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The potential of involving sea transport in the reverse supply chain of used textiles

Master's thesis in Supply Chain Management

Danial Shaheen
Carl Strand

DEPARTMENT OF TECHNOLOGY MANAGEMENT AND ECONOMICS
DIVISION OF SERVICE MANAGEMENT AND LOGISTICS

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Supervisor: Violeta Roso
Examiner: Violeta Roso

Report No. E2022:082
Department of Technology Management and Economics
Chalmers University of Technology
SE-412 96 Gothenburg
Telephone +46 31 772 1000

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CARL STRAND
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Abstract

Today's linear material flows account for half of society's climate effect due to the increasing rate of products being produced and discarded. To address this issue, the concept of circular economy (CE) has become a trend in recent years and aims towards keeping the products in the economy for as long as possible. Textiles is one material which have received increased attention from the European Union due to the potential of having an increased circularity of the material. Furthermore, Sweden, which is a member state of the European Union, has the aim of increasing the circularity in the economy through a new strategy that specifically targets the textile industry due to the loss of resources this industry characterizes. Several Non-governmental organizations (NGOs) in Sweden contribute to CE initiatives by collecting used textiles from consumers which otherwise have a high probability to end up in household waste and eventually sent for incineration. The NGOs aim to sell the collected textiles in their secondhand stores but due to the limited domestic demand for used textiles, the majority are exported. However, the vast amount of transportation needed to export the used textiles can be perceived as an environmental trade-off due to the emission of greenhouse gases, especially if the transport is conducted by road. Sea as a mode of transport entails many economic and environmental benefits as opposed to road transportation. In addition, limited research considering modal choice in the reverse supply chain of used textiles in Sweden has been conducted which is a literature gap this thesis aims to close. Thus, the thesis comprises a qualitative approach to identify the potential for involving sea transport to a higher extent in the export of used textiles.

During this study, several actors including NGOs, ports, and industry experts were interviewed with the aim of identifying barriers and drivers for involving sea transport to a higher extent in the reverse supply chain of used textiles. High costs, laws and regulations, and existing and efficient reverse flow were some of the main barriers identified. Reduced emissions, including external cost in total transportation costs and future recycling centers in Sweden were found to be the main drivers. Eventually, the more dominant barriers opposed to drivers were synthesized to draw conclusions on how to overcome the barriers and accentuate the drivers. The most essential recommendations constituted of including external costs in the total transportation cost, increasing the communication between the actors and overseeing the current highly efficient reverse flow of used textiles.

Keywords: Circular economy, Sea transportation, Used textiles, Ports, Reverse logistics etc.

Acknowledgments

This master thesis finalizes our studies here at Chalmers University of Technology. It has been a remarkable journey where we have gained great knowledge for future challenges in our professional careers. This master thesis alone has been an adventurous expedition, some roads have led to dead-ends and others to more insightful results. We have met a lot of intriguing individuals and received fresh and useful information from various stakeholders along the course of this study.

The subject of this study is relatively new to both of us, and the initial phase of the research was equally challenging as educational and interesting. It has been a pleasure to contribute to a research field of which the importance is ever-increasing for societies around the globe. In addition, sustainable development is something we both are passionate to advocate.

We would like to show our sincerest gratitude towards VTI and particularly Linea Kjellsdotter Ivert for giving us the opportunity to conduct our thesis in collaboration with her project, SHREK. We thank you, Linea for your enormous commitment and your assistance throughout each phase of the process to finalize our research. We are sincerely grateful for your continuous supervision and feedback that steered us in the right direction along the course of the study. Not the least, we would like to thank all the actors for participating as interviewees and their contributions with invaluable insights for our study.

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Danial Shaheen and Carl Strand, Gothenburg, June 2022

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1. Introduction

The opening chapter introduces the background to the topic that will be investigated during the thesis. This chapter continues with presenting the purpose and research questions of the thesis, followed by the delimitations.

1.1 Background

Today's linear material flows, in which products are created and discarded at an increasing rate, account for half of society's climatic effect (Ellen Macarthur Foundation, 2017). In 2018, the European Union alone produced slightly below 2400 million tons of waste, of which barely half was recycled, reused, or recollected (Eurostat, 2021). Such large amounts of waste not only indicate a tremendous amount of pressure on the environment, not the least a suffering economy due to the loss of potential resources, but also calls for a transition towards an arrangement where sustainable growth can be achieved (Tomić & Schneider, 2020). As a result, the concept of circular economy (CE) has received increased attention over the past decade. It is a system solution that addresses the aforementioned issue and aims to reduce the negative environmental effect of production and consumption, particularly in the context of reducing greenhouse gas emissions and waste creation (Johansson & Henriksson, 2020). The European Union and other nations around the globe are forming policies and regulations to prompt domestic municipalities and businesses towards shifting away from traditional waste disposal and toward a more intelligent waste treatment that incorporates the CE concept (Malinauskaite et al., 2017). For instance, as a part of becoming more resource efficient the European Union formed the WFD (Waste Framework Directive) in which the waste hierarchy principle was included and subsequently passed on to the national law of the member states.

The ever-increasing trend of CE will result in less manufactured products, where the demand for transports to retail stores is decreased, while the demand for reverse logistics is instead increased (de Langen & Sornn-Friese, 2019; Moigne, 2022). This has resulted in CE initiatives being further integrated into supply chain management practices since it can bring sustainable advantages for societies (Farooque et al., 2019). Accordingly, the concept of circular- and reverse supply chains has been introduced which aims to reduce waste creation and instead recycle and reuse materials at their end of life with as low emissions from the transports as possible (de Langen & Sornn-Friese, 2019). For certain commodities today, such as glass, steel, and paper, the circular- and reverse supply chains are well progressed, and large amounts of these materials are being circulated (mainly in terms of recycling). For other materials, e.g., textiles, the circular- and reverse supply chains are not that well progressed and there are still limitations in terms of collecting, recycling and reuse, leaving an enormous environmental burden on societies due to the loss of material and energy resources (de Langen et al., 2020).

Consumers of textiles, (i.e., clothes and home textiles) have developed a mindset of replaceability and a throwaway attitude as a result of fast fashion culture (Brydges, 2021). It has resulted in overconsumption and the buildup of used textiles in municipal solid waste (Birtwistle & Moore, 2007; Sandvik & Stubbs, 2019). One country in the European Union who

has adopted a new strategy for increasing the CE is Sweden, and the country has the ambition of becoming the first fossil-free welfare nation. The strategy explicitly emphasizes that textiles is one of the materials that need to be prioritized in order to increase the circularity of the nation (Government offices of Sweden, 2019). The net inflow of textiles in Sweden per year is approximately 14 kg per person where 8 kg ends up in the household waste and are sent to incineration (The Swedish Government Official Report, 2020).

One actor in Sweden who contributes with initiatives and tries to decrease the linear flow which the textile industry is characterized by are NGOs (Non-governmental organizations) who collect approximately 3,8 kg per person a year (The Swedish Government Official Report, 2020). Only a small percentage of used textiles collected by NGOs makes it to the Swedish second-hand market due to the large supply and low demand (The Swedish Government Official Report, 2020). This has resulted in 72 % of all the collected textiles in Sweden being exported abroad for reuse and recycling (SMED, 2018) and this reverse flow results in an environmental trade-off. While the textiles are following the prioritizations sequence in the WFD by the European Union and decreases the environmental impact, the export results in a transport that generates emissions and reduces the overall environmental benefits (Zhuravleva & Aminoff, 2021). As Sweden has the goal of becoming the first fossil-free welfare nation, decreasing the emissions from this reverse flow is possible since the main mode of transport for exporting the used textiles is carried out by road (Berg et al., 2021). In contrast to other modes of transport, it is inferior in terms of cost and energy efficiency (Christodoulou & Kappelin, 2020; Garberg, 2016; Medda & Trujillo, 2010; Suárez-Alemán et al., 2015). However, having cost-efficient reverse flows of waste materials, as in textiles are a prerequisite since the materials are of low value and the feasibility of the entire reverse logistics system is heavily influenced by transportation costs (Dowlatshahi, 2010). In addition, nearly a third of Sweden's total greenhouse gas emissions come from the transportation sector (Trosvik et al., 2020) and thus, shifting to cost- and energy efficient transport modes may decrease costs and the generated emissions from transports in the reverse supply chain of used textiles.

Sea transportation is a transport mode which is considered as one of the most cost- and energy efficient transport modes and studies show that it can, in some cases, be competitive to road transport (Christodoulou & Kappelin, 2020; Medda & Trujillo, 2010). However limited research has been conducted within the context of the used textiles industry in Sweden and the utilization of sea transport in the reverse supply chain of used textiles. This thesis aims to fulfill this research gap by exploring the underlying barriers and drivers of shifting transport mode from the more evidently dominant road to sea.

1.2 Purpose and research questions

The purpose of the thesis is to explore the potential of using sea transport in the reverse supply chain of used textiles in Sweden. To achieve this purpose, three research questions are intended to be answered. The first two questions are focusing on identifying barriers and drivers for utilizing sea transportation to a higher extent in the flow of used textiles in Sweden. This is of uttermost importance in order to see which drivers and barriers the different actors perceive and

are affected by. In addition, these two research questions enable a comparison of the empirical data that is gathered and the literature. Additionally, it sets the stage and offers context for the third and final research question.

1. *What are the key barriers for an increased use of sea transport in the reverse supply chain of used textiles?*

2. *What are the key drivers for an increased use of sea transport in the reverse supply chain of used textiles?*

The final research question focuses on how the identified barriers can be overcome and how the drivers can be utilized. Furthermore, the final question compares the empirical findings with the literature, allowing for more in-depth analysis. It is also designed to offer answers to challenges raised by respondents and the frame of reference.

3. *How can the barriers of involving sea transportation in the reverse supply chain of used textiles be overcome and how can drivers be utilized?*

1.3 Delimitations

The thesis contains several delimitations that impact the project scope. First, it will be restricted to only explore the reverse supply chain of used textiles in Sweden. However, to make a thorough analysis and derive relevant conclusions regarding the potential of incorporating sea transport in the transport chain, the transport mode abroad will also be considered as can be seen in figure 1 (the highlighted dark grey part in the figure). Secondly, the thesis will revolve around the current transport flow of used textiles that are collected by NGOs. Third, the thesis is delimited to look at the textile flow after the textiles have been collected at a collection point (sorting facility) by the NGOs as seen in figure 1. Furthermore, the thesis will be delimited to look at the largest NGOs in terms of collected volumes.

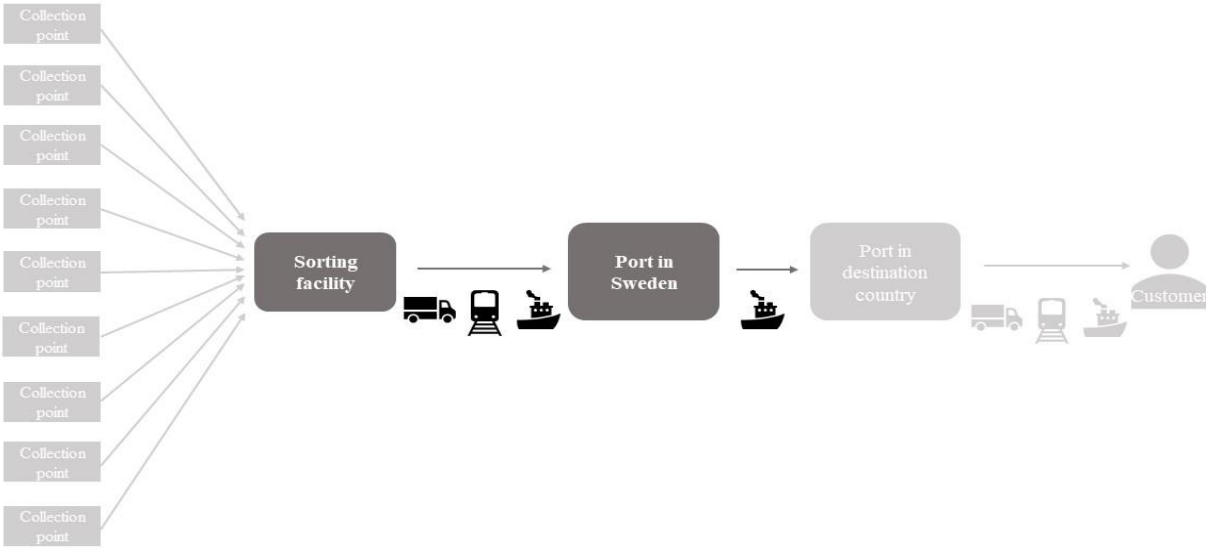

***Figure 1**: Delimitations of the master thesis*

2. Frame of Reference

The frame of reference for this study is divided into six different topics, each of which contributes to answering the research questions and providing the reader with information needed to comprehend the report. The first part will define the concept of circular economy (CE) whereas the second part focuses on the current CE of used textiles. The third part will present road- and sea transport since the thesis purpose is to investigate the potential of involving sea transport instead of road transport to a higher extent. In the fourth and fifth topic, barriers and drivers are presented for involving sea transport in a logistical setup. The last topic will present success factors to overcome the barriers within sea transport.

2.1 Circular Economy

CE, in contrast to linear economics, aims to keep materials and products in use for as long as feasible (Johansson & Henriksson, 2020). Many different definitions can be found in the literature. However, the definition by Ellen Macarthur Foundation (n.d) is widely used and states as following:

> *"A circular economy is a systemic approach to economic development designed to benefit businesses, society, and the environment. In contrast to the 'take-make-waste' linear model, a circular economy is regenerative by design and aims to gradually decouple growth from the consumption of finite resources"*

The CE is founded on three principles: eliminate waste and pollution, keep goods and materials in use, and regenerate natural systems. A CE is guided by these principles and strives to detect and eliminate negative externalities from economic sectors that harm the health of humans and ecological systems, for instance, greenhouse gas emissions (Ellen Macarthur Foundation, 2017). In addition, retaining value in the shape of energy, labor and materials through certain activities is highly favored in the notion of a CE. Such may be accomplished through designing the aforementioned for longevity, reprocessing, recycling and reuse. As a result, the value of the commodities is maintained in the economy over an extended time. Furthermore, circular thinking emphasizes the utilization of renewable resources while avoiding non-renewable resources i.e., fossil fuels (Ellen Macarthur Foundation, 2017; Johansson & Henriksson, 2020)

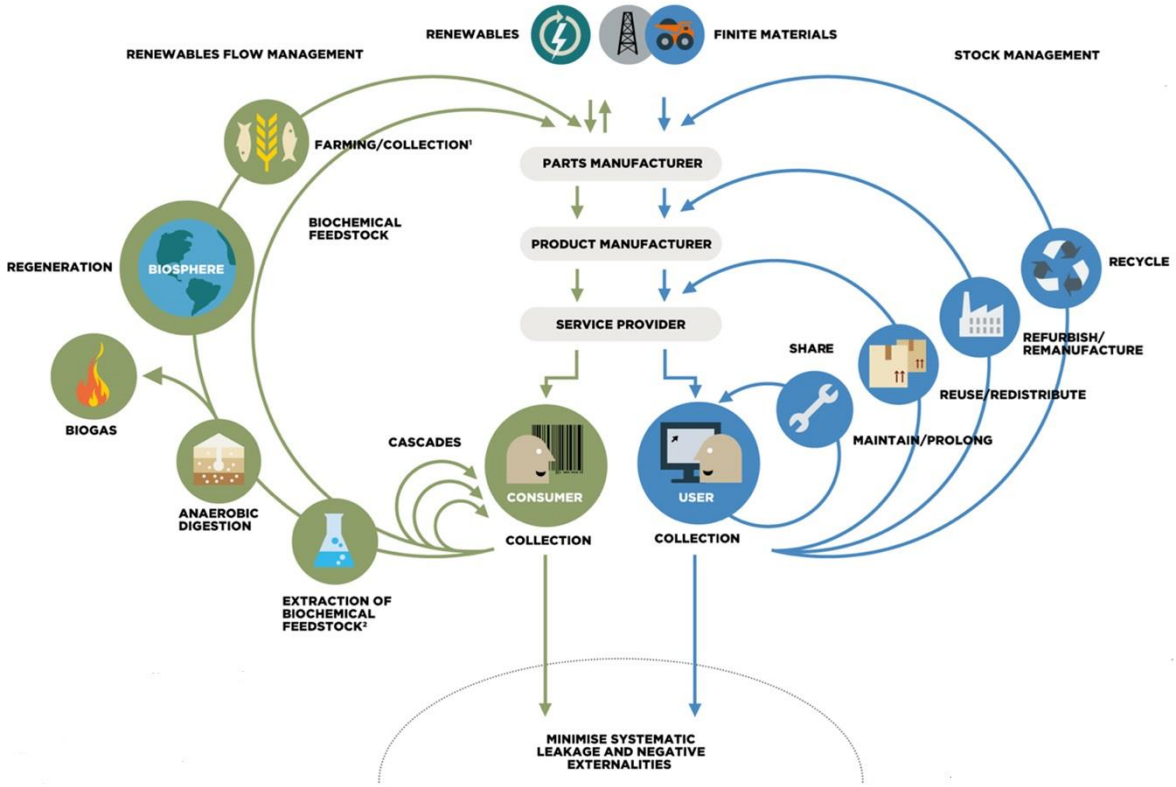

Figure 2: *An illustration of the continuous flow of materials in an economy, known as the "Butterfly diagram" (Ellen Macarthur Foundation, 2017)*

A typical illustration for conveying the concept of CE is depicted in Figure 2. The graphic highlights the feasibility of materials to be dissembled and reappear as biological elements (green circles) or be reused as high-quality materials in the making of new products (blue circles) as technical elements. In its essence, the butterfly diagram demonstrates the continuous flow of materials in an economy. In addition, the aim of the CE concept is to reduce the inflows and outflows of materials and in this way strengthen the resilience of an area (Ellen Macarthur Foundation, 2017). Looping the flow of resources will allow for more efficient use of resources and energy which in the end benefits the local economy and it becomes less dependent on inflows and outflows of resources (Johansson & Henriksson, 2020).

2.1.1 Closed-loop Supply Chains

The closed loop supply chain comprises the forward and reverse supply chains (Govindan et al., 2015). This sort of circular flow, according to Lüdeke-Freund et al. (2019), involves both the movement of physical entities in a supply chain as well as information and the various relationships that transpire between the members of the entire chain. Closed loop supply chain allows organizations to add new value to old items by, for example, reusing the end-of-life product or its components, as outlined by Van Wassenhove and Guide (2008). Furthermore, Van Wassenhove and Guide (2008) describe Closed loop supply chain management as follows:

> *"The design, control, and operation of a system to maximize value creation over the entire life cycle of a product with dynamic recovery of value from different types and volumes of returns over time"* (Van Wassenhove & Guide, 2008)

Furthermore, Schenkel et al. (2015) emphasizes the existence of an interdependency in a closed loop supply chain between the forward and reverse supply chain. For instance, the occurrence of an activity or the making of a decision in one of the supply chains will affect the other. As a result, decisions being made in the forward supply chain may have an impact on subsequent decisions and actions in the reverse supply chain. Because of, for example, either easy or difficult disassembly, the initial design of a product and its components in the forward supply chain influences the product's ability to be refurbished later in the reverse supply chain (Bocken et al., 2016).

2.1.2 Reverse Supply Chains

Unlike typical forward logistics, reverse logistics is the process which enables recycling, reuse, remanufacturing and disposal of used components, products or goods by collecting and transporting them from the point of consumption to processing service centers (Dowlatshahi, 2010). Forward logistics involves moving products from one origin to several destinations whereas the opposite is true for reverse logistics where products need to be collected from many origins to one destination which makes it more complex (Rajagopal et al., 2015). In addition to this, the transportation cost is the most significant expense connected with retrieving products from a location to a processing service center. This is due to the fact that economies of scale and economies of distance are difficult to achieve since collecting locations for the products can be widespread in the reverse logistics system (Rajagopal et al., 2015). According to Dowlatshahi (2010), the value and profit margins of products that are remanufactured are usually small which increases the importance of having a reverse logistics system with low transportation costs. Hence, reverse logistic activities cannot be sustained without appropriate transportation systems of returned products from the place of consumption to processing service centers and then the delivery of the remanufactured products to new customers (Dowlatshahi, 2010).

2.2 Characteristics of the used textile industry

Due to population increase and economic development, worldwide demand for textile goods is growing, and this trend is expected to continue (Sandin & Peters, 2018). Textiles are made with high amounts of nonrenewable resources and are typically only used for a brief length of time which indicates that the present system of production, distribution, and consumption of textiles has the essential characteristics of a linear model (Ellen Macarthur Foundation, 2017). Furthermore, according to Angelova (2020), one of the most polluting industries in the world is the production of textiles and clothing and the author further supports the fact that the textile industry today is characterized by a linear model. Rapsikevičienė et al. (2019) states that approximately 75% of the textile waste that is generated in the European Union ends up in landfills or are sent to incineration. According to Sandin and Peters (2018), landfilling and incineration of textiles has a higher environmental impact compared with reuse and recycling which is why there has been a growing interest in increasing the reuse and recycling of textiles.

The shift towards a CE will reduce the amount of waste generated in the world and can lead to societal, economic and environmental benefits (Angelova, 2020). The European Union has introduced the WFD which aims to prevent the creation of waste to increase the CE. The WFD

created by the European Union is the priority sequence of waste which has the following priority steps: prevention, reuse, recycling, recovery (including energy recovery) and lastly disposal (Pires & Martinho, 2019). It is essential to follow the priority sequence in the WFD by the European Union in order to reintroduce valuable resources into the economy and to achieve the greatest overall environmental outcome (Pires & Martinho, 2019). There is a great potential for the textile industry to have a lower environmental impact by following the WFD and there are currently investments made in new technologies and the development of new products (Rapsikevičienė et al., 2019).

2.2.1 NGOs in Sweden – a key actor in reverse textile supply chains

Figure 3 illustrates the value chain of textiles in Sweden. The net inflow of textiles each year to Sweden is around 14 kg per person and are mainly imported since only 0,48 kg per person is produced domestically each year and the rest (approximately 13,5 kg) are imported which can be seen in the left side of figure 3 (The Swedish Government Official Report, 2020). Roughly 8 kg (of the net inflow of 14 kg) ends up in the household waste and are later incinerated (red arrow in the figure 3) by the waste disposal companies since there is no separate flow of collecting textiles for recycling in Sweden (The Swedish Government Official Report, 2020). According to SMED (2018), around 3,8 kg (of the net inflow of 14 kg) of textiles are separately collected by NGOs each year which are either reused, material recycled or incinerated as can be seen in figure 3. Of these collected textiles, 20% are being reused in Sweden, 0,2% are being material recycled, 5% are being incinerated and the rest which accounts for the largest volume, is exported to other countries either as sorted or unsorted textiles which is illustrated in figure 3 (SMED, 2018).

The remaining textiles are difficult to estimate since they are either handled in different ways or are accumulated to consumers' closets (Regeringskansliet, 2020). These remaining textiles are also believed to be stacked in people's closets and not being used, sold through internet trade on websites such as Blocket or Tradera, sold in flea markets or exchanged/donated between friends or families which is why there are limited statistics for this fraction of used textiles (The Swedish Government Official Report, 2020). This flow is illustrated as C2C exchange in figure 3. Due to the increasing options for consumers, where new alternatives for reuse are introduced, textile collectors such as NGOs have seen a decrease in quality of collected textiles since only the not sellable ones are donated to the NGOs (Palm et al., 2014).

Traditionally, NGOs have dominated the Swedish market for collecting and managing used textiles which includes sorting and selling for reuse. According to Palm et al. (2014), the textiles are usually collected in containers which are typically located at recycling centers and recycling points. In recent years, textile collecting has evolved, with an increasing number of private commercial actors establishing themselves in Sweden's used textile market. This has resulted in retailers having started to collect textiles in their stores through collaboration with NGOs (The Swedish Government Official Report, 2020). NGOs in Sweden handle the sorting of textiles in different ways where some sorts all the textiles in-house which requires professional sorters, while others only sort a part of the textiles internally. NGOs who sort a part of the textiles internally usually distinguish the textiles between what can be sold for reuse in Sweden

and what can be sold unsorted within the EU to sorting companies for reuse in other countries (Palm et al., 2014). The sorting of textiles for reuse is done manually and requires highly skilled personnel since fashion and trends differ between markets which is something that needs to be taken into consideration during sorting (The Swedish Government Official Report, 2020). Manual sorting in Sweden is only done on a small scale since around 72% of the collected textiles are exported to other countries, where unsorted textiles accounts for 79% of the exported textiles (SMED, 2018). The used textiles are sold at kilo price and are either bundled in bales (i.e., a procedure that achieves space savings for easier handling, better and optimum transportation due to more materials can be loaded (Hogland et al., 1999)) or packed in big bags before the export of the textiles (Carlsson et al., 2015). The high share of unsorted textiles is in part due to the labor-intensive nature of sorting and the high labor costs in Sweden, as well as the fact that unsorted textiles demand a higher price per ton on the global marketplace. Unsorted textiles are sought after because no actor has sorted out the high-quality textiles, resulting in a greater proportion of textiles with a high resale value (The Swedish Government Official Report, 2020).

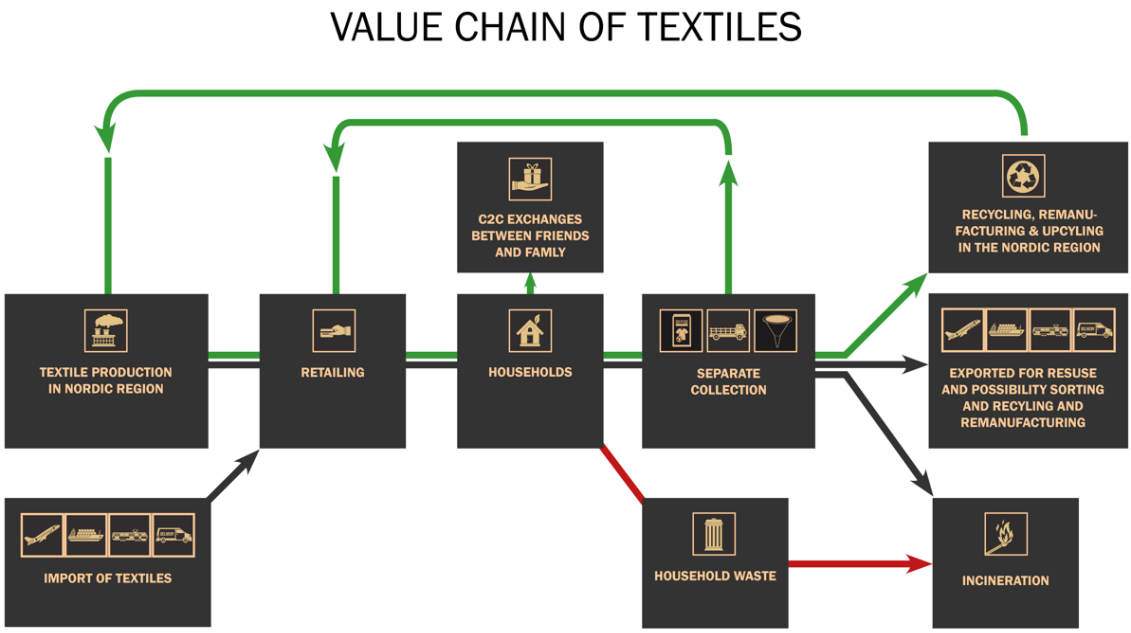

***Figure 3**: Value chain of textiles (SATIN Towards a sustainable circular system of textiles in the Nordic region, 2021)*

2.3 Selected transport modes

As this thesis aims to explore the barriers and drivers of shifting the transport mode from truck to sea, the following section first highlights literature regarding road transportation followed by sea transportation.

2.3.1 Road transport

Road transportation is a mode of transport which can be defined as the movement of freight and passengers over a prepared surface (e.g. motor highway) with vehicles (Rodrigue, 2020)

and has been developed enormously in the last 50 years (Lumsden, 2006). The ever-growing need for rapid and efficient transportation from the commercial and industrial sectors is one decisive factor in trucks' rising share of transportation activity. Truck transport is seen as an attractive mode of transport for its users due to its characteristics where large quantities of goods can be transported from door to door. Consequently, fewer damages to the goods occurs which results in lower costs due to the decreased reloading operations (Lumsden, 2006).

Due to the limited capacity of vehicles used on road in contrast to other transport modes such as rail or sea, it can effortlessly be customized to meet the demands of a single customer. This is necessary in order to establish efficient and appealing direct relationships with transportation buyers (Lumsden, 2006). Furthermore, truck transport offers flexibility since different combinations of vehicles can be used to fit the user's needs and an on-going transport can easily be rerouted to take another highway or road. In addition to this, since the goods are always accompanied, the combination of a vehicle and an accompanying driver inherently provides a high degree of reliability (Lumsden, 2006).

To use roads, maintenance of the infrastructure is needed which is relatively costly and is financed up to 95% by the public sector and the remaining is covered by tolls. This is a difference compared to other transport modes where the infrastructure is usually paid through price mechanisms by the users. Thus, road transportation has a unique feature in that various expenses are externalized, resulting in an indirect kind of mobility subsidy (Rodrigue, 2020).

2.3.2 Sea transport

Sea transport refers to the movement of people and goods over masses of water and is a potential transport mode across oceans, lakes and rivers (Rodrigue, 2020). Sea transport is both cost efficient and an environmentally friendly transport mode according to several studies (Christodoulou & Kappelin, 2020; Lumsden, 2006; Medda & Trujillo, 2010; Suárez-Alemán et al., 2015). This mode of transport has considerable environmental benefits since it is only responsible for 2.2% of the global greenhouse gas emissions while transporting over 90% of the total volume in global trade. (Christodoulou & Kappelin, 2020). Furthermore, the great cost efficiency of ship transportation of passengers and products is due to a number of elements where, the high cargo capacity of ships compared to other modes of transportation, as well as the open passage afforded by the seas on international waterways, are the most essential ones (Lumsden, 2006).

In the ecosystem of sea transportation, it's important to remember that there are four major actors engaged in getting products from point A to point B (Schwartza et al., 2020). First, the cargo owner i.e., the customer or supplier of the cargo. Second, the freight forwarder is the actor who orchestrates the logistics by investigating available carrying capacity and connecting this with the cargo owner. Third, the ship operator has the role and responsibility to transport the goods across the sea. Lastly the ship owner is the actor who sells and charters the capacity (Schwartza et al., 2020).

2.3.2.1 Short Sea Shipping

Even though road freight transport is one of the most expensive, the most environmentally harmful, and the most resource-intensive mode of transportation, the majority of industrialized countries rely on a national highway system to convey goods (Nethengwe, 2022). However, new trends are developed constantly in the global economy where it's important to rethink the current road freight transportation system in order to find new efficient and effective alternatives (Medda & Trujillo, 2010). According to Medda and Trujillo (2010), one complement to road freight transportation which has gained in popularity and also maintains freight flow efficiency as well as enhance economic development and decrease in congestion of traffic, is the use of coastal shipping i.e. Short-Sea Shipping (SSS). Furthermore, this mode of transport uses less fuel and emits fewer hazardous emissions per ton and is considered one of the most environmentally friendly and cost-effective modes of transportation when compared to road transport (Medda & Trujillo, 2010). SSS has been defined by the European Commission as "the movement of cargo and passengers by sea between ports situated in geographical Europe or between those ports situated in non-European countries having a coastline on the enclosed seas bordering Europe". In markets that are already using road, rail or air transport for certain transport routes, SSS can work as a supplement by providing an alternative transport service (Medda & Trujillo, 2010).

Roll on Roll off (RoRo) is a type of sea transport where the truck is rolled on to a vessel and then transported across the sea. At the destination port, the truck is later rolled off the sea vessel (Christodoulou et al., 2019). Christodoulou and Kappelin (2020) further explains that since the cargo does not need to be transshipped in ports, the sea may be viewed as an extended highway and can easily be integrated into an intermodal transportation system and work as a facilitator for the development of sustainable transportation chains due to its environmentally friendly and energy-efficient characteristics. RoRo shipping is considered as a part of SSS which can be an competitive alternative to road transport due to the aforementioned factors (Christodoulou & Kappelin, 2020).

Medda and Trujillo (2010) have assessed the advantages, disadvantages, and goals with SSS which can be seen in figure 4.

Advantages
Sustainability: Efficient and environmentally friendly transport mode.
Cost-effective: To shift long-distance traffic off roads.
Flexibility: Increase in volume does not require infrastructure improvement.
Provides a new alternative:
Attracts freight from other modes.
Stimulates additional shipping.
Reduces pressure on other modes.

Disadvantages
Perception: Old-fashioned mode of transport:
Low frequency.
Low reliability: Departure and arrival times.
Quality and safety: Higher risk of damages to goods.
Complicated shipping logistics: Integration into door-to-door.
Complexity of documentary and administrative procedures.
The efficiency of ports, port services and port-hinterland connections needs to be strengthened.

Goals
Reduce costs and times of nodes (increase the efficiency in ports).
Unitize (standardize) cargo.
Management and control of the transport chain handled by a single entity.
Integrate shipping more fully into door-to-door of freight transport services.
To be both substitute and complement of other transport modes.

***Figure 4**: Advantages, disadvantages and goals with short sea shipping (Medda & Trujillo, 2010)*

2.3.2.2 Ports as actors in a circular economy

Ports are entities that are connected to a sea, river or ocean which results in a waterway connection (Roa Perera et al., 2013). They are an example of intermodal (i.e., combining two or more modes of transportation in the transportation of goods) transport since they permit items to be transferred from one mode of transportation to another and function as a link between sea and land transportation. Ports can be specialized in order to manage different load types and are equipped with technical facilities and infrastructure (Roa Perera et al., 2013).

Ports serve as a crucial node in the global logistics network, connecting industry with customers and suppliers from all over the world. As a result of the association between ports and industries performing foreign commerce, they are inextricably tied to international trade (Sislian et al., 2016). The ability of a port to deliver high-quality infrastructure and other services is critical to its competitiveness.

While a decoupling of economic growth and environmental pressure provides a difficulty for current business models of ports in the short term, port regions have the potential to become crucial locations for establishing a CE in the long run (Psaraftis, 2011). The European Parliament, as well as European port groups like the European Federation of Inland Ports (EFIP) and the European Sea Ports Organization (ESPO), have emphasized ports' immense potential to play a key part in the CE transition. Indeed, ports serve as crossroads for many kinds of transportation and waste movements, as well as housing industrial sites and/or unlocking urban areas and economies. Ports operate in a dynamic and clustering environment, which may present an opportunity for circular treatment of residual flows and products. Furthermore, ports near metropolitan areas may be able to provide the required space for the recycling of all

garbage generated by the city, as well as assist in the city's energy transition (Haezendonck & Van den Berghe, 2020). In addition, Haezendonck and Van den Berghe (2020) explain that to include and integrate ports more in the future of our circular economies, governments must aid their investments and divestments to new circular activities.

The issue with the transition towards a CE is that every port can only have a limited impact on those (industrial) enterprises that are located within or outside their port region and for which the port serves as a nodal point in their supply chain (Haezendonck & Van den Berghe, 2020). Haezendonck and Van den Berghe (2020) explains how ports rely on a circular shift in the sectors that use port services, therefore their transformation necessitates changes in several port subsystems at the same time. As a result, the major difficulty for ports is determining how much pressure they can put on their customers and leverage subsystems towards becoming circular in their design and production (Haezendonck & Van den Berghe, 2020).

2.4 Barriers for sea transportation in a logistical setup

This chapter will present barriers with incorporating sea transport in a logistical setup.

2.4.1 Economical

In order for sea transportation to be competitive, cost-efficiency is one requirement that needs to be fulfilled and ports, as well as shipping companies must take steps to improve the competitiveness and attractiveness to increase the use of sea transportation (Garberg, 2016). Garberg (2016) cites various case studies in which port and handling costs account for roughly half of the entire transport cost. Furthermore, the government inducted fees account for about 7% of the overall costs on average where pilotage fees are the most expensive of these expenses. Garberg (2016) further states that the government inducted fees are relatively high in comparison to the objective of the service.

In order to register a vessel in Sweden for transportation, several fees, charges and taxes need to be considered which is further seen as a barrier to implement a transport flow characterized by sea transportation. Garberg (2016) explains the process of getting access to the Swedish maritime market (flagging the vessel) can be complicated and associated with high costs. Furthermore, the formal process of flagging a vessel in Sweden can result in a cost of 300 000 SEK (30 000 Euros).

According to some scientists, alternative modes of transportation (such as inland waterways, SSS, or rail) must have a cost reduction of 30 to 50% in order for them to be used instead of road transportation (Baindur & Viegas, 2012). This indicates that the sea transportation industry is facing serious economic challenges due to the ever-increasing cost-sensitivity today. One contributing factor for the high costs of sea transport is the partially out-of-date port collective agreements which lead to high expenses and rates for loading and unloading commodities (Garberg, 2016; Rogerson et al., 2020). The expenses of moving goods from its origin to the end destination where port takes a part in the logistics flow including expenses for cargo handling are only one cost factor in the supply chain routing considerations. If port-related and

modal choice expenses result in savings in other logistical costs, shippers or their agents may choose more expensive ports or more expensive hinterland options. Example of these expenses can for example be:

- Costs related the tied-up capital of the goods that are transported
- Costs linked to inventory of the goods and safety stocks
- Costs that are indirect and often connected to the quality of the transport chain. For example if the different actors that are involved are willing to adjust their operation to meet requirements from customers in the sense of ease of administration and provide information and if they are willing to respond to variable flows (Notteboom, 2009)

Notteboom (2009), emphasizes how the high value products that are being shipped today worldwide has resulted in that the three aforementioned cost factors have gained increased relevance today. Actors in the market are becoming increasingly concerned about perceived inefficiencies in chain segments, as well as reliability difficulties.

2.4.2 Political

According to Garberg (2016), there are several laws and regulations that affect the ability to use sea transportation when compared with other transport modes. Shipping is largely governed by international laws and conventions that have been incorporated into Swedish legislation, whereas roads and railways are primarily managed by national and EU regulations (Garberg, 2016). Regarding sea transportation, the legislation sets requirements on the technical equipment and construction of vehicles and ships, staffing, market access and supervision. Furthermore, competing modes of transportation are governed by separate regulations, such as those governing railway fees and infrastructure investments for other modes (Rogerson et al., 2020). Garberg (2016) further explains that shipping is subject to over a hundred national laws, regulations, and rules, whereas road and rail are only subject to about fifty.

Furthermore, to handle waste materials, additional legal and regulatory aspects are essential to consider in contrast to other materials and specific techniques might be required. As a result, in addition to the WFD, the EU has several legislations addressing various forms of waste (European Commision, n.d)

2.4.3 Service quality

According to Medda and Trujillo (2010), Just-In-Time (JIT) is a management technique that tries to adapt necessary supply and production rate to consumer demand. The concept of JIT can result in several benefits such as less stock required, reduced stock that is damaged or becomes obsolete, increased production efficiency and decreased tied up capital (Arjona Aroca et al., 2020). According to Arjona Aroca et al. (2020), in order to implement a successful JIT strategy, accurate planning is required as well as forecasting of the demand and synchronization between actors since stock shortage can be caused by supplier delays. Today, global sourcing and JIT are trends within the area of production which requires frequency and flexibility which is something that is available when using truck as transport mode. This has resulted in increased

environmental impact from freight transport where road transport dominates as the worst transport mode for the environment because of the high average consumption of fuel and emission of C02 (Medda & Trujillo, 2010).

Medda and Trujillo (2010) emphasizes that one of the disadvantages with sea transport is the low reliability of departure and arrival times as well as the low frequency of sea transport which is why JIT operations in ports are limited. The authors also mention the inefficiency of ports and by strengthening the port-hinterland connections, the efficiency would increase (Medda & Trujillo, 2010). Furthermore, Arjona Aroca et al. (2020) support the fact that sea transport is still inefficient today. JIT operations have not yet been properly introduced in ports and it is only during the last 10-15 years the industry has started studying digitization in ports and how to optimize navigation speeds which could increase the potential for JIT transports (Arjona Aroca et al., 2020).

The most variable and costly factor for many companies' supply chains and logistical operations is freight transportation. This causes problems for managers who must deal with transportation system delays, rising energy prices, complex security challenges and imbalances and shortages within labor and equipment. The problems add risk to the supply chain as a whole and managers within the port- and maritime industry need to spend more and more time with handling and transport inefficiencies. Furthermore, the increasing complexity of the network design within transport logistics requires a high level of reliability between the actors involved (Notteboom, 2009). This is further supported by Medda and Trujillo (2010) who states that the entire supply chain is affected by the low reliability and inefficiencies in ports and that ports usually have low adaptability, low reliability and sometimes lack good rail links. Furthermore, intermodal transports in the current global supply chains require synchronization between different geographical areas. However, the increase of these synchronization levels can result in an unstable sea-land network and the whole transport system can be seriously affected by delays even though the transport costs are low (Notteboom, 2009).

In background of these considerations, it is important to consider the whole supply chain to effectively integrate ports in the network and in this way use sea transport as a transport mode. Consequently, the port community's capability to fully leverage synergies with other transport nodes and other participants within the logistics networks of which they are a part is becoming increasingly important (Notteboom, 2009).

Furthermore, the trend during recent years which are characterized by changes in production strategies combined with flexibility and globalization have resulted in smaller freight movements and deliveries that must be made over longer distances and more frequently (Caris et al., 2014). This seems to favor air and road transport, since sea transport in general requires larger volumes in order for the shipment to be profitable (Garberg, 2016). This is further supported by Rogerson et al. (2020) who states that high volumes of goods are needed in order for sea transportation to be successful. Garberg (2016) emphasizes that there is a lack of an appealing variety of services and a business model for inland coast and short sea transportation, particularly for clients with lower cargo quantities. Furthermore, shipowners and operators

believe there are insufficient economic prospects and that purchasing sea transportation is difficult (Garberg, 2016).

2.4.4 Conflicting interests between actors

An essential feature of assessing Short Sea Shipping (SSS) competitiveness is to understand that three different perspectives need to be considered: the shipping firm (i.e. operator or cargo owner), third-party logistics service provider (freight forwarder), and governmental authorities which can create conflicting interests between the actors involved (Santos & Soares, 2017). The major issue of the shipping firm (i.e., operator or cargo owner) is to evaluate the lucrativeness of a new SSS service. It must determine if there is a demand in the market for such a service, investigate uncertainties regarding revenue and expenses and understand the cost of providing such a service (Santos & Soares, 2017; Schwartza et al., 2020). The shipper on the other hand need to evaluate the possibility to ship cargo between two places and see what transport solution that exists which includes evaluating intermodal or unimodal options and the different option´s cost and transport times (Santos & Soares, 2017; Schwartza et al., 2020). Government authorities prioritizes the external costs of the transportation system and the effect it has on society. The external costs are costs that are not directly connected to the actual transport system, instead in includes costs connected to accidents, air pollution, noise, climate change, congestion, nature and landscape (Santos & Soares, 2017)

According to Schwartza et al. (2020), freight forwarders' role might change in the future. If cargo owners can easily identify the required cargo carrying capacity using coordination platforms which enables an increased communication between actors, it is debatable whether it will be a demand in the market for freight forwarders in the future since their role may become obsolete.

2.4.5 Geographical location

The use of SSS services may be favored due to travel distance and geographic location. SSS may compete with land-based forms of transportation within a certain distance range; short routes (under 700 km) are dominated by road as a mode of transport (Christodoulou & Kappelin, 2020). Long coasts, as well as industrial and production areas along the coast, provide short sea shipping, particularly RoRo shipping, a geographic advantage over other modes of transportation, making it easier for specific commodities to be transported by vessels suitable for such shipping distances (Christodoulou & Kappelin, 2020). According to Christodoulou and Kappelin (2020) and Notteboom (2009), geographical location plays an important role in order to utilize sea transport. Thus, having industrial and manufacturing facilities near the coast are an important factor to use sea transport as a transport mode.

2.5 Drivers with sea transportation in a logistical setup

This chapter will present the drivers with incorporating sea transport in a logistical setup

2.5.1 Economical

Medda and Trujillo (2010) explains that in an analysis where intermodal road transport and intermodal transport with SSS between the European corridor between Genoa in Italy and

Preston in the UK illustrates how much environmental damage could be prevented by increasing the use of SSS. It shows that the marginal external cost of shipping is around 0.14 E/km, while the cost of all road transport is around 0.24 E/km. To put it another way, SSS can cut the externality costs imposed by road transport in half (Medda & Trujillo, 2010). Medda and Trujillo (2010) further explains that by outlining the external costs can clarify the situation even further which was done in a study where US routes were compared. The analysis revealed that congestion and infrastructure costs account for almost 70% of the overall external cost. Hence, SSS can result in an economic advantage compared to road transport when the external and social costs are included in the total transportation costs (Medda & Trujillo, 2010).

Garberg (2016) compares the costs of carrying one ton of cargo via rail, road, and sea transportation as illustrated in Table 1. Garberg (2016) further claims that short-distance marine shipping increases the relative cost as there are multiple "firm" charges like port fees and related. When compared to road and rail, they do not reduce with distance but rather increase the cost per ton conveyed. Sea transportation, according to Garberg (2016), is a cost-effective mode of transportation, particularly when delivering big amounts of goods across vast distances. Lumsden (2006) backs this up, claiming that because of the enormous loading capacity, maritime transfers always result in reduced underway cost.

***Table 1**: Different costs for modes of transportation (Garberg, 2016).*

Mode of transportation	**Cost per ton-kilometer (SEK)**
Sea	0,03 – 1,61
Rail	0,2 – 1,62
Road	1,0 – 43,9

2.5.2 Political

The increasing use of SSS is supported by the general public since it can achieve cost- and environmental benefits. However, shippers remain skeptical of the use of SSS because they believe it performs poorly and is an unreliable transport mode compared to road transport (Medda & Trujillo, 2010). Thus, in the last few years, The EU has created various policies with the goal of achieving intermodal competition through different programs, taking into account the benefits of SSS and the potential role in intermodal freight transport (Suárez-Alemán et al., 2015). Examples of programs designed by the EU, amongst others, are Marco Polo I and II, Pilot Action for Combined Transport (PACT) and Galileo. The aim has been to promote other modes of transport. According to Suárez-Alemán et al. (2015), the three aforementioned programs have been giving support in order for companies to shift transport modes from road to other modes of transport (i.e., rail or sea) consequentially promoting an increased use of sea transport. In addition to this, governments have tried to increase the use of SSS through positive and negative incentives in order to try and erase the poor perspective from the general public (Medda & Trujillo, 2010). Increasing the use of sea transport to a higher extent, the European Union has introduced initiatives to promote sea transport which can be seen in figure 5.

Instruments	Policy	
Economic and market based instruments	Green awards	Scheme that offers various incentives in 35 ports around the world, depending on environmental targets
	Eco-Bonus	Incentive for maritime leg utilisation
	Green shipping bonus	From 2001 to 2003, rebate of port fees to ships with high environmental performance
	System of environmentally differentiated fairway dues	Taxes collected from ships of all flags by national authorities based on gross tonnage and volume of cargo
Voluntary instruments	Connect vessel to shore-side electricity in port (Germany–Sweden)	
	Low sulphur project (Wallenius Wilhelmsen)	
	EU shipping companies can register for the EU Eco-Management and Audit Scheme (EMAS)	

***Figure 5**: European initiatives to promote sea transport (Medda & Trujillo, 2010)*

2.5.3 Environmental

Road transport takes up to ten times more fuel than maritime transport to move the same quantity of goods which makes it one of the most energy-intensive modes of transportation (Kotowska, 2016). Consequently, several research papers have been conducted which emphasizes how a modal shift from road transport to sea transport can lower the environmental impact (Christodoulou & Kappelin, 2020), (Kotowska, 2016) and (Medda & Trujillo, 2010).

One of the external costs which arises due to transport on roads are congestion costs. Not only is this cost the root to increased travel time for the goods which impacts the private costs but it also results in other external costs such as infrastructure usage, pollutant emission and noise emissions (Medda & Trujillo, 2010). However, sea transportation tackles the rising congestion problem in the world and thereby decreases the external costs including pollutant emission because it spans across open areas compared to road and rail (Baird, 2007). Furthermore, according to Baird (2007) the sea can be seen as a free highway, it already exists and does not require any constant maintenance like roads and railways.

2.6 Success factors to shift from road to sea transport

In terms of negative externalities, road transport is frequently characterized of producing environmental and societal issues, such as congestions in highways and longer wait times, air pollution, climate change, traffic accidents, noise, infrastructure damage, and excessive energy usage (Raza et al., 2020). However, these externalities are not converted into actual costs i.e., external costs which means that users of road transport don't need to pay for these externalities which affects societies. However, Raza et al. (2020) emphasizes that SSS can become a more competitive mode of transport if these external costs for roads are considered as well. Furthermore, Raza et al. (2020) mentions several studies where the total cost for road (including

external costs) have been compared with the cost for SSS and concludes that by incorporating external costs for road transport the competitiveness of SSS can be increased.

Ports, as important nodes for SSS operations, have the potential to improve the efficiency of SSS systems, which is critical for SSS to compete with road transport by lowering total lead times and related logistical costs (Raza et al., 2020). To shift from road to sea transport, port-oriented features can be developed e.g., harmonization of ports, usage of electronic data identification systems, connection between ports and the hinterland, and administrative and customs processes. Thus, by increasing the overall efficiency in ports (i.e., the time spent in ports), the competitiveness of SSS can be increased (Raza et al., 2020).

Santos and Soares (2017) mentions that SSS can be carried out from three different perspectives which may have misaligned goals. While both road transport and SSS companies want an increased collaboration, companies who offer SSS have highly competitive and go-it-alone tactics which hinder them from doing so (Raza et al., 2020). SSS firms should offer forwarding services and create agreements with other agents in their chains to make it easier for them to integrate into multimodal transportation chains. Such collaborations might boost intermodal SSS's competitiveness (Raza et al., 2020). Thus, to use SSS in a successful way and make it competitive to road transport, agents or actors in the transportation network need to have a seamless integration and have aligned goals Raza et al. (2020).

3. Methodology

The following chapter presents an overview of the methodology used to answer the presented research questions and successfully fulfill the purpose of the thesis. Furthermore, the overview highlights several areas that are explained in subsections: Research strategy, research process, research design, data collection, case description and structure of analysis and discussion.

3.1 Research strategy

This thesis has a qualitative approach. According to (Yilmaz, 2013), qualitative research is centered on acquiring a deep grasp of the study participants' perceptions of social phenomena in naturalistic situations in order to infer theory from empirical evidence. As a result, rather than presenting a solid objective reality that is independent of setting, the focus is on defining how constantly changing social phenomena are perceived in the current context (Bell et al., 2019). The research in this thesis intends to explore areas in which there is a substantial lack of prior research and of explorative nature, making qualitative research appropriate.

3.2 Research process

With the supervisors at VTI and Chalmers together with relevant research within the subject, a definition of broad research questions was created to guide the thesis in the right direction. The first version of research questions was focused on creating a new logistical setup where sea transport is involved to a higher extent and evaluating the potential of this setup. However, after a greater understanding of the subject due to insightful interviews with the NGOs in Sweden, it was found that such a system already had been evaluated. Due to this, the research questions were modified and focused on barriers and drivers of involving sea transport to a higher extent in the flow of used textiles in Sweden.

The process on building the frame of reference began early during this project which enabled to better devise data collecting and methods for the analysis. To design a proper study scope, it was also required to get a full grasp of past studies within the research area. The literature review and the phase for the collection of empirical data took place simultaneously. Furthermore, the empirical data was analyzed immediately following each data gathering event. As a result, data collecting processes and the scope of the literature review could be adjusted to gain a better grasp of important themes to add into the frame of reference.

3.3 Research design

To conduct this research, a case study approach was used which is a research technique that comprises a thorough and in-depth examination of a particular case and the unique nature of the subject in question. Furthermore, some of the most well-known studies in business and management research are based on the case study technique, which is a prominent and commonly utilized research design in business research (Bell et al., 2019). The fundamentals of a case study comprise a thorough and in-depth examination of a particular case and the unique nature of the subject in question are the focus of case study research (Bell et al., 2019). Hence, the case is only focusing on the flow of used textiles in Sweden since different countries

can have different logistical systems for their used textile flows. Furthermore, it was seen appropriate to delimit the thesis to only look at the case of used textiles in Sweden in order to have a reasonable delimitation and to conduct the study within the given deadline. The case research technique was seen as appropriate since the research goal can only be met if a thorough understanding of the current barriers and drivers actors in the logistical system encounters by increasing the use of sea transport. Furthermore, cases are frequently chosen based on practical concerns and their capacity to give useful insights into the study issue that enhance the creation of new theories (Bell et al., 2019). Since there are different flows in Sweden for the used textiles depending on if they are collected for reuse or recycle, the case was chosen to look at the textiles that are collected for reuse. Taking these aspects into consideration, the specific is based on the largest NGOs in Sweden in terms of collected volumes.

3.4 Data collection

According to Bell et al. (2019), using numerous sources of data can help researchers avoid misconceptions by allowing them to cross-check empirical findings across diverse sources. Thus, this study included literature review and interviews to certify that necessary data is gathered and relevant conclusions are presented.

3.4.1 Literature review

A literature review was performed at the start to gain a better understanding of the issue. The literature review has been used to provide a frame of reference that was used to answer the research questions by providing support for the examination of empirical data. The Chalmers library and Google Scholar were chosen as electronic resources to search for literature relevant to this topic and keywords were picked to ensure that the search is thorough and are based on the thesis core topics. Keywords that were used to find relevant articles for this thesis included: “Circular economy”, “Sea transportation”, “Used textiles”, “Ports” and “Reverse logistics” among others. Furthermore, the writers have relied solely on peer-reviewed publications from academic journals to confirm the accuracy of the data, therefore establishing the source's legitimacy (Snyder, 2019).

3.4.2 Interviews

Interviews are appropriate for data gathering in exploratory research, according to Kothari (2004), which is the case for this study. Interviewing the NGOs helped the authors achieve the necessary information and better understand the current reverse supply chain of the textile flow in Sweden. Furthermore, as the purpose of this study is to investigate the barriers and drivers for involving sea transport for the flow of used textiles, it was found appropriate to interview ports since this actor is heavily involved in logistical systems where sea transport is used. Industry experts were also interviewed to give better understanding about NGOs and further information about the challenges with used textiles and sea transport in general. The format of the interviews was semi-structured, with pre-established questions to address the key points. This allowed the authors of this study to let the conversation go off into other directions which was seen fit. This is explained by Collis and Hussey (2014) to be one of the benefits with semi-structured interviews which the authors of this study took advantage of. Furthermore,

According to Bell et al. (2019), semi-structured interviews might lead to the collection of more relevant data since it offers more flexibility. In addition, as the purpose of this thesis is to investigate the involvement of sea transport in the reverse supply chain of used textiles, the interviews' sample design was purposive, which means they were chosen subjectively depending on the study's purpose (Kothari, 2004).

The interview questionnaires were created in line with the thesis' purpose, with the literature review serving as a source for identifying relevant themes within the subject. The sort of interview was determined with regards to the preferences of the interviewees which means that the interview questions were different depending on which actors that were interviewed. To get more detailed answers during the interviews, the interviewees had a chance to prepare since the questionnaire was sent in advance. Furthermore, in order to avoid misinterpretations and to capture everything that was said, the interviews were recorded after an agreement with the interviewees.

Table 2 shows the different actors interviewed during this research which, in total, consists of three different actors. The combination of the actors comprises the entire reverse supply chain of textiles apart from customers receiving the used textiles. Thus, it was deemed appropriate to choose the sample of interviewees based on a realistic representation of the current situation and the perceived barriers and drivers of utilizing sea transportation as a transport mode. As depicted in table 2, a total of nine interviews were conducted during this research.

***Table 2**: Actor group, company, and respondent´s role of the interviews*

Actor group	Organization/Person	Respondent´s role	Date
NGOs	NGO 1	Collecting and sustainability	2022-03-22
	NGO 2	Associate director	2022-03-24
	NGO 3	Collecting manager	2022-04-06
	NGO 3	Export manager	2022-04-06
	NGO 4	Logistician	2022-03-23
Ports	Port 1	Chief Customer Officer	2022-04-14
	Port 2	Marketing & Sales Manager	2022-04-20
Industrial Experts	Industrial expert 1	Head of department within waste treatment	2022-03-15
	Industrial expert 2	Researcher & PhD Candidate	2022-04-04

3.5 Case description

The case was focusing on the used textiles that are collected by NGOs in Sweden and how sea transport can be utilized to a higher extent within this flow. There are several NGOs in Sweden,

and the interviewed NGOs have been selected out of availability and interest. To investigate the potential of increasing the use of sea transport in the transport chain of used textiles, the authors deemed appropriate to interview ports in Sweden, which is an actor who are highly involved in transport chains where sea transport is used. The ports have also been selected out of availability and interest. Figure 6 is illustrating the case scope of this master thesis.

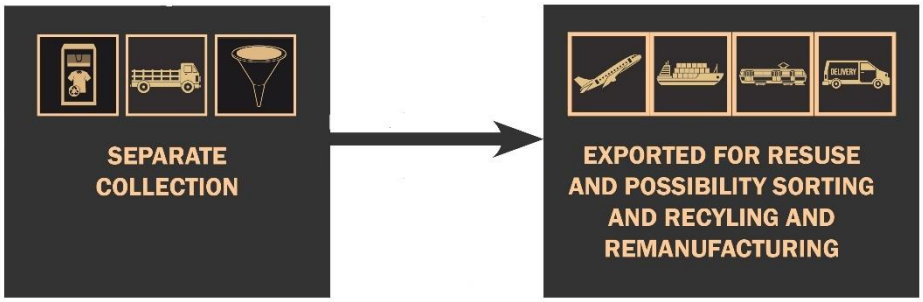

***Figure 6**:* Case scope

As explained in section 2.3.1, NGOs collect approximately 3,8 kg used textiles per person a year in Sweden where the majority of the textiles are being exported abroad. The case is focusing on this export flow of used textiles as seen in figure 6. The demand for used textiles in Sweden for reuse is lower than the supply. Since the main goal of the interviewed NGOs is to reuse the used textiles as much as possible which is favorable in an environmental point of view, the largest amount is exported abroad to their customers which essentially are sorting companies.

3.6 Structure of Analysis and Discussion

In qualitative research, large amounts of unstructured textual material are gathered from interviews, observations and documents which makes it complex to analyze and there are no hard and fast guidelines for conducting qualitative data analysis (Bell et al., 2019). To cope with this, the gathered data from the transcribed interviews are summarized and organized in tables in the section empirical findings. This facilitates the process of building links between the answers from the respondents and further analyze and draw conclusions. Furthermore, answers by the respondents are contrasted with the frame of reference to find similarities and gaps. The barriers and drivers are discussed and analyzed separately and will work as a basis to give recommendations on how to involve sea transport to a higher extent in the reverse supply chain of used textiles.

4 Empirical findings

This chapter presents the empirical findings of this study. The actors that were interviewed are divided into different sections where the barriers and drivers for involving sea transport are presented. The barriers and drivers stated by the NGOs are presented first, followed by the ports and last, the experts.

4.1 NGOs: Barriers and Drivers

This section will present the empirical findings from the interviews with NGOs regarding barriers and drivers for involving sea transport to a higher extent in the transport chain of used textiles.

4.1.1 NGO 1

The respondent emphasizes the most important factor when transporting the used textiles is the cost of the transportation and the importance of keeping it at minimum since the economic value of used textiles is low. Thus, the interviewee explains a consequence of such has led the customers taking ownership of the transportation both economically and operationally. The customers are using their own transport operators due the low-cost solutions they can find in collaboration with them, much due to the already existing relationship with such domestic actors. He further explains that if Swedish operators were to be used for this transportation, it would result in costs exceeding certain tolerance levels where the profit margins would be cannibalized. The respondent further explains that the used textiles today are transported by truck to a port in Sweden and then across the Baltic Sea via RoRo ships to their customers. The trucks are later driven to their customers in the destination country which means that sea transport is used to some extent today. He explains that one major barrier with increasing the use of sea transport is because of the existing reverse flow which is considered efficient since "IKEA returns" are used. He further explains how this flow works:

> *"We have a lot of production in Eastern Europe for IKEA in Sweden. Many of these trailers that have been in, for example, Älmhult are empty as they have delivered large volumes to IKEA".*

The respondent also highlights a major barrier relating to the geographical displacement of the customers. Using trucks and RoRo to get across the Baltic Sea is an efficient solution to utilize, according to the interviewee, since their customers are not located close to a coast or port which means that the trucks need to drive some distance in the destination country. The barriers are displayed in table 3.

***Table 3**: Barriers for NGO 1*

Barriers for NGO 1					
Economical	**Political**	**Service quality**	**Conflicting interests between actors**	**Geographical location**	**Other**
Low value of the goods Low transportation cost is essential			Packing requirements from the customers Not owner of the transport arrangement	Customer proximity to coast/port	Existing reverse flow is efficient

The drivers identified by NGO 1 are displayed in table 4. The interviewee from NGO 1 mentions the less environmental impact as a key driver for sea transportation highlighting particularly reduced carbon emissions. Moreover, the respondent states regarding its awareness of the new EU directive that will take place during 2025 with a new collection structure that will result in increased collected volumes. According to the respondent, there are political interests as well as interest from the textile industry to "loop" the textiles more locally to keep them within the Nordic countries and adds that this will probably reduce the volumes of exported textiles to other countries after year 2025. In addition to this, he highlights that there is a future potential to increase using sea transportation for the used textiles since a new facility for textile recycling will open in Sweden during 2022. This facility will be located in Sundsvall, northern Sweden and close to the coast which creates good conditions for using coastal shipping transportation from the south of Sweden according to the respondent. Furthermore, the requirements from this new actor who will sort the textiles is that the textiles are baled and are shipped with containers which further support the use of sea transport. However, for such a system to be profitable for NGO 1, the interviewee emphasizes that governmental support will be a crucial driver to encourage this potential shift and thus increase the use of sea transportation.

> *"Should we receive support and sorting technology for sorting recycled materials and that we would become a subcontractor to Renewcell (i.e., a company which focuses on recycling of cotton) in Sundsvall, then I see a relevance in shipping with containers. For example, baling this and driving via containers. This actor's main ambition is to have the textiles delivered in bales and with container as a load carrier"*

The respondent concludes by saying that using sea transport will increase in attractiveness the stronger the incentives become to handle the used textiles in Sweden.

***Table 4**: Drivers for NGO 1*

Drivers for NGO 1			
Economical	**Political**	**Environmental**	**Other**
	Governmental support is crucial	Reduction of emissions	Future recycling centers in Sweden Inability of local handling of used textiles

4.1.2 NGO 2

The barriers for NGO 2 are displayed in table 5. NGO 2 is a small actor when it comes to transportation according to the respondent. This has led to that it is difficult to create good collaborations with other actors which is seen as a barrier to utilize sea transportation to a higher extent. His perceived knowledge is that higher volumes are needed for sea transportation to be used as a transport mode. He further explains barriers with using this transport mode since a truck needs to transport the container to NGO 2 and the container needs to be handled in some way in the receiving destination as well, after the sea shipment. Furthermore, another barrier the respondent perceives with sea transport is that using a container is complicated and less flexible compared to the current solution where truck and trailer in combination with RoRo is used. Regarding economical barriers, the respondent emphasized that the intermodal solution that is used today, with truck and trailer in combination with RoRo is probably more cost efficient compared to containerized sea transport and therefore there are limited incentives economically to shift mode of transport entirely. The interviewee also adds that including more sea transportation in the transport chain of used textiles would enforce changing a lot of processes of how they presently work.

Another critical barrier with increasing the use of sea transportation is the question of ownership of the transportation arrangement. The respondent emphasizes the limited influence NGO 2 have as the customers are responsible for arranging the transport.

***Table 5**: Barriers for NGO 2*

Barriers for NGO 2					
Economical	**Political**	**Service quality**	**Conflicting interests between actors**	**Geographical location**	**Other**
Sea transport is perceived as cost inefficient Low value of goods leads to the customer arranging for as cheap transport as possible		Small actor hinders good collaboration Inflexible with pure sea transport due to transshipments	Not owner of the transport arrangement	Customer proximity to coast/port	

A strong driver emphasized by the respondent relates to the environmental aspect, particularly the reduction in emissions, as highlighted in table 6. In addition, it was also believed that the environmental driver would perhaps be the most prominent driver amongst other drivers. The interviewee also mentions a strong driver for increasing the use of sea transportation being the limited knowledge, capacity, and insufficient know-how for the sorting and other handling activities of used textiles, thus, enforcing the used textiles to be exported and therefore potentially increasing the use of sea transportation. In case it was to be done in Sweden, the respondent expands, the labor of doing such would be too costly and economically unjustified. In addition, the interviewee highlights the limited domestic demand of second-hand clothes and rather a greater global demand acting as a driver for the usage of sea transportation to export the used textiles. All drivers identified by NGO 2 are displayed in table 6

***Table 6**: Drivers for NGO 2*

Drivers for NGO 2			
Economical	**Political**	**Environmental**	**Other**
Decreased costs Larger global demand in contrast to limited domestic demand	Subsidies from the state or grants.	Reduction of emissions	The domestic inability to handle used textiles

4.1.3 NGO 3

The respondent at NGO 3 explains that they are having two different types of collection flows in Sweden and the respondent emphasizes that they first make sure that they have enough volumes for their own secondhand stores. One flow collects textiles in Sweden and is then sorted for reuse in their secondhand stores. In this flow, the textiles of the highest quality are collected for their secondhand stores and the remaining textiles are of low quality which can't be reused in the Swedish market. These textiles are instead good enough for the market in

underdeveloped countries and are sent to the middle east by sea transport in containers. This is possible due to the fact that the clothes are baled before packed into the container and then later sent by sea to these countries.

In their other flow, 100% of the textiles that are collected are being exported to countries in the EU for sorting and further distribution to other countries since they already have the necessary volumes for their own secondhand stores in Sweden. When the textiles have been collected in Sweden, they are first pre-sorted in order to take away trash (i.e., objects that are not textiles) and only send textiles to these countries. However, in this flow no textiles are sorted for their own secondhand stores which means that high quality textiles are sent to their customers in the EU. The respondent explains that they are using truck transport and RoRo ships to get across the Baltic Sea. He further explains that they have looked at increasing the use of sea transport in collaboration with a freight forwarder for this flow of textiles that crosses the Baltic Sea and over to their customers in Europe who further sorts the textiles. It came to their realization that transporting by container would increase the total cost of the transportation tremendously as well as increase the complexity for the logistics operations. For instance, the need for containers on site with vehicles that have special equipment to handle it or the use of regular trucks to move the textiles to a container yard and eventually load the container there would result in additional work and transshipment.

The particular pilot test of using sea transport was therefore not considered of being sufficiently competitive opposed to truck transport with trailer as a load carrier. Furthermore, their largest customer is in Poland where 75% of their total export of textiles are sent to has a vastly limited inland waterway transport system which means that truck or train would have to be used to reach the end destination which increases the complexity in the transport chain even further. Nor are the customers located close to a coast or port which is why truck, and the RoRo solution is in place at present time. The interviewee further explains that they are not allowed to bale the goods for their customers in Europe since there is a risk of the clothes being damaged when they are too tightly packed. The low profit margin is the reason, explained by the respondent, of why the customers disallowed risking damaging the clothes. Instead, big bags need to be used which are not completely dense and there is a risk of the clothes being wet in a container when they are packaged in this way. This can potentially increase the risk that the clothes will be contaminated with mold, consequently resulting in unsellable clothes. He further explains that using the container results in that more air is transported compared to using a truck since it can’t be packed equally well in a container and the respondent explains that it is not good for the environment to transport air. He further explains that when using a truck for the transport, a trailer is used where it is possible to open the roof and due to this, press the textiles and pack the trailer more efficiently. According to the respondent, this is not possible when using a container. All the barriers from NGO 3 are illustrated in table 7.

The respondent concludes the issues with using sea transport to a higher extent by the following quote:

"Environmentally, it will have about the same impact whether we choose a trailer for truck transport or container for sea transport. It does not work logistically with containers for the customers we work with and the requirements they have for the shipping process. Schenker has looked at this for us, but it does not prove to be sustainable in both environmental and economic terms"

***Table 7**: Barriers for NGO 3*

Barriers for NGO 3					
Economical	**Political**	**Service quality**	**Conflicting interests between actors**	**Geographical location**	**Other**
Cost efficiency		Increased lead time Complicates logistics operations Inflexible	Packing requirements from the customers Not owner of the transport arrangement	Customer proximity to coast/port	Existing reverse flow is efficient External factors (container shortage)

The interviewee highlights a critical driver of using more sea transportation in the reverse supply chain of used textiles, depicted in table 8, as being the reduction of emissions if the distance is favorable. In addition, the respondent mentions the essentiality of port related operations being efficient as another key driver for sea transportation. The respondent means to argue that if, for instance, the container is unloaded inefficiently and in an excessively time-consuming manner it would become too expensive with sea transportation in contrast to road. Another key factor for the competitiveness of sea transportation is highlighted is the geographical displacement of the customers. If customers are located, for instance, in cities where the coastline is extensively far away and there is an absence of proximity to inland waterway it would stem the competitiveness of sea transport. However, if the customer is located close to coast lines or ports, the attractiveness of sea transportation increases tremendously. Lastly, the respondent from NGO 3 accentuates the reliability of sea transportation. As the transportation mode is perceived as a more secure mode of transport, the customers, as explained by the respondent, could vouch for a sea transport despite the increased costs related to operations.

***Table 8**: Drivers for NGO 3*

Drivers for NGO 3			
Economical	**Political**	**Environmental**	**Other**
		Reduction of emissions	The importance of reliability and security Customers proximity to coast or ports Efficient port operations

4.1.4 NGO 4

The respondent at NGO 4 is skeptical to increase the use of sea transport since this entails an increased number of transshipments and results in a higher transport cost (see table 9). The respondent is using an agent for their transport and has, in collaboration with this agent, investigated the possibilities of increasing the use of sea transport.

> *"We have made a pilot in cooperation with our agent who is responsible for our transports where we tried to use sea transportation. However, it was found to be too expensive to use sea transportation due to all the transshipment that was needed to be made."*

The respondent emphasizes that it is important that the transport cost is low due to the low margins of the used textiles. Furthermore, the respondent explains that they don't have a focus on their transport and that their agent is the one responsible. However, she emphasizes that the export of used textiles is not profitable for them, but they do it in order to not contribute to the disposal of used clothes. Instead, they want to contribute to the reuse of used clothes for people in need.

The NGO 4 is using special bags where the textiles are packed in since their customers have a requirement to receive the bags in this way. This is seen as a barrier for using sea transport with containers since the used textiles can´t be baled which increases the packing efficiency. Furthermore, the biggest barrier according to the respondent is that they don't have the knowledge about sea transport and the respondent further explains that it's difficult to find information about using sea transport and that you probably need to be a larger actor in order to utilize it to a higher extent.

***Table 9**: Barriers for NGO 4*

Barriers for NGO 4					
Economical	**Political**	**Service quality**	**Conflicting interests between actors**	**Geographical location**	**Other**
High transshipment costs Transportation costs are high relative to the margins.			Packing requirements from the customers	Customer proximity to coast/port	Limited access to information about the know-how Perceived as a small actor

Regarding drivers for sea transportation which are illustrated in table 10, the respondent from NGO 4 first mentioned how the increased stability in a transport chain was an odd yet impactful driver. It was explained that using another transport as a complement would increase the stability of their transport chain since road transport is somewhat unstable currently. Furthermore, it is emphasized that a sustainable development and environmental impact is something that is valued highly at the company, and they have recently started to calculate their

emissions for their transports. This is seen as another driver for involving sea transport to a higher extent.

The establishment of a new textile recycling plant in Sweden in 2022, there is a future possibility to boost the usage of sea transportation for old textiles according to the respondent. This facility will be displaced in close proximity to the coastline in the northern parts of Sweden and therefore enable favorable circumstances for employing coastal shipping from the southern part of the country. Additionally, the new sorting facility will require the textiles being baled and delivered in containers, which will further support the utilization of sea transport even more.

***Table 10**: Drivers for NGO 4*

Drivers for NGO 4			
Economical	**Political**	**Environmental**	**Other**
		Environmental focus	Future recycling centers in Sweden Using another transport mode will increase the stability in the transport chain

4.2 Seaports: Barriers and Drivers

This section will present the empirical findings from the interviews with ports regarding barriers and drivers for involving sea transport to a higher extent in the transport chain of used textiles.

4.2.1 Port 1

Barriers identified by the respondent from Port 1 are depicted in table 11. The respondent at Port 1 starts with explaining that their primary goal is to find opportunities and create new and efficient logistical systems. In other words, their main goal is to optimize the logistics for their customers by creating efficient flows, warehousing and sometimes having the same role as a third-party logistics actor. They have collaborations with several actors in the chain including haulage operators, railways, and shipping companies. They have currently no earlier experience with handling textiles in the port. However, they are currently transporting textile mass that are later used to produce new clothes.

The respondent is discussing several barriers that they have encountered during recent years. These barriers are considering external factors such as trade restrictions by the US after Donald Trump was elected as president, Brexit and Covid 19 which has led to disturbances in the supply chains and the price for sea freight has increased five times. In addition to this, the recent war between Ukraine and Russia have further created disturbances in the supply chains. Due to this, the respondent believes that JIT will no longer be an efficient strategy in the new normal state and is a difficult strategy for sea transport. He further supports this statement by saying that a

big retailer in Sweden is currently building their fifth warehouse in Sweden because of the limitations of JIT today.

> *"What we have seen so far in recent years with Trump, Brexit, Covid 19 and war, is barriers that we have never encountered in our segment before. This has changed how we handle goods, how we transport, etc. It feels like anything can happen"*

According to the respondent, sorting and storage of textiles will be a problematic activity to perform in the port since port workers who load and unload vessels in the ports in Sweden have the second highest salary for physical work. The same issue is present in the ports outside of Sweden too, the workers have high salaries. Due to this reason, you should not do these kinds of activities in the port as it will be far too expensive. Furthermore, another barrier the respondent sees with sea transport is all the rules that need to be followed which result in that sea transport becomes complex.

***Table 11**: Barriers for Port 1*

Barriers for Port 1					
Economical	**Political**	**Service quality**	**Conflicting interests between actors**	**Geographical location**	**Other**
Sea transport has increased in price	Laws and regulations need to be followed	Limitations in JIT			Affected by external factors High salaries for workers

Regarding the drivers for involving sea transport, the respondent explains that no specific requirements need to be met regarding volumes to use the port as a node in the transport chain (see table 12). He further explains that if the goods are loaded in a container, it is seen as a unit and what's in the container does not matter.

Furthermore, the port cannot lock out a shipping company due to the modes of transport they use and that for example electrified ships should be used more frequently. The port cannot make any demands on their customers to use electrified vessels, but this is something that the government has the power to do according to the respondent. Hence, a driver the respondent sees to increase the amount of sea transport is government incentives for fairway fees, port fees, etc. and that these fees are removed or reduced.

Another issue that was brought up by the respondent is that foreign drivers do not pay road taxes in Sweden, but this is something that every shipping company does regardless of which country the customers are from. However, in Germany for example, foreign drivers also pay taxes there. Another driver the respondent sees in order to use sea transport to a higher extent is by incorporating external costs for road transport. The respondent emphasizes that truck transport would not be used to the same extent if you had to pay for what it costs to use truck transport.

***Table 12**: Drivers for Port 1*

Drivers for Port 1			
Economical	**Political**	**Environmental**	**Other**
Include external costs for road transport No maintenance needed for seaways	Potential incentives from governments		No specific requirements towards customers considering volumes

4.2.2 Port 2

Barriers identified by the respondent from Port 2 are displayed in table 13. Port 2 tries to see the customer needs and offers various services in their port. From the port's perspective, the material they handle does not matter. However, as soon as they handle waste material, the rules and regulations are different. The same tools and machines are used to handle the material but since it is waste, the requirements for handling the waste materials are different. The port might need to protect the material in a certain way along with other requirements which is seen as a potential barrier by the respondent. He further explains that it might lead to that they can handle the materials but are not allowed to because of all the laws and regulations.

In order to use sea transport, some factors are needed to be looked upon according to the respondent. Firstly, it is important to check where in the world the goods are transported i.e., geographical location of the goods. Furthermore, another important aspect is to look at the requirements for the transport which can depend on what type of material that is transported. For example, if the material is sensitive to moisture, the time in the load carrier might be a problem if you use container and sea transport since it takes longer. Furthermore, frequency is also usually a problem when talking about shipping as it can depart 1-3 times a week while truck in combination with RoRo ships where you might have 7-14 departures a week instead. In addition to this, it is important to look at the customer's ability to use certain load carriers since the working methods change depending on which load carrier that is used.
For example, with a container, you may need to have a small truck and a small ramp.

According to the respondent, volume is important if we are to make an investment that is aimed at a certain flow. This can reduce unit cost, bring up the utilization rate, and overall be more efficient. In addition to this it must be economically sustainable to invest in machinery, fixed assets, and in this way be helpful. The respondent also emphasizes that they want to be able to use their assets for several customers.

The respondent also brings up issues that have occurred because of the recent pandemic where supply chains have been more affected than ever and that the concept of JIT has not been working. Furthermore, he explains that companies should base their decisions of where to locate factories and warehouses etc. more with regards to logistics:

"In short, companies don't think about logistics in the first place, which is a problem, and you realize later that you are in need of logistics and transport. This is certainly quite natural, but it would have been desirable for companies to think about this earlier and base their decision on where factories and warehouse etc. should be located in terms of logistics and transport"

According to the respondent, there is a lot of talk about changing fuel to more sustainable, electrification, etc. but not to change transport mode from road to sea transport which is seen as another barrier. The respondent further explains that here is a lot of inefficiency in the transport system today and it is important to work with goods transfer, route planning, return transport and various behaviors to increase the utilization rate.

***Table 13**: Barriers for Port 2*

Barriers for Port 2					
Economical	**Political**	**Service quality**	**Conflicting interests between actors**	**Geographical location**	**Other**
	Laws and regulations for waste materials Sea transport is more regulated compared to road transport	Shipping frequency Long transit times Technical conditions at the customer site Limitations in JIT		Facilities proximity to coast/port	High salaries for workers

Regarding the drivers for involving sea transport (see table 14), the respondent brings up several ways where ports can be more helpful. Ports can take a larger responsibility to let actors know what kind of services ports can offer for customers to utilize them. He further explains that Port 2 has competencies and machinery which actors can use and that this should be communicated to their actors. Furthermore, the port can store goods if customers don't have room for this in their own facilities. In this way, the port can function as a bridge and can take on a role for small and large actors, so they don't have to make large investments. The respondent emphasizes that this can lead to ports taking a larger part in the transport chain and that the use of sea transport becomes more attractive.

Another driver that is brought up by the respondent is the laws and regulations for "dirty transports" (i.e., transports that emit large amounts of greenhouse gas emissions) which indirectly makes it cheaper with using "clean transports" (i.e., transports that emit small amounts of greenhouse gas emissions). The respondent emphasizes that sea transport is still emitting greenhouse gas emissions However, per ton km, it is a better transport mode compared

to road i.e., the energy value per transported kilometer or per ton is considerably lower for sea transport. In the near future, it is important to not only look at the C02 emissions since it is important to use an energy efficient mode as well, especially now when there is a lack of electricity and biofuels. in the future, when we want biofuels that they lack or electricity that they also lack, then we must consider that aspect of consuming the least possible energy. And not just weave in C02.

Furthermore, if you consider a social perspective when choosing transport mode, sea transport is more regulated compared with road transport which also should be considered when choosing transport mode according to the respondent. This is also seen as a driver for using sea transport instead of road.

***Table 14**: Drivers for Port 2*

Drivers for Port 2			
Economical	**Political**	**Environmental**	**Other**
	Laws and regulations for environmentally friendly transport options	Low C02 emissions Energy efficient	Can be helpful to customers in many ways Sustainable from a social point of view Facilities near coast & ports

4.3 Experts: Barriers and Drivers

This section will present the empirical findings from the interviews with experts regarding barriers and drivers for involving sea transport to a higher extent in the transport chain of used textiles

4.3.1 Industrial expert 1

All barriers identified by Industrial expert 1 are illustrated in table 15. The transport mode when exporting the textiles is dependent on the destination country according to the respondent. When transporting the used textiles to European countries, the most common transport mode is by truck. The respondent emphasizes that using sea transport for these shipments would not be efficient and the transport would result in too high costs which is seen as a barrier. However, he emphasizes that sea transport is used to some extent today where trucks are used in combination with RoRo ships across the Baltics to the destination country and the underlying reason for this transport mode is the low cost and flexibility it entails. This is seen as a barrier for involving more sea transport in the transport chain due to the low cost and flexibility the transport chain has today. He further explains that for the textiles that are sent to countries far away, for example the middle east, the textiles are packed into containers and then exported by sea transport which means that sea transport is already used to a high extent in this flow.

The respondent discussed another barrier regarding geographical location where the respondent explains that to use sea transport, the facilities for handling the used textiles need to be located

close to a port which is not the case today. If the facilities are located in the middle of Europe and in the middle of Sweden, there is no major opportunity to pack textiles in containers and use sea transport because it will travel such a short distance and will only complicate the logistics in the transport chain.

Another barrier was also discussed during the interview with regards to volume. In order to use a container and increase the use of sea transport, larger volumes are needed which can create problems. First, the NGOs would need to store the textiles for a longer period which would mean that they can transact the money as quickly as by using trucks. Second, this can create problems for their customers since larger volumes will arrive less frequently. Furthermore, to have a container placed at the NGOs facilities will result in a cost as well.

***Table 15**: Barriers for Industrial expert 1*

Barriers for Industrial expert 1					
Economical	**Political**	**Service quality**	**Conflicting interests between actors**	**Geographical location**	**Other**
High costs		Inflexible Larger volumes needed Less frequent deliveries		Facilities proximity to coast/port	

One potential driver for increasing the involvement of sea transport in the transport chain of used textiles is to have facilities in close proximity to coasts or ports (see table 16). In order to increase the use of sea transport in the transport chain, a facility is needed in both the sending port and the receiving port. If the logistical setup would be rearranged in this way, there is a potential to use sea transport to a higher extent in the transport chain of used textiles. In addition to this, the respondent emphasizes the importance of looking at the transport chain in Sweden as well since there is a potential to use inland waterways in Sweden, especially in the Stockholm area due to the many canals that exists there

***Table 16**: Drivers for Industrial expert 1*

Drivers for Industrial expert 1			
Economical	**Political**	**Environmental**	**Other**
			Facilities near coast or ports Inland waterway potential

4.3.2 Industrial expert 2

The respondent explains that some of the large and medium sized NGOs have their own fleet with trucks. During recent years, these NGOs have started to do a lot of things for increasing the sustainability and some actions related to their transports. One example of this is NGOs who have started to switch to more environmentally friendly fuels such as biodiesel which is seen as a barrier for involving sea transport to a higher extent (see table 17). In addition to this, the purchasing power for some NGOs are low due to the many subcontractors that are buying textiles from them. This is seen as another barrier for involving more sea transport since it restricts the NGOs possibilities to set environmental targets for their transports.

Another interesting aspect brought up by the respondent is that some NGOs don't want to look at the environmental side since they want to keep their identity as a charity organization rather than being seen as a collector of textiles. However, when it comes to larger NGOs, then they start to see themselves as collectors of textiles due to the large volumes and hence start to look at environmental aspects due to the large amount of transport it incurs. Furthermore, capacity is another barrier for the NGOs and everything they collect can't be stored in their facilities may complicate the use of sea transport. According to the respondent, seasonality plays an important role when it comes to the collection of used textiles. Since people usually donate warm clothes such as winter jackets in the spring and there is no season for this in the country, these textiles are often exported due to limitations in capacity.

According to the respondent, recycling of textiles will increase in the Nordics since the know-how and factories will be located there. This might lead to the Nordic countries needing to import textiles instead of exporting them. In this scenario, ports might need to take a larger role since all these textiles will probably come with sea transport due to the large volumes and the requirements from the recycling facilities.

***Table 17**: Barriers for Industrial expert 2*

Barriers for Industrial expert 2					
Economical	**Political**	**Service quality**	**Conflicting interests between actors**	**Geographical location**	**Other**
	Export of textiles will decrease in the future	Capacity problems	Low purchasing power		Sustainable fuels for truck transports

From the interview, no specific driver for involving sea transport for the export flow was mentioned due to the limited knowledge by the respondent (see table 18). However, the respondent mentioned the EU framework directive which will result in European countries needing to have a national system for the collection of used textiles. According to the respondent the know-how and factories for recycling the used textiles will be located in the Nordics and sees a future potential for sea transport to these factories because of the large volumes. The respondent further explained that the Nordic countries might need to import textiles from other European countries.

***Table 18**: Drivers for Industrial expert 2*

Drivers for Industrial expert 2			
Economical	**Political**	**Environmental**	**Other**
			Future recycling centers in Sweden

5. Analysis and Discussion

The following chapter presents the analysis and discussion of the findings from the research, combining both the theoretical and empirical aspects. Firstly, the barriers are analyzed and discussed followed by the drivers. The analysis and discussion will act as a basis for the recommendations by the authors which will answer the third research question on how to overcome barriers and to utilize the drivers identified.

5.1 Barriers

In table 19, all the barriers identified by the different actors are displayed. This is to give an overview of what the different actors have stated to enable cross functional analysis on the empirical findings in contrast to the current literature on the subject.

***Table 19**: Barriers for the different actors*

Barriers for the studied actors	Economical	Political	Service quality	Conflicting interests between actors	Geographical location	Other
NGO 1	Low value of the goods Low transportation cost is essential			Packing requirements from the customers Not owner of transport	Customer proximity to coast/port	Existing reverse flow is efficient
NGO 2	Sea transport is perceived as cost inefficient Low value of goods leads to the customer arranging for as cheap transport as possible		Small actor hinders good collaboration Inflexible with pure sea transport due to transshipments	Not owner of the transport arrangement	Customer proximity to coast/port	
NGO 3	Cost inefficiency		Increased lead time Complicates logistics operations Inflexible	Packing requirements from the customers Not owner of the transport arrangement	Customer proximity to coast/port	Existing reverse flow is efficient External factors (container shortage)
NGO 4	High transshipment costs			Packing requirements from the customers	Customer proximity to coast/port	Limited access to information

	Transportation costs are high relative to the margins.					about the know-how Perceived as a small actor
Port 1	Sea transport has increased in price	Laws and regulations need to be followed	Limitations in JIT			Affected by external factors High salaries for workers
Port 2		Laws and regulations for waste materials Sea transport is more regulated compared to road transport	Shipping frequency Long transit time Technical conditions at the customer site Limitations in JIT		Facilities proximity to coast/port	High salaries for workers
Industrial expert 1	High costs		Inflexible Larger volumes needed Infrequent deliveries		Facilities proximity to coast/port	
Industrial expert 2		Export of textiles will decrease in the future	Capacity limitations	Low purchasing power		Sustainable fuels for the truck transports

5.1.1 Economical

The majority of the NGOs emphasized the low value of the used textiles and thereby an inherently low profit margin of which the entire reverse supply chain must monetize on in order to run business as usual. Consequentially one determining factor they can affect is the transportation cost and to keep this certain cost component as low as possible. This is aligned with the statements from Dowlatshahi (2010) where the author explains that it is important to have low transportation costs in reverse logistics systems. However, it is perceived by many of the NGOs that increasing the use of sea transport will lead to higher costs which decreases these margins even further, or in the worst case, erases the margins entirely. Additionally, two of the NGOs have tested to integrate more sea transport in their transport chain, yet it was shown

to be costly where the profit margins of the textiles would be too low. This is, in some sense, assured by Garberg (2016) where the author explains the port handling costs accounting for roughly half of the total transportation cost and no similar costs can be found when transporting the goods by road. Considering the low value of the used textiles, additional costs might hinder involving sea transportation to a greater extent. Adding to this, Baindur and Viegas (2012) states that in order for sea transport to be used instead of road transport, the total cost of the transport needs to be decreased by 30-50%. Furthermore, Notteboom (2009) also states that the ever-increasing cost sensitivity today is a big economical challenge for sea transportation in general, a concern the empirical findings of this research also highlights.

One of the experts and one of the ports also emphasized on the high costs related to sea transportation. Furthermore, the respondent from the port also mentioned that lately, the prices for sea transport have shown to be extremely volatile in correlation to external factors such as Covid 19, especially for containerized sea transport due to container shortage. Container shortage was also mentioned by the respondent at an NGO as a barrier for involving more sea transportation in the chain of used textiles.

5.1.2 Political

According to the respondents from both Port 1 and Port 2, a political concern for the attractiveness of sea transportation is the many more laws and regulations that need to be followed in contrast to road transportation. This can be connected to what Garberg (2016) states where shipping needs to follow over a hundred laws, regulations and rules while road on the other hand is only a subject to approximately fifty. One of the ports particularly mentioned this notion in terms of waste materials, as they require meeting additional laws and regulations compared with regular commodities. Thus, this can indirectly be seen as a barrier for shipping the used textiles by sea transport. However, this cannot be directly linked to the actual sea transport, it is rather linked to the nature and characteristics of the goods.

None of the respondents from the NGOs mentioned any political barriers for the export of used textiles. A potential reasoning of their lack of insight within this area can stem in the question of transportation ownership where they clearly state the arrangement of the transportation lies within the authority of their customers. Thus, they might have a limited understanding of the political requirements the transport needs to fulfill.

5.1.3 Service Quality

The literature and the statement from the interviewees show alignment in service quality being a major barrier for involving sea transport to a higher extent in the transport chain of used textiles. However, these barriers differ depending on the narrative of the actor. What was acknowledged by the respondents from the NGOs was the inflexibility as well as increased lead times and less frequent deliveries which was also mentioned by one of the experts. Such are major barriers within sea transport as explained by Medda and Trujillo (2010). Additionally, Rogerson et al. (2020) explains the necessity of large volumes as a favoring characteristic for the use of sea shipping as a transport mode since the shipment becomes unprofitable when small volumes are shipped and the export of used textiles is aligned with this argument as well. What

was highlighted by one of the NGOs is that they are a small actor with relatively low volumes and that this hinders a good collaboration with important sea transport facilitating actors. Furthermore, another NGO had the same view regarding the use of sea transport and declared it problematic in terms of their size and handled volumes.

JIT was brought up by the ports as barriers with sea transport which is aligned with what is argued by Medda and Trujillo (2010) and Arjona Aroca et al. (2020). However, JIT deliveries aren't essential in the transport chain of used textiles, but the time aspect of the transport is important due to the nature of the goods. The importance of time was particularly emphasized by one of the NGOs explaining the risk of textiles being damaged due to mold if the transportation encounters humid or a wet environment for a prolonged amount of time. Interestingly, the same NGO in collaboration with a freight forwarder investigated the possibility of involving more sea transport in their export of used textiles to European countries. However, this was shown to complicate the logistics extensively due to all the additional transshipments needed to reach the end destination. Furthermore, the transshipment resulted in a considerably higher cost for the transport due to the added port and handling cost, a barrier also mentioned by Garberg (2016) and Rogerson et al. (2020). The respondent from the same NGO also explained the limited additional environmental benefit by involving sea transportation to a higher extent compared to their current transport chain when using RoRo ships across the Baltic Sea.

It can also be difficult for the NGOs to densely pack shipping containers leading to air being transported which diminishes the concept of sea transportation since the major benefit with the transport mode in contrast to road is the emission per unit due to the ability of transporting high volumes (Lumsden, 2006). This can also be connected to the capacity problems that were brought up by one of the experts where the expert explains that NGOs can't store large quantities of textiles in their facilities due to capacity limitations. Packing the textiles in containers and then shipping them by sea transport might lead to some air being transported since the NGOs might need to ship the textiles before the container is fully loaded.

According to Christodoulou and Kappelin (2020) RoRo is a part of SSS and can be a competitive alternative to road transport which is something that the NGOs are using today. This means that sea transport is used to some extent. By increasing the use of sea transport, sea shipping with containers is needed since with this load carrier, a potential for using inland waterways becomes available. However, as mentioned earlier in this section, this results in a more complex logistics system and is seen as a barrier by several of the NGOs as well as one of the experts.

5.1.4 Conflicting interests between actors

All NGOs, except from NGO 4, emphasized very clearly on the barrier of not having ownership of the transportation´s economical arrangement and operational execution. Consequently, they perceived great limitations in their power to influence the customers decision of choosing transport mode. However, many of the NGOs stated that they had an interest in sea transportation and to seek the possibility to involve it more in the transport chain but due to

their inability to have authority in the transportation question, they were unable to. Evidently a conflicting interests occur between different actors. Santos and Soares (2017) emphasizes on this specific notion of conflicting interests between actors and how they perceive different barriers depending on what role they play in the supply chain. Thus, being able to rightfully assess SSS´s competitiveness to road transportation requires having the perspective of different actors according to Santos and Soares (2017). For instance, for the shipping firm to evaluate (NGO) SSS, the cost of using such a service is of interest. On the other hand, the shipper concerns about shipping the cargo between origin and end destination. Yet the literature does not particularly highlight the customers point of view, or even less the point of view of a single actor who owns the entire transportation chain.

Another aspect relating to being a barrier of sea transportation mentioned by the majority of the NGOs are the packaging requirements. The NGOs emphasized how their respective customers put certain requirements on how the textiles shall be delivered which hinders the ability to use sea as a transportation mode. For instance, the NGOs explained the customers' concern with the damaged textiles being delivered and therefore disallows baling of the delivered textiles. Consequently, the NGOs perceive very limited options when considering the choice of transport mode besides road.

5.1.5 Geographical location

From the interviews with the NGOs, there seems to be a consensus with regards to the concern of their customers' location. All the NGOs mentioned that the geographical displacement of the customers are far distanced from coasts or ports which is seen as a barrier for involving sea transport to a higher extent. Christodoulou and Kappelin (2020) and Notteboom (2009) mentions that having industrial and manufacturing facilities close to a coast is crucial in order to utilize sea transport thereby supporting the concern emphasized by NGOs. Furthermore, some of the NGOs have their largest customers in Poland where the use of sea transport is not common due to limited inland waterways which limits the possibility of using sea shipping even further considering the difficulties with door-to-door solutions with container-based sea transportation. One of the experts also mentioned the necessity of NGOs to provide operations relating to handling or sorting in the port region to further involve the use of sea transportation and that such would require substantial new investments for which the incentives must be clear and beneficial. The respondent further emphasized if the geographical setting is unattractive i.e., as explained by the NGOs where their facilities are located far away from the coasts or ports today it might hinder the attractiveness of sea-based shipping methods. However, having handling or sorting operations in the ports might be an issue. According to the two respondents from the ports, the labour costs for stevedores (i.e., workers who load and unload ships in the port) are relatively high. If the handling and sorting operations would be executed in the ports, this would potentially lead to high costs for the total transport costs. The current literature does not mention and sees this as a barrier and it is not mentioned by the experts, nor the NGOs. However, it is mentioned by the respondents from the ports and is therefore an important notion in order to facilitate a greater use of sea as a transport mode.

5.1.6 Other barriers

What is mentioned by several of the NGOs is that the current flow of used textiles is very efficient. The trucks which are driving material from Poland to IKEA in Sweden are used for the export of used textiles back to the Baltic countries. Since the trucks are empty after dropping off all the material at the facilities in IKEA, it is a very cost-efficient way of transporting the textiles according to several respondents. In addition, using a cost-efficient reverse flow is important since the value of the goods are low as explained earlier. Also, Dowlatshahi (2010), mentions the high importance of having low costs of the reverse logistics system due to the low value and low margins of the products. Moreover, the author argues that it is essential to have planned and efficient reverse flows which is an aspect that needs to be considered to evaluate if sea transport with containers is competitive against other modes of transport. This indicates a substantial change in the current logistical setup of NGOs if they desire to increase the use of sea transportation. Firstly, they would have to find the incentive to oversee a setup of which is already considered efficient. Secondly the new logistical setup and the new transportation chain will have to be evaluated to be more, if not equally, efficient. However, Schenkel et al. (2015) states decisions that are made in the forward logistics system may have an impact on the decisions that are taken in the reverse supply chain. If IKEA chose to initiate a change in their forward logistics flow, for instance, by shipping their goods instead of transporting them by road, there is a potential for the NGOs to be a part of IKEA´s reverse flow and send the used textiles with sea transport. However, changing the forward logistics (i.e., the IKEA flow), might be outside the power of NGOs as they, in comparison, are a vastly smaller actor. Moreover, being two completely different actors operating in different industries might limit their influence even further.

Another aspect that is brought up by one of the experts is that NGOs today are working on introducing more sustainable transportation solutions. The respondent mentions that there have been initiations of projects towards this direction i.e., using sustainable fuels i.e. bio diesel in order to increase the sustainability in their transport chain. Sustainable fuels for truck transports are seen as another barrier for involving more sea transport. This is something that was only mentioned by this specific expert and neither of the other actors mentioned this notion. The same industry expert also emphasized how exporting textiles to other countries hinders the progress towards a CE since the textiles are not kept within domestic borders. Johansson and Henriksson (2020) arguments align with the point of view of the industry expert as the authors argue inflow and outflows of materials should be kept at low levels and the materials should be circulated locally to contribute to a CE. However, exporting the textiles for reuse in other countries can be seen as a tradeoff. Either the used textiles are kept within the local and domestic markets and continuously being incinerated to a major extent or releasing more emissions by transporting the goods longer distances out of the national borders but for the purpose to be reused or recycled in accordance to the priority sequence of handling waste in WFD by the European Union (Pires & Martinho, 2019).

5.2 Drivers

In table 20, all the barriers identified by the different actors are displayed. This is to give an overview of what the different actors have stated to easier analyze the findings and in this way find similarities and differences with the frame of reference.

***Table 20**: Drivers for the different actors*

Drivers for the studied actors	Economical	Political	Environmental	Other
NGO 1		Governmental support is crucial	Reduction of emissions	Future recycling centers in Sweden Inability of local handling of used textiles
NGO 2	Decreased costs Larger global demand in contrast to limited domestic demand	Subsidies from the state or grants.	Reduction of emissions	The domestic inability to handle used textiles Future recycling centers in Sweden
NGO 3			Reduction of emissions	The importance of reliability and security Customers proximity to coast or ports Efficient port operations
NGO 4			Environmental focus	Future recycling centers in Sweden Using another transport mode will increase the stability in the transport chain
Port 1	Include external costs for road transport No maintenance needed for seaways	Potential incentives from governments		No specific requirements towards customers considering volumes
Port 2		Laws and regulations for environmentally friendly transport options	Low C02 emissions Energy efficient	Can be helpful for customers in many ways

				Sustainable from a social point of view Facilities near coast & ports
Industrial expert 1				Facilities near coast & ports Inland waterway potential
Industrial expert 2				Future recycling centers in Sweden

5.2.1 Economical

Some of the respondents never mentioned any economical driver yet other respondents emphasized the economical aspect of being a driver for sea transportation. However, it is evident that many of the interviewees, perhaps depending on what actor they are and what responsibility they take in the reverse supply chain, perceive economical drivers differently. For instance, NGO 2 perceives the financial driver for using sea transportation from the international demand which is unmatched domestically. NGO 1 on the other hand sees the economic motivations for sea transportation stemming from governmental support policies, perhaps in terms of grants.

Port 1, instead, highlights how it is essential to incorporate the total costs related to a transportation when assessing a transport mode, i.e., include the negative externality costs incurred when transporting certain goods from point A to point B in addition to the actual cost of transporting the goods from point A to point B. The ports show consensus on the notion of how sea transportation can actually also reduce the negative externality costs and thus the total transportation cost would therefore be lower considering sea transportation. The point of view from Medda and Trujillo (2010) shows consensus of the arguments made by the ports, where the authors argue that the competitiveness of sea transportation is immensely greater when external and social costs are included in the total cost calculations. In addition, Garberg (2016) has highlighted how sea transportation actually is a cheaper alternative transport mode when measuring a certain goods movement in tons km.

Interestingly, it is only by the ports that emphasize on the inclusion of external and social costs are highlighted. None of the other actors evoke the same subject or share the same point of view. Either some actors entirely lack a perspective on an economical driver, or they perceive the competitiveness of sea transport economically vastly different. The reasoning behind the indifferent results can potentially relate to the ports having an economical benefit as shipping and sea transportation is a service they provide and monetize on. Thus, they could potentially have more business incentives and acumen to argue for what actually drives sea transportation economically versus road transportation.

5.2.2 Political

Two NGOs and both ports have in some sense spoken and emphasized the importance of increased governmental intervention as a key driver to enable a greater use of sea transportation. It is understood, however, that they have different opinions on how the government should intervene and aid the competitiveness of sea as a transport mode. NGO 1, as previously mentioned, underlines the importance to have the necessary help from governmental municipalities and other governmental actors in order to fully grasp and accentuate the future potential of sea transportation as a transport mode in the reverse supply chain of used textiles. NGO 2, on the other hand, want incentive models to economically justify imbalances between the two transport modes. The ports, in the similar notion as the NGOs, also believes in the essentiality of governmental involvement. Specifically in questions as grants or other policies are an important driver. It is especially important, from their perspective, if ports were to be a greater part of the reverse supply chain of used textiles and in which they could potentially aid in certain activities. This perspective is also shared by Haezendonck and Van den Berghe (2020) where they argue that it is critical for governments to support new investments of ports to reach national and European union level goals to promote and increase the use of sea transportation.

5.2.3 Environmental

Amongst the respondents it is evident that a reduced environmental impact is highlighted as a major driver for increasing the use of sea transportation in the reverse supply chain of used textiles. The NGOs, with consensus, emphasized on the ability of reducing emissions when using sea as a transport mode in comparison to road. Accordingly, Port 2 underlined how cargo transported per ton km on ships is more environmentally friendly in contrast to other modes of transportation, particularly road, which coincides with the arguments made by Garberg (2016). In addition to the reduction of emissions, Port 2 also stressed another environmental feature. According to the respondent from the port, in the near future, the need for energy efficient transport modes will be equally important to evaluate as the transport modes carbon emission footprint. This growing importance stems from the lack of electricity and biofuels according to the respondent and therefore having transport chains consuming the least amount of energy will be essential. According to Kotowska (2016) carrying the same number of products on road consumes up to four times more fuel in contrast to rail, and more importantly ten times more than using sea transportation making it one of the most energy-intensive modes of transportation. Thereby, the concern portrayed by the port is highly justified by the current literature.

Neither of the experts mentioned any environmental driver for shifting transport mode from road to sea. However, one of the experts shared insights on the negative impact road transportation has on societies economic and sustainable development and that this is a concern in any transportation chain to consider. The respondent also mentioned actor's concern with their environmental impact being related to their organizational size in terms of collected volumes. Smaller NGOs put less effort towards their environmental impact as they do not necessarily want to be connected with the term "collector" and being majorly involved in extensive transportation. Vice versa, larger NGOs collecting large volumes put greater emphasis on their environmental impact as they are accepting towards being perceived as a

collecting actor in the supply chain and their strong involvement in the occurrence of many transportations.

5.2.4 Other drivers

A driver for a greater involvement of sea transportation that was discussed by one of the NGOs is the national inability to handle all the used textiles locally due to both the domestic capacity to handle and the expertise to sort the textiles are limited. Thus, if the used textiles are deemed unsuitable for the domestic market and rather attractive for the international market it increases the competitiveness for sea transportation as the distance is far greater to the end destination and the probability for the used textiles to cross the ocean increases dramatically. A driver for a greater involvement of sea transportation that was discussed by one of the NGOs was the national inability to handle all the textiles locally as both the domestic capacity and the in-house expertise and an export result in that more of the textiles are being reused which is the NGOs main goal. This cannot directly be connected to increased use of sea transport, but it can be seen as a potential driver for involving sea transport to a higher extent by exporting the textiles by sea instead of road.

Two of the NGOs mentioned a future potential for involving sea transport in the transport chain of used textiles. What was mentioned here was a new recycling factory of cotton that will open in Sundsvall close to the coast. One of the requirements for sending textiles to this facility is by baling the textiles and using a container as a load carrier according to the respondent from NGO 1. By being able to bale the textiles, the efficiency will increase since the textiles can be packed more tightly which is one benefit with baling as mentioned by Hogland et al. (1999). During the interview with NGO 3, one issue with using big bags for sea transport instead of bales and pack the container was that the container can't be as tightly packed. There is a risk for a certain amount of air being transported and thereby the efficiency of the transport decreases. Furthermore, another problem was that the textiles were at risk of being damaged due to potential mold from the sea transport when using big bags instead of bales. However, by letting customers ship the textiles in bales will handle this issue and this is probably why NGOs see a future potential of shipping textiles by sea transport.

Interestingly, one of the experts also mentioned the future potential of recycling textiles of low quality which are today being incinerated or sent to underdeveloped countries. The same expert even mentions a potential shift where Nordic countries will start to import textiles due to an upward trend of demand for recycling of textiles as the know-how and the factories will be based within the country. By closing the loop earlier of low-quality textiles by local recycling, the contribution to CE will increase since the underdeveloped countries have limited capabilities in terms of recycling. Exporting textiles to such countries might result in textiles ending up in landfills which eventually contributes to a greater environmental impact negatively in contrast to recycling which is aligned with the arguments made by Sandin and Peters (2018). Furthermore, since the textiles will be kept locally by shipping them to these recycling factories in the Nordics instead of exporting them abroad, the contribution to CE will increase from the arguments that are made by Johansson and Henriksson (2020). Consequently, the need for ports to take a larger role in the transport chain will increase according to industrial

expert 2 since the textiles will probably be shipped by sea transport. Haezendonck and Van den Berghe (2020) present similar arguments where the authors explain the possibility of ports playing a key part in the transition towards a CE and can be a potential actor of circular treatment of residual flows and products. Also, Port 2 explained that ports can be helpful to their customers in many ways due to all the machines, tools and know-how they possess and the importance of such information relating to these port capabilities reaching other actors. By communicating this properly to their customers the possibility to increase the collaboration with the NGOs increases, especially as the flow of such information is not efficient evidenced by one of the NGOs lack of knowledge on how to collaborate with a port in order to use sea transportation as a transportation method and more importantly, that many of the NGOs have shown a concern relating to capacity and handling of which the ports can aid in.

The ports mentioned that no specific requirements are needed for their customers in order to use sea transport. However, one of the ports mentioned that if the port is to initiate handling of a new type of flow where investments are needed i.e., investments in new machinery, the investment is justified if the volumes of the flow are sufficient and continuous. In addition, the respondent from the port mentions that it is desirable to find synergies with this investment (other customers might potentially use the same machinery). However, since the volumes NGOs are exporting are relatively low, it might be difficult to make ports invest in new machines and tools if this is needed for handling and exporting the textiles abroad. However, taking into consideration the volumes collected by the NGOs jointly it has a potential to increase the use of sea transportation by meeting the necessary large volume requirements from the ports in order for them to invest in the handling of used textiles. This possibility opens the discussion for a collaboration between NGOs rather than the current competitiveness that exists in between and thereby could be a key driver for increasing the attractiveness for sea transportation in the reverse supply chain of used textiles.

The respondents from Port 2 mentioned that there must be an increased emphasis on how logistics should be performed before locating warehouses in order to use efficient and sustainable transport modes such as sea transport. Furthermore, one of the experts touched upon the same issue where he explained that the NGO´s warehouses don't have a favorable position to involve sea transport to increase the use of sea transport in the transport chain of used textiles. There seems to be an alignment from what was said by these actors with the arguments by Notteboom (2009) and Christodoulou and Kappelin (2020) who mentions that sea transport is favorable when industrial and manufacturing facilities are close to the coasts. Thus, it becomes clear that a driver for involving sea transport to a higher extent in the transport chain is to have facilities close to coasts. Hence, it seems necessary to evaluate the location of NGOs facilities in order to involve sea transport to a higher extent.

5.3 Recommendations

Today, the customers, (i.e., the sorting facilities in Europe) are owners of the transportation chain, both in terms of its costs and in terms of its execution. A potential solution to overcome this barrier and increase the involvement of sea transportation in the reverse supply chain the NGOs can rearrange and/or renegotiate the authority over the ownership of the transportation

arrangement. Perhaps the economical and operational cost components of the total transportation cost can be split up and divided in-between the customers and the NGOs. The customer could agree on financing the transportation and take accountability for the economical element, whereas the NGO instead takes the entire responsibility for the operational part of the transportation which includes administrational work such as negotiating with freight forwarders. This can be justified as the customers could save costs as they would need less resources allocated towards arranging and executing the transportation as this instead would be the responsibility of the NGO. In addition, NGOs, that have already expressed an interest towards having more environmentally friendly transportation solutions for their used textiles can get a chance to include the social and negative externality costs in the total transportation costs they present to the customers, and thereby increase their awareness towards more sustainable transportation solutions. Important to denote, is to evaluate the current capabilities of the NGOs to arrange transportations, particularly if they have the significant expertise.

Based upon the input from the majority of the respondents, the transportation cost is centered on the actual cost of transporting goods from its origin to end destination, thus, neglecting any other costs that occur. However, literature has shown the importance of considering costs, with intangible characteristics, incurred on third parties by the transportations, namely, negative externality costs i.e., C02 emissions. In addition, the literature argues contemplating such costs and including them in the total transportation cost bears a great potential to increase the competitiveness and attractiveness of sea transport as a mode of transport. Evidently, such costs today are deserted from the knowledge of the actors in the reverse supply chain. Initiatives to include such costs when evaluating transport modes from any of the actors involved, for instance the NGOs, can immensely increase the use sea transportation. However, the actor taking responsibility for conducting calculations which include external costs in the total transportation costs should be able to effectively communicate this to the other actors in the reverse supply chain. The importance of this stems from the aforementioned problem relating to the ownership of transportation. For instance, if the NGOs was the holder of such vital information regarding calculations, its value would not reach its potential if the information is not to be effectively communicated to the customers, who is the actual arranger of the transportation. Furthermore, neither of the respondents showcased any awareness of the various governmental initiatives i.e., the eco bonus. This indicates a lack of knowledge on the existence of such initiatives amongst various actors in the reverse supply chain of such programs and initiatives but also the failure from governments on their intentions of these efforts. Thus, governments need to reallocate the resources put into such programs and consider putting more exertion towards reaching the correct target audience to realize its potential.

Another barrier discovered was how modal choice is influenced by the lack of knowledge about sea transportation in general. The NGOs have a perception of large volumes being required to use sea transport. Moreover, the NGOs believe that the current transport chain with trucks and trailers in combination with RoRo is the most cost-efficient solution today. However, according to the ports, there are no requirements regarding the volumes for using sea transportation and it seems clear that NGOs perceived knowledge does not align with what is actually required from the port´s point of view. Nevertheless, the ports did emphasize on the notion of having sufficient

and continuous volumes in the entire market of used textiles if they were to make investments to handle this particular flow. Taking these perspectives into consideration it is evident that communication between NGOs and ports has the potential to be a major facilitator for the involvement of sea transportation. For instance, if it was to be assumed that the entire market of used textiles characterizes the necessary prerequisites ports have and thereby new investments are not needed to handle and export used textiles abroad with containerized sea transport, yet the respective actor lacks such knowledge, the potential of using sea as a transport mode gets lost. Increased, clear and transparent communication between the actors might be a potential solution to this subject.

In addition, communication can also solve the issue of NGOs prejudices of certain requirements that are not necessarily true, for instance, concerning having enough volumes to use sea transportation. Furthermore, two of the NGOs investigated if sea transport could be used to a higher extent in collaboration with freight forwarders, yet it was found that it would complicate logistics and be cost-inefficient. However, Schwartza et al. (2020) mentions that the demand for freight forwarders might be obsolete in the future if the communication between actors increases and cargo owners can identify the required cargo carrying capacity without involving freight forwarders. Since freight forwarders certainly have the goal of charging for their work and thereby obviously contributing to an increased total transportation cost, disintegrating them from the reverse supply chain of used textiles might be a potential solution in overcoming the barrier of cost-inefficiency. However, the NGOs seem to work by traditional methods which might need to be changed to use sea transport to a higher extent. By reaching out to ports and increasing the communication without the involvement of freight forwarders, new opportunities might be found where there is no need for freight forwarders and sea transport can be involved to a higher extent and the barrier of cost-inefficiency might be overcome.

To overcome the barrier of geographical proximity, the NGOs might need to evaluate their logistical setup. What is found in the literature is that geographical location plays an important role when evaluating the competitiveness of sea transport, having facilities close to coasts or ports increases the competitiveness of sea transport. What was stressed from the interviews is that today, NGO´s facilities don't have the optimal geographical proximity in order for sea transportation to be considered in all circumstances. By locating their facilities close to coasts is a potential solution of overcoming this particular barrier. However, this will certainly result in huge investments that might not be justified, thus, raising such awareness to governments and politicians for their aid might be crucial. This opens the possibility for governments to redistribute, reorganize or create new forms of incentives to reach their targets with sustainable transportation solutions.

Finally, one of the most important barriers identified during the project was the competitive and efficient reverse flow that exists today. As explained in the empirical findings and the analysis, the NGOs are using trucks for transporting the used textiles which have previously transported material to IKEA in Sweden. This is a well-developed and efficient reverse flow which might be difficult to compete with and thereby it is a highly justified transport solution for the NGOs. The literature stresses that having efficient reverse flows for waste materials is important since

the material usually is of low value which is aligned with the case of used textiles. Thus, there is limited incentive for the NGOs to find alternative transport solutions to this already cost-efficient, and partly sustainable, transport solution. In order to overcome this barrier, addressing this particular issue is of uttermost importance. A potential solution is adjusting the forward logistics of IKEA. For instance, if IKEA would establish a new and efficient flow of goods in their forward logistics by involving sea transportation the probability of sea transportation being involved in the reverse logistics might increase due to the correlation between the forward and reverse logistics emphasized in the literature. However, to realize this potential, other factors need to be considered i.e., the negotiating power of NGOs, a comparably small organization, opposed to a major organization such as IKEA. Nevertheless, the NGOs can use the knowledge of such an efficient logistical setup established by IKEA and create collaborations with other actors using sea transportation in their forward logistics. Consequentially enabling opportunities for using sea transportation in their reverse logistics for used textiles.

6. Conclusion

The following chapter will present the conclusion of this master thesis. It will conclude the answers by the three research questions in three different subtopics, one for each research question.

6.1 Research question 1

The following research question was conducted as research question 1 to fulfil the purpose of this study:

"What are the key barriers for an increased use of sea transport in the reverse supply chain of used textiles?"

During the course of this study, the following key barriers were found:

- Existing reverse flow that is highly efficient and thereby hinders the attractiveness of evaluating other transport solutions.
- The low value of the used textiles in contrast to sea transport being expensive limits the attractiveness of increasingly using this transport mode. The expensive costs stem from the increased amount of activity necessary i.e., transshipment and handling.
- Prejudices and perceived knowledge, which is not aligned with reality. For instance, transportation buyers lack the know-how of how to arrange sea transportation or has an inherently complex depiction of its usability and usefulness.
- Uncompetitive mode of transport in terms of service quality.
- The proximity to coasts for customers (receiving the used textiles) and respective facilities of both the NGOs and customers are not optimal which hinders an increased use of sea transportation.

6.2 Research question 2

The following research question was conducted as research question 2 to fulfil the purpose of this study:

"What are the key drivers for an increased use of sea transport in the reverse supply chain of used textiles?"

During the course of this study, the following key drivers were found:

- Governmental incentives are essential to promote sea transport and thereby increase its use in the reverse supply chain of used textiles.
- Reduction of negative environmental impact sea transport might potentially result in.
- Future recycling centers that will be built in Sweden for recycling of cotton. Thus, textiles of low quality which are being incinerated today, can be transported with sea transport to these facilities where the textiles are being recycled instead of incinerated.

- The limited domestic capabilities of handling used textiles in Sweden which results in a great opportunity for using sea as a transport mode for continental export.

6.3 Research question 3

The following research question was conducted as research question 3 to fulfil the purpose of this study:

"How can the barriers of involving sea transportation in the reverse supply chain of used textiles be overcome and how can drivers be utilized"

By synthesizing the analysis of this research several conclusions of how to overcome barriers and utilize drivers may be drawn:

- The NGOs should change from their traditional working methods and try to increase the communication with ports and actors in order to find new logistical systems where sea transport is involved to a higher extent. In addition, doing this without the involvement of freight forwarders might increase the cost-efficiency due to less intermediaries in the transport chain.
- By dividing the transportation arrangement between the customers and the NGOs, the possibility to include external costs can be realized and brought to the awareness of the actors. Thus, increasing the competitiveness of sea transportation in contrast to road transportation.
- Rearranging the established logistical setups by relocating facilities in closer proximity to coasts or ports could eventually result in an increased probability to consider sea as a transport mode. However, reallocation of resources comes with high costs and large investments and therefore a feasibility analysis of such is necessary in each NGOs case.
- Find other actors who use sea transport in their forward logistics. Thus, increasing the possibility to use sea transport in the reverse logistics to a higher extent.

6.4 Future research

Further exploring the potential of involving sea transportation relating to the new facility in Sundsvall is interesting for future research purposes since many of the respondents from this study mentioned the future potential it comprises for the competitiveness of sea transportation as a transport mode in contrast to road. Not only has this particular flow of textiles a possibility to contribute to a greater transition towards CE as textiles of low quality can be kept locally within the Nordics, but it also encompasses the potential for a more sustainable transport solution if sea transport is to be involved. Additional interesting future research can be to investigate the current forward logistics of IKEA and explore the reasoning behind the vast amount of road transport used in the transport solution of this flow in Sweden. As literature has revealed the correlation between reverse logistics and forward logistics, if containers would be utilized in IKEAs flow there might be a possibility to explore a greater use of sea transportation for the NGOs in their reverse supply chain of used textiles. Finally, this study has evolved around reverse flow of used textiles in Sweden. However, performing a comparable study using

the same approach but with more examples from different nations and continents might be interesting. If research from other nations and continents provide comparable results, this study will have greater credibility, and it will be possible to compare how other nations approach the difficulties mentioned in this thesis. Thereby also providing other important insights to be further researched building from the conclusions of this research.

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DEPARTMENT OF TECHNOLOGY MANAGEMENT AND ECONOMICS
DIVISION OF SERVICE MANAGEMENT AND LOGISTICS
CHALMERS UNIVERSITY OF TECHNOLOGY
Gothenburg, Sweden
www.chalmers.se