making with different mills, customers on different continents, product grades, demand fluctuations and time constraints, the field of logistics in any company is difficult to ever be fully optimized.

Logistics can have a share even as high as 45% of total costs, out of which transportation takes up to a half (Andrejic et al, 2018). This impact on the total costs of product makes the development of the logistics area especially interesting for companies, as a multitude of the costs can be cut by developing or optimizing the process. Logistics play an especially important role in pulp sales, as the product itself is mostly sold as the cheapest way to transport wood fibres. Also, as a kind of commodity good, a big portion of profitability in pulp sales comes from saving costs in manufacturing, but also in distribution.

In this chapter the background of the study and its objectives are introduced. The different research methods used to get toward the goals are also presented. Lastly, the structure of the study is familiarized to the reader. This is all to give a better understanding of the context of the study.

1.1 Background

The focal company for this thesis has a vast logistics network spanning continents, with multiple different functions acting on different parts of the supply chain. The decisions related to efficiently managing costs related to logistics is therefore far from simple, especially in times of unpredictability. Managing these costs is, however, a crucial part of success in today's global commodity markets. Working in an industry where cost efficiency dictates many of the decisions, it is also important to consider other factors as well, like supplier relations, service-levels, and overall supply chain flexibility. Due to the number of factors

required to be considered when making decisions related to logistics, optimizing on just costs alone is bound to lead to failure. This creates pressure for companies within the industry to look deeper into their decision-making processes to find possible areas with clear optimization possibilities.

It was recognized within the case-company that as there are numerous factors to take into consideration with logistics and broader supply chain development, performing an inspection on the current practices and challenges within the supply chain could prove useful. In addition, the possibility of the implementation of a new framework to guide decisions toward better costs-efficiency was shown interest.

1.2 Research objectives and limitations

The main objective of this study is to create a uniform view of the current general and special features of the operational logistics within the focal company, as well as find areas of development and look into some related frameworks and models that might be worth implementing in the context of the focal company. Two research questions were formed to be used in the study:

1. *What are the current practices and main challenges in pulp logistics?*
2. *How can the current logistics decision-making practices within the focal company be further improved on a strategic level?*

Getting an answer to the questions requires a good understanding of not only the available logistical models and frameworks that may be learned from, but also how these tools may be integrated with current logistical practices. By integrating both qualitative and quantitative research metrics into the study, a more detailed answer can be achieved.

The study will be focusing solely on outbound pulp logistics, leaving other business areas of the focal company out of the scope. The part of logistics focused on will be from mill to customer, which means that logistics related to raw wood transportation is not included in the scope of the study. It is important to note that while new logistics cost optimization models and factors their implementation are being researched, no actual implementation is included within this study, which is left as a possible topic for future research.

1.3 Research methods and data

The research for the thesis is done as a qualitative single-case study, with a focal company at the center to provide a base for the empirical part. The study contains a theoretical, and an empirical part. With them, the study can be divided into three phases. The different phases of the study – as well as their main objectives – are presented in Figure 1.

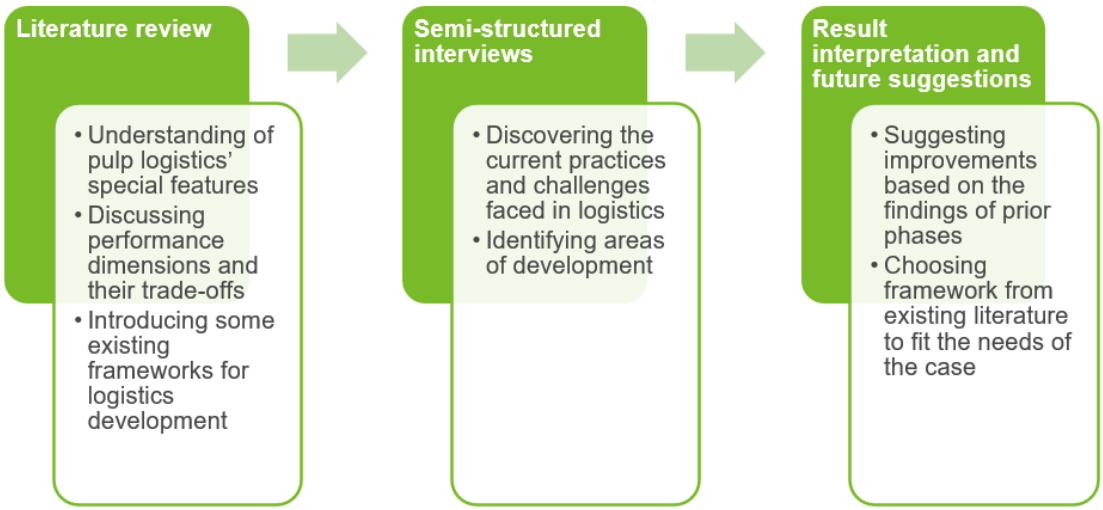

Figure 1. Research design

The theoretical part of the study utilizes a narrative literature review. The main topics of the literature review include the current practices and challenges of pulp logistics on a general level, strategical approaches to pulp logistics management, and specific frameworks used for developing logistics practices. A narrative literature review is a type of literature review with the goal of identifying themes and synthesizing information from different sources (Baumeister, & Leary, 1997; Pautasso, 2019, p. 363-369). As opposed to systematic reviews, a narrative literature review offers more flexibility in both source selection, as well as evaluation criteria (Rother, 2007), both of which are desired to achieve the objectives of the study. For this study, a narrative literature review was chosen to provide more flexibility in the approach to the varying topics discussed.

The empirical part of the study consists of semi-structured interviews. The main objective of the interviews is to gain an understanding of the current practices of logistics operations – especially related to the decision-making process – and the challenges faced in this area. With a proper mapping of the situation, development ideas can be identified and addressed. The methodology of the interviews is gone into more depth in chapter 3.2.

In the end of the study, the results from the previous phases will be looked at together, and improvements are suggested based on the findings and identified development areas. A framework from existing literature – introduced in the first part of the study – will then be fitted to the needs of the case.

The phases are meant to be independent from each other, but the results of prior phases are referenced in later ones. When discussing the results in tandem, however, the findings' differences and commonalities are meant to be highlighted. These factors set limitations to the workflow of the study, as the phases need to be conducted in order.

1.4 Structure of the study

The study is structured in an Input/Output diagram format as shown in Figure 2. The necessary information is described on the input side. The output will be generated based on the results of the given chapter and can then later used as the input at a later stage of the study.

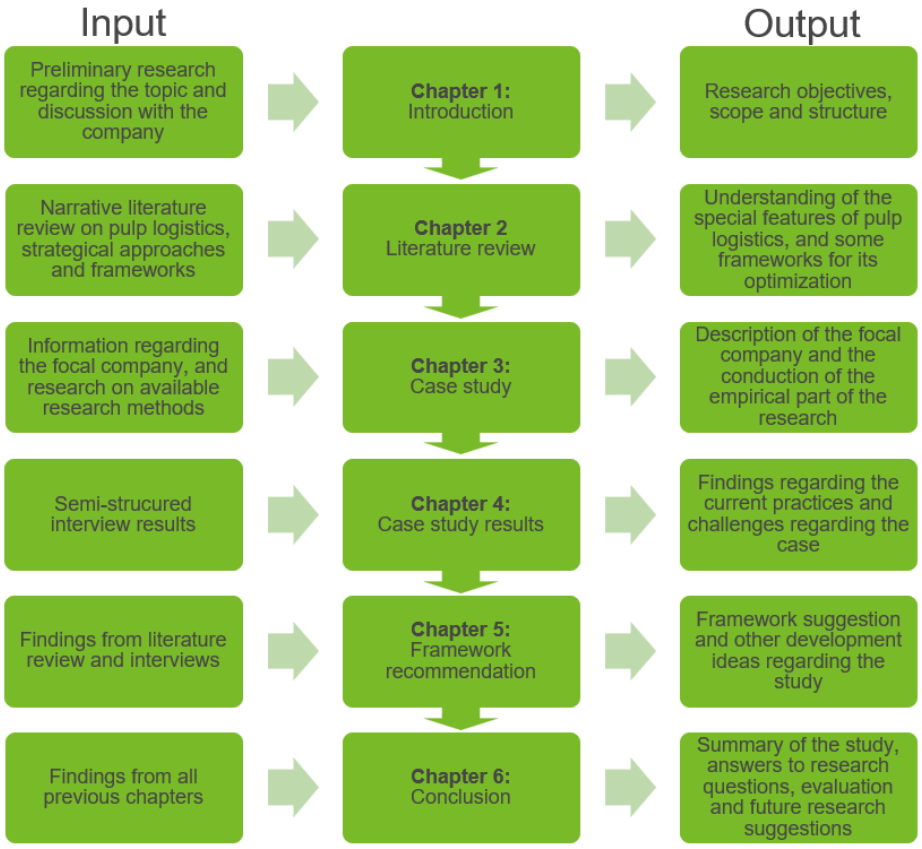

Figure 2. Input/Output diagram on the structure of the study

During the first chapter, the background, objectives, and research methods are presented. The second chapter introduces the related literature, from which a more educated approach to later stages of the study can be formed. Chapter three presents the case in more detail, describing the focal company and its current logistics environment, while also offering an explanation of the empirical research methodology. In the fourth chapter the findings from the interviews conducted for the study are presented and analyzed. Based on the findings, a suitable framework is then fitted to enhance the effectiveness of the current practices in chapter 5. Finally, the study is concluded in a summary. Along with the answers to the initial research questions, the quality of the study is evaluated, and future research areas are suggested.

2 Literature review

A conducted literature review serves as the theoretical base for this study. The idea behind a literature review is to build a foundation for advancing research (Webster & Watson, 2002). By combining together findings from multiple different sources, there is a wider view on the subjects related to their own research questions (Snyder, 2019). More specifically this study uses a narrative literature review, as a systematic review was deemed as a too narrow of a way to go over a wide variety of different topics.

Despite being a narrative literature review, specific keywords, limitations, and databases were set for the review. These are presented in Figure 3.

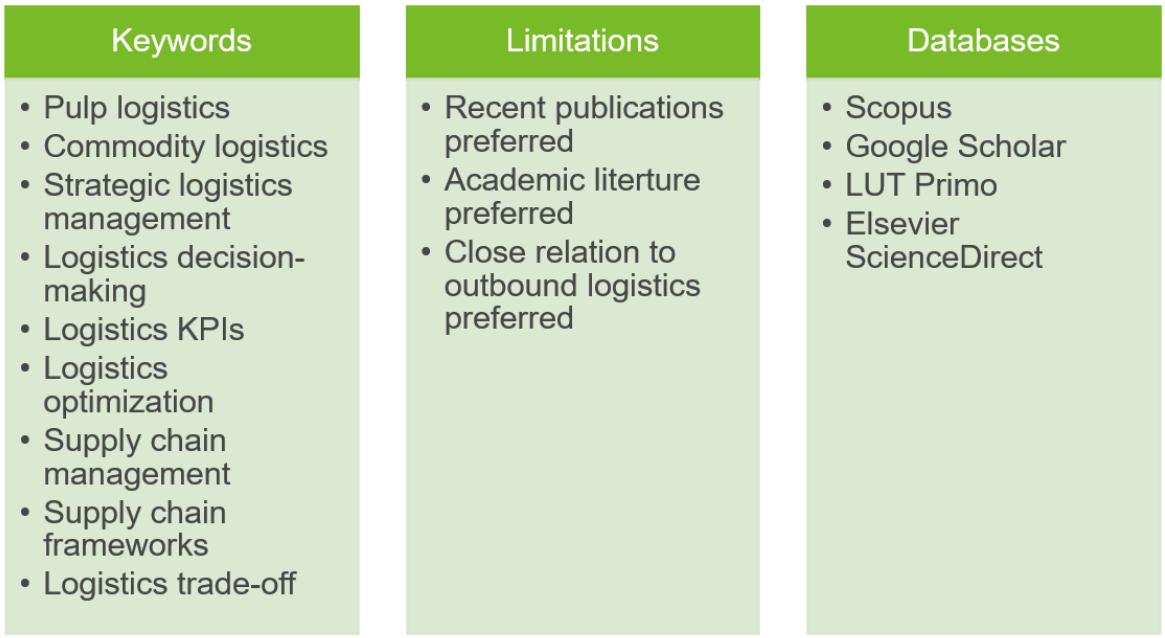

Figure 3. Keywords, limitations, and databases

2.1 Introduction to pulp logistics

Pulp is a simple product made from wood fibers. The fibers are first separated from the lignin of the wood via a mechanical or a chemical process. After separation, the fibers are bleached, often chemically handled and dried, and then pressed into paper-like sheets, that can then be

further refined into whatever paper product is desired. There are multiple classes of pulp based on purity, manufacturing process, and raw material used for the pulp. The most important distinction between different pulp products is the fiber length, roughly divided into short- and long fiber products. (Bajpai, 2018; Biermann, 1996, p. 61-86; Piirainen, 1986; Saban et al, 2022)

The main use for wood pulp is the creation of all kinds of paper, as well as different packaging materials like cardboard. Recently developments have been made toward other – such as medical, textile and even food related – uses (Balkissoon et al. 2023). A key to wood pulp's popularity is its general availability: raw wood is found almost everywhere in large quantities, making its acquisition relatively easy and cheap (Anderson, 1917). As paper products are widely used all over the globe, having access to a way to get acquire or produce pulp is, and has been, an important factor in some countries' economic growth. For example, paper and other wood related products, like pulp, take up almost half of the exports in tons from Finland (Tulli, 2024).

The main trend driving change in the pulp market is digitalization. Due to electronic news, books, articles, and other media, the need for communication papers has greatly decreased in the 21st century. This decrease is clearly visible in the need for pulp in the creation of newsprint as well, especially in high-income areas, like Europe and North America. (Berg & Lingquist, 2019). There is, however, another trend counteracting this decrease in paper production: growing middle class. Due to the increased wealth within the middle class, a lot more people have the capability to increase their standards of living. One such change comes in the form of increased demand for tissue paper, especially in Asia. Another impact of changes to the structure of the middle class comes from the desire for more convenient day-to-day solutions, so the demand for packaging has increased. (Berg & Lingquist, 2019) Hetemäki et al (2023) suspect that within the upcoming years pulpwood consumption will greatly increase in regions with greater disparity between classes, like Asia and Latin America, and the greatest decrease in regions with traditionally broader use of graphical papers and newsprint, like North America. Overall, it is predicted that the overall trend of pulp demand is upward, constituting to more need in the future (Berg & Lingquist, 2019; Hetemäki et al, 2023).

As a more recent development in the pulp industry, another impactful problem has emerged. The Russian invasion of Ukraine in 2022 has posed trade sanctions against it, leading many

countries importing much of their raw wood used for pulp production from Russia to cut their imports. Globally, this has created a significant raw wood discrepancy, naturally leading to increased wood – and therefore pulp manufacturing – costs. (Nepal et al, 2024)

A commodity can be defined as "a product that has broad recognition and which trades in markets which have prices based on homogeneous products", like described by Gordon et al. (1999). The most defining characteristic of a commodity product is that it does not greatly differ in quality with competing offers, and the competition therefore happens mostly with pricing (Hill, 1990). Capstick (2019), however, argues that different recognized levels of quality are also present, so smaller competitive markets may still come to existence. Typically, commodity products are produced – or refined – in very high volume in a mostly continuous standardized flow (Hayes & Wheelwright, 1979).

Based on these descriptions, even though not as elementary of a product as food or minerals, pulp can be interpreted as a commodity product, and is often discussed as such, like done in Bethlahem's (1994, p. 10) book. Pulp, although having multiple different grades based on pulping process, fiber lengths, raw material, and bleaching method (Brämvall & Annergren, 2009; Paperonweb, 2024), is mostly a uniform product regardless of the producer. The production of pulp is also continuous, and it is produced in great quantities, adding to its classification as a commodity product. Depending on the importance of the different pulp qualities in different situations, smaller markets have emerged. Most importantly the markets for softwood (long fiber), and hardwood (short fiber) are kept separate, as demonstrated by services like Fastmarkets (2024). Both markets have a cyclical pricing pattern mostly unrelated to each other.

As a commodity, a lot of market trends can be assumed in pulp sales. One of the most impacting trends present in commodity markets is their price volatility, as they are severely impacted by changes to supply and demand. Due to the high volatility and constantly shifting imbalance between supply and demand, commodity markets often follow a cyclical price variation, which makes these markets somewhat predictable. The cyclical change can sometimes also be affected by seasonal changes and other similar factors, as well as major events that impact international trade. The price changes generally seem small, but – due to the market's dependency on constantly keeping track of the price as accurately as possible – have big impacts on the market (Chevallier & Ielpo, 2013, p. 221; Geman, 2005, p. 28; Pirrong, 2011)

As a commodity product, pulp as a product benefits greatly from cost efficiency. This is due to the fact that with the price of the finalized product being more or less being out of the producer's control, lowering costs is the key to maintaining or achieving a higher profitability. Generally, with commodity markets, economies of scale provide huge benefits, as the process can be scaled up with relative ease, and the benefits provided in the cost efficiency of the process is an important factor in the overall profitability of the business. The benefits of economies of scale in pulp production are so significant, that despite the price changes, the production of pulp is usually relatively unaffected by them. What is impacted in more significance, however, is the supply chain of the product, especially regarding warehousing and transportation.

Pulp itself is often sold as a logistical solution for wood fiber transportation. Transportation can contribute to almost a quarter of a product's price (Andrejic et al, 2018) and transporting larger and heavier loads unnecessarily has an obvious negative impact on it. Logistically, it makes the most sense to produce pulp as close to the source as possible and to produce the finished paper product closer to the end user (Hetemäki et al, 2013). This is because pulp is the most compact way of transporting the wood fibers, as a ton of pulp is produced with about four tons of wood (Bertaud, Ottenio, Aubigny & Dufour, 2023), and the finished products are much less dense, taking up more storage space, especially in cases like soft tissue paper. Another benefit from transporting pulp instead of raw wood or finished materials is its standardized composition, which allows for more accurate and easier logistical planning. Pulp bales make up cubical units with the same dimensions and weight, making stacking and loading them easy, allowing more product to be shipped faster.

Although transportation of pulp has been made relatively easy, it still inherits some difficulties with it being an organic product. Even though pulp is dried, it still contains water. This sets two conditions for pulp transports as the bales will be drying and losing moisture: the environment must be conditioned to allow the excess moisture to leave, and the bales must be packed in a way that considers them losing a bit of their volume. Both conditions are especially true with long trans-oceanic shipments.

As the journeys made for inbound logistics are relatively short, and changes to the cost optimization of manufacturing pulp generally require large-scale investments, lowering the costs of outbound logistics from mill to customer is an appealing option for pulp producers.

This is especially true with the customers spread around the globe with vast distances between the mill and the destination.

A lot of pulp is shipped with trans-oceanic vessels from countries with good pulp production-capabilities to countries with a larger demand than themselves. Shorter vessel shipments are also made. These shipments are divided into two categories: break bulk, and container shipments. The main benefits and downsides of each are presented in Figure 4.

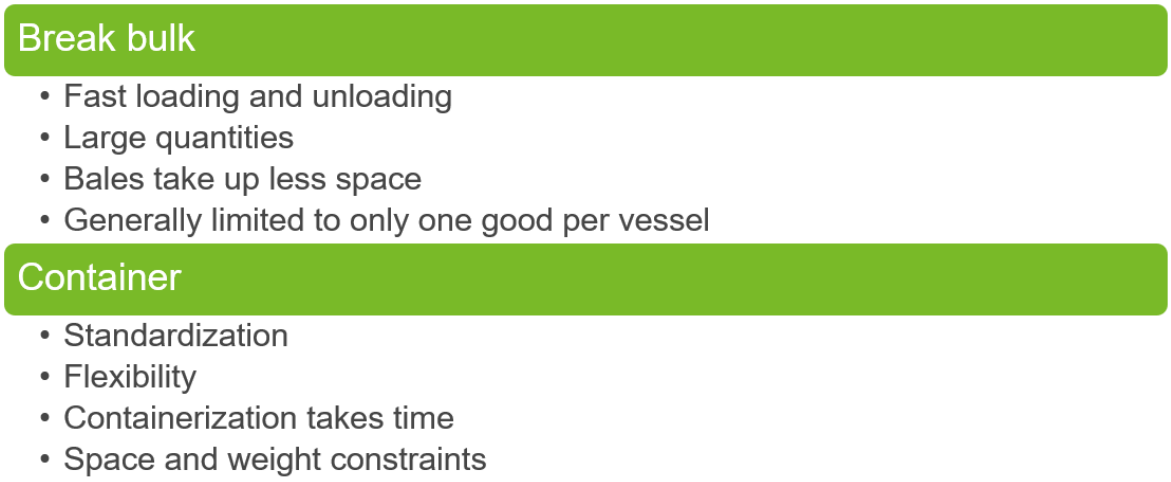

Figure 4. Benefits and downsides of break bulk and container shipments

Break bulk shipments – or bulk cargo – are shipments made up of individual units of the product itself, rather than standardized containers (Rowbotham, 2022, p. 9-10). Regarding pulp trade, break bulk shipments are built with standardized pulp bales as units. With tightly packed standardized commodity products like pulp, break bulk shipments have several advantages. The most impactful benefit of these shipments is their speed, as the bales can be directly loaded into the vessel without the need for time costly containerization which in turn also decreases the cargo handling costs. Another benefit of break bulk shipments especially with pulp is their ability to be more tightly packed, as the space between the cubical units can be minimized. This factor is especially impactful in the total volume of goods shipped with a single vessel.

Container shipments have become increasingly more common throughout the years, as containers have become more common, and therefore less expensive (Kawasaki & Matsuda, 2014). While BB-shipments are in fact usually faster to load and unload with one port pair than containers, the main upside of container shipments becomes visible with more complex transports. As a BB-vessel usually needs to be loaded with only the same product, it can be

more difficult to gain the economies of scale effect with them without having full shipments. Containers, however, are standardized, so a container vessel can ship multiple completely different products from different manufacturers at the same time. Containers are also easier to load and unload in multiple different ports, giving room for a wider reach that cannot be achieved with a few fully loaded BB-vessels. Negative sides of container shipments include the time "wasted" on containerization, as well as the fact that the containers cannot always be fully stuffed. The latter is most often caused by the maximum weight or volume constraints set for containers. A standard 40ft shipping container can carry just over 30 tons (Raunek, 2024), with the container itself taking up almost 4 tons of the capacity (Jones, 2023). In the case of pulp, that leaves the container to be stuffed with only 26 tons of pulp, which leaves empty space in every container.

Generally, with shorter distances – like shipments that stay in Europe – break bulk is preferred, and containerization is preferred with larger distances. Another factor to consider is routing: an oversupply of containers in one direction may have a significant impact on the overall costs of containers. (Hameri et al, 2014) More broadly the decision on the use of break bulk or container vessels also largely depends on how common and complex the voyage is. If a voyage is made periodically with large quantities of the same goods, using break bulk vessels, and saving time on containerization is more attractive than with voyages with numerous intermediate locations and small quantities to each.

Although vessel shipments deal with massive amounts of goods and require a lot of planning, a large portion of pulp is also moved inland with trucks and trains; not considering ports that work in tandem with the producing mill at the same location. Most of this inland logistics consists of transporting the pulp to ports, where it is then stuffed and loaded into vessels, but inland deliveries directly to the customer are also possible.

Pulp, as any other commodity, requires a lot of focus toward its warehousing in different phases of its supply chain because of its continuous production flow. As found in research done by Karić et al (2013), less specialized general goods – like pulp – have a high inventory turnover rate, meaning that generally the inventories are relatively small compared to the amount of product sold. This traditionally means that the warehousing costs are reduced, as there is little need for long-term storage.

Because of the high inventory turnover rate, the safety stocks of pulp are generally small, often ranging from just a few weeks to a month of outbound product. Also, since pulp is produced in high volume constantly, it is susceptible to bottlenecking risks, especially in situations where the supply chain is disrupted in surprising ways. These factors increase the need for companies to try to constantly enhance their resilience, and related costs, effectively.

2.2 Performance dimensions in outbound logistics management

As logistics have a huge impact on the costs and overall profitability of pulp sales, proper logistics management is crucial. Not only is there a need for the costs to be optimized, resilience and adaptability also play a key role in the long-term success of the business. With the scope of this research leaving out procurement of raw materials, only outbound logistics management approaches are discussed within this chapter as well.

There are multiple sides to performance when discussing strategic approaches to supply chains. As the supply chain should always be optimized toward efficiency and flexibility, Lean and Agile methodologies are often shown to be discussed as viable strategic approaches to logistics, as shown by Farahani et al (2011, p. 55-71). A common topic – especially after some recent global disruptions with COVID-19 and the invasion of Ukraine – is also the resilience and the risk management capability of supply chains (Ozdemir et al, 2022). All the sides are crucial to understanding why a company rarely can focus on just one. Most of the time to achieve progress toward one dimension, compromises must be made in others.

2.2.1 Efficiency in logistics management

When it comes to approaches to efficiency, Lean methodology as a paradigm usually offers insight into what to do. Lean is the name of a business ideology originating from the automobile factories of Toyota. The term itself was coined in the book “The Machine that Changed the World” (1990) by Womack et al, and quickly gained appreciation afterwards. The idea behind Lean thinking is to remove waste – non-value adding components – from

processes, improving efficiency and decreasing costs. Continuous improvement is also at the core of Lean practices.

While Lean was originally created to work in a manufacturing environment, its use has expanded, and the lean principles can be implemented in multiple other industries and areas. Examples oof these include healthcare (D'Andreamatteo et al, 2015) and services (Suárez-Barraza et al, 2012), as well as logistics (Jones et al, 1997). As Lean is a system originally designed for manufacturing companies, some alterations to the core principles must be taken into account when discussing it in a different environment. The core "wastes" of Lean thinking, as well as their meaning in the context of logistics, are presented in Table 1. The table is based on interpretations by Bednár et al (2012), Escuder et al, (2022), Kilpatrick (2003), and Sutherland & Bennett (2007).

Table 1. Wastes defined by Lean (Adapted from Bednár et al, 2012; Escuder et al, 2022;Kilpatrick, 2003; Sutherland & Bennett, 2007)

Type of waste	**Meaning in manufacturing context**	**Meaning in logistics context**
Overproduction	Producing over demand.	Shipping over demand, resulting in increased warehousing costs.
Waiting	Time wasted on materials, transportation, etc.	Delays in loading/unloading.
Transportation	Unnecessary movement of materials or goods.	Inefficient movement of goods by bad routing.
Overprocessing	Doing more work than necessary, producing over agreed quality.	Excessive inspecting and packaging, repeated quality checks.
Excess inventory	Warehousing too much material or finished goods.	Overstocking, leading to increased holding costs.
Defects	Errors requiring fixing.	Shipping the wrong quantity or quality. Damages during transport.
Motion	Unnecessary movement of workers.	Inefficient warehouse layouts. Need to unload goods from the way of others due to bad route planning.

Overproduction simply refers to producing or preparing too much stock when compared to demand. Producing over demand causes increases in warehousing costs, as well as possible bottlenecking issues. In certain industries, like electronics, overproduction may even lead to product obsolesce (Chan et al, 2021).

Waiting can derive from delayed or badly planned transport vehicles as well as bottlenecks. In transportation logistics waiting is common, so much so that companies are rewarded and

penalized in the form of demurrages and detentions depending on whether they can keep up with arranged loading dates (Storms et al, 2023). Excess inventory in the context of logistics has very similar negative effects as overproduction. In addition, large inventory levels at ports especially have an impact on the workflow, as the products may obstruct or limit movement.

Waste in product transportation can be mainly attributed to bad or inefficient route planning. The goods should be transported to their destination with as little legs as possible. Waste in motion generally refers more to wasted movement on the human side, referencing extra movement needed to cover distances due to bad warehouse layouts, for example.

Overprocessing means putting more effort into the quality and attributes of the product than is necessary to meet the quality standards of it. For example, quality inspections for the product should be done, but only in correct quantities: not every single product and step of their production should be inspected.

Defects are a simple waste, but they have a significant impact. Not only is there a need to deliver the same order to the same customer again, but there is also the factor of possible decreases to reputation, although the exact impact is difficult to measure (Soares et al, 2021).

Due to its unique environment, when considering commodity good supply chains, Lean thinking provides both benefits and negatives. As price is the main competing factor in these markets, achieving cost benefits with efficient supply chain planning is paramount. With certain Lean practices and focusing on eliminating the biggest wastes, companies can improve the efficiency of their supply chains drastically, improving profitability.

However, because some commodity products inherently contain a lot of price variation – even though the market can be thought of as relatively stable otherwise – streamlining the supply chain too much may leave vulnerabilities.

While Lean is generally a good approach to achieving efficiency, it has its limitations, as efficiency comes at the cost of resilience and flexibility. Lean is therefore best implemented in stable environments, as the variation in demand have less effect. Other important factors in the environment include costs being the main customer driver, and low product variety. (Cox & Chicksand, 2005)

2.2.2 Flexibility in logistics management

While efficiency is important for directly building better profit margins in a stable environment, building flexibility into a supply chain provides possibilities to respond to more varying conditions provided by the real world (Barad & Sapir, 2003). Flexibility in the context of logistics can be defined as the capability to respond to changes in the environment with little impact on performance (Upton, 1994). Improving flexibility positively affects the competitiveness of companies (Alvarez-Gil, 1994), as they are better able to respond to demand and cost variations, improving customer satisfaction (Sánchez & Pérez, 2005). With proper increase methods in flexibility, it is also possible to decrease the total value of the inventory within the complete supply chain (Lummus et al, 2003).

One of the main driving forces demanding increased flexibility in logistics is globalization, and the effects it has had on the incline of international business and how different companies interact with each other. The shift in bargaining power from the producer more on the side of the customer, due to the increase of competing suppliers, has also played a key role in more flexibility-oriented supply chains. (Duclos et al, 2003; Kumar, 2010) The demand for increased flexibility due to globalization stems from companies having to focus more on their core capabilities and out-source their other needs, leading to more complex, interconnected supply chains spanning multiple different companies. Interaction with other parts of the supply chain, as well as reacting to shifting logistical landscapes, requires flexibility. (Manders et al, 2017)

There have been numerous attempts at trying to divide flexibility into different dimensions based on varying factors (Seebacher & Winkler, 2013). Huo, Gu, and Wang (2018) conclude that the division has often been shown to be based on business functions, hierarchy, or final production changes. Huo et al. also offer a distinct division between internal and external flexibility, further dividing external flexibility between customers and suppliers. Internal flexibility refers to a company's ability to alter its own functions based on necessary production variations and unexpected errors. Customer flexibility refers to being able to meet the changes in customer demand, and in a similar way supplier flexibility's definition is the capability to respond to sudden changes in the supplier landscape.

According to Sanchez (1995), strategic flexibility can be divided into two dimensions: resource flexibility and coordination flexibility. Resource flexibility means the capability to

use the given resource in multiple different ways, as well as the costs and time required for switching the resource to another. Coordination flexibility, on the other hand, refers to the ability to redefine processes and reconfigure supply chains.

A paradigm so often attributed to flexibility they have almost become synonymous is agility. Even though they share multiple similarities, it is important to recognize their different approaches to external collaboration with suppliers and customers. (Abdelilah et al, 2018) As they are both similar approaches to handle variations in different business environments, however, their concepts regarding logistics uncertainty can be discussed in tandem. An example of a take on the concepts regarding agile supply chains based on the interpretation of Christopher (2000) is provided in Figure 5.

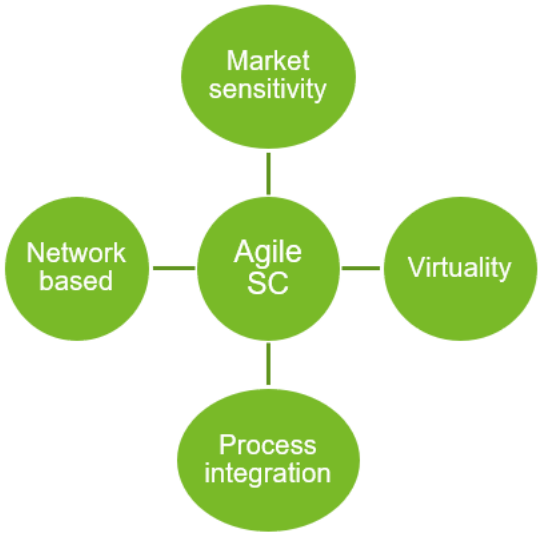

Figure 5. Concepts of the agile supply chain (adapted from Christopher, 2000)

Market sensitivity refers to the capability of responding to changes in demand, as well as the knowledge regarding predicting it. By being able to share this information between customers and suppliers, a virtual environment is created, where the sharing of information holds more value than the actual inventory levels. Sharing information between different partners within the supply chain allows for more collaboration, which can lead to improved process integration. Finally, as these factors come together and create supply chains made up of multiple partnering parties, the competition shifts from individual companies to entire networks.

As commodity logistics is traditionally more focused on delivering a steady supply of product mostly independent of variation in price or demand shifts, it is easy to neglect the

importance of flexibility in these environments. Efficiency and Leaness have been shown to be the priority, as the transported amounts are large and variation in order size relatively small. The importance of flexibility and agility should not, however, be neglected, as with the supply chains networks having become more interconnected throughout the recent decades, the focus in logistics has shifted to also take into account the necessary responses to other parts of the chain (Kumar, 2010). In a more direct cause-relation interaction, flexibility should be integrated to pulp logistics due to the varying nature of the pricing of the product.

2.2.3 Resilience in logistics management

Inherently, building resilience seems like the opposite of building efficiency (Ruiz-Benítez et al, 2018). For example, while efficiency prioritizes lower inventories, resilience is gained from building buffer into inventories (van Hoek, 2020). Resilience is the internal capability of a company to continue or recover its basic functions even in the presence of greater disruptions (Holling, 1973, p. 1-23). When discussing resilience, the concepts survivability and adaptability in within the environment are highlighted (Fiksel, 2006). The key difference between distinguishing resilience from flexibility is the severity of the disruption: having enough resilience might be the difference between a company surviving in extreme situations, like COVID-19 (Ivanov & Dolgui, 2020). Importance of resilience is highlighted by complexity of supply chain and logistical networks in today's world (Pettit et al, 2010). As resilience is strongly linked to the entirety of supply chains, its effect on just the logistics part will be discussed with less detail.

Resilience can be built on three different levels: pre-disruption, during the disruption, and post-disruption. The levels can also be called, anticipation, resistance, and recovery & response. Resilience is achieved by integrating methods of prevention, mitigation, and recovery for all levels. (Kamalahmadi & Parast, 2016; Shishodia et al, 2023)

The most critical step for achieving resilience comes from good preparedness via anticipation. A big part of disruption anticipation is done by devising contingency plans for possible risk-scenarios, as well as keeping the supply chain more maintainable in emergency situations. Methods of anticipation traditionally include buffer inventories in case of supply

shortages or other disruptions and keeping visibility high on all levels of the supply chain to increase responsiveness.

The importance of methods related to disruption resistance rises when the disruption realizes itself. The purpose of these kinds of methods is to decrease the response time toward controlling the disruption before its effects deal too much damage. Similarly, as with flexibility, the company's ability to quickly alter its course of actions and reconfigure its resources is important. Visibility and collaboration are a big part of these capabilities.

Emerging from a situation where certain disruptions have indeed negatively influenced performance, response immediateness should be prioritized. In addition to recovering from the effects, the company should keep in mind that something can always be learned from these emergencies, and that the company should look toward gaining an advantage over others by improving from the mistakes around the disruption. Good knowledge management is paramount in handling post-disruption situations.

In addition to the aforementioned dimensions, resilience can be viewed through a series of core principles. According to Christopher & Peck (2004), the principles of resilience can be defined in reengineering, collaboration, agility, and culture, as shown in Figure 6. The given principles have since been adopted widely (Kamalahmadi & Parast, 2016), and later coined by Wilding (2013) as the "pillars" of supply chain resilience.

Figure 6. Principles behind resilience (Adapted from Christopher & Peck, 2004)

Reengineering refers to the idea of companies needing to provide contrast to the dominant cost- or customer centricity. While companies traditionally tend to focus on improving and optimizing around these factors, Christopher & Peck (2004) argue that proper resilience is built by (re)engineering entire processes around it. Identifying risks and building capabilities on disruption prevention and handling should be invested in, even at the cost of efficiency. A few easy examples of process reengineering around resilience include diversifying suppliers and keeping buffer inventory at key points of the supply chain.

Due to the nature of today's supply chains being networks consisting of multiple suppliers and companies, the importance of collaboration is highlighted in the context of resilience as well. The main benefit of collaboration comes in the form of reduced uncertainty, as sharing information between the different parties is encouraged. Information sharing can be performed on a high strategic level in the form of mapping out risks regarding specific players within the supply chain. This enables all of the individual players to gain a better understanding of the entire supply chain and plan their use of resources accordingly. In addition, information can also be shared regarding the future in a shorter term.

Agility in itself can be considered a part of resilience. According to Christopher & Peck (2024), two aspects of agility are especially connected to resilience: visibility and velocity. Visibility refers to the transparency of the supply chain, with higher visibility allowing for more insight into the different entities within. With velocity, the authors refer to increasing the speed at which the product moves from one end of the supply chain to the other. Both factors combined allow for easy and fast maneuverability, increasing resilience as well as flexibility, like stated earlier.

In addition to structuring and reengineering the processes around resilience, the company culture should also be built to reflect that. The culture change should start at the management level of the organization, and advancements and improvements related to resilience should be actively discussed in board meetings. This principle is often overlooked. Not only should this culture change happen on the management level, but on every other level as well, to properly communicate the importance of resilience and risk management.

Even though companies from all industries should pay close attention to building their resilience capabilities, some are more susceptible to the turbulences of their economic environment than others. Rahman et al. (2022) found that essential commodities are considerably

less researched than higher-variety products, possibly hinting toward the discrepancy in importance between different product-types.

2.2.4 Logistics management trade-offs

Approaches to logistics management via efficiency, flexibility, and resilience all seem logical. All approaches have clear advantages, but also disadvantages. Combined with the fact that the approaches have competing points of interest makes balancing them a difficult task for many companies (Roscoe & Blome, 2019). The act of balancing these different factors can be thought of as a trade-off, as with a deliberate development of one of them has a negative effect on the others (Jacobs & Chase, 2018, p. 23-41). The priorities between the different strategic approaches are compared in Table 2.

Table 2: Priorities of different strategic approaches

Aspect	**Efficiency**	**Flexibility**	**Resilience**
Primary objective	Increasing profitability by minimizing costs, maximizing resource utilization.	Adapting quickly to shifts in the environment, like price variation.	Mitigate and recover from demanding disruptions.
Strengths	High profitability by eliminating redundancies in operations.	High customer satisfaction by responding to short-term demand variation.	Long-term stability by being able to withstand market defining crises.
Weaknesses	Vulnerability to considerable variation and operation disruptions.	Increased operating costs, and complexity in implementation.	Redundant inventories and operations in normal situations.

Efficiency vs. Flexibility

There is a clear discrepancy in the objectives of an efficient and a flexible approach. At times it might even seem impossible to try to implement methods from both approaches, as they seem to completely undermine each other. (Pettit et al, 2010; Tiwari et al, 2015) Efficient approach prioritizes in streamlining the logistics process by simplifying it, while flexibility tries to keep more options open even at the cost of possible redundancy. Even though the implementation of both approaches is difficult, it has become easier with more technological advancements (Xue & Li, 2023; Zhang et al, 2002).

The two approaches, however, also complement each other. Investing in efficiency too much leaves big vulnerabilities that flexibility can in part counteract, and vice versa. Implementing a bit of flexibility to balance for demand variation reduces the main weakness of overexaggerated efficiency. Similarly, as investing in flexibility is costly and complex, a suitable reaction is to increase profitability in other areas, as well as improving visibility by reducing unnecessary functions. When correctly implemented in tandem, the two approaches provide more benefit, than separately (Kapasuwan et al, 2007). A trending term for a concept that has successfully integrated both approaches is "Leagile" – a combination on the words Lean and agile (Mason-Jones et al, 2000).

Efficiency vs. Resilience

Much like with the comparison to flexibility, the goals of efficiency and resilience seem to completely contradict each other (Ruiz-Benítez, 2018). This contradiction is even stronger, though, as the methods of implementation seem to be polar opposites to each other, as apart from a few technological advancements, the trade-off is very difficult to ignore (Xue & Li, 2023). While efficiency strives toward having little inventory and streamlining the entire supply chain to be as simple as possible, resiliency is achieved by doing the exact opposite.

Despite the clash in methods of implementation, both approaches are paramount for survival in today's economic landscape (Xue & Li, 2023). They do not necessarily complement each other in the sense that they would cover each other's weaknesses. Instead, both approaches contain practices that cannot be ignored. The basic idea of having both approaches covered is that investing in efficiency ensures economic well-being in normal operations, and building resilience safeguards the continuation of the operations in case of disruptions.

Flexibility vs. Resilience

As agility can sometimes be grouped as a part of resilience (Christopher & Peck, 2004), it is no surprise that their goals do not clash as violently as to when comparing efficiency to either of the two. An important distinction between them, however, is the difference in their effective time periods. While resilience can also be thought of containing short-term deviation handling, it is mostly distinguished in dealing with more severe disruptions and ensuring

company survivability in the long-term. By contrast, flexibility focuses more on the short-term deviation handling, with the focus on operational day-to-day activities.

The methods for achieving flexibility often contribute toward better resilience as well. This is not, however, always the case, as poor focus on flexibility method implementation can lead to the supply chain becoming more complex, which in turn negatively affects resilience via increased uncertainty (Prater et al, 2001).

Balancing performance dimensions

It is important to note that the priorities regarding the different approaches widely depend on industry they are applied to. Generally, the focus should be shifted for the side of efficiency toward better flexibility in accordance with the product profiles in Figure 7 detailed by Cox & Chicksand (2005). Mass-produced products with little variety, high predictability, and low profit-margins should prioritize efficiency, while workshop-like-produced products lean more on the side of flexibility. In addition, it should be recognized that the strategical approach should consider the market winners. Efficiency should be focused on especially when the competition is around cost, and flexibility when markets are centered around maintaining a good customer service level. (Christopher & Towill, 2001; Mason-Jones et al, 2000)

Distinguishing Attributes	Lean Supply	Agile Supply
Typical products	Functional products	Innovative products
Marketplace demand	Predictable	Volatile
Product variety	Low	High
Product life cycle	Long	Short
Customer drivers	Cost	Availability
Profit margin	Low	High
Dominant costs	Physical costs	Marketability costs
Stockout penalties	Long-term contractual	Immediate and volatile
Purchasing policy	Buy materials	Assign capacity
Informatioin enrichment	Highly desirable	Obligatory
Forecasting mechanism	Algorithmic	Consultative

Figure 7: Lean and agile product profiles (Cox & Chicksand, 2005)

Disruptions, and risks thereof, are apparent across industries. Therefore, companies should focus on resilience regardless of their main competition being around efficiency or flexibility. Keeping in mind that while certain industries are more inclined than others to build resilience due to the inherent uncertainties within the market (Rahman et al, 2022), some

disruptions will still have an effect. Uncertainties are ever-present and recent global disruptions – like the COVID-19 pandemic – have highlighted the importance of resilience (Ivanov, 2022).

Regarding commodity logistics, maintaining profitability via focusing primarily on efficiency should be held as the most important thing. This is not to say, however, that the other approaches can be ignored, as they provide complementary benefits. Due to the unpredictable or cyclical nature of the price within many commodity markets, as well as the small innate variation in demand, introducing flexibility can help improve customer satisfaction levels. In addition, as many commodity markets are global, companies dealing within these markets inherently have multiple interconnected entities in their supply chain networks. This gives an increased chance of the need to adapt in case something goes wrong. Regarding resilience, while essential commodity products like pulp are on the lower end of suffering unexpected disruption, they still have a lot of variables to consider. In short, the strategic approach in commodity logistics should focus on efficiency, while maintaining sufficient flexibility, and having enough resilience to last through most severe disruption risks.

2.3 Existing frameworks

In addition to theoretical strategic approaches to logistics development, a lot of work has been put toward developing frameworks around balancing different factors in the real world. This chapter focuses on shedding some light into a few established frameworks, that could provide to be beneficial for logistics development within the focal company as well. The presented frameworks were chosen based on their possibility to provide value as a result for the case study, and their relative differences to each other.

2.3.1 Lean, Agile, Resilient and Green - LARG

Generally, four paradigms have been raised to cover different dimensions of logistics optimization: efficiency, flexibility, resiliency, and – more recently – sustainability. These four sides of supply chain management practices have been shown to be discussed together in more recent academic literature, and the emerging model developed from combining

practices from each side has been coined as the “LARG practices”, coming form the terms Lean, Agile, Resilient and Green (Azevedo et al, 2011). The core concepts of LARG are presented in Figure 8. The aforementioned paradigms have their own focus area within the supply chain, but often interact with each other’s goals negatively. Due to this factor companies often choose only one high-level strategic approach. There are, however, attempts made toward the integration of these approaches. (Carvalho et al, 2023; Khanzadi et al, 2024)

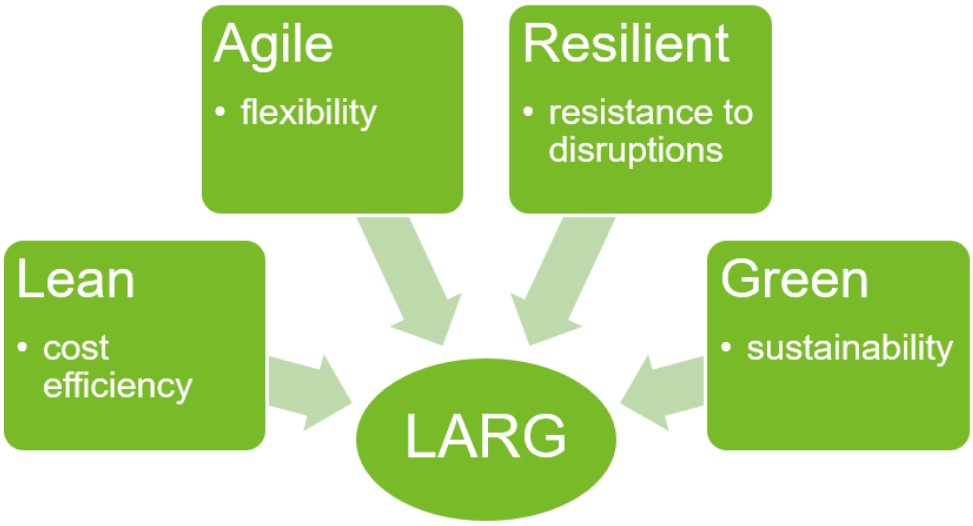

Figure 8: LARG practices (Adapted from Azevedo et al, 2011)

In addition to the conflicts and synergies between different strategical approaches demonstrated in chapter 2.2.4, LARG is also concerned about supply chain sustainability in the form of the “Green” factor. Even as a relatively new factor in the business sector, the importance of sustainability has been growing mainly due to the increase of consumer expectations toward it. The customers today are well aware of different environmental risks, putting pressure on companies to try and minimize their negative impact on the world or face monetary penalties. (Blowfield, 2013, p. 3-26) The penalties may come from consumers deciding to boycott companies not meeting sustainability standards (Klein et al, 2004). In addition, laws and regulations related to sustainability are constantly being passed and refined. A recent example of this in relation to the forest industry is the upcoming EU deforestation regulation, which forces affected companies to increase their level of reporting – and change in some cases change their practices – regarding their wood sourcing (Köthke et al, 2023).

The LARG practices are usually decided in a way that the company's performance can be enhanced in three dimensions: operational, economic, and environmental. Practices related to operational performance focus on reducing inventory levels, quality, customer satisfaction and time. Economic performance is concerned with costs – environmental costs in addition to the normal – as well as cash-to-cash conversion cycle speed. Environmental performance is strongly affected by business wastage. The importance of the dimensions, as well as the specific practices thereunder, are prioritized differently depending on the industry they are being applied to. (Anvari, 2021; Salleh et al, 2020) The factors and some example practices related to them concerning logistics are presented in Table 3.

Table 3. Example LARG practices

Factor	**Affected performance**	**Example practice(s)**
Inventory levels	Operational	JIT, increased demand forecasting
Quality	Operational	Long-term carrier relationships
Customer satisfaction	Operational	Contingency planning for disruptions
Time	Operational	Planning around bottlenecks
Cost	Economic	Elimination of waste
Environmental cost	Economic	Complying with regulations and customer demands
Cash-to-cash cycle	Economic	JIT, increasing response speed
Business wastage	Environmental	Elimination of waste, eco-friendly carriers

LARG is a holistic approach to supply chain management, providing a more realistically equipped approach to different important factors concerning the supply chain than individual strategies. The main idea behind LARG is the concept of trying to make the different paradigms work together in the best possible way, trying to include as much positive things from each, while balancing the negatives out with factors from the other aspects. The focus is in selecting a set of practices, that provide the most benefits without compromising the other aspects. (Azevedo et al, 2016)

A good approach to the implementation of LARG practices is to compare the relative importance of the individual practices to each other, as shown by Salleh et al (2020) in an article discussing the implementation within a seaport system. In the study performed, a set of individual practices related to each paradigm, which are also compatible to the industry they are being applied to, were collected. Next, through a series of questionnaires, experts were asked to score the practices, so that the calculation of their weighed relation to each other would be made possible. The method is similar to that of a trade-off analysis.

Regarding pulp logistics, many of the same conclusions as made in chapter 2.2.4 can be made with the implementation of LARG practices: the priority should be in focusing on increasing cost efficiency with the prioritizing of Lean practices, with increased focus on keeping a high level of resilience as well. The factor of green, however, adds an interesting dimension, as sustainability within the forest industry has been in discussion with topics like deforestration (Damette & Delacote, 2011), and multiple directives and regulations have been made toward ensuring it's sustainability, with more in the horizon (Köthke et al, 2023). Maintaining a high sustainability performance on the side of logistics might give companies within the industry a competitive advantage over the others, especially if other benefits can be achieved in tandem with it.

2.3.2 Multi-Criteria Decision Analysis - MCDA

Multi-Criteria Decision Analysis (MCDA) – and in relation Multi-Criteria Decision-Making (MCDM) – is a decision-making framework that considers multiple, often conflicting, criteria. Usual factors compared within MCDA include costs, time, benefits, service-level, and sustainability. The purpose of MCDA is to be able to analyze the trade-offs between the different factors, providing a valuable framework for complex environments with multiple areas of interest, like pulp logistics. MCDA is a roof-term, as there are numerous different MCDA methods. (De Montis et al, 2004; Shahsavarani & Azad Marz Abadi, 2015)

There are multiple ways to perform MCDA, but the common approach includes steps similar as shown in Figure 9. First, the area of focus should be strictly defined to allow for all further analyzation to be relevant. Next, the individual factors related to the area should be identified, and comparatively weighed against each other based on a subjective comparison. Finally, as MCDA can be managed in multiple different ways, as suitable method should be chosen, and the importance of factors ranked based on the results of the tool used. (Guitouni & Martel, 1998; Pramanik et al, 2021)

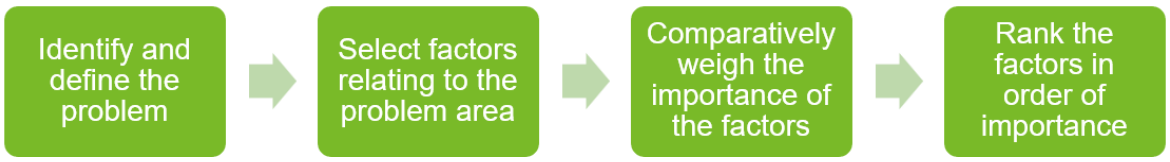

Figure 9: Common MCDA steps (Adapted from Guitouni & Martel, 1998; Pramanik et al, 2021)

MCDA often requires the use of a case-specific method. From dozens of available methods, a couple stand out in the amount they have showed up in recent – 2012-2022 – literature: AHP, DEA, FST, and TOPSIS. (Taherdoost & Madanchian, 2023).

The Analytical Hierarchy Process, or AHP, method works with a finite number of variables and factors. It is largely focused on pairwise comparisons; that is to say individual factors are pitted against and compared to each other. Each pair of factors is given a score from 1 to 9, indicating their relative importance over each other. Putting the comparisons within a matrix, the relative weight of each value can be derived, and later used in comparing the overall importance of the factors, giving room for prioritization. The method is also used in breaking down hierarchical decisions. (Saaty, 2008)

Data Envelopment Analysis, DEA, is based on evaluating so-called decision-making units, or DMUs. The DMUs need to be homogenous: regarding logistics, the DMUs can be suppliers, for example. The DEA method is based on comparing the input-output regarding each DMU. The best performing units are set as a standard, called the efficiency frontier, which other units are then compared to. (Charnes et al, 1978; Cooper et al, 2011, p. 1-40)

Fuzzy Set Theory, FST, method offers the possibility to improve decision-making even in uncertain dimensions, using vagueness in inputs. The inputs required for the FST method do not need to be numeric, and outputs can be achieved with more ambiguous inputs. The method is especially useful in situations with a lot of uncertainty, as the model is able to produce actionable results even with broader linguistic inputs. (Zadeh, 1978; Zimmermann, 2010)

Technique for Order Preference by Similarity to Ideal Solution, TOPSIS for short, is quite self-explanatory. TOPSIS is a simple method with the goal of ranking alternative options based on their distance from the ideal solution, while straying away from the worst: the nadir point. Unlike some other MCDA methods, TOPSIS itself offers no insight into the actual

weighing of different factors, and therefore needs help from other methods on that regard. (Olson, 2004; Yoon & Hwang, 1995, p. 38-45)

As in the field of logistics the decision-making process rarely has only one factor to worry about, the implementation of an MCDA framework seems paramount. Being able to simultaneously optimize costs, delivery times, service-level, and sustainability, while intricately balancing the trade-offs between them offers numerous advantages. The different methods under MCDA can help optimize routes, carrier shares, as well as warehouse locations. Regardless of the specific method, however, a lot of effort has to be put into the thought process behind weighing each factor, as subjectivity can greatly influence the usefulness of the framework in a negative way (Steele et al, 2009).

2.3.3 Supply Chain Operations Reference - SCOR

Supply Chain Operations Reference (SCOR) model is a standardized supply chain management framework originally developed in 1996 and has since risen to be widely used in SCM regardless of industry (Ntabe et al, 2014). SCOR has gone through many iterations under multiple ownerships; SCOR Digital Standard (DS) is currently the most recent one, released by Association for Supply Chain Management, ASCM for short, in 2022 (Becker, 2023). The SCOR model consists of four major sections meant to help align supply chain related factors for decision-making in a cohesive manner: performance, processes, practices, and people. (ASCM, 2022)

ASCM (2022) define the performance section as “the measurement and assessment of the outcomes of supply chain process execution”. SCOR itself is built around three performance categories of resilience, economic, and sustainability, all of which are defined by related attributes. The categorization of attributes is shown in Figure 10. The association has also defined suitable metrics and performance indicators that correlate with the attributes, giving insight into the overall performance of the supply chain. The metrics are built in a three-level hierarchical structure, with lower levels providing possible reasoning for the performance of the higher levels. Costs, for example, can be tracked using a metric for Total Supply Chain Management Cost, which in turn consists of numerous other metrics: distribution, insurance, and planning costs to name a few (ASCM, 2024b).

Figure 10: SCOR performance categories and attributes (Adapted from ASCM, 2022)

Processes in SCOR are defined as "predefined descriptions for activities most companies perform to effectively execute their supply chains" (ASCM, 2022). As with performance metrics, different process levels have been defined ranging from 0 to 4, with larger processes on higher levels, and more operational processes being closer to level 4. SCOR DS processes are presented in Figure 11. Orchestrate is presented as the roof for everything else, it being the only level 0 process with the goal of linking all other processes to supply chain strategy.

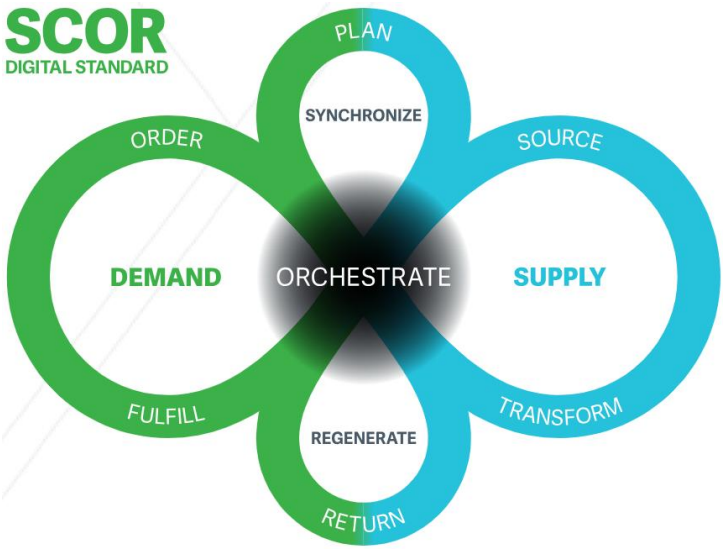

Figure 11: SCOR Digital Standard processes (ASCM, 2024a)

The rest of the processes presented in the macro-level approach – plan, order, source, transform, fulfil, and return – are level 1 processes, with the purpose of setting the general scope and targets for the entirety of the supply chain. Level 2 processes are meant to define the level 1 processes by determining capabilities related to them and setting the operational strategy for the different areas. Level 3 is about processes required for achieving the goals of the strategy, and companies can go to level 4 by further developing standardized practices around the processes. The beneficial aspect of the level system provided by SCOR is to give companies an easy and standardized way of describing their supply chain performance and processes, no matter the level of its complexity. (ASCM, 2022; Hosseinzadeh Lotfi et al, 2023)

In SCOR, practices refer to the distinct ways of performing certain processes. The practices have been built so that they retain their relevance across different industries, but it is recognized that individual industry level differences in importance and standardization of practices emerge. Four distinct "pillars" of practices have been defined to help interpret the possible benefits provided and focus areas of individual practices: analytics, technology, process, and organization. People, and related skills, competences, and experiences, create the final part of the SCOR framework. The goal of this aspect is to fit together correct people and the correct parts of the processes. (ASCM, 2022; Hosseinzadeh Lotfi et al, 2023)

The main benefits of SCOR come from the fact that it is standardizes across different industries, giving objectively good insight into the practices performed within supply chains, as well as providing a better tool for benchmarking. The commonality across industries gives the model a lot of flexibility regarding its compatibility with varying industries, while giving companies objective performance metrics regarding their processes. In addition, unlike many other models, SCOR is constantly updated, making it more steadfast against the corrosion of time. (Delipinar & Kocaoglu, 2016; Huan et al, 2004)

Due to its size, complexity, and cross-industry aspirations, the SCOR model is bound to have some flaws that need to be considered. As SCOR offers hundreds of different metrics for measuring the performance of a supply chain, companies need to identify the performance indicators with much care, as measuring all metrics is not feasible (Nguyen, 2024). Becker (2023) argues that the SCOR model also has underlying problems in not differentiating scheduling, prioritizing and the time factor from the planning process. Becker also criticizes

the model for lackluster focus on industries with more complex product transformation processes, as well as on inventory management.

In the context of pulp logistics, the SCOR model can provide general improvements in all aspects from efficiency to resiliency. By being able to implement a more standardized framework to the supply chain is bound to increase performance, as well as visibility in the for of clearer benchmarking. The model offers followable metrics to help in better knowledge management. The implementation of such a framework is greatly beneficial all around the supply chain, but should be performed with care, as the complexity and size of the model make the implementation a resource intensive process.

2.3.4 Risk Management

There are numerous ways for companies to try and increase their resilience, most of which deal in analyzing the severity and probability of certain risks, comparing their impacts, and developing countermeasures for them. No risk management approach is universally accepted to be superior, and instead many companies opt for the use of multiple approaches and tools available to gain a more complex understanding of the landscape they are dealing with. Common dedicated risk management approaches are presented in Table 4.

Table 4. Common risk management approaches

Approach	**Type**	**Related discussion**
ISO 31000	Framework	(Olechowski et al, 2016; Purdy, 2010)
Risk Mapping	Tool	(Scandizzo, 2005)
Failure Mode and Effects Analysis (FMEA)	Tool	(Ouyang et al, 2022; Wu et al, 2020)
Monte Carlo Simulation	Tool	(Mooney, 1997, p. 1-10; Raychaudhuri, 2008)

ISO 31000 is a risk management standard developed and maintained by the International Organization for Standardization – ISO – that can also be interpreted as a holistic risk management framework. At the core of the framework is the desire for standardized risk management achieved from uniform processes, evaluation, and treatment of different risks. An emphasis is put onto integrating proper risk management practices within the organization on a high-level, with commitment and support from management. (Olechowski et al, 2016; Purdy, 2010)

The process behind the ISO 31000 framework describes Communication and Consultation, as well as Monitor and Review as the two activities to be continually carried out. The basic idea is for companies to constantly be on the lookout for new risks, while improving and negating found risks. A critical part of the process it Risk Assessment, which is done after a risk is identified: the risk is first analyzed and evaluated, and if need be, treated in a proper manner. The importance of understanding, not just dealing with, each risk is highlighted within the framework. (ISO, 2018; Purdy, 2010)

Risk mapping is one of the most widely used methods of risk assessment. Though there are varying mapping methods, the most common way to map risks is to use a probability/severity chart. The idea behind the mapping is to identify risks related to the supply chain – or a part of it – and place them on the map based on their assumed probability of actualization and severity of the impacts they have. An example of a risk map is shown in Figure 12. The goal is to identify and minimize the risks with high probability or frequency of happening, that also pose a significant threat of disruption. (Scandizzo, 2005)

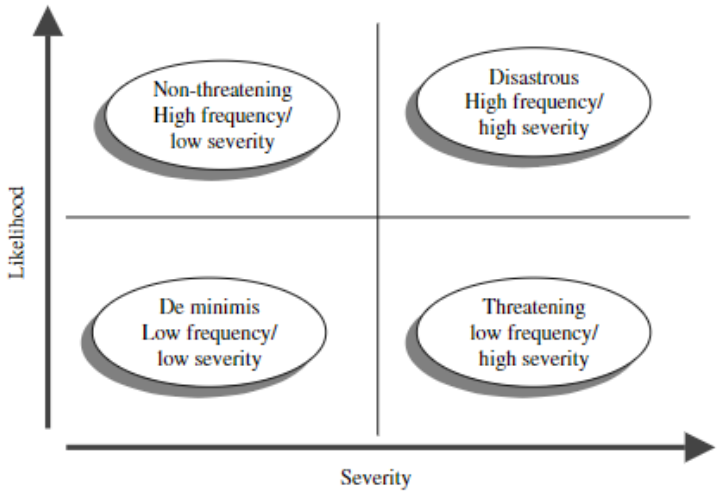

Figure 12. Risk Map (Scandizzo, 2005)

FMEA is another tool used for risk management, with the primary goal of identifying potential failure points within processes. It is very similar to risk mapping in the sense that risks are mapped with the dimensions of severity and occurrence, but it also incorporates the dimension of detection into the framework. Each dimension of each risk is evaluated on a scale of 1 to 10, and then the numbers from each dimension are multiplied together to make them comparable to each other. The higher the relative number, the more the risk treatment should be prioritized. Even though FMEA has originally been designed to fit the environment of

manufacturing processes, the model can be used in multiple other contexts as well, including logistics. It can be used in, for example, identifying possibilities in transportation failures. (Ouyang et al, 2022; Wu et al, 2020)

Monte Carlo simulation is a random sampling simulation model designed to analyze processes with inherent uncertainty. The idea behind the simulation is to input variables and expect a range of results, instead of a definite answer, giving a more realistic approach to risk management. By first analyzing historical data, input variables can be approximated and by simulating thousands of scenarios with varying random values, a good grasp of the overall expectancy of risks realization can be gained. (Mooney, 1997, p. 1-10; Raychaudhuri, 2008)

2.4 Summary of literature review

Pulp – a kind of commodity good shipped in bulk – is a logistics solution to shipping wood fibres. Shipped globally with a wide range of uses, it has been an integral part of many manufacturing industries. The global market trend for pulp is at an interesting place; with old uses – like newsprint paper – being less prominent due to megatrends like digitalization being replaced with new innovative uses, as well as an increasing market of fluff paper. With the product being sold and shipped in huge quantities, it suffers from the general effects of economies of scale, providing better profit margins with larger quantities produced and sold. Therefore, large part of pulp sales profitability is affected by the overall cost-efficiency of the supply chain. Generally, this also means that the inventory levels – especially that of safety stock – of pulp are very small compared to the amount produced, putting additional pressure into keeping the production of pulp continuous.

The performance dimensions of logistics – and supply chain – management can be divided between efficiency, flexibility, and resilience. The approach of efficiency calls for reducing redundant operations and other wastes to decrease the amount of non-value adding components. The goal is to keep the costs of normal operations to a minimum to ensure profitability. Flexibility describes the ability to answer shifts and variations continuously happening in the operational environment. The ability to mitigate or avoid larger disruptions is referred to as resilience. It was shown that in the context of pulp logistics, efficiency should justifiably take priority as the primary dimension, but the other two dimensions should be addressed in

meaningful ways to achieve better total costs optimization. A summary of the dimensions is presented in Figure 13.

Figure 13. Performance dimension summary

Suitable frameworks from existing literature were studied on the basis that they could provide value for the focal company if implemented. Out of the multitude of variable frameworks available, three – presented in Figure 14 – were chosen to be studied based on their seemingness to prove useful in the context of the study, as well as their relative differences to be more accurately fitted depending on the findings of the empirical part of the study.

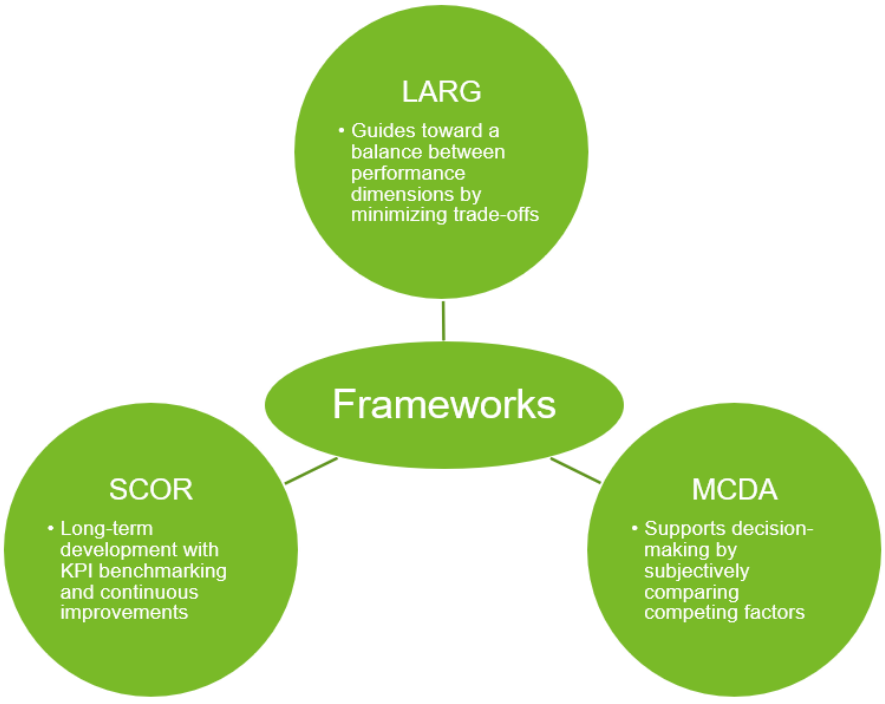

Figure 14. Studied frameworks

The first framework – LARG – promotes a good balance between the different performance dimensions, also adding the dimension of sustainability. It is a more stable framework, providing ideas on what factors to balance to minimize negative trade-offs between dimensions. The MCDA framework focuses on measuring the comparative differences of conflicting factors. It is less static, providing more alterations to its usage, making it effective in environments with complex variables. Finally, the SCOR framework provides insight into long-term performance measurement, with the focus on continuously improving operations based on chosen KPIs. It is a more process-oriented framework, providing less guidelines to real-time decision-making.

3 Case study

This chapter gives more context about the focal company, as well as the empirical research methodology and its implementation. The structure and motives for the chosen data gathering methods are also explained. The logistics chains regarding pulp movement of the company are presented.

3.1 Focal company overview

The focal company is a large Finnish forestry company with global business and a number of different business functions, one of which is Pulp. The thesis and study conducted are related to this specific function, which is characterized by even-quality bulk products and global logistics networks with a lot of depth. The company owns 5 pulp mills in 2 different countries, use multiple different transport methods, and ship the product all over the globe.

As is tradition with many other commodity products as well, the focal company deals with pulp in huge quantities. Even with a relatively notable presence within the pulp market, the company faces challenges and pressure toward reducing logistics costs. It must also continually adapt to fluctuating demand and varying shipping costs. Balancing between these different factors while maintaining good service levels is a task that requires much support.

A relatively small portion of the pulp sales made by the company are shipped directly from the mill to the customer with the use of trucks or trains. A majority, however, is shipped all around the world using large vessels either in containers or as break bulk (BB) shipments. BB shipments are preferred on lanes with less variability and larger shipment quantities as container stuffing naturally creates additional logistics costs. A breakdown of the moment of pulp is presented in Figure 13.

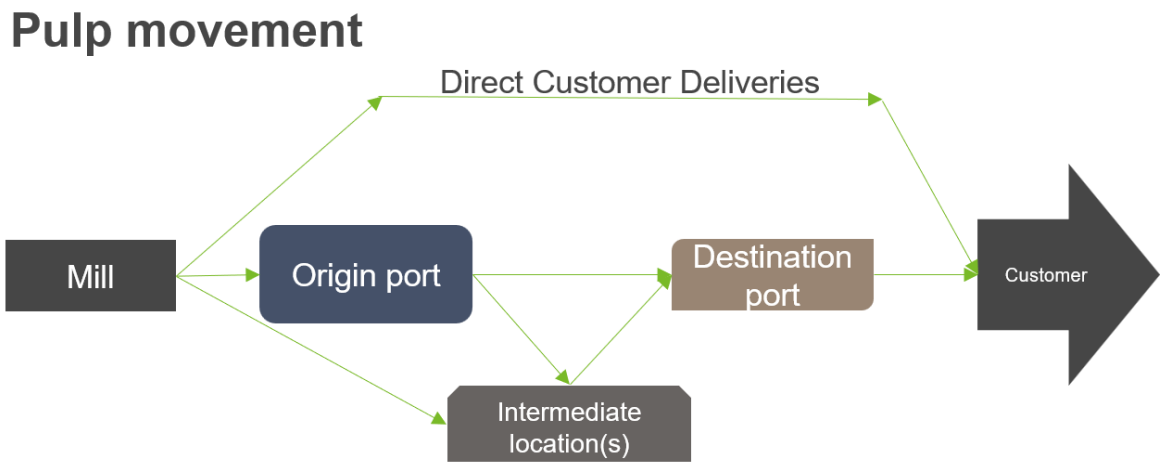

Figure 15. Pulp movement within the focal company

Most mills first ship their pulp into a nearby port, where the pulp is either directly loaded into BB vessels or stuffed and loaded into container shipments. There is one exception, with one mill being integrated with the port so there is no need for the pre-leg transportation. The BB shipments rarely have multiple intermediate locations, while container shipments may usually contain multiple of them.

This study offers the company deeper insight into the current logistics related factors while also providing frameworks to further develop and simplify the decision-making process. By diving into the current practices and challenges and considering the possible enhancements that can be made in them, the goal is to provide insights into changes and improvements that can realistically be implemented to further the company's performance.

The focal company wants a better understanding on the effect on costs different practices and decisions have, as well as insight into the factors regarding these decisions. Special interest is put into discovering what causes large deviations in costs, and how to mitigate – or even negate – them. In addition, a mapping of some possible general improvements in logistics development is also requested.

3.2 Empirical research methodology

The study's empirical design is performed as a series of semi-structured interviews. According to Adams (2015, p. 365-377), there are multiple factors that contribute to the use of semi-structured interviews instead of other information gathering methods. Firstly, he highlights

the need for open-ended questions to provide more room for variation in the answers. The need for answers from individuals rather than a concentrated group is underscored, both from the perspectives of answer independence, as well as release of pressure from a group. The author also mentions uncertainty of answers to be an important factor in choosing semi-structured interviews as the method for gathering information, as the methods provides an easy way to continue investigating risen topics in differing dimensions. Kallio et al (2016) also argue for this, mentioning the main benefits of conducting-semi structured interviews to come from the fact that there can be some improvisation in the follow-up questions based on the responses given.

The interviews' main purpose is to give insight into the current logistics practices and challenges. Given the expected variation between answers and the possibility of an unexpected answers, the use of open-ended questions is preferred. There is a need to hold follow-up question regarding answers, especially in cases where the main topics are discussed in greater depth. Based on the needs of the study, the use of semi-structured interviews as a method for the empirical part of the research is found to be suitable.

3.3 Interview data collection

There were 15 semi-structured interviews conducted for the study. A majority of the interviews were held remotely, but some in person. All interviews were recorded in support of notes made during the interviews. All interviewees were sent an invitation to the meeting with a brief description of the agenda of the interview. The agenda was further clarified in the beginning of each interview, with an emphasis on the anonymity of the interviews and a permission to record.

All of the interviewees were employees of the focal company. To get a good view on the different levels of logistical planning and operations, directors, managers, as well as specialists were interviewed. The interview questions for employees in the logistics function can be found in Appendix 1. Logistics as a function of the focal company is strongly tied to other functions, especially planning and sales, with factors from other functions working as strong drivers for the others. Therefore, employees from those functions were also interviewed with an altered set of questions, which are presented in Appendix 2.

With a total of 15 interviews, the total length of the interviews amounted to 11 hours and 51 minutes, with each interview taking about 47 minutes on average. There was a test interview conducted with the thesis supervisor form the company's side prior to any actual interviews. Based on the feedback given, the questions were then refined to provide more accurate insight into the objectives of the interviews. Small changes to the format of the questions were also made during the first interviews to make them more understandable. As there is a lot of room to dig deeper into the answers of the interviewees in a semi-structured interview, many more questions arose in the interviews with different people. The summary of the interviewees is presented in Table 5.

The general idea with the order of the interviews was to try and first get the perspectives of the directors and managers of the logistics and planning functions to get a better baseline understanding of how the high-level operations function around logistics. This provided a better understanding of the answers of specialists, and the capability for more meaningful follow-up questions. During and after the round of interviews, follow-up questions for different interviewees were also asked via messages when needed.

Table 5. Interviewee summary

INTERVIEW ID	FUNCTION	INTERVIEW DATE
1	Logistics	2.1.2025
2	Logistics	8.1.2025
3	Logistics	10.1.2025
4	Logistics	16.1.2025
5	Logistics	23.1.2025
6	Logistics	28.1.2025
7	Logistics	30.1.2025
8	Planning	13.1.2025
9	Planning	14.1.2025
10	Planning	20.1.2025
11	Planning	21.1.2025
12	Planning	23.1.2025
13	Sales and Customer Service	31.1.2025
14	Sales and Customer Service	6.2.2025
15	Sales and Customer Service	10.2.2025

4 Results

In this chapter the results from the interviews are analyzed, and findings from them discussed. Company sales and logistics cost data are also referenced to give insight into the effectiveness of current methods as well as the impact of faced challenges. Important trends recognized from the data that were not necessarily mentioned within the interviews are also discussed to support the creation of the overview of the current situation.

4.1 Current practices

A large part of the interviews focused on trying to develop a strong understanding of the current practices within the logistics function and its collaboration with the other functions. Many of the questions reflected this, as trying to get an understanding of the current situation is the basis for future development. The priorities – and differences in thereof – in decision-making between the interviewees was particularly important, and they had the objective of trying to find discrepancies in what different functions value over others.

Multiple different levels within the organization were interviewed, the goal of which was to gain insight into how the logistics practices differ on an operational, tactical, and strategical levels. With this in mind, it is important to distinguish the point of view of the different interviewees and take it into account when considering the answers. This comes apparent in some answers, where on an operational level the amount of influence an interviewee has on certain topics might be very different from higher level decision-making. Certain questions, therefore, proved more insightful with some respondents than others.

4.1.1 Priorities in decision-making

When discussing factors related to decision-making – regardless of the level or function of the interviewee – customer centricity and high service-level were considered to be the highest priority factors in logistics and broader supply chain planning, mentioned by all interviewees. This was emphasized by the sales function even further. The finding is not

surprising as if the customer is left neglected and they do not get their orders for extended periods of time, the company will lose business. Prioritizing the customer means, in short, that even in the case of disruptions, the pulp should be moved onward as fast as possible, even with increased costs in logistics. Getting the agreed upon pulp to the customer on time, in full, and of the correct quality were agreed upon many to be the goal of the entire supply chain.

There are situations, where the customers themselves need to be prioritized over each other due to strikes, or other significant disruptions to the supply chain. This was largely mentioned to be the responsibility of the sales function, but with each other function having their own opinions on the matter. Logistics and an approximation of its costs was described as an important factor in choosing the priority customers. Other factors regarding the topic included whether the customers have other sources of pulp available, convenience in shipping, and overall customer relationship. The survivability of the customers is also considered: those with little to no material are prioritized over ones with larger inventories that have the option to wait for the next shipment. All in all, representatives of the sales and customer service functions can be thought of as being the ones mainly responsible for having the customer as their mostly undivided priority.

Along with the customer there were numerous other things mentioned as important to take into consideration. Costs were mentioned by all interviewees as the other parallel priority adjacent to customer-centricity. 71% of the interviewees from the logistics function clearly described the top priority of logistics as a good mix of both costs-efficiency and service level, like shown by Interviewees 3 and 5:

"The first priority is cost-efficiency, but of course, we need to take the customer into account with everything."

"There is a balance to be kept between the pulp arriving at the correct time and the costs."

As the costs of logistics have a big impact on the profitability of pulp sales, this finding is not particularly surprising either. With much more focus on costs recently also due to some macro-economic factors like the Russo-Ukrainian war and weaker economic situation, this was highlighted even further. There are numerous factors that contribute to the total logistics costs, most prevalent of which are categorized as the carriage costs for the transportation, handling costs for the loading, unloading and container stuffing, fuel costs, and the extra

costs from contingencies, demurrage, as well as dead freight. There is much variation between the prices of different carriers on the same lanes, so choosing the right ones is a big responsibility on the strategical and annual planning level. In addition to the costs of different carriers, the reliability and past carrier relationships also play a big role in choosing the correct carriers for the supplier portfolio. Factors considered when choosing between carriers are gone into more detail in chapter 4.1.3.

As for the operational logistics tasks, managing the shipments in accordance with the yearly tenders for each carrier plays a big role. As the tenders are generally meant to provide a good mix of costs and reliability, they should offer a good guideline for the operational work. As summarized by Interviewee 7:

"As long as you stay true to the contracts made, the costs should stay low."

This creates two options for logistics development: either by lessening the impact of deviations to the operational tasks, or by improving the portfolio of the carriers and the tendering process. Both options and possibilities therein are discussed in the following chapters.

While the logistics costs and their optimization are the main responsibilities of the logistics function, all of the different functions need to play together to achieve maximum cost efficiency. Many interviewees outside of the logistics function described logistics as just another factor in their decision-making, which promotes the need for a good understanding of the realistic expenses posed by the transportation for other functions. As mentioned by Interviewee 8, sometimes the overall supply chain needs to be valued over individual functions like logistics:

"The optimal logistics solution is not necessarily the most profitable one overall."

This interconnectedness between functions encourages straying away from partial supply chain optimization solely based on logistics; most decisions should instead be made to achieve better overall costs efficiency. The customer and transport costs are not, however, the only things in need of balancing to achieve a more optimal supply chain. The key factor in the planning function is the need to take the stock levels in all the warehouses throughout the supply chain into consideration. Planning a Lean-like continuous flow is currently a must, as there are little to no buffer in the inventories to minimize the tied-up capital and free it up for other uses. One of the main priorities mentioned by all interviewees from the Planning function is to ensure the production of pulp; needing to halt production due to

having full inventories should be avoided at all costs. The lack of larger safety stock further highlights the difficulties this poses. Interviewees 9 and 10 from the Planning function summarized their point of view as follows:

"The main goal is to balance the inventory levels, so the production continues"

"The priorities start from ensuring the flow of production."

There were only a few mentions regarding sustainability. A very unfortunate reality with the current situation is that the regulations are the main driving force for sustainability. In the current economic situation, where the company is forced to prioritize costs over other factors, green choices can be thought of as an extra cost on top of other necessities. Without a direct increase in the revenue of pulp sales, it is difficult to argue for the importance investments into sustainability. It is important to note that even with this in mind, the company is performing well on this area overall, with less emissions than most of the competition. Interviewee 1 summarized the current relationship with sustainability in the following quotes:

"We fill the requirements for current regulations very easily, but performing over them is currently too expensive."

"The customer is not willing to pay anything extra for sustainable solutions."

Overall, the current priorities align with Lean principles quite well, with a lot of practices supporting continuous flow, removal of waste, and efficiency. This is understandable given the context of the current economic situation, where profitability drives a majority of the decisions. It is apparent, that even though the customer was mentioned as a priority by all interviewees, not all functions act on it in the same way. Sales and customer service are the first contact for the customer, and it is natural for them to prioritize the customer's needs over everything else. The Logistics function can be thought of as a party with the main focus on improving cost efficiency and maintaining good relations with the carriers. The priority within the Planning function can be considered as making sure there are no halts in production and keeping the inventories at a good level.

4.1.2 Cross-functional communication

A point that was mentioned by 80% of the interviewees was the need for cross-functional communication between the different functions. As each function closely works with a different stakeholder – Logistics with the carriers, Planning with the mills, and Sales & Customer service with the customers – information regarding changes in each needs to be exchanged internally efficiently. The relations between the different functions are visualized in Figure 14.

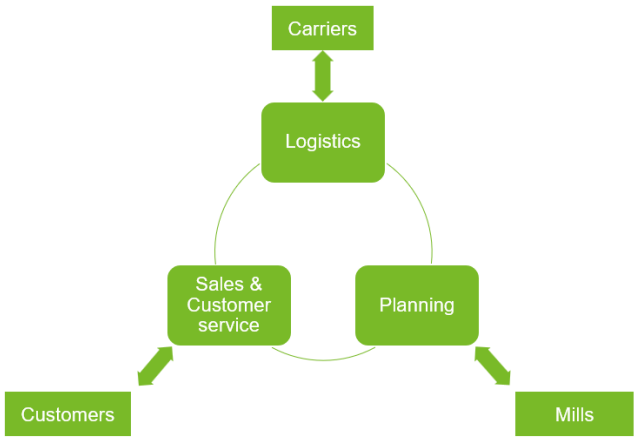

Figure 16. Relations between functions and stakeholders

The importance of communication is highlighted by all interviewees directly. 100% of the managers and directors interviewed mentioned it to be crucial in successful cross-functional operations. Interviewee 8 quoted the following:

"Communication and transparency are the most important factors in everything we do."

Transparency was often used almost as a synonym for good communication, with mentions of it appearing in 80% of the interviews. This shows that the responsibility of communication is meant to be on the information provider's side, instead of promoting the need to constantly have a need to ask for the necessary information. This is summarized by Interviewee 7:

"It is important that your own work is transparent and available for everyone."

With most of the pulp being delivered with trans-oceanic vessels with rigid schedules, logistics provide limitations to the other functions. Vessels pose a significant bottlenecking possibility in times of strife, and deviations in schedules need to be communicated onward as

quickly as possible. Even in a situation without problems, the fact that the vessels arrive on shore ready for loading once every two to four weeks – as opposed to multiple times a day like trucks – creates additional stress in ensuring a swift loading without overstocking the inventories before the arrival. As mentioned by Interviewee 9:

"Logistics provide a strict frame for our operations, as the schedules for the vessels are the way they are."

The quote suggests that due to the lead time for delivering the pulp being so strongly tied to huge amounts being transported at the same time, there is less room for operational, or even tactical flexibility. Communicating any changes to the given schedules onward to other functions efficiently is at an utmost importance. As the Planning function is under pressure to keep a constant flow with the production, delays in vessel loadings may affect the need to transport pulp between inventories. Delays in the loading time sometimes also means delays in arrival dates for the customer, requiring information to be shares to sales as well, to be possibly further communicated to the customer. Generally, small delays in loading have little to no impact in the actual arrival time for the customer, but larger delays usually demand some actions.

A significant cause for additional costs in logistics comes from demurrages; costs for extended loading periods. The cost on the opposite end of this is dead freight, which is derived from transporting too little pulp due to not having enough to be shipped in a given time. Logistics specialists are often faced with a situation where balancing between these two costs is needed. Information regarding the optimal solution in these situations includes production information from planning, and customer demand information from sales.

Planning has a relative straightforward role in communication, as the main thing to communicate to the other functions are larger deviations to production, which may impact the availability of pulp. Small deviations rarely cause problems within the supply chain later, but problems arising from longer periods of unplanned lost production stack quickly. In addition to this, the inventory levels sometimes require actions on part of logistics, as pulp is sometimes transported onward just to make room for more production in earlier storages.

Sales pose an important role in communication, as the stakeholder they have to communicate with is arguably the most important: the customer. As the demand for customers may vary from the agreed upon amounts, the changes need to be made clear toward logistics and

planning. The Sales function is also responsible for prioritizing specific customers over others, so having all the required information for making an educated decision is desired. As the logistics costs are an important factor in this process, transparency in the costs of specific lanes from the logistics side is highlighted. The general question of whether there even is enough pulp to be promised for the shifting demand on the other hand must be answered by the Planning function and made clear for sales.

In total, the information should be delivered between the functions without friction and as fast as possible. Information between the functions is currently being shared in two ways, which are presented in Figure 15. Methods of manual sharing require an answer from another person, while automatic information is readily available for everyone within the different functions. Manual sharing is done primarily with the use of reoccurring meetings and ad-hoc messaging, and automatic sharing with reports and other shared data. Currently both methods of communication are crucial.

Figure 17. Information sharing methods

The automatic information sharing methods are mostly based on shared information that all functions can access without the need to ask. While the goal is to be able to keep the information automatically updated, some of the information is still in need to be kept up-to-date manually. Most actions done on the company's ERP system are automatically transferred to a common data platform – a CDP – where they are used in a multitude of Power BI reports available across functions.

There are varying opinions regarding which method of communication is preferred between different interviewees. The consensus, which will be gone into more detail in chapter 4.2.1. is that the most appealing factor about the manual contacts is the certainty of the answers, as there are currently problems with the trust in data. Even the people preferring to use automatic sources find themselves having to double-check some of the information manually.

As the increase in digital and automated solutions are expected to take a bigger role in the future, Interviewee 9 argues the following:

"In addition to communication and dialog, everyone needs to keep their end updated on IBP."

In conclusion, the importance of communication between the functions cannot be overstated. Many interviewees highlighted the need to further break down the silos of different functions, promoting an even more collaborative environment. Interviewee 14 summarized the thought regarding this as follows:

"We (different functions) need to work together… cooperate and share information. Without that we will not survive."

4.1.3 Carriers

Carriers are one of the main factors to consider in logistics. Balancing between the costs and service level is a big part of the tactical planning and choosing between different carriers. A direct comparison is made by Interviewee 2:

"You can't reduce the costs because it will most probably have a negative impact on the service level."

A big part of the current strategic and annual planning is in the form of tendering and planning the carriers for the coming periods. Tendering offers several benefits for the company as it is a good way to not only gain insight into the current market prices of specific transport lanes, but to also periodically update the nominated carriers more cost efficiently. It was mentioned that the importance of tendering more actively is highlighted in the current global situation, as there is more uncertainty and unpredictability, leading to more fluctuation in prices. Contingency surcharges – derived from increased risk in transoceanic shipments – may impact the total cost of a lane by 20%. With the surcharge varying greatly between quarters, the cost of carriers on specific lanes may quickly change significantly shifting their priority over each other.

Carriers are allocated based on the tendering results for the coming periods. This means that an agreement on the prices and the amount of goods to be shipped are agreed upon between

the company and the carriers, committing both sides. The length of the period strongly depends on the availability of alternatives, as well as variability, on the given lane. Lanes with a lot of alternatives are allocated for shorter periods, as the flexibility of being able to respond to price changes is desired to be maintained. Meanwhile on lanes with less alternatives resilience and stability in price is given a higher priority, with contracts with carriers lasting even as long as a decade. The contracts made also offer limitations to the operations of logistics, as they commit the company to try and keep their end of the contract, leading to certain biases when choosing which customers to ship to.

In support of tendering certain carriers are used as benchmarks for others to gain a deeper understanding of the relative prices offered by different carriers. Benchmarking is especially useful regarding container shipments, with a lot of accurate and easily comparable information available. It is, however, recognized that information of the same caliber is not as accessible regarding BB shipments, nor land transports.

To adequately increase the resilience within the transports, usually a single lane will have multiple named carriers that are made contracts with to account for possible disruptions in some of them. I addition, the overall portfolio of named carriers contains numerous carriers, not just one. Generally, when choosing carriers for the portfolio, the goal is to mainly get a good mix of costs-efficiency and reliability. Even though reliability is often the more important of the two, a balance needs to be found according to Interviewee 1:

"I appreciate quality in the service of the carriers over all else, but not at any cost."

Other quantifiable factors to have an impact on choosing a specific carrier include their advancements in sustainability – as they need to be regulation compliant – and flexibility. The past experiences and relationship with the carrier were also mentioned to play an important role; it is safer to stick to an old carrier partner than save a small amount of money in the short term by risking the transports with a newer one.

4.2 Current challenges

Another goal for the interviews was to shed light into the current challenges faced within the logistics operations. By understanding the problems within the current environment, they can better be addressed. The different functions interviewed have different priorities in their

decision-making, so there was an interest to also find out their interests when faced with challenges.

Both the most usual, and the most critical of challenges were given the most attention, as they have the most room for development. The current prevention and mitigation strategies were inquired to get an understanding of the already available methods, and to find out if they were sufficient. Questions for the functions other than Logistics were positioned to provide insight into their relationship and challenges with it, but often other, more function specific, problems in need of addressing arose in the interviews as well.

4.2.1 Communication

Communication between the different functions, as well as the key stakeholders, was perceived to contain room for improvements. Even though cross-functional communication was praised to be one of the most important things in the operations by many, there were a lot of mentions about it not being on a desired level. 93% of the interviewees gave direct critique towards the current level of communication in one way or another. Both the quality and speed at which information is shared were in debate, as shown by Interviewees 10 and 13:

"Communication could be better in both ways."

"I think an issue right now is communicating the right information faster."

On behalf of the Logistics function, information regarding carrier delays were agreed upon to be the most critical one to communicate toward the other functions. Currently, the function gained some critique regarding how fast this information reaches the Planning function, as pointed out by Interviewee 11:

"The information from the carriers reaches us very late."

The same is also true the other way around, with Interviewee 4 from the Logistics function assessing the situation of the flow of information as follows:

"One of the biggest challenges we face currently is that we get the information too late compared to when we would actually need the information."

As discussed in chapter 4.1.2., it is crucial for planning to be aware of any changes to schedules due to the small warehouse capacities available. Even though it is recognized that most challenges arise very late even from the carrier's side – with some delays only becoming apparent a week prior to the agreed upon arrival date – there is still some improvement in the internal communication as well. Regarding the Sales function, it was mentioned that small deviations ranging up to a couple of days of delay do not cause significant problems but should nevertheless be communicated onward. Larger delays, however, cause more significant reactions from all functions, as they cause significant problems in all parts of the supply chain. As highlighted by Interviewee 12, there needs to be an understanding of the impacts the problems with carriers have everywhere within the supply chain:

"When making the contracts with the carriers there needs to be an understanding of the supply chain from start to end."

As for the needs of the Logistics function, the changes in either production or customer demand have an effect on the short-term operations, and thus are in need of communication. The flow of information was deemed to be at a sufficient level when significant changes were noticed, but two interviewees expressed dissatisfaction in situations where the gravity of the impacts is not as apparent. As the capability to make optimal solutions from the logistics side sometimes requires the input of representatives from other functions, the need for efficient communication is needed. There were significant development wishes on regrading this issue. A key point being emphasized by Interviewee 4 was the need for all the required parties to understand the need for fast reaction:

"It would be valuable if all parties, who's reaction is needed, would understand when the reaction is needed in a matter of hours instead of days."

A majority of communication-related challenges arose from the extensive need for manual communication. Even though there were a lot of positive comments given to the flow of information even manually between functions, it was recognized that in cases of deviations, not all parties necessarily got the addressable information or realized that action was needed on their part. There is also a bit of a bias toward older ways of working; the interviewees often overlooked the amount of dependency on manual information sharing and risks therein. For example, most interviewees upkeep Excels for their own work that contain useful information that is periodically communicated to the people in other functions interested in the

findings. The reality could be instead that the file – or a report based on it – could be shared cross-functionally, giving all parties concerned full access to it without needing to depend on the availability of the person holding it.

As there are currently numerous different platforms for the people working on different parts of the supply chain to get their information from, there exists difficulties in remembering what information is available, and where to find it. This also promotes the need for manually inquiring about the important information from other functions.

The way forward should include more focus on the more automatic channels of sharing information to promote shared and transparent information over the current more silo-like structure. However, as will be discussed in chapter 4.2.3., there are other problems to be faced in the transition than just the initial resistance to change.

In addition to the internal information being shared, all functions have a separate stakeholder they are responsible for sharing information with. Often, however, the information is transferred from the stakeholders at a very late stage. This creates a situation where all parties need to be able to quickly respond to changes within different parts of the supply chain, be it in the form of varying demand, production losses, or carrier delays. In other words, even though some information is shared at a relatively fast pace, it suffers from the information itself becoming available very late.

4.2.2 Lack of flexibility and resilience

Due to the turbulence faced within the environment of the supply chain, the ability to flexibly respond to changes in demand, as well as the resilience to get through even the larger disruptions are a must within the supply chain. The role of flexibility was emphasized in 40% of the interviews.

Transportation of pulp over long distances is very much reliant on large vessels, giving the supply chain certain unaffectable rigidity. A vessel meant to ship tens of thousands of tons of pulp at once being delayed has a way more significant of an impact than a truck carrying just 20 tons. By default, therefore, the context with most of the pulp being transported is very easily disrupted by shifting schedules. That also affects choices available in case any

disruptions are actualized. When asked about the mitigation of challenges regarding delayed vessels, Interviewee 4 answered the following:

"In maritime logistics, there usually aren't that many options to choose from. Let's say three at best."

Regarding shorter delays of just a few days, rarely any drastic measures need to be taken. Longer disruptions – caused by strikes for example – instead currently cause significant damage to the operations. The disruptions with a more significant impact can luckily be mitigated a bit by pre-shipping small amounts of pulp to where needed before the actualization of them, and this was mentioned to be one of the few things that are viable to do in these kinds of situations.

Accurately predicting the demand of specific customers is key in being able to optimize the differences in priority between customers at any given time. As deviations to the planned shipments are bound to happen due to the supply chain being so susceptible to small variations, the importance of planning the shipments so that no customer is left critically dissatisfied is highlighted. Constant contact with the customer needs, and the communication of that information internally help with getting on top of the problem, but as discussed in chapter 4.2.1., the communication is not yet on a desired level. This leads to a situation where not all deviations can be responded to in an appropriate manner, and some decisions are currently based on intuition and old – or downright wrong – information.

Changes to customer demand – especially increases in thereof – often are communicated from sales at a very late stage. Partially, this is due to a bit of a processing time from the sales' part, but more often it is the customer who communicates the changes late. As this is largely out of control of the company, instead of an approach to gain more room, it is requested by the Sales function that the supply chain should be more flexible. When asked about improvement suggestions, Interviewee 13 said the following:

"What we need to do better is to be able to respond faster."

Due to the restrictions posed by the Planning function in production and inventory management, there is also a need to be able to flexibly answer these as well within the Logistics function. Deviations to the normal operations arise, and optimal solutions to these situations need to be found, as mentioned by Interviewee 9:

"I expect creative solutions, as even though I recognize we need to act according to our contracts, there is sometimes a need to respond to changes outside of them."

The requirement posed to the Logistics function demand the need to take multiple different factors into consideration when trying to find an optimal solution when faced with a disruption. The different factors include not only the logistics-specific factors like the vessel schedules, but also the production and inventory levels, customer priorities, as well as external factors like the weather. It is sometimes difficult for the people to get the required information to make an optimal decision.

In total, as is usual with bulk commodity products, efficiency seems to be prioritized over the flexibility and resilience of the supply chain. There are, however, possibilities in optimizing the total costs by increasing the flexibility and resilience in a planned manner. Developing a common understanding of the value of different factors apparent in situations of deviations with a common framework could promote faster response time. Regarding resilience, the use of large vessels creates limitations. Delays in vessel arrivals were deemed to impact all parts of the supply chain, and the delays were mentioned to be quite common. The delays have an impact not only on the immediate shipping schedule, but also affect the planning of stock and production, as well as the time the pulp arrives to the customer. The carrier portfolio is created in a way to balance costs with risk, and there was little critique in its current stage, and it is constantly being developed. There is, therefore, already measures taken in place to increase resilience with smarter carrier allocations. Another point of resilience – or lack thereof – within the supply chain is the absence of safety stock, and small inventory capacities especially in the mill sites. As the quantities of pulp produced are huge, and profitability was mentioned to be at the core of logistics operations currently, it is understandable that the capital invested within the finished product is tried to be kept at minimum. The lack of buffer inventories later in the supply chain provides additional costs when faced with the need to pre-emptively transport pulp into further ports, especially when the stuffing of containers is postponed to a later port. Small safety stock levels at strategical points within the supply chain could prove to provide increased flexibility and decrease costs when faced with disruptions.

4.2.3 Data quality and user errors

Even though the possibilities in the use of automatic methods for information sharing are great, and some interviewees already appreciate the readily available information, one factor agreed upon by many was the lack of trust in the data available. The main critique toward the methods came in the form of lackluster data quality due to human errors. Key reason for the human errors was pointed to be the number of manual inputs, as mentioned by Interviewee 6:

"With the tools that we have, everything is very manual, leaving room for a lot of mistakes."

As most information that is relayed to the visible platforms is based on manual inputs, or automatically calculated forecasts and assumptions, the usefulness of the tools available is hindered. Even in situations where the data is readily available for the people in need of it, the lack of trust undermines any use it may have. This is directly addressed by Interviewee 4:

"The accuracy of IBP is currently at a level at which we cannot directly plan anything with it, and the input regarding the information needs to come from a person."

This lack of trust greatly increases the amount of manual work needed to share information between the different functions, as highlighted by Interviewee 7:

"I have to go around asking via messages if the information (in IBP) is correct."

When asked about the range of available tools, they were mentioned to be at a sufficient level. There was, however, interest shown toward refining the current tools, as shown by Interviewee 6:

"I don't want more tools; I want the tools we have to work as they should."

Another problem regarding the use of the automatic solutions is the lack of knowledge regarding the tools. This can become apparent either in the use of the tools, or the misunderstanding of needing to keep certain fields updated. According to Interviewee 7:

"We have a wide variety of tools available, but nobody is trained to use them."

When asked about the current suggestions for improvement in collaboration with logistics, Interviewee 9 mentioned the following:

“Learning IBP and getting the maximum value out of it.”

A final challenge regarding the information available comes from the differences of processes depending on a variety of factors. It was mentioned that learning the differences in ways of working with different carriers and port operators might significantly impact the ease of cooperation, as well as data quality. The data quality is also very much dependent on the specific partners being dealt with, as there is a lot of variation between the possible ways of communication. The clearest example of this is with certain port operators there is an established Electronic Data Interchange (EDI) connection to automatically manage the necessary documentation with them, lessening the possibility of manual mistakes. Due to the different processes not being fully dependent on the focal company, there are little possibilities in making any changes toward fixing this challenge in the short-term. The company can, however, try to assimilate its internal processes.

Shifting from a manual information sharing focused environment towards it being more automatic is currently a process being hindered by the data quality issues caused mainly by human errors and lack of knowledge regarding the tools. The shift toward automation in information sharing would offer a variety of benefits, like increased response time to deviations and more optimal solutions to challenges and promote the functions to work as one. A common program to educate the personnel in the correct tool usage and requirements for keeping the data quality at a sufficient level could prove to be an efficient way to make advancements in this shift.

4.3 Summary of interview findings

Based on the interviews conducted, a better understanding of the current practices and challenges is created. The findings offer opportunities for development, but also show the important details of the current situation with its weaknesses and characteristics. The most crucial findings are summarized in Figure 18.

Figure 18. Summary of interview findings

The most noteworthy finding is the presence of multiple conflicting factors in decision-making between functions. It is understandable that as each function communicates with a different stakeholder at the focus, some biases are created. The biases, however, sometimes skew the decisions made further away from the optimal solution.

Communication – both success and failures therein – are an integral part of the broader supply chain planning. Currently, the communication between different functions was praised to be successful, but deeper discussion revealed areas of improvement. A lot of information in shared manually via messages and meetings, leaving room for development in information automation.

Regarding the logistics function specifically, choosing a good portfolio of carriers is at the core of total cost optimization. A balance between costs and reliability in carriers needs to be found and updated based on different situations. It was found that currently only a few lanes are benchmarked is an advanced manner, proving a lack of an overarching framework in choosing carriers.

Finally, it was recognized that pulp logistics operations are very susceptible to disruptions due to the long lead-times from using large vessels. This creates additional tension in keeping the production and delivery flow stable. Response time to smaller deviations was also shown to have room for improvement.

5 Development recommendations

Based on the findings from the interviews and other relevant data, in this chapter a framework is suggested to be implemented within the focal company. The framework is suggested based on its suitability given the current practices and challenges. In addition, some general recommendations are presented for the development of the current logistics practices to further enhance efficiency therein.

5.1 Framework justification

As found from the interviews, the focal company currently struggles with integrating different focus areas between the functions in its supply chain – namely logistics, planning and sales – in an optimized manner. Even though the customer is recognized by all to be the priority, it was shown that other factors play an integral part in choosing solutions in cases of deviations and disruptions. With there being multiple factors that each function is better equipped to analyze than the others, all having an impact on the total costs and finding the optimal solution, a framework to help the functions calculate the significance of different factors could prove useful.

Along with the competing priorities between functions, there was also mention of difficulties in communication between functions. While there are solutions to better address this challenge – which are gone into more detail in chapter 5.4. – a common framework used cross-functionally could also help by standardizing the processes required when disruptions are faced. In addition, a common framework could increase the speed at which deviations are handled, increasing flexibility and resilience.

Based on the findings of the interviews and the literature review, the implementation of the Multi-Criteria Decision Analysis – MCDA – framework could very possibly prove useful for the focal company. As presented in chapter 2.3.2. the framework is ideal in situations with numerous conflicting factors are present and – as was found in the interviews – the focal company deals with finding a balance between the priorities of different functions. To continue on the fact, it was also shown to be in the interest of the focal company to not focus

on solely cutting costs by increasing efficiency, but also by reducing the impact of disruptions to the operations. MCDA is also great in environments where a lot of the considerable factors come from uncertainty and risks, which is also true for the focal company.

Compared to the other frameworks presented in chapter 2.3. MCDA benefits from its focus on unevenly weighing different factors, the need of which is necessary in environments with complex trade-offs between variables. While the LARG framework presents a good idea on the overall balance of different factors within a supply chain, it offers no way to quantify nor compare the importance of the factors. Instead, it serves more as a guide or a philosophy rather than an actionable decision-making guide. Meanwhile, the SCOR framework – while proving an effective way to measure and develop the overall performance of the supply chain – suffers from a lack of guidelines for real-time decision-making, opting for more focus on process standardization and benchmarking.

The main benefit of the implementation of the MCDA framework in the focal company would come from better total cost optimization due to improvements in multiple different areas. The framework would offer answers to the challenges mentioned in the interviews to currently plague the environment. The benefits of the implementation are presented in Figure 16.

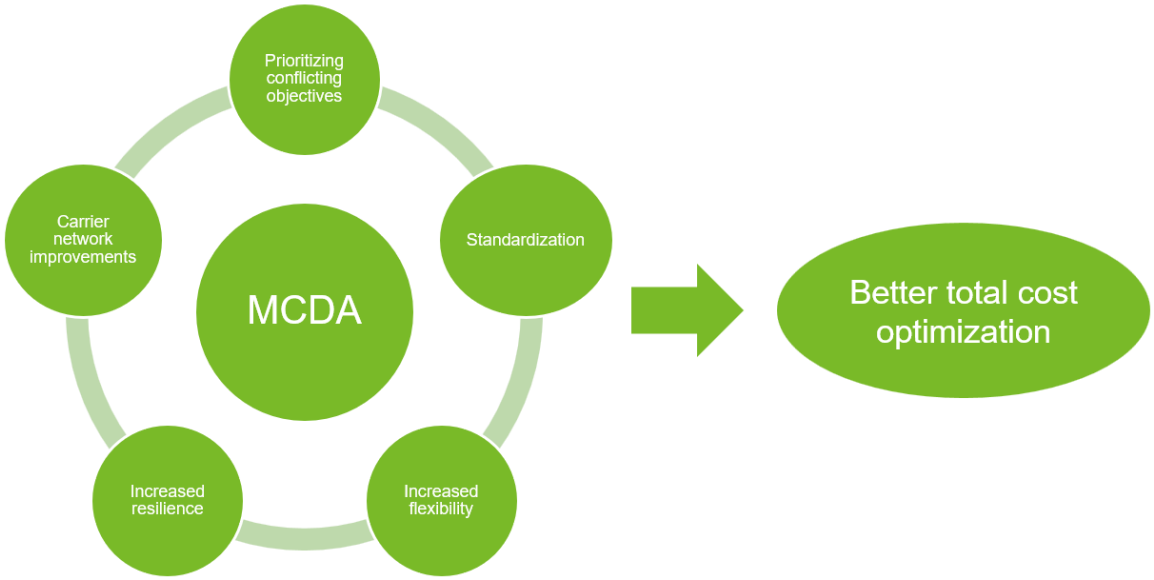

Figure 19. Benefits of MCDA implementation

As was found in the interviews, there are currently somewhat conflicting priorities between the functions. All functions naturally tend to prioritize their own focus are and stakeholders

more than others, and therefore exhibit an innate bias. With the different functions focusing on transportation costs, stock and production levels, customer satisfaction, and service level, figuring out the optimal balance between the factors case by case is at the very least time intensive, but most likely impossible. This is due to the entire process needing excessive communication, but more importantly, understanding of the needs of the other functions. With a common, pre-emptively set up, framework dedicated to figuring out the relative importance of different factors, there would be a better balance between the different factors, as well as a better understanding of common goals between the functions.

Having a better understanding of the importance of different factors within the supply chain introduces a level of standardization to decision-making processes. Standardized processes lessen the variation between different challenges faced, making planning for the longer term more predictable. Having common responses to the challenges also lessens the variability in inputs, making finding the root causes for changes to the output easier to understand. With a standardized decision-making process, therefore, continuous improvement is made more achievable.

A nice side effect of having a common understanding of the priorities is the ability to also respond to changes and variations within the operations faster. This directly increases flexibility within the entire supply chain, as meeting shifting demand targets or changes to vessel schedules are answered faster. Instead of needing the input and communication of multiple specialists to keep up with the constantly changing environment, a set of pre-defined criteria could be used to figure out the optimal solution in a shorter period. This reduces bottlenecks in decision-making, especially in situations where fast responses are required. With developments and iterations to the framework, some responses could even be automated.

MCDA would also help in balancing between the factors in a more resilient way than before. Incorporating risk management within the supply chain by weighing them and taking them into account in all steps of the decision-making process has clear benefits to the overall costs. In addition, transparent understanding of the effects decisions have in other areas of operations constitutes to a decreased likelihood of significant disruptions occurring. While the external challenges faced would still affect operations, the supply chain should be built in a way to mitigate the impact of these challenges as well. Internal disruptions would, on the other hand, be avoided at an improved success rate than in the current situation.

The MCDA framework is not limited to solving cross-functional challenges, as it also has clear potential in the context of logistics by itself. The clearest use for the framework is with carrier network management by improving the existing portfolio. Benchmarking was mentioned to be a dominating way of comparing carriers currently, so implementing a more varied approach should not pose to be a challenge. As the method of choosing carriers is currently mostly based on immediate costs and multiple more arbitrary factors like reliability, there is a lack of a method to objectively quantify and value each metric to get a holistic view on the actual performance of carriers. Implementing MCDA by weighing each variable between the carriers could prove to decrease the overall costs within the carrier portfolio. With this use-case of the framework, it should be taken care of not to cannibalize total supply chain costs by sub-optimizing the carriers too much.

5.2 Framework details

One of the most critical parts of the successful implementation of the MCDA method is choosing the correct variables and weighing them correctly. The list of variables should, at the very least, include factors to complement the different aspects of efficiency, flexibility, and resilience. While service level and the direct costs from logistics should be the key factors, there are other things to keep in mind. A broad description of what were found to be most the crucial factors are presented in Table 6.

Table 6. MCDA factors

Factor	**Description**
Base charges	The base costs provided by carriers.
Disruption costs	Most dominantly demurrages and dead freight costs.
Service level and customer satisfaction	Delivering correct amounts at the correct times.
Production flow	Keeping the production continuous and not letting full inventories bottleneck the process.
Inventory levels and capital committed	Keeping the inventories at a good capacity, not committing too much capital in them.
Reliability of carriers	Being able to depend on the dates promised by carriers.
Carrier relationships	Keeping promises made to carriers to ensure stability in the future.
Priority customers	Some customers hold priority over others.

Choosing the correct MCDA method is another crucial part of the implementation process. Some of the most used MCDA methods – which were detailed in chapter 2.3.2. – are summarized in Table 7.

Table 7. Common MCDA methods

Method	**Description**
AHP	1 vs 1 comparisons between variables to find out their relative importance.
DEA	Comparisons between homogenous DMUs.
FST	Vague or ambiguous inputs to give outputs even in uncertain environments.
TOPSIS	Comparison made by analyzing distance of alternatives to the ideal solution.

Out of the presented methods, the Analytical Hierarchy Process – AHP – is deemed to be most fitting for the case study. As the different factors for MCDA presented in Table 6 are difficult to homogenize, they should instead be compared more directly. The AHP method supports pairwise comparisons between the different factors, giving a clearer view of their relative significance in the supply chain. In addition, the method can be used to further break down the individual factors into smaller sections, improving its usefulness on different levels of operations.

It was also shown that the current carrier portfolio has room for development. As the carriers are more homogenous to compare, the Data Envelopment Analysis – DEA – method would be a good tool for their optimization. The current methodology was described to closely describe the TOPSIS method but given how the DEA method offers more of a data-based approach to the comparison process, it would be more ideal to advance toward its use in the future. Additionally, the results from the use of the AHP method can also be further used with the DEA method to combine the upsides of both methods.

5.3 Framework implementation

There are numerous factors to keep in mind with the process of framework implementation. The implementation process is not gone into too much detail in this study, as it was initially left out of scope. It is, however, left as a good place to continue upon in future research. Some preliminary suggestions and warnings are discussed.

Moullin et al (2020) point out multiple important things to consider when implementing a new framework. One of the highlights is to select an already existing, or more personalized implementation strategy for the framework. With multiple available methods – like EPIS or QIF – commonalities arise in that the different methods highlight different phases visualized in Figure 17 (Meyers et al, 2012; Moullin et al, 2019).

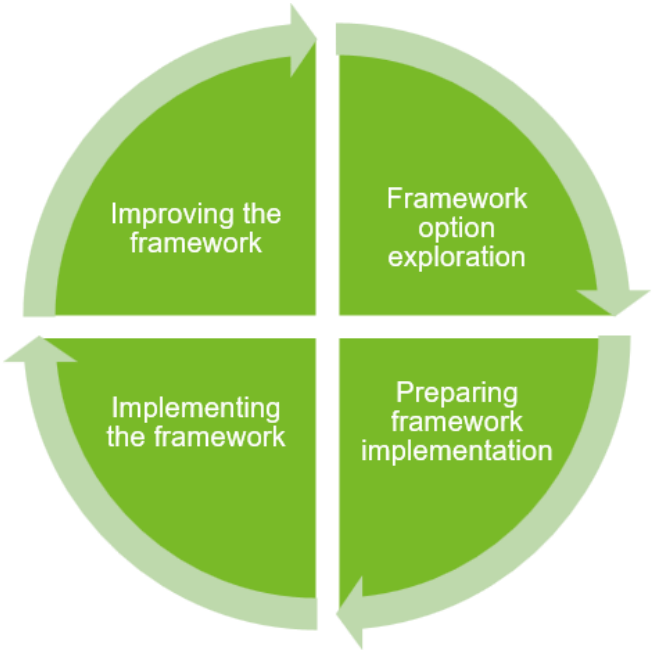

Figure 20. Generic framework implementation phases (Adapted from Meyers et al, 2012; Moullin et al, 2019).

The purpose of this study can be interpreted as the framework option exploration, with multiple alternatives explored, and ultimately one suggested to be implemented based on the focal company's specific needs and challenges. The preparation phase in the context of the focal company could prove to be a topic of future research. The goal of this phase is to provide clear specifics on the factors regarding the framework and go more in depth about the actual implementation; it is better to plan the implementation well than to jump straight into execution. The exact weights of different variables should be clear by the end of this phase, and all stakeholders within the supply chain should take part in this part of the process. The implementation of the framework itself should ideally be very straight forward after proper planning. Finally, the framework should be continuously developed further based on feedback.

Another highlight made by Moullin et al (2020) is to start using the framework at a micro level to conduct a pilot-like experiment with the framework. This is also suggested for the focal company, even though difficult with the main benefits coming from improving cross-functional operations. An idea would be to start with the use of the DEA method in carrier management, giving room to learn the use of the basics of the framework to help with expanding it to provide benefits across functions.

Some challenges with the framework should be considered. Triantaphyllou & Mann (1995) argue that as the weights have a big impact on the results of the framework, regardless of method, extra caution should be put into this part of the process. Especially in the beginning of the use of the framework, the results provided need to be monitored closely. The authors go as far as to warn blind use of the framework, instead suggesting its use as a tool, rather than a guide.

As with all developments in the context of organizations, the framework implementation can be subjected to resistance to change. At its core, the concept means the initial desire to keep things as they were before. It is proven for the concept to introduce challenges that must be addressed by the organization if successful implementation is desired. Resistance should not always be viewed as negative, as it can also be interpreted as valuable feedback. It is, however, important to distinguish between constructive feedback and innate willingness to change practices. (Pardo del Val & Martinez Fuentes, 2003)

5.4 Other recommendations

Even though the implementation of the MCDA framework would prove to take the effectiveness of the logistics operations to another level, developments can be made with smaller adjustments as well. The developments can also be made in addition to the implementation of the framework. The list of recommendations is presented in Figure 18.

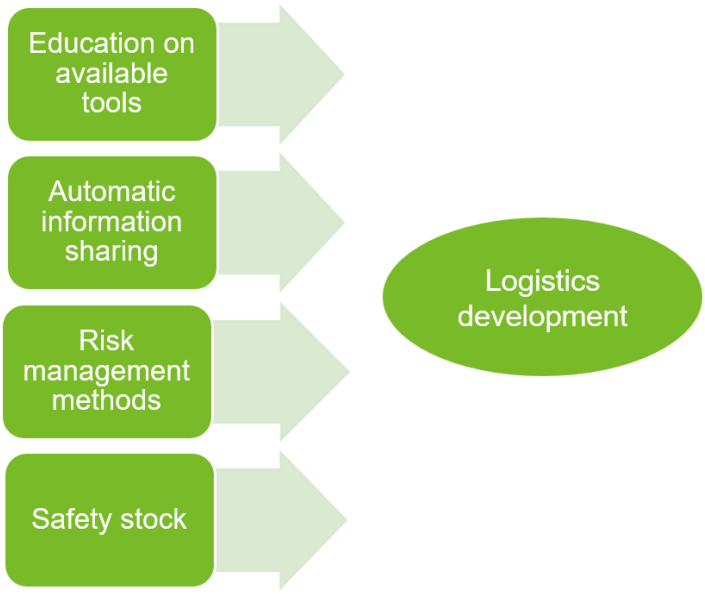

Figure 21. Development recommendations

A very low-hanging fruit toward making the communication within the supply chain run smoother and therefore provide more opportunities for savings would come from educating the personnel within the functions with the proper usage of already existing tools. There was shown to be a lack of knowledge in proper tool usage, or even knowledge of their existence. In addition, it should be made clear how the work of the personnel affect the operations of others, as this would decrease accidental lack of transparency.

More effort should be put into automating the information sharing channels. Advancements in this area were shown to be in development already, but the importance of moving away from the need to "ask around" should be underscored. Instead, focus should be on creating transparent reports to help employees be on top of all variables cross-functionally. A significant factor in the future development of this area is the data quality, as it was mentioned to be a crunch in the current tool usage.

The risk management strategies were found to be mostly based on intuition and experience. Therefore, the implementation of a risk management method – or framework, even – could very well provide the focal company with some additional resilience with minimal effort. Having a method to more accurately evaluate risks would also make factoring them into the decision-making process easier, providing more accurate use of the MCDA framework as well. As the implementation of simpler risk management methods – like FMEA or risk

mapping – is relatively simple with a lot of potential for increased resilience, they are highly recommended for the focal company.

Lastly, the idea of having safety stock at strategical locations could be beneficial. Due to there being multiple risks found related to shifting demand or transportation delays, conducting continued research on the optimal allocation of the pulp would possibly highlight inexpensive solutions to increasing the resilience and flexibility of the focal company. Safety stocks would, however, increase the total amount of capital committed to the supply chain, which was found to be deliberately avoided in the current macro-economical situation. Investigating the possibilities provided by increasing safety stock levels could be a possibility for a future research topic.

6 Discussion and conclusions

In this chapter, the structure of the study, as well as the findings and future suggestions are revisited and summarized. Answers to the research questions are provided. The reliability of the research is assessed and ideas for future research are recommended.

6.1 Results

The main objective of this study was to create an understanding of the practices and challenges faced in logistics of the focal company and find areas for development therein. The objective was dissected into two research questions to divide the study into simpler parts.

What are the current practices and main challenges in pulp logistics?

The first research question was designed to direct the research toward basing the findings on the actual current situation, instead a hypothetical one. Multiple themes were found to guide the current operations in logistics, most prominent of which was found to be limitations set by other functions surrounding logistics. Successful communication across functions and between different stakeholders was proven to be a key factor in being able to maximize the effectiveness of all operations, including logistics. As it was also recognized that the functions have differing priorities in decision-making, communicating these differences to optimize decision-making processes is crucial to avoid unexpected costs. Communication was also shown to be important due to the environment being prone to deviations and larger operational disruptions that require the inputs of multiple different functions.

On a more logistics-specific level, the process of tendering carriers – making contracts on the amounts transported on different lanes – was shown to be of high value. As the decisions made in choosing a carrier portfolio has long-lasting effects, it currently serves as one of the key optimization opportunities in the outbound logistics of the focal company. A good balance of costs and reliability need to be found between the carriers; currently the decisions are mostly made without basing them on any specific framework.

Cross-functional communication – while found to be crucial in the overall operations within the supply chain – was proven to be difficult, sometimes leading to situations where

decisions are made with insufficient information, or at a late stage. Being able to react to variations more proactively would pose savings, so smoothening the flow of communication would be beneficial. Miscommunication and information sharing delays, on the other hand, cause inefficiencies and increase operational costs.

Challenges with communication do not only arise from the human-related delays, but also from the absence – or lack of quality – of transparency-promoting tools. Currently, a lot of information is shared manually, leading to cross-functional dependencies on certain information. Not only is the need for sharing information manually slow, but it is poses risks in critical personnel being unavailable when needed. Automated tools for sharing the information with shared reports or platforms would increase the efficiency in the flow of information and address these problems. However, the quality of data within the tools was mentioned to currently be at a non-sufficient level mostly due to human-related errors in inputs.

The emphasis on prioritizing efficiency over flexibility and resilience in pulp logistics, while being strongly suggested toward in literature, was confirmed to hold true in practice as well. With much effort put into trying to decrease costs where possible, the supply chain is left with risks in its disability to react to deviations effectively, having a negative effect on the overall profitability of operations. With pulp having a large lead time to be delivered to customers, and its shipments made in huge quantities, disruptions are prone to happen, and their effects usually have a significant impact.

How can the current logistics decision-making practices within the focal company be further improved on a strategic level?

The second research question was built to provide a clear goal for the study, requiring a deeper understanding of the fit for different solutions to the context of the focal company. A summary of the final improvement suggestions is shown in Figure 22. To address multiple challenges faced within the company, it was found that the MCDA framework is suggested for implementation. The main benefit of the framework would be to effectively increase total cost optimization between different functions, as well as providing improved decision-making support within the logistics function. The benefits are achieved in multiple ways, like by prioritizing between the conflicting factors and interests between different functions. Having a clear and uniform view across functions on the relative importances of the different variables – like transport costs, reliability, and stock levels – would help in creating an optimal

solution to different situations fast and effectively. Having a standardized way of weighing different decision-making criteria would also help in further developing the process. Finally, by properly appreciating the risk factors and variables, more informed decisions on the side of resilience and flexibility can be made. The framework can also prove useful within the logistics function solely in itself as well, with the framework providing a good basis for choosing between different carriers.

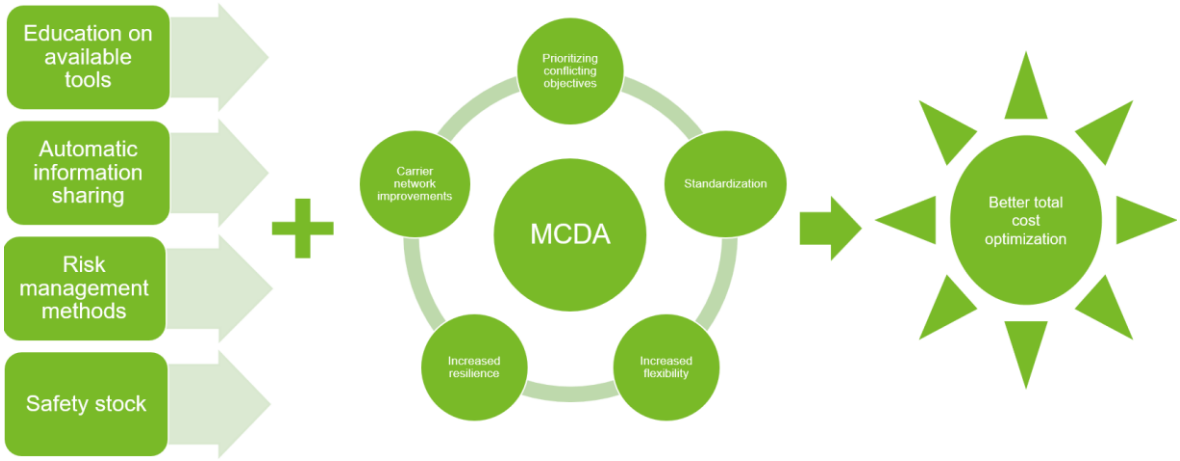

Figure 22. Improvement suggestions for the focal company

Other developments by the focal company are also recommended. With much focus around the importance of sharing information, the methods should be made more effective. As there are many tools for sharing information available within the company, their effectiveness should be addressed. As there were mentions on the lack of knowledge in using the tools – or even their existence – conducting some education on the available tools and their usage could hold a lot of value. In addition, further development of the tools to promote more transparent ways of sharing information would lessen the friction of cross-functional communication. The inherent risks provided in the environment of the focal company suggest a uniform risk assessment or management method would be valuable. The implementation of such a method is relatively simple to achieve, and its results could be used in tandem with the MCDA framework as well. It was also discovered that resilience within the company could also be improved by increasing safety stock levels at strategical locations.

6.2 Research quality

Ensuring the quality of research is crucial for the credibility – and therefore usability – of the results. The quality of research can be demonstrated in multiple ways as different types of research require differences in validation (Glazsiou et al, 2004). For assessing qualitative research, validity is raised as a key factor by Mays & Pope (2000). This was mentioned by the authors to be provable with methods like triangulation, where the results from multiple different sources are referenced to each other to look for patterns. This study uses findings form literature as well as interviews, which are shown to be related to each other, providing evidence of the validity of the study.

As for the limitations of the study, the sample size of the interviews, as well as the research being a single-case study provide issues in reliability. To mitigate the limitations on generalizability, a clear description of the background of the study was provided, potentially allowing the application of the findings in similar settings.

6.3 Future research

Due to the research being a single-case study on the operations of the logistics function of a single focal company, the findings of the study cannot be generalized. A topic of future research, therefore, could be conducting a study across multiple cases to possibly develop findings across the industry. The results could then be used to create a generalized view on the topic.

As a conclusion in this work, it is suggested for the focal company to begin experimenting with the implementation of MCDA as a framework to guide the decision-making of the logistics, planning, and sales functions. As was mentioned in the introduction of the thesis, the actual implementation process was left out of scope. Conducting deeper research on the actual implementation process, requirements thereof, and other surrounding factors could serve as a natural continuum for this thesis.

The feasibility of adding safety stocks in strategical locations was shown to provide possibilities in increased flexibility and resilience with relatively small commitments of capital. By smart use of buffers, maintaining higher service levels would become possible without

significant increases in costs. The exact amounts and allocation of these stocks still requires further research to be properly balanced with the goals of the organization, providing another area for possible future research.

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Appendix 1. Interview questions for the logistics function representatives

Background

1. What is your position in the company, and what are your primary responsibilities?
2. How many years have you been in this position, and in the field of logistics altogether?

Current situation and practices

3. What does your typical day look like?
4. What tools or systems do you use in your work?
5. What are the key objectives you aim to achieve in your position?
6. What factors do you take into account in your decision-making process?

Challenges

7. What are the usual challenges you face in logistics operations?
    a. How do you prepare for and mitigate these challenges?
    b. What is prioritized when faced with a challenge?
8. What are some unexpected costs related to logistics?
9. What are some examples of some recent major disruptions affecting logistics operations, and how have you handled these disruptions?

Prioritizing trade-offs

10. How do you balance between different performance factors, like costs efficiency and resilience, or costs and service level?
11. Do you have any specific frameworks or models you follow when trying to prioritize between the factors?

Follow-ups and conclusion

12. Are there any tools, data, or other resource you wish were available to improve your work processes regarding logistics?
13. Is there anything you would like to add, or feel like is important to share?

Appendix 2. Interview questions for representatives from other functions

Background

1. What is your position in the company, and what are your primary responsibilities?
2. How many years have you been in this position?

Role of the function and logistics collaboration

3. What are the key objectives you aim to achieve in your position?
4. What factors do you consider regarding working with logistics?
5. What are your expectations of logistics in supporting your work and how do you feel you can support logistics operations?
6. What areas do you feel are most lacking in collaboration between your function and logistics?
7. What tools or methods are used when collaborating with logistics?
8. Where do you get the data you use in your decision-making regarding logistics?

Challenges

9. What are the usual challenges you face when aligning your objectives with logistics operations?
    a. How do you prepare for and mitigate these challenges?
    b. What is prioritized when faced with a challenge?
10. What are some examples of recent situations where logistics operations impacted your operations?

Follow-ups and conclusion

11. Are there any tools, data, or other resource you wish were available to improve collaboration with logistics?
12. Is there anything you would like to add, or feel like is important to share?