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Reducing Unnecessary Empty Repositioning of Containers

Transport Efficiency on a Regional Level in Sweden

Master's Thesis in Supply Chain Management

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Transport efficiency: reducing unnecessary empty repositioning of containers
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Abstract

Trade imbalance and the empty container repositioning (ECR) it results in is a constant problem in today's globalized world. However, some of the repositioning performed is considered as unnecessary, but there is a potential for improvement.

This master thesis aims at increasing the understanding of how empty container repositioning can be reduced on a regional and local level in Sweden with drivers, barriers and possible solutions as a starting point. Consideration is given to fewer containers moved and shorter distances transported. Suggestions for possible solutions' potential and how they can reduce certain barriers are made.

Literature studies have been made to obtain theoretical background for already identified drivers, barriers and possible solutions for reducing ECR. Interviews have also been made, with actors within the container transport chain related to port of Gothenburg , to clarify whether literature and empirical findings agree or not. Observations of this have finally been made in order to develop new takes on the subject.

Two drivers, nine barriers and fourteen possible solutions have been identified. The possible solutions and how they can manage existing barriers for reducing ECR have been created to fulfill the purpose of this master thesis. The potential for each solution is further described in clusters where consideration has been taken to feasibility to implement and impact of the solution.

This master thesis indicates that different actor groups within the container transport chain are considered to have different possibilities to affect ECR problems. Furthermore, the thesis shows that several factors increase the complexity of the container transport chain, making ECR more difficult to reduce. Findings in this report can contribute to future research within the subject.

Keywords: ECR, container transport chain, empty container, driver, barrier, solution, potential, actor

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Abbreviations

3PL - Third Party Logistics

COC - Carrier Owned Container

ECR - Empty Container Repositioning

FEU - Forty-foot Equivalent Unit

ft - foot

HC - High Cube

ICD - Inland Container Depot

SOC - Shipper Owned Container

TEU - Twenty-foot Equivalent Unit

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1

Introduction

This chapter presents a background to the study and the problems that the study intends to solve. Based on this problematization, the aim and limitations of the study are presented. Finally, the research questions forming the basis of the study are formulated.

1.1 Background

Globalization continues to increase and shared economies all over the world are more inter-dependent than ever. In addition to increased exchange of opinions and culture between people, the increased globalization results in to an increased exchange of goods around the globe, mainly influencing the seaborne trade. This, together with the increased containerization, "which was designed to improve transportation productivity and reduce the incidence of damage associated with loading and unloading cargo" (Li et al., 2014), results in enormous amounts of container movements in the world. However, the container movement is unbalanced due to differences in consumption and production around the world (Feng and Chang, 2010). This is called trade imbalance, and is one of the biggest problems maritime transport is facing today due to the empty container repositioning (ECR) it creates.

The movement of laden containers is the root cause to why empty container movement exists (Song and Dong, 2012). Easily explained, a laden container reaching its' customer is causing a movement of an empty container as it is transported to a new supplier. Hence, trade imbalances between geographical areas create shortages and accumulations of empty containers. The movements of these containers do not generate any revenue (Braekers et al., 2011) and should be kept to a minimum. Furthermore, Boile et al. (2004) describes the global problem of storing empty containers, driving some ports into using more and more land just for housing, which in turn affects the efficiency at ports. However, trade imbalance is not the only factor impacting the movement of empty containers. For instance, Song and Carter (2009) list the following additional factors; uncertainty in demand, uncertainty in handling, uncertainty in transportation, blind spots in the transport chain, a shipping line's operational and strategic practices and different types of equipment.

The movement of empty containers around the globe is estimated to be 21% of the total amount of containers moved (Shintani et al., 2010). For sea transport, it is estimated to be 20% (Boile et al., 2006) while the land transport is estimated to be around 40% (Shintani et al., 2010). One of the biggest shipping companies in the world (15-16 percent of the global container market), Maersk Line, currently spends

1 billion USD annually on moving empty containers around the world (Kristiansen, 2010). This is mainly due to trade imbalances between Europe and Asia. Song et al. (2005) also mention that the global cost of empty container repositioning in 2002 was estimated to be around 27% of the total world fleet running cost.

In addition to the economic incentives for reducing ECR, there is also a lot to gain in an environmental perspective. As the traffic of vehicles is reduced with a reduction in ECR, congestion and air pollution will decrease (Olivo et al., 2005).

Many reports already discuss possible solutions to reduce ECR, either to increase revenue for certain actors or to reduce the environmental impact it results in. However, there seems to be more barriers than drivers to implement these solutions. Since most reports available today are focusing on implementing solutions on a global scale our aim is instead to examine the possibility to implement possible solutions on a smaller scale. Data from Trafikanalys (2019) shows that Sweden imported 568 thousand TEUs and exported 652 thousand TEUs by sea in 2018, leading to an imbalance in trade and ECR. The study will therefore be made on a regional and local level, focusing on the possibilities to reduce ECR within Sweden.

This study is being carried out at SSPA's research department as part of the EU project Value2Sea. The project aims to find innovative and sustainable transport solutions focusing on the Scandinavian region, more specifically, the area of Öresund-Kattegat-Skagerrak.

1.2 Aim and Research Questions

The aim of this master thesis is to increase the understanding of how ECR can be reduced on a regional and local level in Sweden. Considering fewer containers moved and shorter distances transported, drivers, barriers and possible solutions for empty repositioning are analyzed.

The preferred outcome of this master thesis is to identify correlations between possible solutions and barriers for reducing ECR. Furthermore, the thesis aims to identify the potential for each solution.

In order to increase the understanding of how ECR can be reduced on a regional and local level in Sweden, it is of high importance to identify existing drivers, barriers and possible solutions to the subject. The first research question is therefore made to identify these factors. The research question also allow for a comparison between the frame of reference and findings. In addition, it establishes a background and provides context for research question two and three.

RQ1: What are drivers, barriers and possible solutions for reducing empty repositioning of containers?

The second research question is made to contribute to the research area of ECR by establishing a correlation of barriers and possible solutions. It compares current literature with empirical findings and analysis, as well as proposes a new take on how to manage barriers for reducing ECR.

RQ2: How can barriers regarding empty repositioning of containers be managed with possible solutions?

The third research question is made to analyze the potential of the solutions identified. The potential is qualitatively produced based on challenges for each solution identified by the respondents, and the frame of reference.

RQ3: Which solutions have high potential for reducing unnecessary empty repositioning?
In this context, high potential solutions refers to (a) the feasibility of implementing possible solutions, and (b) how big impact the possible solution will have.

1.3 Scope and Limitations

Most reports related to ECR attempt to solve the problem by implementing global solutions. These global solutions seems great in theory but are harder to implement in reality. In contrast, this study aims to target the ECR problem from a regional and local level, with Sweden as a reference point. The idea is to examine if it is easier to implement solutions regarding reducing ECR on a smaller scale. The project will, primarily, focus on a societal perspective, leading to reduced ECR for the entire container transport chain. However, the societal and economical perspective are interrelated and a positive impact for society will, most likely, generate a positive impact for single actors. Thus, the economical perspective for different actors will be included in this study, although at a secondary perspective. Since this report will be built on qualitative research methods, quantitative methods will, to a large extent, be disregarded.

2
Frame of Reference

This chapter starts by explaining containerization and how it has affected the world trade. It further describes the concept of ECR before presenting existing literature on drivers, barriers and possible solutions for reducing it.

2.1 Containerization

For hundreds of years, mankind has used maritime transport to globalize the world. However, the boom of globalization first occurred in 1956 when containerization was established (van Ham and Rijsenbrij, 2012). Containerization is a concept where standardized containers are used to facilitate simple transport and handling of goods. The invention of the standardized container enables the use of intermodal freight modes, and by adapting vessels, trains, trucks, handling equipment and terminals to the standardized containers, economies of scale for transporting cargo is attained (van Ham and Rijsenbrij, 2012). Containers are now the foundation of the global transport system, and the low cost for transporting them long distances facilitates trade between continents and increase globalization.

2.1.1 Containers

According to International Organization for Standardization (ISO), a container is a durable transportation unit designed to fit and enable transfer between different modes of freight (Lumsden, 2012). Further, the design needs to facilitate loading and unloading of goods, and constitute an inner volume of at least 1 cubic meter (Lumsden, 2012). A container can be either carrier owned (COC) or shipper owned (SOC) (Manaadiar, 2018). A carrier can in this case be a shipping line or a leasing company. Different models for standardized containers are presented below.

Standard containers
The two most common container types are the standard 20ft and 40ft container (Lumsden, 2012). The standard container have the length of 20ft or 40ft, height of 8ft and the width of 8ft (Branch, 2006). The term Twenty-foot Equivalent Unit (TEU) is being used to define capacity specifications for containers. In other words, the number of containers are converted to 20-foot units (Lumsden, 2012). As 40ft containers have grown in popularity the term Forty-foot Equivalent Unit (FEU) has also been introduced, although it is not as commonly used as TEU (Rodrigue, 2020). Song and Dong (2015) differentiates between 20ft and 40ft containers. The former are typically used for heavier cargo with high volumetric mass density whereas the

latter typically are used for lighter goods with low volumetric mass density.

Tank containers
Tank containers are used to transport bulk in form of liquids, gases and powders (Lumsden, 2012). The tank itself is surrounded by a steel frame to enable stacking.

Flat rack containers
Flat rack containers can be used to transport goods that otherwise do not fit in a container. These containers are also suitable for heavy loads and heavy goods, which must be loaded from above or on the side (DSV, 2020). They can appear as foldable and non-foldable containers with or without gables.

Refrigerate or heat containers
Some goods need to be stored at certain temperatures while transported and therefore use cold or heat containers. These containers contains refrigerators or heaters and are enclosed in material that more easily retain the right temperature (Lumsden, 2012).

Tipp-enabled containers
For some bulk, the access to easily unpack the goods is of great importance. Tipp-enabled containers solve this problem by having one side of the container raised and lowered, unpacking the bulk goods on the other end due to gravity (Lumsden, 2012).

High cube
The high cube (HC) container often has the length of 40ft or 45ft and a height of 9ft 6 inches (GDV, 2020). Due to its' size, the HC is suitable for voluminous and light cargo (Branch, 2006).

2.1.2 Tracking of Containers

One way to increase visibility of container logistics is to increase tracking of containers. A common approach in today's setup of the container transport chain is that each actor has its own tracking system (Song and Dong, 2015). For example, transport operators use Global Positioning Systems (GPS) in their trucks to keep track of containers. Shipping lines keep track of their containers by determining the geographical location of vessels through Geographic Information Systems (GIS) or GPS. Finally, radio-frequency identification (RFID) technology is being used by terminal operators to keep track of the movement of containers inside terminals.

2.1.3 The Container Transport Chain

Figure 2.1 describes how the container transport chain looks like in a simplified version (Song and Dong, 2015). Consignors (exporters) need empty containers in order to transport their cargo, hence they are considered as customers. Shipping lines are responsible for delivering empty containers to their customers. 3PLs offers complete logistical solutions, including transportation from point A to point B (Lumsden, 2007). Consignees (importers) are the ones receiving goods.

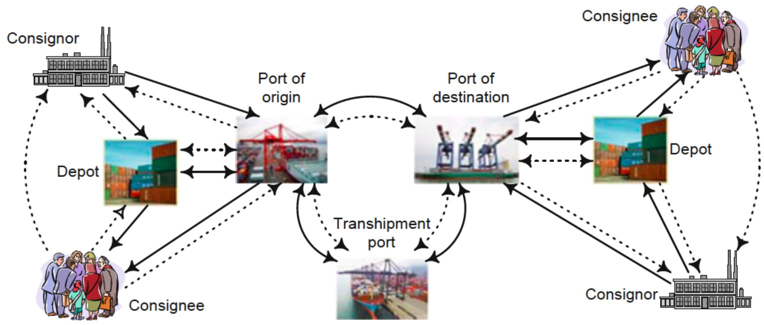

Figure 2.1: *The container transport chain (solid-lines indicate laden container flows and dashed lines indicate empty container flows) (Song and Dong, 2015).*

Empty containers can either be found at sea ports or at inland depots (Song and Dong, 2015). The containers are transported to an exporter where goods are being consolidated. The laden containers are then transported to a depot or port before being shipped out on vessels. The laden containers may be transshipped from a feeder vessel to an ocean liner and back to a feeder vessel before arriving at the port of destination. Finally, the laden containers are being transported directly to the importer or an inland depot where they are being stripped of the goods. The emptied container can be moved to a port or depot for reparation (if necessary) and storage. It can also be repositioned to a new port in the shipping network.

According to Song and Dong (2015) the container transport chain can be seen as a two-staged supply chain; the backward supply chain which focuses on the flow of empty containers, and the forward supply chain which focuses on the flow of laden containers. Furthermore, both empty and laden containers utilize the same type of shipping network and the same type of resources (e.g. facilities, vessels, trains, and trucks) when being moved and stored. A difference between the two chains is that the flow of empty containers is internally driven by the laden container flow, which is determined by shipping lines. Whereas the flow of laden containers is externally driven by customer demand. Overall, the container transport chain is characterized by a high complexity, since the two supply chains are interlinked and dependent on each other.

2.1.4 Nodes in the Container Transport Chain

The physical flow of goods and resources can be put together into a net structure, which in turn includes both nodes and links (Lumsden, 2012). Nodes are referred to as ports, terminals or other type of production facilities, i.e. a point in which the flow can be stopped. Links are, on the other hand, represented by all types of transportation, such as truck, train or sea transport etc.

Ports

Ports are located on the shoreline and responsible for the transfer of both passengers and cargo between land and maritime systems (Rodrigue, 2020). Compared to other type of terminals, ports are capable of handling more freight than any other of them combined. The increased importance of containerization has impacted the layout of port terminals. Specialized container ports, which demand more space, have emerged. Rodrigue (2020) has listed four main port constraints:

- Maritime access - Refers to a ports physical capacity to accommodate ships, i.e. tidal range, channel depth, berth depth etc.
- Maritime interface - In order to support maritime access a port needs to have an available shoreline.
- Infrastructures and equipment - In order to support port operations, piers and cranes needs to be installed.
- Land access - Vicinity to industrial areas and efficient inland distribution systems to these areas.

Inland terminals

Inland terminals refers to some extended port activities transferred inland (Notteboom and Rodrigue, 2020). However, the terminology has been widely debated due to the different functions, shapes and network positions these terminals can have. Terms like inland ports, inland terminals, dry ports, inland container depots, inland logistics centers and inland hubs have all been used to describe this type of node. Irrespective of the terminology used, Notteboom and Rodrigue (2020) list three features that characterizes an inland node:

- Connection with a port terminal - A high capacity passageway, usually through truck, rail or barge services
- Intermodal terminal - Movement of freight through several modes of transport
- Logistical activities - A number of different logistical activities can be linked to inland terminals, for example, depots for empty containers, warehouses, distribution centers and logistical service providers

In this report, the two definitions inland container depots and dry ports are used when referring to inland terminals and these two are described further below.

Inland Container Depots

An inland container depot (ICD) offers services related to handling and temporary storage of laden and empty containers for import/export (Roso, 2009). These facilities usually have public authority status and fixed installations that can be used commonly. Activities that can take place in this type of node are, for example, temporary storage, temporary admissions, transshipment, clearance of goods for home use, re-export and warehousing.

Dry Ports

The dry port concept has been defined by Rosa and Roso (2012) as inland extensions of seaports. Furthermore, the authors define a dry port as *"an inland intermodal terminal directly connected to seaport(s) by rail where customers can leave/pick up* *their units as if directly to a seaport"*. Example of services available at dry ports are storage and maintenance of containers, tracking and tracing of containers and customs clearance.

2.1.5 Actors in the Container Transport Chain

The following section presents actors in the container transport chain. It starts with shipping lines and continues with 3PLs, terminal operators, transport operators and companies importing/exporting goods.

Shipping Lines
Shipping lines are considered as a key actor in the container transport chain since they, usually, carries the costs associated with ECR (Song and Dong, 2015). Furthermore, they perform port-to-port services (transportation of empty and laden containers at sea). Some shipping lines are also responsible for door-to-door services (inland transportation). A shipping line creates a shipping service network, which consists of a number of service routes. A shipping line's service route consists of a specified number of container vessels, calling predetermined ports in a regularly time schedule (usually on a weekly basis).

Third Party Logistics
The trend between transportation companies today are to extend their offerings to include more than the transferring of goods. The idea is to offer complete logistical solutions, including both the physical transfer as well as planning and storing of goods. Third party logistics (3PL) can, according to Lumsden (2007), be defined by its flow control. According to the author, the transport consists of both a physical flow and an immaterial flow. The physical flow refers to the physical transfer of goods whereas the immaterial flow refers to the flow of information needed to control the physical flow. A 3PL aims to control both these flows, which give the company total control of the material flow (Lumsden, 2007). The role of a 3PL, and how it differentiates from other type of actors, can be seen in figure 2.2.

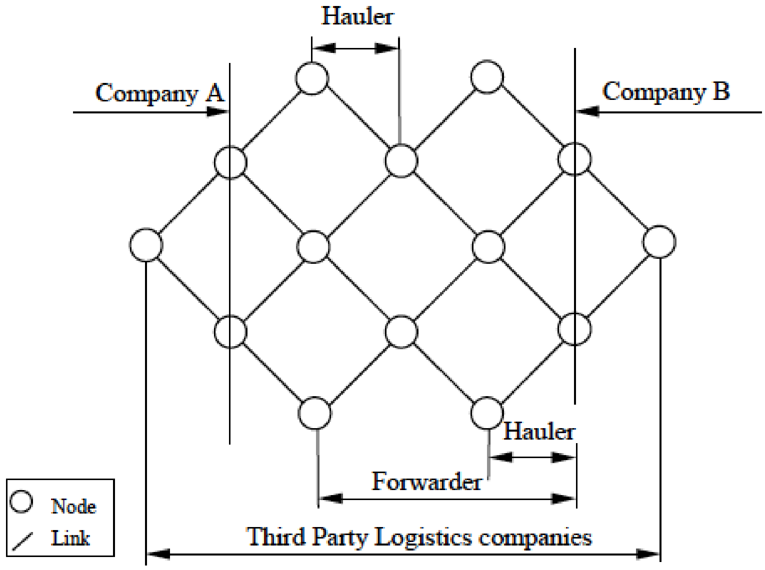

Figure 2.2: The responsibility of a 3PL in relation to other actors involved with transport activities (Lumsden, 2007).

Terminal Operators

Terminal operators are actors working at terminals (inland terminals or ports) where containers are passing by (Rodrigue, 2020). As containers arrives and departs at terminals, the terminal operator need to handle and store containers before changing the mode of transport for them. Terminal operators consequently need to own land for handling and storage, but also cranes and vehicles to relocate containers. Terminal operators can be either state-owned or private, however the former is more common.

Transport Operator

According to Lumsden (2007), a transport operator (mentioned as hauler in figure 2.2) is responsible for the transportation between two geographical points, i.e. the actor is responsible for one link in the transportation chain. A transport assignment is described as a relatively simple task that does not differ much in execution. Hence, the transportation service is relatively easy to copy, resulting in costs being the biggest competing factor. Furthermore, the transportation assignment consists of primary and supportive activities. The transportation between two points is the primary activity whereas tasks outside of the standard offer, such as re-packing, can be seen as supportive activities.

Companies Importing/Exporting Goods

Companies importing/exporting goods are considered as customers (consignees/-consignors) to other actors in the container transport chain (see chapter 2.1.3).

2.1.6 Transportation Services

According to Transporteca (2020) an actor can perform different types of services when transporting goods in the container transport chain. Each type of service entails different responsibilities when it comes to both payment and transportation. A selected number of transportation services are listed below:

Port-to-port
Port-to-port transportation services includes the transportation from one seaport to another, including all costs associated with both shipment and handling of containers at the ports.

Warehouse-to-warehouse
Warehouse-to-warehouse transportation services includes the transportation from the 3PLs origin warehouse to the 3PLs destination warehouse. The importer and exporter handles the transportation to and from the warehouses while the 3PL handles all costs associated with transportation and handling between the warehouses.

Door-to-door
Door-to-door transportation services includes the entire shipping process from the address of the exporter to the address of the customer. All costs associated with the container transport chain, such as road, rail and sea transportation as well as handling of containers at all depots, are included in this type of service.

All the above mentioned transportation services can be combined with each other, e.g. port-to-door and door-to-warehouse.

2.2 Empty Container Repositioning

One problem the use of containers and containerization leads to, is the need to perform ECR (Braekers et al., 2011). Containers are transported laden or empty and according to Song and Dong (2012), the movement of laden containers is the root cause to why empty container movement exist. As an example, an importer of goods needs to get rid of the container after it is unloaded, and that triggers a movement of an empty container. In the opposite direction, an exporter triggers a movement of an empty container as they need it for exporting goods. Song et al. (2005) discuss that from the total world fleet running cost, 27% consists only from moving empty containers. In addition, the movement of empty containers around the globe is estimated to be 21% of the total amount of containers moved (Shintani et al., 2010). ECR is consequently an inevitable and persistent problem of containerization due to trades around the world (Braekers et al., 2011, Konings, 2005).

Song and Dong (2015) say that ECR needs to be performed as efficient as possible in order to reduce costs, while still satisfy customer demand. They further discuss how environmental and sustainable impacts can be reduced if the problem is faced effectively.

Li et al. (2014) take another approach on ECR, mentioning how a reduction of ECR can be seen more as a barrier, as it sometimes has a greater impact on the environment than if not performing the repositioning. According to them, ECR is one of the green initiatives within maritime industry, as it lowers the consumption of natural resources needed to produce new containers. Producing a new container in the area where it is needed consequently has a greater negative impact on the environment than if performing ECR to this area (Li et al., 2014).

According to Olivo et al. (2005), the ECR problem affects terminal operators as well as transport operators. As an example, the authors mention how terminals around the world are enforced to expand to meet the demand in storing empty containers. Thus, a reduction of repositioning results in bigger container terminals, which in turn is expensive to build.

2.3 Drivers for Reducing Empty Container Repositioning

In this chapter, drivers for reducing ECR are presented. First, the financial driver is presented, followed by the environmental driver.

2.3.1 Financial

As mentioned in chapter 2.2, a large proportion of the movements of containers is made when they are empty. These empty movements result in costs for actors handling containers. Kristiansen (2010) mention, after a dialogue with Maersk Line, that the shipping company annually spends over 1 billion USD on the movement of empty containers. Maersk Line further mention that they want to reduce the movement of empty containers to save money. The huge costs associated with ECR are supported by Olivo et al. (2005) and Konings (2005). Estimations made in 1999 showed that the cost for moving empty containers exceeded 25 billions USD, including handling at ports and depots (Olivo et al., 2005). Konings (2005) mention that the total cost for only the movement of empty containers by sea voyage was 10 billions USD in 2003. By adding land transports, another 5 billions USD must be added (Konings, 2005).

2.3.2 Environmental

Braekers et al. (2011) explain that a reduction of ECR consequently result in less congestion and less pollution of the air. Song and Xu (2012) mention that efficient policies regarding ECR are proved to reduce the emission of CO2. This is supported by Olivo et al. (2005), saying that the environmental impact will be reduced as vehicles transporting empty containers are reduced.

2.4 Barriers for Reducing Empty Container Repositioning

In this chapter, barriers for reducing ECR are presented. Trade imbalance is presented before technical balance. These are followed by dynamic operations, blind spots, and strategies and operational practices. Finally, container fleet size and uncertainty factors are presented as barriers for reducing ECR.

2.4.1 Trade Imbalance

Researchers in the field of container freight agree that trade imbalance is the main reason to why ECR exists (Boile et al., 2004). This imbalance is an affect of when import and export does not match, meaning trade volume is bigger in one direction (Song and Dong, 2015). Olivo et al. (2005) argue that empty movement of containers would not need to exist. In a perfect world, goods would always be available to fill up empty containers, no matter where or when it was emptied. However, in reality, commercial traffic is characterized by imbalance both in volume and value. In order to take advantage of transportation opportunities, transporting actors must relocate empty containers on a global, national and local scale. According to Song and Dong (2015), the trade routes Europe-Asia and trans-Pacific are heavily imbalanced. The authors argue that China's economic boom during the last three decades has created an increased demand of containers out of China. Braekers et al. (2011) differentiate between global trade imbalances and regional trade imbalances. The former includes major seaports and (global) empty movement between them. The latter includes ECR on a small geographical area, focusing on the movement between local ports, inland depots, and exporters and importers. An analysis of container flows on a regional level in Sweden has been made by Engström and Matsson (2015). They compile import and export of containerized goods for ports in Sweden and conclude that foreign trade is heavier in the southern part of Sweden compared to the northern part.

Container Movement in the World

The accumulated collection of empty containers is a well-known problem in many places around the world (Boile et al., 2004). Song and Carter (2009) mention the Europe-Asia trade route as an example in which Asian ports are facing severe shortages of empty containers whereas European ports encounters a high surplus. Olivo et al. (2005) list the purchasing power of many Asian currencies as one of the main causes to the problem. This has made western products more expensive in the Far East and created an increased consumption of cheap Asian products in both the European and American market. As a consequence of the increased Asian export, a great number of empty containers have been stranded in both the U.S and Europe.

Boile et al. (2004) use the port in New York / New Jersey as an example in which seven terminals, of an area exceeding 1200 acres, are devoted to container storage. Up to eight containers are stacked on each other and creates what can be described as the "Everest" of containers. The same phenomenon can be seen in Sydney, where stacking of empty containers keeps increasing. The reason behind this is the insufficient match of export to a steady rate of import. The cost of returning an empty container overseas was, back in 2004, estimated to be between \$300-\$600. Considering the number of containers being close to 200´000 one can imagine the total cost of ECR.

Container Movement in Sweden

Figure 2.3 illustrates the import and export flow of laden containers for different regions in Sweden during 2018. The numbers in the map are derived from a report by Trafikanalys (2019) and demonstrate that the port of Gothenburg handles most containerized goods in Sweden. This is not surprising since Gothenburg has the shortest route, by vessel, down to the big ports in Europe (and the rest of the world) according to Engström and Matsson (2015). The port of Gothenburg is also the only port in Sweden able to accommodate ocean-going vessels, which is a contributing factor to their high turnover of goods (Engström and Matsson, 2015). Furthermore, the areas in the north, Umea/Sundsvall and Hudiksvall/Gavle both have predominant shares of exports whereas the area around Stockholm (Norrtalje/Nynashamn) have more import than export of containerized goods. This is supported by Santén et al. (2018) discussing imbalances in the Swedish maritime container industry. In their report, the west coast of Sweden (e.g. Gothenburg, Helsingborg, Malmo etc.) is described as fairly balanced in terms of goods flow compared to the east coast of Sweden (e.g. Gavle, Stockholm etc.), which is fairly imbalanced. However, the authors also point out that there is a difference between trade imbalance (the amount of loaded/unloaded goods) and technical imbalance (the balance between different types of handled containers). For example, in Gothenburg there are more 20ft containers being imported compared to the demand of exported 20ft containers. Regarding 40ft containers the opposite applies, where more containers are needed for export compared to the number of containers being imported. Thus, empty 40ft containers are repositioned to Gothenburg to handle the export, while empty 20ft containers are transported to other departure ports.

Figure 2.3: *Overview of the container flow for different areas within Sweden during 2018. The map is developed by numbers from Trafikanalys (2019).*

The numbers in the map present the total amount of laden containers shipped in TEUs for each region in Sweden. However, Trafikanalys (2019) also listed the number of empty containers imported and exported to each region during 2018 and that is presented in table 2.1. It demonstrates that the port in Gavle imported the largest amount of empty containers whereas Gothenburg exported the largest amount of empty containers.

Geographical area	**Empty containers imported (TEU)**	**Empty containers exported (TEU)**
Umea/Sundsvall	28 602	2 093
Hudiksvall/Gavle	81 194	6 139
Norrtalje/Nynashamn	1 334	16 216
South East Cost	8 804	15 442
Gothenburg	74 459	51 212
Halmstad/Varberg	5 757	6 644
Helsingborg/Malmo	18 106	36 316
Karlskrona/Trelleborg	11 241	928

Table 2.1: Shows the number of empty containers imported and exported in certain geographical areas within Sweden during 2018. The numbers are collected from Trafikanalys (2019).

2.4.2 Technical Imbalance

As seen in chapter 2.1.1, containers are available in different types and sizes, and they are all developed to facilitate transportation of different cargo. However, the mismatch between customer demand and type (or size) of empty containers available causes a shortage of empty containers (Song and Dong, 2015). This type of imbalance is described by Lumsden (2007) as technical imbalance. In order to deal with this imbalance it is necessary to perform ECR. Branch (2006) argues that different types of goods are better suited for different types of containers. For example, refrigerated containers are ideal when transporting meat, dairy products or fruits whereas tank containers are designed for liquids. Song and Dong (2015) also state that some areas with insignificant trade imbalance still have to perform lots of ECR. This is a result of mismatch in customer's demand and empty containers available, which consequently requires ECR.

2.4.3 Dynamic Operations

Imagine two regions having a long-term balanced flow between each other. The two regions can, however, have demand of empty containers and arrivals of laden containers at different times due to seasonality. Dynamic operations can therefore be explained as a periodic trade imbalance. According to Song and Dong (2015), the periodic demand of empty containers can be met in two different ways (1) accumulation of empty containers to meet the expected future demand (2) reposition empty containers as they are needed. They further explain that research have confirmed that the dynamic operations favors ECR as it increases the utilization of the container fleet.

2.4.4 Blind Spots

Lack of visibility in the container transport chain affects the handling of empty containers (Song and Dong, 2015). If actors within the chain do not collaborate with each other, so called blind spots occur. This means that shipping lines lose containers' location when they are transported via rail/truck or when they are located at inland terminals/customers. This result in problems regarding containers real-time status and location, and reduce the opportunity for shipping lines to utilize their container fleet in the most efficient way. Further, this result in increased ECR.

Boile et al. (2004) discuss the lack of visibility of containers prevents the reduction of ECR. They mention that an increased visibility potentially could lead to better utilization of containers by transport operators. If transport operators would receive better information regarding available containers within an area they could reduce ECR by using these containers instead of moving empties.

2.4.5 Strategies and Operational Practices

According to Song and Dong (2015), shipping lines are the ones controlling the movements of empty containers. However, laden containers are usually prioritized on the vessels due to customers' requirements. This priority, together with vessel capacity constraints, increase ECR. Consequently, shipping lines' practices risk affecting ECR negatively if used inappropriate or inefficient. However, a shipping line's strategies and operational practices have the potential to reduce ECR if used appropriate.

Braekers et al. (2011) and Lam et al. (2007) clarify a distinction in a company's planning levels to address the ECR problem. The planning levels can be divided in strategic, tactical and operational planning, where the former tackles long-term decisions, typically involving large capital investments, whereas the tactical strategy focus on mid-term decisions such as service selection, terminal policies and empty balancing strategies, and the latter takes care of day-to-day decisions, trying to handle the dynamic environment. Braekers et al. (2011) further describe that there is room for improvements within each planning level in order to reduce ECR.

Theofanis and Boile (2009) explain several strategies for ECR and divide these strategies in regional/local, interregional and global levels. Regional/local strategies include ECR between importers, exporters, inland depots and ports. Interregional strategies include effective container handling in areas of surpluses and deficits, and at what ports containers should be available for overseas ECR. The global strategy is more complex than the others and includes the percentage mix of owned and leased containers, and the global service network, to mention a few. In figure 2.4, the different strategies are explained from a perspective of unit repositioning costs and repositioning distance. The figure shows that within the two lines, ECR of a container is economically feasible. However, as soon as the upper line is crossed, the costs of moving the container empty is higher than the reward associated with it. Below the bottom line, the imbalances is not considered a problem and consequently a strategy for handling ECR is not needed.

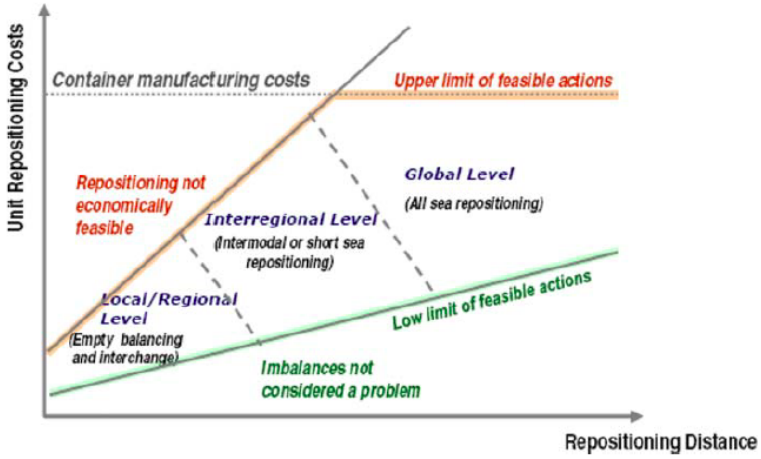

Figure 2.4: *ECR strategies and their relation to unit repositioning costs and repositioning distance (Theofanis and Boile, 2009).*

2.4.6 Container Fleet Size

According to Song and Dong (2015), container fleet sizing focus on determining the optimal ratio between owned and leased containers in a company's container fleet. Decisions regarding fleet sizing typically occurs at the strategic planning level in a company (Braekers et al., 2011). Furthermore, Dong and Song (2009) argues that the ECR problem and the fleet sizing problem are correlated. Having a large fleet size can, on the one hand, reduce the need for transportation of empty containers. Efficient ECR can, on the other hand, help increase the utilization of containers by reducing the idle storage of empty containers. Thus, implementing ECR could help companies save costs in term of owning fewer containers and at the same time increase the utilization of their container fleet.

2.4.7 Uncertainty Factors

Song and Dong (2015) mention the characteristics of uncertainty as one of the reasons to why ECR exists. According to them, uncertainty can either be related to the actual transport of containers, or to interfaces with the external environment. Congestion at ports, weather conditions, resource unavailability and strikes are some uncertainties affecting the actual transport of containers. As containers are delayed and their movement deviates from the plan, extra ECR needs to be performed to meet customer demand. The uncertainty in the external environment is presented as political and economical factors, as well as random customer demand. As they all affect the ability to predict future demand, they will increase the demand of ECR.

Di Francesco et al. (2013) have conducted research on how actors within the container transport chain should adapt to disruptions at ports to reduce ECR. The disruptions are explained to result in delays of container delivery and will affect the customers waiting for containers. Factors that Di Francesco et al. (2013) consider to be disruptions are divided into natural causes, such as hurricanes and earthquakes, and human-generated causes, such as accidents and failures.

2.5 Possible solutions for reducing empty container repositioning

In this chapter, possible solutions for reducing ECR are presented. These solutions have all been found in previous literature about the subject.

2.5.1 Street Turns

A solution to the ECR problem is the use of street turns. This is a method where importers (consignees) and exporters (consignors) move containers between each other without the use of a container terminal (port or inland depot) (Braekers et al., 2011) (see figure 2.5 (b)). In the traditional approach (a) however, the empty containers are subject to two movements. The empty containers are also passing the terminal and thus needs to be managed due to unloading and loading. In addition to reducing handling cost and transporting cost, the street turn approach can also help reduce congestion in crowded container terminals, decrease container waiting times and increase container utilization.

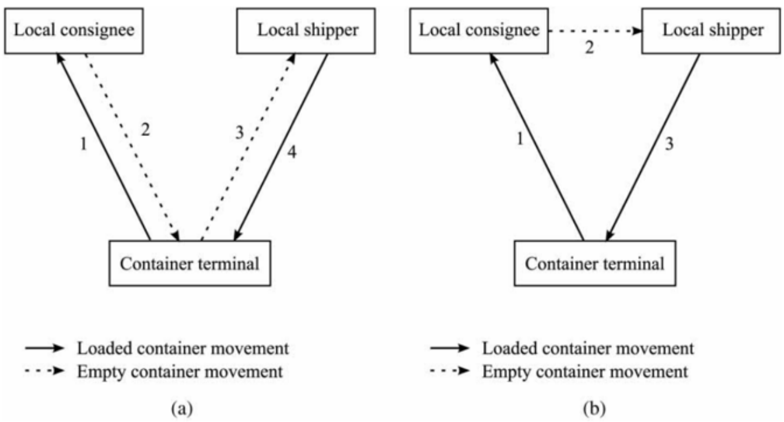

Figure 2.5: *Simplified explanation of the street turn approach (b) in relation to the traditional approach (a) (Braekers et al., 2011).*

There are, however, some challenges to overcome before street turns can be implemented. Braekers et al. (2011) points out three challenges; (1) tight time windows, (2) finding partners for collaboration and (3) ownership of containers.

1. Tight time windows - the demand of empty containers from exporters needs to match the outgoing flow of empty containers from importers at the right time.
2. Finding partners for collaboration - partners should be close and have a demand of the same sort of containers.

3. Ownership of containers - who is responsible for damages on a container if several actors handles it?

Song and Dong (2015) elaborate even further on challenges to implement street turns by focusing on specific tasks for each actor. First, the transport operator need to identify that there is an opportunity to reuse an empty container and communicate that to the driver. Second, the contractual agreement between the shipping line and the transport operator must allow for a reuse of an empty container. There is also a need for the shipping line to document and track the interchange of a container between two parties. Third, the exporter needs to be reasonably close to the emptied container, and the time window needs to be matched. Fourth, the emptied container needs to be equipped for the export goods (e.g. reefers are needed for refrigerated products).

2.5.2 Collaboration

The definition of collaboration is *"a relationship characterized by openness and trust where risks, rewards and costs are shared between the parties"*(Sandberg, 2007). Aharonovitz et al. (2018) introduces the concept of logistics collaboration, which involves the two logistic activities, joint planning and information sharing. Furthermore, the authors conclude that increased logistics performance can be achieved by enhanced logistics collaboration.

Collaboration can exist both vertically and horizontally. Vertical collaboration focus on partnership between firms on different levels in a supply chain whereas horizontal collaboration focus on collaboration between firms on the same level (Vanovermeire et al., 2014, Cruijssen et al., 2007). According to Cruijssen et al. (2007), horizontal collaboration is a common concept in maritime shipping where different shipping lines can form alliances. These alliances result in several advantages, such as improved customer service and increased economies of scale (by higher vessel utilization). In addition, Song and Dong (2015) have seen how collaboration among customers, 3PLs and shipping lines has facilitated container sharing between actors. These collaborations include internet-based systems, operated by a neutral party, where actors share information with each other. Song and Dong (2015) further elaborate that there still is resistance with these kind of collaborations. However, as the reduced costs outweighs the resistance to share information, it becomes a good solution for all actors involved.

In order to succeed with horizontal collaboration, Vanovermeire et al. (2014) believe various challenges need to be overcome. As example, the authors mention the difficulty of building trustworthy relationships, the risk of information disclosure, and lacking IT-support systems.

The container transport chain involves several actors which all have different agendas (see section 2.1.5). Making them collaborate is not always easy and could therefore be described as a challenge for implementing this solution. According to Song and Dong (2015), coordination issues are particularly common in the hinterland transport chain. Furthermore, the authors conclude that increased collaboration between actors was limited due to information asymmetry, a lack of incentives for collaboration and a lack of contractual relationships.

2.5.3 Internet-based Systems

Internet-based support systems can be applied to handle the ECR problem. According to Braekers et al. (2011), a more detailed container status can be achieved by increasing the transparency and sharing of information between actors. By sharing information regarding inventory of empty containers and upcoming transports, truckers, carriers and terminals can coordinate their container movement better, leading to reduced congestion and reduced ECR. The internet-based system can, in this case, be seen as a “virtual container yard” (Braekers et al., 2011). An internet-based system also facilitates the completion of paperwork needed to transfer the container responsibility between an importer and exporter. Due to lack of willingness to share information between actors this solution has proved to be difficult to implement on a greater scale.

The importance of a well functioning IT-system is further emphasized by Song and Dong (2015), who states that vertical and/or horizontal collaboration in a supply chain only can be achieved through the application of IT-systems. Being able to share information in a timely and accurate manner can help reduce uncertainty between involved actors in the container transportation chain and thus lead to increased collaboration.

2.5.4 Inland Depots

Inland depots are a possible solution to reduce ECR. In this report inland depots refer to the storage of containers, which can take place at all types of nodes in the container transport chain (see section 2.1.4). Instead of moving back empty containers to the port after each shipment, they can be stored at inland depots (Braekers et al., 2011). In that way a container can be transported directly to the exporter when a demand for empty containers arise, which can be seen in figure 2.6. That will help reduce costs associated with ECR, as well as reducing empty vehicle kilometers travelled. In addition, inland depots will add multiple benefits such as increasing buffer capacity to terminals at ports, facilitate the drop-off and pick-up of empty containers at congested ports and establish neutral supply points for empty containers.

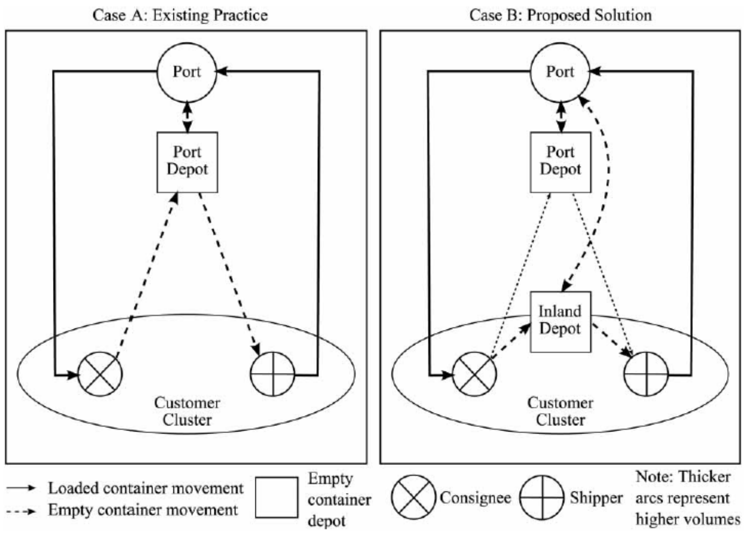

Figure 2.6: *Explanation of the configuration of an inland depot (Braekers et al., 2011).*

A couple of challenges regarding the implementation of inland depots have been discussed in the literature. Branch (2006) mentions that shipping lines would duplicate operating costs if moving into inland depots since they already have storage areas at sea terminals. However, this is not necessarily true, as terminal operators operating container terminals at ports usually not operates inland terminals. Instead they are owned and operated by separate firms. Thus, the only cost incurred with inland terminals would be extra storage costs, which might be offset by increased costs for container operations and the cost of renting space at ports (Braekers et al., 2011). Furthermore, the interest of shipping lines in keeping empty containers close to the port also needs to be taken into consideration, as they often demand (and strive for) full visibility and easy access to their containers (Boile et al., 2008). The cost of building an inland terminal also has to be taken into consideration before a decision regarding the implementation of an inland depot is made.

2.5.5 Grey Boxes

As the ownership of containers complicates the utilization of empty containers, the idea regarding common box pools (grey boxes) has emerged. This is a solution that removes the ownership of containers for shipping lines, by removing brands on the containers, and introduces a common container fleet between shipping lines (Boile et al., 2004). By this introduction, the problem of importers and exporters using different shipping lines will disappear. Instead of shipping lines optimizing their own flow of containers, the overall container fleet can be optimized, thus leading to reduced ECR (Monios and Wang, 2014).

However, the idea raises a number of questions which makes the introduction of grey boxes very difficult. A common container portal need to be managed by someone - who would that be? What happens if a container is damaged? Who is responsible for paying repairing costs? On top of this, a shared pool of containers would require a lot of coordination, and shipping lines involved in a project like this need to be willing to share information with each other (Kristiansen, 2010).

2.5.6 Secondary Uses of Empty Containers

According to Boile et al. (2004), shipping lines can sell containers that are taken out of sea service. This is a way for them to make money on containers which otherwise would be scrapped. Except from transporting goods, containers can be used for other types of services, for example as building material to build classrooms, restaurants, etc. (Boile et al., 2004).

2.5.7 Transport Policies

Transport policy is defined by Rodrigue (2020) as *"the development of a set of constructs and propositions that are established to achieve specific objectives relating to social, economic and environmental conditions, and the functioning and performance of the transport system"*. Furthermore, the goal of transport policies is to allocate transport resources more effectively. A government can use a number of different policy instruments in order to influence the transport system. A common instrument is regulatory control, which consists of environmental regulations that can influence the construction and operation of transportation infrastructures (Rodrigue, 2020). Furthermore, the author states that the orientation of government policies have changed, and now focus more on environmental and security issues rather than economical ones. However, policy instruments are not faultless, and sometimes they can lead to unintended consequences. For example, when ethanol production (using corn) was promoted through biofuel policies, the unintended consequence was a surge in food prices globally. The new policies made it more beneficial to grow crops for energy production rather than food production.

2.5.8 Foldable Containers

The uniqueness of foldable containers is that their walls and doors can be lowered inwards together with the roof (Konings, 2005). These containers can then be bundled together to make up the size of one container. Being able to stack and fold containers reduces the volume of the moved containers and the number of transports needed to move empty containers from A to B can thus be reduced (Konings and de Brito, 2008). The use of these containers are suitable in areas of trade imbalance. According to Konings (2005), challenges linked with this solution are primarily the high handling costs associated with folding and unfolding, the high purchase price and the low durability of the containers.

2.5.9 Tworty Boxes

A tworty box (twenty + forty = tworty) is a 20ft container that can be combined with another 20ft container to create a 40ft container (Malchow, 2015). The uniqueness of the tworty box is that one of the doors is opened inwards and can be fixed to the ceiling of the container. From this side another container can then be assembled to create the 40ft container. The use of these containers are suitable in areas where a mismatch in import and export of 20ft and 40ft is noticeable.

2.5.10 Container Substitution

A container can differ when it comes to both size and type (see section 2.1.1). Container substitution refers to the flexibility of switching between different containers (Braekers et al., 2011). For example, the supply of one 40ft container could help fulfill the demand of two empty 20ft containers. In order to make container substitution possible, certain substitution rules have to be identified. These substitution rules needs to be specified regarding the weight of cargo, the destination of cargo, the nature of cargo and differences in handling capacity of loading and unloading facilities (Braekers et al., 2011). Container substitution can only be a common practice if substitution the rules are clear and well-defined to all actors.

2.5.11 Container Leasing

Shipping lines can either own or lease containers in order to secure them. If shipping lines are allowed to rent containers at places where they currently experience a shortage, and drop off containers at places where they currently experience a surplus, the ECR could be reduced globally (Braekers et al., 2011). Furthermore, it could also help optimize repositioning decisions on a regional level by expediting the introduction of containers in cases of abundance and/or shortage. However, the cost savings associated with container leasing is affected by the terms and conditions set by leasing companies. There is a high probability that leasing companies will face surpluses and deficits on similar locations as shipping lines. In order to avoid this, leasing companies could limit the number of drop offed containers each month at a specific location. They could also impose charges related to pick-up and drop-off for certain locations.

3
Methodology

This chapter presents the methodology used for this project. The research approach is described briefly and followed by both research strategy and design. Finally data collection, analysis and research quality are brought up.

3.1 Research Approach

This report consists of literature studies that forms the basis of a frame of reference. The findings from the literature review have in its turn been complemented by empirical findings, in form of interviews. An analysis has then been performed, based on the frame of reference and empirical findings. After making the analysis, the report culminates in a discussion and conclusion. A reference list from the supervisor was handed to the authors in the beginning of the project, which facilitated the start-up process. However, relevant literature to the subject were also found through searches in the database *Summon*, provided by Chalmers University of Technology, and the search service *Google Scholar*. The literature studied in this report mainly concerns areas such as empty container repositioning, the container transport chain, ocean container transport, container logistics, liner shipping networks, container management etc.

3.2 Research Strategy

Research methods can be divided into two different sections depending on how the collected information is processed and analyzed. If the information is based on measurements, statistical analysis and processing methods, the research is considered to be quantitative in its orientation (Patel and Davidson, 2011). If, on the other hand, the information is based on interviews and own analysis (observations), the research is considered to be qualitative in its' orientation. The orientations are often presented as two end points on a continuum, in other words incompatible, which is not the case in practical research (Patel and Davidson, 2011). On the contrary, a combination of the two orientations can make up for the weaknesses of each orientation, thus strengthen the research work (Bryman and Bell, 2011).

Several studies regarding ECR have already been made. However, most of it has been based on a quantitative research strategy, meaning the problem has been described as an allocation problem and thus solved with mathematical formulation. For example, Crainic et al. (1993) developed dynamic and stochastic models for the allocation of empty containers while Olivo et al. (2005) develop a mathematical programming approach for empty container management. Additionally, Dong and Song (2009) use an algorithm based on Genetic Algorithms (GA) and Evolutionary Strategy (ES) in order to simultaneously optimize ECR and the container fleet size. This master thesis has instead mainly been qualitative in its' nature, since the information was collected through interviews and based on own analysis. The aim has been to increase the understanding on how ECR can be reduced by identifying possible solutions and how they can correlate with identified barriers.

3.3 Research Design

Case study is a common research method which can be used in most scientific studies (Ejvegård, 2009). According to Patel and Davidson (2011), an organization or an individual can be classified as a "case" where the survey is based on a holistic perspective. The purpose of a case study is to be able to say that the case being studied represents reality. This is done by focusing on a small part of a large process, using the selected "case" to describe reality (Ejvegård, 2009). In order to get a clear picture of the case, information of various kinds is usually collected, which means that several data collection methods, such as observations and interviews, can be combined (Patel and Davidson, 2011).

This master thesis has been analyzing ECR from a societal perspective, leading to reduced ECR for the entire container transport chain. As a consequence, the movement of containers on a regional and local level in Sweden was studied. The movement of containers contains several actors, such as shipping lines, 3PLs, terminal operators and transport operators. Hence, this study has consisted of a case study, examining actors involved in the movement of containers.

3.4 Data Collection

There are different ways to gather information to answer a question, and some examples are interviews, surveys and observations (Patel and Davidson, 2011). It is difficult to emphasize one technique over another. To get the best result the choice of data collection method should instead be based on the resources and time available (Patel and Davidson, 2011). Furthermore, Yin (2009) emphasizes the importance of using multiple sources of evidence when conducting a case study, also known as triangulation. When triangulating data, different sources of evidence are being used to support the events or facts of the case study.

This study has collected information primarily through interviews with actors managing containers. Shipping lines have been in focus, but input from 3PLs, terminal operators and transport operators have also contributed with valuable information. This in turn, has created an understanding of how today's working methods affect the empty movement of containers in a larger perspective. The interviews carried out are mainly characterized as semi-structured interviews. This has allowed questions to change from one interview to the other based on information emerged in previous interviews. These types of interviews are, according to Yin (2009), associated with a qualitative research strategy.

An interview guide, with a list of questions related to the subject, has been made in advance in order to prepare for the semi-structured interviews. The interviews were conducted face-to-face, over the phone or through e-mail. Since the goal was to have two rounds of interviews, two interview guides have been made. Interview guide one was based on previous literature about ECR and can be found in appendix A. Based on the findings from interview one and previous literature an excel file with potential solutions for reducing ECR was made (see appendix B). This excel file was sent out to the respondents in advanced and formed the basis for the discussion in interview round two. Hence, the questions in interview guide two was based on this excel file (see appendix C). Some questions in the interview guides have also been changed to better suit the interviewed actor. The semi-structured interviews was believed to be favorable in this project. They allowed more open interviews where the respondents was able to elaborate on his/her answers. This has provided the project with valuable primary data and has formed the basis of which new contribution to the subject has been provided.

In order to define the potential of each solution, the results from the excel file was analyzed in combination with the information gathered from the second interview. The respondents were asked to rank each solution from 1-10, with 10 being the highest number, both in term of feasibility to implement and impact for reducing ECR (see appendix D). Based on this result, the authors were able to prepare the second interview with each actor, discussing their estimations of each solution. The findings from the second round of interviews resulted in a matrix, made by the authors, with axis ranging from low to high regarding feasibility to implement a solution and impact for reducing ECR. These two dimensions are focusing on the system at large and not just a single actor's potential in implementing a solution. Each solution was then qualitatively placed within the matrix by the authors.

3.4.1 Involved Actors

Table 3.1 is a compilation of companies interviewed in this report. The table includes what actor group the companies belong to and what position the respondent from each company has. To be able to use the information gathered from the interviews, the companies are anonymous when presenting the findings. Instead of mentioning the company names, their role in the container transport chain will be presented. As an example, if CMA-CGM has stated something it will instead be presented as: A shipping line mentioned... Thus, it might as well be Greencarrier who said it, and who said what is impossible to figure out.

Actor group	Company	Respondent's position
Shipping lines	CMA-CGM Greencarrier Maersk	Logistic Manager CEO for liner services Operations Coordinator
3PLs	DB Schenker DHL	Key Account Manager Director of Ocean Freight
Transport operator	Green Cargo	Strategic Account Manager Salesman
Terminal operators	Eskilstuna Logistics Jula Logistics Lundby Container Service Port of Gothenburg	Logistic Developer Freight Manager Depot Manager Senior Manager Business Development

Table 3.1: Summary of companies interviewed and respondent's position.

3.5 Research Analysis

To analyze the collected data and the literature of this report, an iterative process has been used. Literature review has been made to collect the foundation of the frame of reference. The frame of reference has then, except from increasing the knowledge of the subject, formed the basis of the first interview guide. A first round of analysis has been made after the data collection, where similarities and differences between the collected data and the theory have been analyzed. In the second round of analysis, the framework has been expanded in response to the collected data which later have formed the basis for the second interview guide. The third round of analysis includes new data collection and depending on the findings, the last analysis has resulted in the development of correlating barriers and possible solutions, and the potential of each solution.

In order to answer research question one and two, each actor has been analyzed separately, before the results were merged and the entire chain of actors was analyzed (as a whole). Research question three, on the other hand, has been analyzed by categorizing the retrieved data into different clusters.

3.6 Research Quality

This report has, as already mentioned, been of qualitative nature. According to Bryman and Bell (2011), the easiest way to confirm the quality of a qualitative study is to look at its' trustworthiness. Trustworthiness further consists of four criteria: credibility, transferability, dependability and confirmability.

3.6.1 Credibility

Credibility is used to ensure that respondents' answer correlates with the interviewers' perception of the answer (Bryman and Bell, 2011). In this report, the credibility has been ensured by interviewing different actor groups within the container transport chain. To strengthen the credibility further, people at different companies and with different professions was interviewed. During each interview, the respondent was informed of how the gathered information would be used and that anonymity was promised. This will, according to Yin (2009) lead to untwisted answers. However, one thing that potentially affects the credibility negatively is that each actor group contain a different amount of actors. This study consists of three shipping lines, two 3PLs, four terminal operators and one transport operator. Since terminal operators contain most actors, they have the greatest possibility to influence the outcome of the study, even though they might not be the most important, or influential, actor group. Furthermore, the study was supposed to contain two rounds of interviews with all involved actors. However, halfway through the study the pandemic Covid-19 hit the world, affecting some actors' ability to participate in the second interview. This resulted in that the second round of interviews only included five out of ten actors.

3.6.2 Transferability

Transferability in qualitative studies refers to their possibility to be applied in a general context or in a similar context, at another time (Bryman and Bell, 2011). This report has been using detailed information from the interviewed respondents. This can potentially make it hard to apply the findings from this report more generally. However, as the findings is compared to previous research, most of the findings usually match the literature, proving that the findings is of general nature. A detailed description regarding both nodes and actors have been provided in order to strengthen the transferability of this study. However, the container transport chain is characterized by a complex environment with actors performing similar tasks. For example, an actor described as a 3PL in this report could potentially be seen solely as a forwarder in another report. Hence, making a similar study would probably, due to the many detailed answers and complexity of the chain, result in a slightly different outcome than in this report.

3.6.3 Dependability

Dependability in a qualitative study would, according to Bryman and Bell (2011), imply that peers validate that the research process has been followed correctly. To facilitate this, it is essential that documentation of all phases in the research process is made. To strengthen the dependability of this research, the gathered information was recorded, stored and visualized in the most accessible way. The interviews were transcribed and the material was categorized for each actor in order to facilitate a comparison between different actor groups. The research process was also compiled in a Gantt-scheme to be able to see when different moments was performed. The information gathered, was analyzed by supervisors from both Chalmers and SSPA throughout the report. Important to mention here, is that the supervisor at SSPA was changed halfway through the report. This resulted in difficulties to proceed as planned and a new approach had to be established to continue the report. A peer review with other students has also been performed to strengthen the dependability of this research.

3.6.4 Confirmability

Confirmability of a study is determined by how much the authors' personal values influence the collected information (Bryman and Bell, 2011). To increase the confirmability in this report, thus reducing the authors' personal value, information regarding drivers, barriers and possible solutions have been discussed with supervisors throughout the report. The gathered material from the interviews will also be handed to the supervisor at SSPA when finished. However, this person will not be able to validate the material before this report is published, but will instead be able to use the information in future research.

4

Findings & Analysis - Drivers & Barriers

This chapter presents actor groups involved in this report. Furthermore, drivers and barriers for reducing ECR are presented.

4.1 Actor Groups

In this section, a short introduction of all companies involved in this project will be presented. They are presented as different actor groups to facilitate the understanding of their role in the container transport chain. The introduction includes a short summary of each company and the respondent's position at the company.

4.1.1 Shipping Lines

CMA-CGM is a family owned shipping line with headquarters in Marseille, France. The company is currently ranked as the fourth biggest shipping line in the world (Alphaliner, 2020). The office in Gothenburg is responsible for the Scandinavian market, which includes Sweden, Norway and Denmark. CMA-CGM distinguish itself from competitors in the Scandinavian market thanks to the company's focus on short-sea shipping, which lets them compete with inland transport operators (rail, road etc.). As a shipping line CMA-CGM owns both their own vessels and containers. The person interviewed at CMA-CGM works as a Logistic Manager and has operational responsibility for the Scandinavian market, which includes intermodal logistics, customer care as well as operations management. Regarding ECR the respondent leads an equipment team of five people in Gothenburg which is responsible for handling and transportation of empty containers.

Greencarrier Liner Agency, with headquarters in Gothenburg is one of the companies that has been interviewed. Greencarrier Liner Agency act as agent on behalf of Evergreen Line, which is one of the biggest shipping lines in the world. Evergreen Line owns both containers and vessels and as Evergreen's agent, Greencarrier Liner Agency handle all activities on behalf of Evergreen Line within Scandinavia, Finland and the Baltics. As representative for Evergreen Line they organize transportations based on door-to-door, port-to-port, port-to-door and door-to-port (see section 2.1.6). The respondent at Greencarrier Liner Agency Sweden AB is the CEO with more than 20 years of experience in the field. As a CEO, the respondent have a strategic point of view when looking at ECR.

Maersk is the largest shipping line in the world (Alphaliner, 2020). In addition to maritime transport, the company offers other type of logistic services such as storage of containers, inland transportation and custom clearence. Hence, the company can be seen as an integrated logistics company trying to simplify their customers' supply chain. However, in this report the company will be analyzed from a shipping line perspective. As a shipping line, Maersk owns their own containers and vessels. The respondent at Maersk works as an Operations Coordinator, which means having overall responsibility of the flow of empty containers in and out of Scandinavia. In other words, the respondent has to make sure the right type of container is in the right place at the right time and to the right cost.

4.1.2 Third Party Logistics

As a 3PL, DB Schenker organize door-to-door transportation of containers for their customers. They are responsible for road transportation themselves, as they own their own trucks, the rest, however is outsourced to other transporting actors. DB Schenker is owned by the German state but acts as a global logistics provider by linking transporting actors around the world. The interviewed person at DB Schenker works as a Key Account Manager and has worked there for 20 years. In this role, the respondent works with multiple clothing companies, leading to responsibility of the flow of goods between Asia, where the goods is produced, and Sweden.

DHL is a 3PL, responsible for door-to-door, port-to-door and door-to-port transportation. Considering container movements, DHL buys the transport service from shipping lines and transport operators while they manage consolidation and planning of transports themselves. Most of the import to their customers comes from Asia while the export is world wide. The person interviewed is responsible for the sea division and has had the role as Director of Ocean Freight for 6 years. However, the respondent has been working at the company for almost 16 years.

4.1.3 Transport Operators

Green Cargo is a state owned limited company with focus on movement of goods. They specialize in rail transportation between ports and dry ports but offers road transports as well, which makes them able to perform door-to-door transportation. The company owns their own freight trains. Since they are state owned, they have access to a large part of the Swedish rail network and that make them stand out from their competitors who only traffic commuter trains from point A to point B. Green Cargo is the biggest actor within rail transportation in Sweden with 58% of the total market (Green Cargo, 2019). The company performs both domestic as well as cross-border delivery of goods and have multiple partners within Europe. Two respondents contributed with information to this report. Respondent one works as a Strategic Account Manager and is as such responsible for intermodal transports. Respondent two works with sales but has previous experience from shipping lines, with focus on short-sea shipping, where the respondent worked for 13 years.

4.1.4 Terminal Operators

As the owner of a dry port, Eskilstuna Logistics is one of the interviewed terminal operators in this report. The company is owned by Eskilstuna municipality, which goal is to facilitate for new businesses to establish in the area. Eskilstuna Logistics acts as a node in the network between a port and an importer/exporter, with trains transporting containers to and from the ports and trucks transporting containers to and from the importer/exporter. The shipping lines store empty containers in depots at the dry port and a hired operator performs all the physical lifts of containers. The respondent has worked as a logistics developer at the company for 6 years and is responsible for intermodal transports to and from the dry port.

The Port of Gothenburg, which is part of the City of Gothenburg, is the owner of land and infrastructure at the port. The operative functions are outsourced to other actors, and instead Port of Gothenburg's primary task is to maintain and develop the port to increase its' competitiveness and attractiveness to importers and exporters. They are also responsible for the leasing of depot space to shipping lines at the port. This makes them a port authority. However, in this report they will be presented as a terminal operator to facilitate the possibilities for comparison between actors in this actor group. The authors admit that this may not be entirely correct. The respondent at Port of Gothenburg is a senior manager within business development and has worked at the port for the last 12 years.

Jula is a family owned wholesaler with headquarter in Skara, Sweden. The company has department stores in Sweden, Norway and Poland and imports a large part of its products from Asia. As the company has grown, focus on logistics has increased which led to the introduction of Jula Logistics AB, which is an independent company under Jula Holding AB. Jula has, from an empty container perspective, contributed with the perspective of an importer (or end customer). However, both in the interview and in this report most focus have been on Jula Logistics AB and their work with ECR. Jula Logistics owns a dryport located in Falkoping which has direct connection with the port in Gothenburg through rail. A depot of empty containers exists at the dryport. Jula contribute with storage areas and seeks collaboration with shipping lines for storage of empty containers. The person interviewed at Jula Logistics works as a Freight Manager and as such the respondent is responsible for the coordination of incoming and/or outgoing goods.

Lundby Container Service (LCS) is a terminal operator located just outside the port of Gothenburg. In addition to acting as a depot for storing containers, LCS also works with maintenance of containers by inspecting and repairing them. Their customers are major shipping lines but they also have customers in the form of goods owners that lease containers from them. Accordingly they are the owners of some containers but it will be neglected in this report when analyzing ECR. The interviewed person at LCS is the Depot Manager which has worked at the company for almost 30 years. In the role as a Depot Manager the respondent is responsible for the daily work at the depot.

4.2 Drivers for Reducing Empty Container Repositioning

In the following sections, the literature is presented in relation to the empirical findings extracted from the interviews. Analysis are made to reflect on similarities and/or differences between the two. Table 4.1 consists of a list of the drivers and where the information originates. Empirical data refer to number and type of actor discussing each driver whereas literature refers to which authors that are discussing them.

Drivers	**Empirical data**	**Literature**
Financial	All actors	Kristiansen (2010) Olivo et al. (2005) Konings (2005)
Environmental	All actors	Braekers et al. (2011) Song and Xu (2012) Olivo et al. (2005)

Table 4.1: Compilation of drivers for reducing ECR

4.2.1 Financial

When being asked about drivers for reducing ECR, all actors arrived to the same conclusion, and hardly surprising they all mentioned financial drivers as the main motivator. As the owner of containers, shipping lines are the ones carrying the cost of moving empty containers (see section 2.1.3). The representative from one shipping line stated that a container costs money as soon as it is empty and not loaded with goods. The costs associated with ECR is supported by previous research done by Kristiansen (2010), Olivo et al. (2005) and Konings (2005) as seen in section 2.3.1. They all found that billions of dollars are spent every year on moving empty containers in the world. One of the biggest driver to reduce ECR, for actors within the container transport chain, is therefore indicated to be of financial nature (see figure 4.1). The representative from another shipping line further described how the transport industry, in general, is characterized by very low margins. Closing a deal that generates a profit margin of three percent at the bottom line should be considered as a victory for companies in this industry. This can be compared to companies in the manufacturing industry who often reaches a profitability of 25 percent, as mentioned by a shipping line. Thus, every dollar saved will contribute to increased profitability, and reducing the number of empty containers being repositioned will reduce costs associated with handling and transportation of these containers.

Figure 4.1: *Explanation of financial driver for reducing ECR.*

Actors within the container transport chain are affected differently when it comes to ECR and transport operators are a great example of that. They are dependent of companies owning containers (shipping lines) since they are the ones placing orders with transport operators. Hence, for transport operators it does not really matter if the train/truck is loaded with laden or empty containers, they get paid anyway. The important thing for them is instead the number of units transported on each train/truck. However, this does not make transport operators neutral when it comes to ECR. In an interview with a representative for a transport operator, it appears that they make more profit transporting laden containers compared to transporting empty ones, as explained in figure 4.2. Thus, transport operators still have an incentive to reduce ECR although it might not be as great for them as for other actors. The same argument can be applied to other actors within the container transport chain. For example, as mentioned by all shipping lines, they also get paid when transporting empty containers for competitors. Hence, the service they perform can be compared to the ones performed by transport operators.

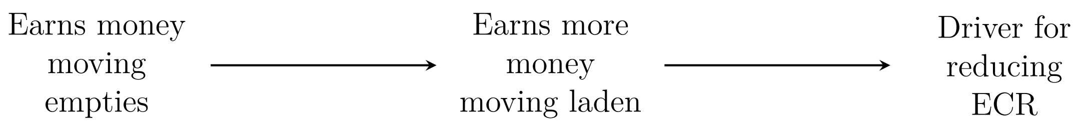

Figure 4.2: *Explanation of financial driver for reducing ECR.*

4.2.2 Environmental

As mentioned by Braekers et al. (2011), Song and Xu (2012) and Olivo et al. (2005) in section 2.3.2, the environmental impact is reduced as the transports of empty containers are reduced. Thus, in addition to the financial driver, a reduction of ECR can be seen as an environmental driver as well. This is supported by all actors interviewed in this report, as they mention the environmental driver as an important aspect. However, the subject of ECR often got lost when this question was asked to the respondents. Instead, most actors talked about how they try to develop the transport mode itself to reduce their environmental impact. As an example, shipping lines try to develop larger and better vessels that are able to carry more goods and run on less fuel. Most actors eventually had to admit that in comparison to the financial driver, the environmental driver is mostly overshadowed when talking about ECR. As long as the actors make money on transporting an empty container, the environmental perspective is disregarded. Worth mentioning, however, is that one of the 3PLs in the last years has seen a change in customer behavior as customers have increased their environmental awareness. Reducing the carbon footprint is therefore a way for this company to be competitive and gain customers (see figure 4.3). However, most actors say that the way to gain customers is to offer the lowest price on the market as most customers, up to this point, do not pay extra for the environment.

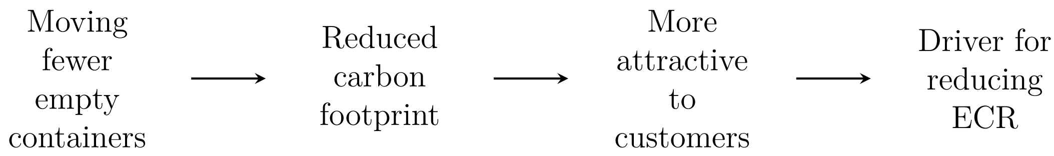

Figure 4.3: *Explanation of environmental driver for reducing ECR.*

4.3 Barriers for reducing empty container repositioning

In the following sections the literature is presented in relation to the empirical findings extracted from the interviews. Analysis are then made to reflect on similarities and/or differences between the two. Table 4.2 consists of a list of barriers and where the information originates. Empirical data refer to number and type of actor discussing each barrier whereas literature refer to which authors that are discussing them.

Barriers	Empirical data	Literature
Trade Imbalance	All actors	Boile et al. (2004) Braekers et al. (2011) Engström and Matsson (2015) Olivo et al. (2005) Trafikanalys (2019)
Technical Imbalance	Shipping line x2 Terminal operator Transport operator	Santén et al. (2018) Song and Dong (2015)
Dynamic Operations	Terminal operator	Song and Dong (2015)
Blind Spots	Shipping line	Boile et al. (2004) Song and Dong (2015)
Strategies and Operational Practices	3PL Shipping line Terminal operator x2 Transport operator	Braekers et al. (2011) Lam et al. (2007) Song and Dong (2015) Theofanis and Boile (2009)
Container Fleet Size	Shipping line x2	Braekers et al. (2011) Dong and Song (2009) Song and Dong (2015)
Number of Actors	3PL Shipping line	Transporteca (2020)
Contracts	Shipping line	None
Uncertainty Factors	All actors	Di Francesco et al. (2013) Song and Dong (2015)

Table 4.2: Compilation of barriers for reducing ECR

4.3.1 Trade Imbalance

Trade imbalance in Sweden is mentioned as the biggest reason behind ECR by all actors involved in this study. This is in line with previous research done by Boile et al. (2004) and Olivo et al. (2005), affirming that trade imbalance is the main reason behind the existence of ECR. However, both shipping lines and 3PLs point out that Sweden, in general terms, has a pretty good balance between import and export. This might seem a bit contradictory to figure 2.3 in section 2.4.1, showing import/export of containers in different regions of Sweden. However, the representative from one of the 3PLs explain how trade imbalance instead occur between local regions, such as ports. For example, the port in Halmstad is mentioned as an import area due to the fact that Biltema (a Swedish retailer) has its' central warehouse in that region. Ahus, on the other hand, is mentioned as a port with large export. In Ahus the famous Swedish liquor brand Absolut Vodka has its factories and headquarters. This type of local trade imbalance have been described in the literature by Braekers et al. (2011) who used the term "regional trade imbalance". According to the authors, regional trade imbalance include ECR on a small geographical area between actors, such as local ports and inland depots. Thus, the example given by the 3PL above is not a new phenomenon but rather something that has been studied before.

Another reason for the trade imbalance between different regions in Sweden is mentioned by a terminal operator, a transport operator and a shipping line. They all state that Sweden's geographical layout, with most of its population in the south and most of its industry in the north, is an underlying factor. This is supported by Engström and Matsson (2015) in section 2.4.1, who stated that foreign trade is heavier in the southern part of Sweden. The reason for and the cause of trade imbalance is explained in figure 4.4.

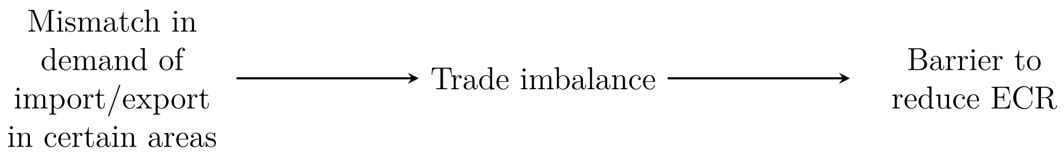

Figure 4.4: *Explanation of how mismatch in demand can be a barrier to reduce ECR.*

4.3.2 Technical Imbalance

Technical imbalance occur because demand of different containers exists (Song and Dong, 2015). When the respondents were asked the question why ECR exists, technical imbalance was one of the most common answers except from trade imbalance. In the interviews, a transport operator and a shipping line mentioned that there is an existing imbalance of 20ft and 40ft containers at some ports today, and highlights the port of Gothenburg as an example. This imbalance is described in the literature by Santén et al. (2018), who stated that the port of Gothenburg imports more 20ft container (compared to what it needs for export) and exports more 40ft containers (compared to what it imports) (see section 2.4.1). Hence, there is a need for ECR in the port of Gothenburg. Furthermore, the respondent from a terminal operator explained that it is up to each respective shipping line or goods owner to choose a container size that best fits the goods being shipped. Thus, other actors in the container transport chain, such as ports, terminals or transport operators cannot affect the type of container transported.

Another example of why technical imbalance exists is mentioned by a shipping line. They clarify that containers carrying garbage from the United Kingdom to Sweden, cannot be reloaded with clothes because of the smell. This can consequently, according to them, result in a deficit of containers in an area, even though the right kind of containers, in reality, are available. This is supported by Song and Dong (2015), stating that areas with insignificant trade imbalance still have to perform ECR due to a mismatch in customer's demand and empty containers available (see section 2.4.2). Figure 4.5 explains this connection. Even if the right type of container is empty and available it does not match the requirement for the exporting customer (in this example the company exporting clothes).

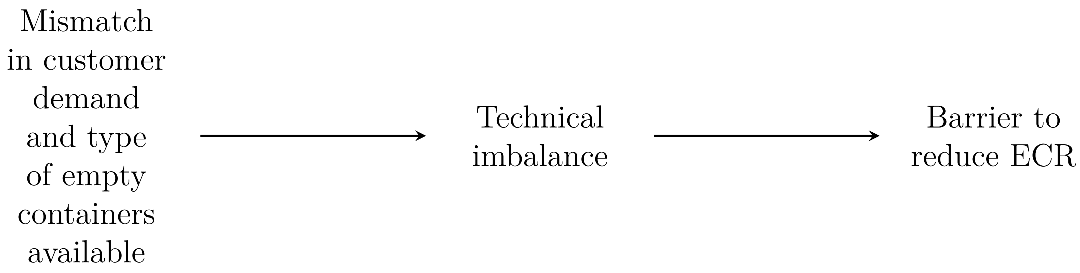

Figure 4.5: *Explanation of how mismatch in demand and available container types can be a barrier to reduce ECR.*

4.3.3 Dynamic Operations

The dynamic operations within the transport sector and the periodic trade imbalance it creates is mentioned as a barrier for reducing ECR, by Song and Dong (2015) (see figure 4.6). This was not mentioned directly as a barrier for reducing ECR by the respondents. However, as all actors mentioned trade imbalance as a barrier, they might not have differentiated between the two barriers but considered them to be one and the same.

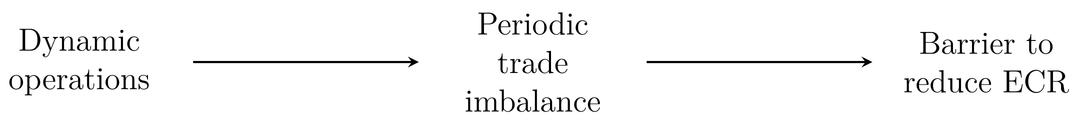

Figure 4.6: *Explanation of how dynamic operations can be a barrier to reduce ECR. The figure is developed from the concept described in section 2.4.3.*

4.3.4 Blind Spots

Blind spots occur when owners of containers (shipping lines) do not know where their containers are located (see section 2.4.4). One of the shipping lines supports the fact that they usually do not know the location of a container after it is handed over to a transport operator. One way to possibly remove the blind spot for shipping lines is to increase tracking of containers throughout the whole transport chain (see section 2.1.2). Song and Dong (2015) further explain that the lack of real-time status and location of containers is a problem for shipping lines to reduce ECR, which is further explained in figure 4.7. This statement is however, not supported by the shipping line. They believe that the implementation of some sort of GPS for all containers would be very expensive and they do not see a result that would benefit the reduction of ECR. For them, the only relevant information about the container is: Who is responsible for it? By knowing this, they can charge the responsible actor if it is not returned on time. Consequently, the findings done by Song and Dong (2015) is different from the empirical data in this report. The interview with the transport operator did not indicate problems regarding lack of visibility of containers from their side. However, no interview was conducted with a transport operator performing road transportation. The empirical data consequently lacks information if increased visibility of containers' location would reduce ECR, as mentioned by Boile et al. (2004).

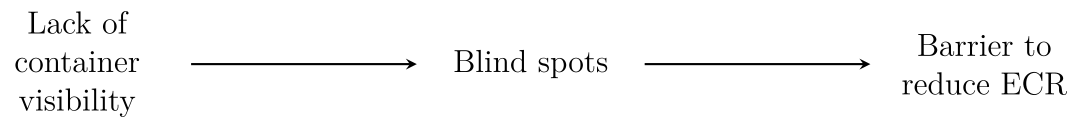

Figure 4.7: *Explanation of how blind spots can be a barrier to reduce ECR.*

4.3.5 Strategies and Operational Practices

Shipping lines are the ones controlling the movements of empty containers, and depending on how they formulate and follow their own strategies and operational practices, ECR will be affected negatively and/or positively (Song and Dong, 2015) (see section 2.4.5). Furthermore, a company's planning level can be divided into three different levels; strategic, tactical and operational, which all can help improve ECR (Braekers et al., 2011; Lam et al., 2007). Finally, strategies for ECR can be divided in regional/local, interregional and global levels (Theofanis and Boile, 2009). In this report, the assumption that the strategic planning level and the global ECR strategy are interrelated is made, due to the fact that they both handle long-term decisions. The tactical and operational planning level is, in similar way, assumed to be interrelated with regional/local and interregional ECR strategies due to their short- and mid-term decisions.

While conducting the interviews, three examples of performing ECR as an economically feasible action were mentioned (high storage and reparation costs, low transport price, variation in demand for seasonal goods). Analyzing these examples as strategies for ECR, as mentioned by Theofanis and Boile (2009), can indicate that actors within the container transport chain performs ECR if it is worth it. The financial part of a company's strategies and operational practices therefore acts as a barrier for reducing ECR. Below, the three examples are presented, proving that economical factors influence a company's strategy, which in turn affects ECR.

While interviewing one of the terminal operators, they discussed the behaviour of shipping lines as a barrier for reducing ECR. This terminal operators store containers, but they also have the possibility to inspect and repair containers. According to them however, shipping lines rather send empty containers to be stored or repaired at their own depots in other parts of Europe. This is done first and foremost because it is cheaper to store and repair containers at their own depots, but also because it usually benefits shipping lines to store containers where the frequency of use is greater, which it usually is outside of Sweden. Thus, the barrier is that savings to store and repair a container at another location is greater than the cost of moving an empty container, see figure 4.8. From a financial perspective it is therefore economically justifiable to act in this way for a shipping line, although it results in increased ECR. This proves that shipping lines' ECR strategies, on a global level, affect the movement of empty containers from Sweden to major port cities in Europe.

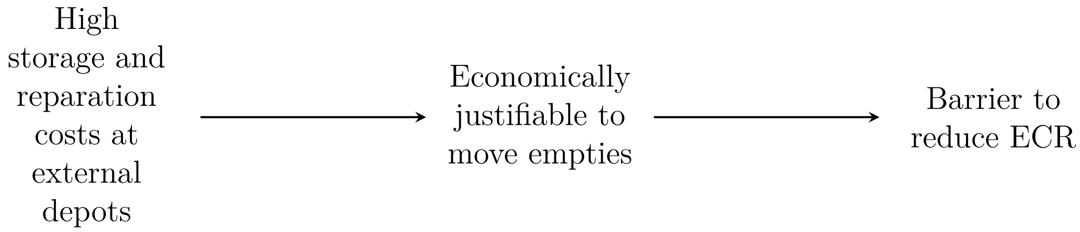

Figure 4.8: *Explanation of how costs at external depots can be a barrier to reduce ECR.*

One of the biggest barriers to ECR is the low price for the transportation of a container. The representative from a 3PL describe how the price of shipping a container from Asia to Europe has been cut in half since the 80's and nowadays costs less than 20´000 SEK. The same 3PL estimated that the commodity value in a single container roughly equals to 1´000´000 SEK, which implies that transportation costs for an empty container almost can be neglected. Hence, it is economically justifiable for shipping lines to perform ECR. A transport operator share the same view, and representatives from the company admits that, in the end, everything is controlled by the price. According to them, if an exporter is in great need of a container in order to export goods, they will pay for ECR without hesitation. The connection of how the low transport price can be a barrier to reduce ECR is seen in figure 4.9. This supports the ideas mentioned by Theofanis and Boile (2009) in figure 2.4. If an actor consider the movement of a container to be accommodated between the lines in this figure, ECR will be performed according to the ECR strategy. This is further enhanced by the representative from one of the terminal operators, who acknowledge that there is money to be made when dealing with ECR. According to this person, some actors in the container transport chain gets paid to transport empty containers.

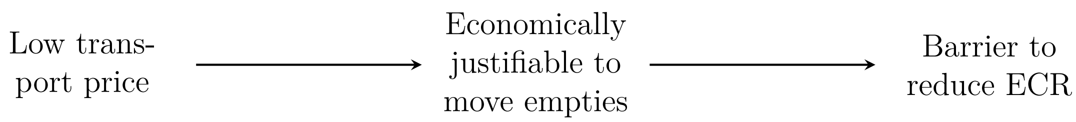

Figure 4.9: *Explanation of how the low transport price can be a barrier to reduce ECR.*

One aspect that can make the reduction of ECR difficult is speculation in demand of seasonal goods (see figure 4.10). The representative from a shipping line admits, that in order to acquire export of seasonal goods, they sometimes need to "gamble" (or make an educated guess) about when the demand of containers will occur at a certain location. The fishing industry in Norway is being used as an example of a big export market in which speculation of demand occurs. Depending on the time of the year, different types of fish need to be exported. For example, during a couple of weeks/months a lot of mackerel need to be exported and when that happens, fishing companies need to have refrigerated containers available to meet the demand. These fishing companies are willing pay extra for containers, and therefore it is easier for shipping lines to make ECR economically feasible, as mentioned by Theofanis and Boile (2009). According to the same shipping line, the actor that has containers available for immediate export wins the bidding process. The shipping lines without containers in the area at the right time will consequently lose the deal. Because of the short time window, it is hard for the shipping lines to match import and export of goods and instead empty containers are being transported and stored during a shorter time period in order to meet the demand. The decision for shipping lines to transport and store containers, in this example, can thus be described as a tactical strategy due to the involvement of empty balancing strategies on a mid-term horizon, as described by Braekers et al. (2011) (see section 2.4.5).

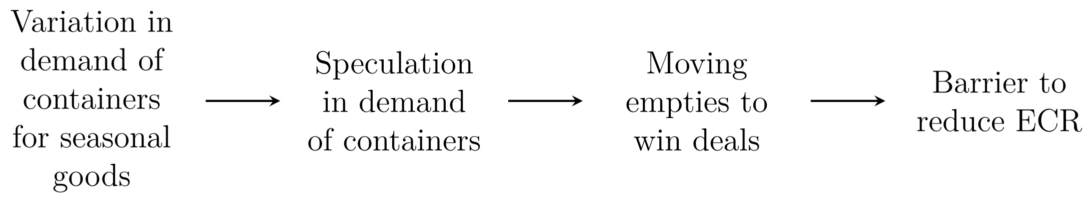

Figure 4.10: *Explanation of how seasonal goods can be a barrier to reduce ECR.*

4.3.6 Container Fleet Size

A company's optimal container fleet size depends on the ratio between owned and leased containers (see section 2.4.6) (Song and Dong, 2015). Two of the shipping lines say that they lease containers in order to handle certain peaks in demand (e.g. Chinese New Year). However, leased containers are usually only used in one-way trips before being returned to leasing companies. Dong and Song (2009) argues that the container fleet size and the ECR problem are correlated, i.e. the utilization of containers can increase by moving empty containers. In other words, a small container fleet leads to a higher utilization of containers, but at the same time it increases demand for ECR and thus acts as a barrier to reduce ECR (see figure 4.11).

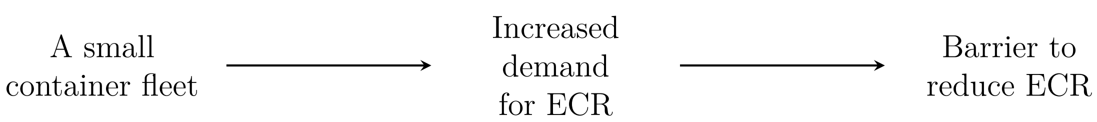

Figure 4.11: *Explanation of how the container fleet size can be a barrier to reduce ECR.*

When being asked about the decision of owning containers compared to leasing them, one shipping line says that it is a major strategic decision, which is made by their parenting company. Hence, the shipping line do not lease one or two containers in order to cover a transport on a local level between Gothenburg and Stockholm. Instead, the parenting company conducts a financial assessment based on forecasts globally and decides how many containers need to be bought and leased. This is in line with previous research done by Braekers et al. (2011), who state that decisions regarding fleet sizing are made on a strategic planning level.

4.3.7 Number of Actors

Actors within the container transport chain perform different transportation services (Transporteca, 2020) (see section 2.1.6). When analyzing the actors interviewed in this report, it can be determined that different actors sometimes perform overlapping services. This is proved in section 4.1, where it can be found that a shipping line, a 3PL and a transport operator, all perform/control door-to-door services. This indicates that actors probably fight over the same customers, thus acting as competitors. One of the shipping lines supports the argument and mention that competitors make it more difficult to match imports with exports, which result in increased ECR. Furthermore, another shipping line explains that their competitors naturally are other shipping lines. Actors present on road and rail, however, may affect shipping lines as they sometimes offer cheaper transportation than shipping lines, between two destinations. A 3PL supports the argument that number of actors is a critical barrier to reduce ECR. According to them, an imported container transported by them, can be booked for export by another actor after it is unloaded. This reduce their possibility to match import and export, resulting in increased ECR for them. Number of actors' impact on ECR is simplified in figure 4.12.

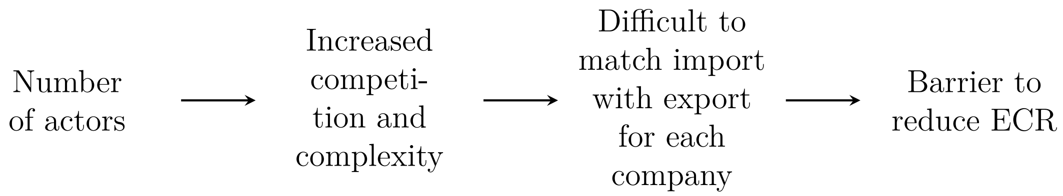

Figure 4.12: *Explanation of how number of actors can be a barrier to reduce ECR.*

Goods owners importing and exporting goods are also actors complicating the shipping process for shipping lines and 3PLs. One 3PL explains that if an importer and exporter are located close to each other, having similar need for containers in different directions, a collaboration between them can be established to reduce ECR. They further acknowledge that there is a lack of communication to establish collaborations between goods owners today as they mainly focus on their own supply chain. A problem for a collaboration, distinguished by the same 3PL, can however be that goods owners have to export to different destinations while shipping lines cannot offer transport to both places.

4.3.8 Contracts

During the interviews, contracts are mentioned as a barrier to ECR by a shipping line. They explain, from a shipping line's perspective, how contracts with important clients might force them to transport empty containers. For example, if a shipping line has promised to export 50 containers for a client but, for some reason, are having trouble matching the promised export with the import of 50 containers. Then they are still obliged to fulfill their contract with their client. Not fulfilling the agreed parts in a contract could potentially lead to penalty and/or compensation fees, and the risk of losing a valuable client. Hence, shipping lines have no choice but to transport empty containers to the exporting client. However, entering a contract as strict as this would probably do more harm than good to shipping lines. Consequently, this is not a usual situation shipping lines put themselves into. However, no link between this type of contract and ECR have been found in the literature.

According to a 3PL, the container transport chain is also characterized by short contracts between transporting actors and their customers. A contract is usually no longer than 6 months, and sometimes it can be even shorter. Thus, contracts usually have short expiration dates. The 3PL further explain that this increases the complexity regarding transporting actors' operations. An optimization of their transports performed today, can be ruined tomorrow due to the fact that customers change transporting actor. Finding areas with an even flow of import and export is therefore hard to sustain due to customers ability to change supplier of the transporting service. The two ways that contracts act as a barrier to reduce ECR is explained in figure 4.13.

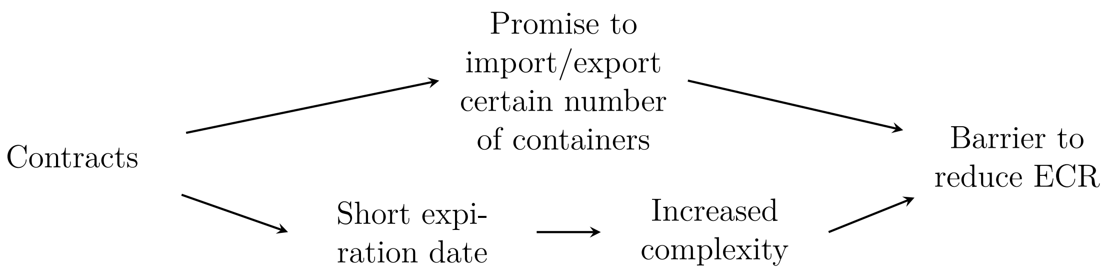

Figure 4.13: *Explanation of how contracts can be a barrier to reduce ECR.*

4.3.9 Uncertainty Factors

The transport industry is characterized by very low margins, as mentioned in section 4.2.1. As soon as something unforeseen happens with a transport, a chain reaction, that adversely affects the entire chain, is started. Song and Dong (2015) differentiates, in section 2.4.7, between uncertainty within the actual transport of containers (weather conditions, congestion and strikes) or the external environment (political factors, economical factors, and random customer demand). Di Francesco et al. (2013) take a different approach to the uncertainty problem and mention the causes as natural or human-generated. However, they all imply that uncertainty may occur due to human action and natural forces.

One shipping line mentioned bad weather and congestion in big ports outside of Sweden as two major external issues for late delivery of imported containers. The late delivery affects the possibility for them to perform street turns as planned and therefore empty containers have to be transported to exporters to fulfill their need, making it a barrier to reduce ECR. This argument is supported by the representative at one of the 3PLs, who mentioned that they often need to solve problems with delays, due to weather conditions and congestion, as they occur for their contractors (shipping lines). The representative at the shipping line also mentioned strikes at ports as an external factor, affecting the amount of ECR performed. When this occur, shipping lines often need to re-route their vessels to other ports in order to reach their customers, which in turn leads to delays in delivery of imported containers. The connection of the mentioned uncertainty factors and their effect can be seen in figure 4.14.

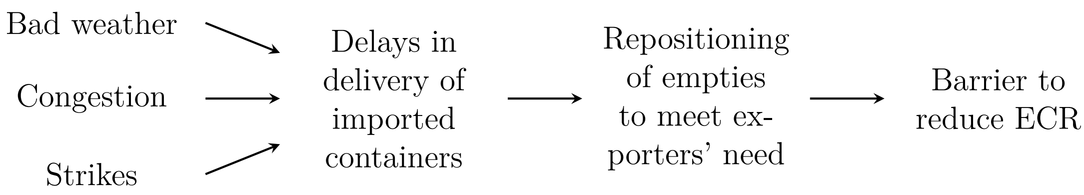

Figure 4.14: *Explanation of how bad weather, congestion and strikes can be a barrier to reduce ECR.*

When looking at ECR in Sweden, it is impossible to not compare Sweden's economy with other, bigger economies, in the global world economy. As a relatively small economy, Sweden is dependent on its export. If the export decreases, empty containers, used for import of goods, need to be sent back to Europe. As an example, a transport operator mentioned how increased tariffs on steel in the U.S. can affect steel companies in Sweden and their export. A reduction of exported goods from Sweden will affect ECR negatively since there will be an abundance of imported containers, which in turn need to be repositioned abroad. Another example mentioned by the transport operator is how an overproduction of pulp in China suddenly can cause a drop in price. Then, Swedish pulp companies will have a hard time selling their products, even though the quality might be superior, and that will cause a drop in export as well. These two examples can be related to external factors, as described by Song and Dong (2015). How the global world economy acts as a barrier to reduce ECR is explained in figure 4.15.

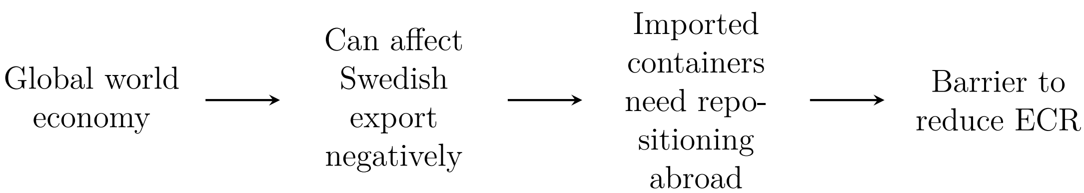

Figure 4.15: *Explanation of how the global world economy can be a barrier to reduce ECR.*

Another external factor affecting the movement of containers, which has been an issue at stake while writing this report, is the Covid-19 pandemic. A pandemic of this magnitude affects the world in an extreme way and is therefore difficult to put into a theoretical context. As it affects both the actual transport of containers as well as the external environment described by Song and Dong (2015) in section 2.4.7, it has been assigned a separate paragraph. All representatives interviewed have somehow mentioned Covid-19 and how it affects their business negatively. The shipping lines are the ones facing the issue first-hand due to their everyday flow of goods from and to Asia. When vessels from Asia are canceled (blank sailings) due to the virus, the number of imported containers are reduced. This in turn, leads to a shortage of empty containers for Swedish exporters and to solve the problem, ECR is performed (see figure 4.16). The terminal operators are also affected by the Covid-19 as the number of containers in the terminal are reduced. One terminal operator mentioned that they usually store 4000-5000 containers but as the import has decreased, the number of containers at the depot is reduced to 2000 units. This affect the amount of work needed at the terminal but is not yet seen as a major problem at the time of writing. However, this would of course not benefit their business in the long run.

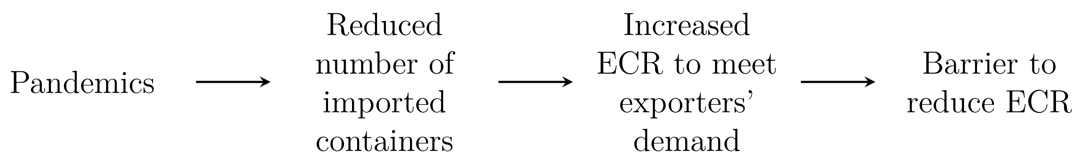

Figure 4.16: *Explanation of how pandemics can be a barrier to reduce ECR.*

5

Findings & Analysis - Possible Solutions

In this chapter possible solutions for reducing ECR are presented. The different solutions are then grouped together in different clusters based on their potential before being compared to each other.

5.1 Possible Solutions for Reducing Empty Container Repositioning

In the following sections the literature for possible solutions is presented in relation to the empirical findings extracted from the interviews. Analysis are then made to reflect on similarities and/or differences between the two. The sections also presents challenges associated with these solutions. Based on these challenges, each solution is given a potential regarding how feasible it is to implement and how big impact it has on ECR. Finally, an analysis of the correlation between barriers and possible solutions regarding ECR is presented for each solution. Table 5.1 consists of a list of all solutions and where the information originates. Empirical data refer to number and type of actor discussing each solution whereas literature refer to which authors discussing them.

Possible Solutions	Empirical data	Literature
Street Turns	Shipping line x3 3PL x2 Terminal operator	Braekers et al. (2011) Song and Dong (2015)
Collaboration	All actors	Cruijssen et al. (2007) Sandberg (2007) Song and Dong (2015) Vanovermeire et al. (2014)
Internet-based Systems	All actors	Braekers et al. (2011) Song and Dong (2015)
Inland Depots	All actors	Boile et al. (2008) Braekers et al. (2011) Branch (2006)
Grey Boxes	Shipping line x2 3PL Terminal operator	Boile et al. (2004) Kristiansen (2010)
Secondary Uses of Empty Containers	Shipping line	Boile et al. (2004)
Transport Policies	All actors	Rodrigue (2020)
Foldable Containers	All actors	Konings and de Brito (2008) Konings (2005)
Tworty Boxes	All actors	Tworty Box (2020)
Container Substitution	Shipping line	Braekers et al. (2011)
Container Leasing	Shipping line x2	Braekers et al. (2011)
Increased Transport Price	All actors	None
Standardization of Containers	Shipping line x3 Terminal operator	Branch (2006) GDV (2020) van Ham and Rijsenbrij (2012)
Shipper Owned Containers	Shipping line x2 Terminal operator	Manaadiar (2018)
Non-applicable Solutions	Shipping line Transport operator	None

Table 5.1: Compilation of possible solutions for reducing ECR.

5.1.1 Street Turns

Street turns are a way to transport containers between an importer and exporter without using a container terminal in between (Braekers et al., 2011) (see section 2.5.1). This will reduce the number of movements for an empty container and consequently reduce ECR (see figure 5.1). All shipping lines and 3PLs interviewed in this report use street turns as a way to be more efficient and reduce the movements of empty containers. It is also a way for them to be more competitive as they can offer lower price to the customers if they can reduce the distance of transport, as mentioned by a shipping line and a 3PL. Two terminal operators believe that close collaboration and transparency between actors have the opportunity to facilitate the utilization of street turns further. By letting other actors within the container transport chain know when empty containers are available, they see the opportunity in reducing the repositioning of them. Based on all this, the solution is assumed to have medium potential regarding impact for reducing ECR.

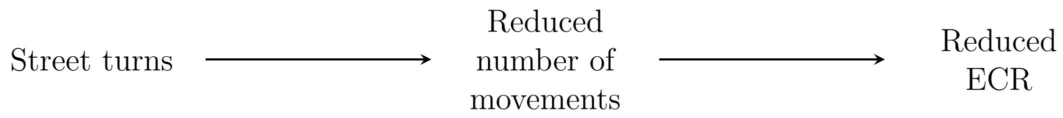

Figure 5.1: *Explanation of how street turns can reduce ECR.*

Braekers et al. (2011) point out tight time windows, finding collaboration partners and ownership of containers as three major challenges to implement street turns. It can be argued that Song and Dong (2015) explain the same challenges, although they formulate the challenges as contractual agreement, importance of matching time windows, closeness between importers and exporters, and the need for the container to be equipped for export goods. One of the shipping lines mentioned the challenge with finding collaboration partners. According to them, customers' demand for a certain quality on a container makes it hard to implement street turns. Even if the right kind of container is available in the area, some customers do not settle for anything but top quality. The same shipping line also mentioned the challenge with ownership of containers. As they perform street turns today, they are the ones responsible if a container is damaged between customers. This is because they cannot prove where the damage occurred and consequently not charge the right customer for it. Another shipping line discussed the tight time windows as a problem as customers have their own schedule to relate to. This makes it hard for shipping lines to adapt to customer requirements, while still performing street turns.

Other challenges, mentioned by all shipping lines and one 3PL, are the fact that they work in a changeable and complex environment, and that other actors within the container transport chain complicate the usage of street turns. According to these actors, this makes it hard to use street turns between the same customers every time, and the solution therefore has to be adapted from day to day. Another interesting thing obtained during an interview with a terminal operator is that street turns are a solution that would be bad for them. They earn money for handling and verification of a container's quality, and this would be reduced if depots is not used between an importer and an exporter. Based on all challenges related to street turns, and the fact that the solution is being used today, the solution is assumed to have medium potential regarding feasibility to implement.

Correlation between Barrier and Street Turns
Street turns can improve shipping lines' and 3PLs' *strategies and operational practices.* The implementation would, as already mentioned, reduce ECR, increase ef-

ficiency and make actors more competitive. The street turn concept would consequently make a company's strategies and operational practices more profitable, thus making ECR less economically feasible.

5.1.2 Collaboration

In the literature, collaboration is defined as a relationship based on trust and openness where involved parties share both risks and rewards (Sandberg, 2007) (see section 2.5.2). Actors involved in this study share this view. When being asked about collaboration they point out words like "transparency", "cooperation", "give-and-take", and "communication".

Horizontal collaboration has been defined as collaboration between firms on the same level in a supply chain (Vanovermeire et al., 2014). Furthermore, Cruijssen et al. (2007) stated that horizontal collaboration was common in maritime shipping through alliances. All shipping lines involved in this study are part of an alliance. However, collaboration in an alliance mainly applies to the sharing of vessels, where members easily can buy storage spots on each others' vessels. As soon as the vessel reaches a port, the impression is that the collaboration ends. This is supported in the literature by Song and Dong (2015), stating that coordination issues are particularly common in the hinterland transport chain. Furthermore, the authors stated that increased collaboration was limited due to information asymmetry and a lack of incentives for collaboration. Two shipping lines believed collaboration between shipping lines would be illegal due to the free market. Too close collaboration would lead to cartels, which are forbidden. The same argument is being used by one of the 3PLs regarding horizontal collaboration between other 3PLs.

Vertical collaboration has been defined as collaboration between firms on different levels in a supply chain (Vanovermeire et al., 2014). When being asked about vertical collaboration one of the shipping lines describes the relationship between themselves and 3PLs as purely customer-related, thus confirming that no such collaboration exists today. However, one 3PL believes collaboration between shipping lines and 3PLs would be possible.

In general, the impression from the interviews with all involved actors is that everyone is looking after their own interests. They are afraid of sharing information that might favor a competitor and often comes back to how competitive the transport industry is. One thing that often gets mentioned when talking about collaboration is a common IT-system where information can be shared easily. Collaboration could then be seen as a prerequisite for internet-based systems, which ultimately would lead to reduced ECR (see figure 5.2). Song and Dong (2015) describes it differently and according to them, a common internet-based system, operated by a neutral party, could impact the collaboration between customers, 3PLs, and shipping lines, which in turn would help facilitate container sharing between actors. Based on this and the challenges mentioned with horizontal and vertical collaboration, the solution is assumed to have medium potential regarding impact for reducing ECR while having low potential regarding feasibility to implement.

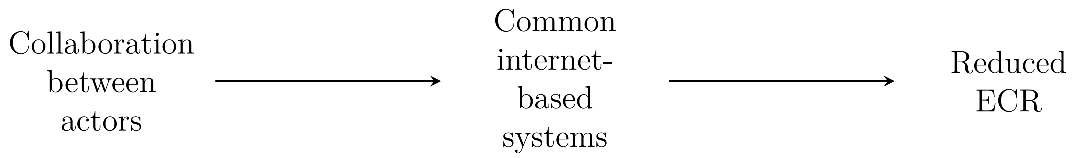

Figure 5.2: *Explanation of how collaboration between different actors can reduce ECR.*

Collaboration does not solely have to take place between different actors in the container transport chain. One shipping line emphasizes the importance of close collaboration internally between different departments. The representative describes how the department of operations work close to commercial departments (e.g. sales department) in order to reduce the imbalance between import and export in different regions (ports). For example, if the company has control of export in one port, it might be beneficial for them to try taking control of the import in that port as well. This would help simplify the matching between import and export, thus facilitating the street turn solution, which ultimately would help the company save money in terms of reduced ECR (see figure 5.3).

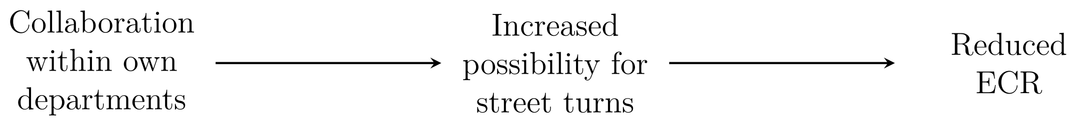

Figure 5.3: *Explanation of how collaboration within own departments can reduce ECR.*

Correlation between Barriers and Collaboration

Analysing collaboration's affect on barriers, it can be assumed that the barrier *number of actors* can be managed with this solution. The barrier originates from competition between actors and how this affect their possibility to perform efficient ECR. Collaboration between actors in the container transport chain would consequently reduce the competition, and solutions to improve the overall system can be achieved.

Another barrier that collaboration, together with internet-based systems, can manage is *dynamic operations* (see section 5.1.3). The combination of collaboration and internet-based systems could, as mentioned, potentially increase the information sharing between actors in the container transport chain, which in turn would clarify when and where the demand of containers exists. As dynamic operations refer to periodic trade imbalances, it is assumed that the earlier the information about future demand is shared, the easier it is to match the demand with the least possible ECR performed.

5.1.3 Internet-based Systems

Sharing information between actors through an internet-based system can reduce ECR and facilitate the completion of paperwork between an importer and exporter (Braekers et al., 2011) (see section 2.5.3). Song and Dong (2015) take another approach to internet-based systems and explain that they are needed to achieve vertical and horizontal collaboration within a supply chain. However, the findings from all actors indicate that internet-based systems can help actors share information between each other and improve utilization of containers, which in turn will reduce ECR (see figure 5.4).

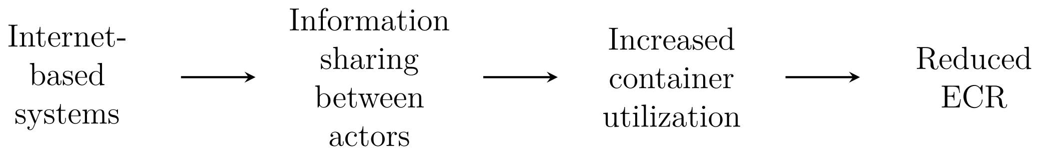

Figure 5.4: *Explanation of how internet-based systems can reduce ECR.*

Braekers et al. (2011) have found that internet-based systems can be challenging to implement in the container transport chain. This is mainly due to the unwillingness to share information between actors. A transport operator supports this argument and mentions that shipping lines do not share information about the location of their containers to others. One of the shipping lines also mentions that a common internet system between all actors would be hard to implement due to competition, and further explains that one way for them to be competitive is to have containers more accessible than their competitors. Based on this challenge related to internet-based systems, the solution is assumed to have low potential regarding feasibility to implement.

Another shipping line takes a more prospective approach to internet-based systems, by explaining how the technological development helps foster new, and improved, internet-based systems. As an example, the block chain technology is mentioned. The same shipping line states that block chain is believed to increase actors' access to real-time information in the future. This way of sharing information will also increase shipping lines' possibilities to improve calculations to make better decisions regarding containers. The respondent from this shipping line believes that block chain will improve more in the future, making information sharing a major part of the industry. A terminal operator and a 3PL are both positive to increased information sharing through internet-based systems. They both think that actors within the system actually can increase their competitiveness compared to actors not willing to share information. All actors interviewed at least agreed to the fact that an independent actor should implement and control the internet system used by the actors. Based on the future potential of a common internet-based system with increased information sharing between actors and the introduction of block chain technology, the solution is believed to have medium potential regarding impact for reducing ECR.

While the literature usually focus on external internet-based systems as a way to reduce ECR, the empirical findings in this report point at internal internet-based systems as well. All actors mentioned that they work in systems that are developed to facilitate their working tasks and increase efficiency. However, all actors agree that these systems can be improved. Several actors mentioned how improved internet-based systems can have a positive effect when performing street turns. As mentioned, all shipping lines and 3PLs interviewed in this report already have street turns implemented in their business to sync import and export between their customers. According to one of the 3PLs however, shipping lines and 3PLs need to sync their import and export better to decrease trade imbalance. One way to improve this, mentioned by the same 3PL, a shipping line and a terminal operator, is to develop internal internet-based systems, containing algorithms calculating this. The actors want the system to better calculate for possible street turns to decrease ECR, thus syncing import and export to a greater extent.

Correlation between Barriers and Internet-based Systems
A common internet-based system could help improve collaboration between actors in the container transport chain. If different actors can share information about when and where containers are available, this would result in better container utilization and reduced ECR. This is supported in the literature by Braekers et al. (2011), stating that information sharing leads to improved coordination of different actors' container movement, which in turn leads to reduced ECR (see section 2.5.3). Internet-based systems could in combination with collaboration be seen as a solution to several barriers mentioned in this study; number of actors, contracts, dynamic operations, and blind spots.

The barrier *number of actors* originates from competition between actors and how this affect their possibility to perform efficient ECR. To reduce this barrier, the actors within the container transport chain need to be reduced, or the collaboration between them need to be increased. Internet-based systems could improve the latter.

The barrier *contracts* might cause actors to be tied up in agreements they cannot keep, which potentially creates ECR. An internet-based system can allow container owners to get a better overview of the flow of containers. Getting access to more information helps the owners to form better decisions and prevents them from making promises they cannot keep without increasing ECR. Thus, an internal internet-based system can reduce the risk of entering a contract with bad terms.

Dynamic operations within the transport sector cause periodic trade imbalance and can thus be described as a barrier for reducing ECR. It could potentially be reduced by implementing an internet-based system between importers/exporters and container owners (shipping lines) to help improve collaboration between the two. If importers and exporters improve their forecasts and share this with the shipping lines, they can better prepare when and where it is a demand for containers. The ECR linked to variations in demand would consequently be reduced to a minimum while still resulting in containers being available at the right time.

Blind spots occur when owners of containers do not know where their containers are located. Furthermore, a lack of container visibility is, according to the literature, believed to make it more difficult to reduce ECR. If information regarding when and where containers are available is shared between different actors, ECR could be reduced. This could be achieved through the implementation of a common internet-based system.

5.1.4 Inland Depots

As mentioned in section 2.5.4, inland depots refer, in this study, to the storage of containers in all types of nodes in the container transport chain. Instead of moving back empty containers to the port after each shipment they could be stored at an inland depot, which would help reduce ECR (Braekers et al., 2011) (see figure 5.5). Furthermore, Braekers et al. (2011) explain that inland depots could lead to several benefits, such as reducing costs associated with ECR, reducing empty vehicle kilometers travelled and increasing buffer capacity for terminals at ports. All actors involved in this study confirm these benefits and clarify that inland depots already work as a solution for decreasing ECR in Sweden. Hence, the argument made by the actors confirms the literature. Based on these benefits, the solution is believed to have medium potential regarding impact for reducing ECR.

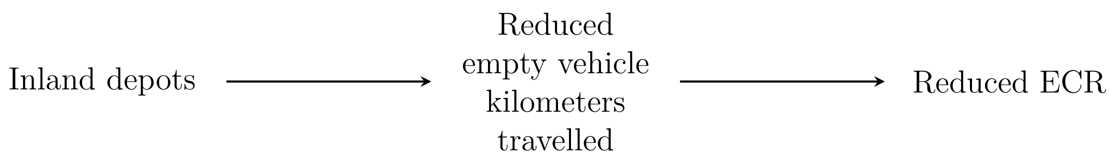

Figure 5.5: *Explanation of how inland depots can reduce ECR.*

According to a shipping line, inland depots could also be seen as a possible solution to street turns. If shipping lines and 3PLs are having trouble setting up street turns, inland depots could be implemented in order to store containers until an exporter needs it, which would help reduce the necessity to transport empty containers back to the ports. However, two of the shipping lines makes an important point regarding the number of inland depots. More depots do not automatically lead to an increase in the number of available containers, instead it divides the existing number of containers. Hence, in order for inland depots to work, a certain number of conditions are required according to the two shipping lines: (1) a large flow of containers (high demand), (2) control of both import and export within a limited geographical location, (3) contracts to secure volumes for a longer time period. This is supported by Boile et al. (2008), who argued that shipping lines demand full visibility and easy access to their containers and thus might be reluctant to store containers at inland depots. However, after interviewing all shipping lines, the impression is that they are positive to the concept of inland depots as long as the number of depots are kept small and the conditions are met. Finally, Branch (2006) argued that carriers would duplicate operating costs if moving into inland depots, which is contradicted to what Braekers et al. (2011) say (see section 2.5.4). This was not mentioned by any actor involved in this study and hence it cannot be confirmed or denied. Based on the conditions related to inland depots, the solution is assumed to have medium potential regarding feasibility to implement.

Depending on a company's location and its' proximity to a port, it might be beneficial to use a dry port and transport containers by rail. According to Rosa and Roso (2012), a dry port can be seen as an extension of a seaport, where containers can be stored and maintained (see section 2.1.4). Dryport Skaraborg is mentioned as an example of how a dry port can be used to reduce ECR by a terminal operator and a 3PL. The success of Dryport Skaraborg can be linked to the involvement of a few key actors, both in the start-up process as well as in ongoing, day-to-day operations. In this particular case, the terminal operator can be seen as the initiator and main investor to the project since they bought train wagons and invested in infrastructure, as well as promised to export a certain volume of goods. This in turn, made the municipality of Falkoping and a 3PL interested in the project. The municipality of Falkoping owned the land needed for the dry port whereas the 3PL took responsibility for operating trains, finding new customers for the dry port and consolidating import and export of goods. In order to attract customers in the start-up process and to demonstrate the long-term nature of the project, the 3PL offered exporting customers five year contracts. According to the representative from the 3PL, this project has been defined by 100 percent transparency between all involved actors, were everyone use a give-and-take approach. This is supported by the terminal operator, who emphasizes the importance of cooperation and transparency when dealing with ECR.

Correlation between Barriers and Inland Depots

Setting up an inland depot of empty containers locally can help reduce several barriers related to ECR. The depot acts as a safety stock and can be used when unexpected event occurs. *Uncertainty factors* are described in the literature as something that delays containers and make them deviate from the plan. It can either be related to the actual transport of containers or the external environment. No matter the cause, it creates increased ECR. Having a safety stock of empty containers available can help reduce the vulnerability of these uncertainty factors.

Dynamic operations within the transport sector cause periodic trade imbalance and can thus be described as a barrier for reducing ECR. Implementing inland depots could reduce this barrier. By storing empty containers in depots, when demand is low, and then use these containers, when demand again is increasing, would reduce ECR. Instead of moving these containers to other areas when demand vary, they are accumulated to meet future demand. Implementing this solution would reduce ECR. However, as mentioned by Song and Dong (2015), dynamic operations favors ECR as it increases the utilization of the container fleet (see section 2.4.3).

Shipping lines are the ones owning containers, which makes them in control of the movement of empty containers. Hence, their *strategies and operational practices* regarding ECR can help reduce the overall ECR in the container transport chain. One way for shipping lines to reduce ECR is to implement inland depots in areas where street turns are feasible, but perhaps difficult to implement. The empty containers can then be stored in the depots to wait for a demand.

5.1.5 Grey Boxes

Introducing a common container fleet, thus removing the ownership of containers for shipping lines, would help optimize the overall container fleet and reduce ECR (Boile et al., 2004). Representatives from a shipping line, a 3PL and a terminal operator admit that grey boxes, from a theoretical perspective, would help reduce ECR. However, two shipping lines argue for the feasibility of the solution in practice. According to one of the shipping lines, it would be hard to determine who owns the right to the shared containers and where to ship them. For example, in times of container shortages, which company is most entitled to use the shared containers? Is it the company paying most for each container? Or the company that first places an order? The same type of questions have been raised by Kristiansen (2010), who stated that a common container portal need to be managed by someone (see section 2.5.5). The shipping line believe that it would require some type of central governing from an independent organization. The representative from the other shipping line draws a parallel between the central governing of containers and companies leasing containers. According to this person, a leasing company's container fleet can be seen as jointly owned by everyone and regulated by a central organization who owns the actual containers (the leasing company). Furthermore, this representative states that when dealing with leasing companies, the one that pays the most for a container get access to it. To conclude, the impression is that all actors are negative and somewhat sceptical to grey boxes as a solution to reduce ECR. Shipping lines have the strongest arguments and points to the market conditions in the container transport chain, where containers are their means of competition. Removing the ownership of containers would limit competition and create a more monopolistic market, thus breaking the rules of a free market. Based on all challenges related to grey boxes, the solution is assumed to have low potential regarding feasibility to implement. However, regarding impact for reducing ECR, the solution is believed to have high potential due to the optimization of the overall container fleet, see figure 5.6.

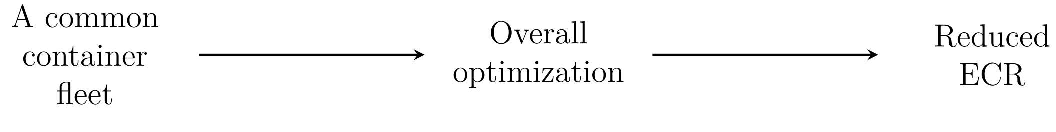

Figure 5.6: *Explanation of how grey boxes can reduce ECR.*

Correlation between Barrier and Grey Boxes
Based on the actors' perspective, grey boxes will be hard to implement as a solution. However, if the solution could be implemented, it would help overcome the barrier *container fleet size*. According to the literature, a company's optimal container fleet size depends on the ratio between owned and leased containers (see section 4.3.6). Grey boxes removes the ownership of containers and forces actors to collaborate more, in order to utilize a common container fleet in a better way. If implemented worldwide, this solution would lead to one commonly owned container fleet, which would eliminate the need for balancing between owned and leased containers. However, implementing a common container fleet worldwide is very unrealistic. Another, more realistic option is to implement grey boxes on a smaller scale, in a local region (for example in Sweden).

5.1.6 Secondary Uses of Empty Containers

Containers can be used to more than just shipping goods (Boile et al., 2004) (see section 2.5.6). By selling containers as they approach their estimated lifespan, one of the shipping lines believe ECR can be reduced. They explain that by selling old containers in a region close to their last voyage, the empty movement to restore or scrap a container is avoided. Consequently, a reduction of ECR is achieved, although for one trip only (see figure 5.7). The solution therefore has low potential regarding the impact for reducing ECR. The shipping line further explains that the market for old containers is big and that there is no problem for them to sell old containers at the end of their lifetime. All shipping lines involved in this study say that they sell their old containers. Based on this, the solution is assumed to have high potential regarding feasibility to implement.

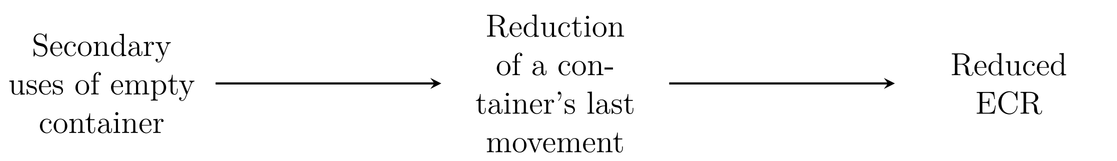

Figure 5.7: *Explanation of how secondary uses of empty containers can reduce ECR.*

Correlation between Barrier and Secondary Uses of Empty Containers
Secondary uses of empty containers can be seen as a solution to manage the barrier *technical imbalance*. Technical imbalance occur, according to the literature, when there is a mismatch in customer demand and types of empty containers available (see section 2.4.2). Selling old containers is a way of phasing out old container types, which would help increase the standardization of containers. In turn, increased standardization of containers would help reduce the technical imbalance.

5.1.7 Transport Policies

Environmental regulations are a common policy instrument governments can use in order to influence the transport system, according to Rodrigue (2020) (see section

2.5.7). However, all actors are doubtful to policies and do not believe regulations, as described in figure 5.8, is the way to reduce ECR. One shipping line argues that transporting companies would be the ones suffering the most if, for example, penalty fees would be introduced as a mean to limit ECR. They further explain how actors within the container transport chain transfer costs to other actors within the chain. For example, ports charge rent to shipping lines for storing containers at their terminals. In turn, shipping lines charge rent to 3PLs or inland terminals for handling and/or storing containers. Thus, the cost is transferred to actors involved in the container transport chain, and introducing penalty fees or other type of government regulations would probably not reduce ECR but instead increase costs for some actors.

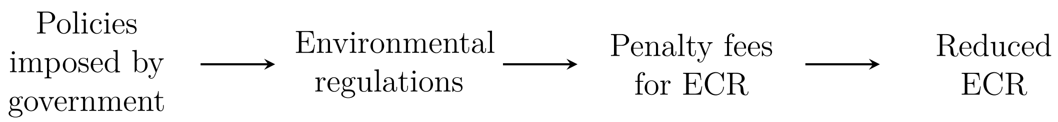

Figure 5.8: *Explanation of how transport policies can reduce ECR.*

A challenge related to transport policies is the unintended consequences a policy can lead to. Rodrigue (2020) used the example of ethanol and how it was promoted through biofuel policies, which caused a surge in global food prices. The same argument is being used by actors involved in this study. One transport operator believes, for example, that government policies would hurt Sweden's primary industry (steel, forest, automotive etc.), which ultimately contributes to the Swedish welfare (hospitals, healthcare, home care service etc.) with tax payments and employment. Instead of implementing restrictions on ECR, they argue that regulations could be implemented with the objective to transfer more empty containers on rail. In this way the environmental impact will be lowered, since rail transports entails lower emissions compared to road transports, even though ECR still exists. Based on this and the transferring of costs mentioned in the section above, the solution is assumed to have low potential regarding impact for reducing ECR and low potential regarding feasibility to implement.

Correlation between Barrier and Transport Policies

By introducing penalty fees for ECR, transport policies have the potential of reducing unnecessary ECR. This would be a way of forcing actors to manage the barrier *strategies and operational practices*, in order to make them move empty containers as short distances as possible.

5.1.8 Foldable Containers

Foldable containers are designed with walls and doors that can be lowered inwards together with the roof (Konings, 2005) (see section 2.5.8). They can be stacked on top of each other when they are folded, making up the size of one regular container and as mentioned by Konings and de Brito (2008), the number of transports to move empty containers can thus be reduced (see figure 5.9). In this study, an assumption that a reduced number of transports result in reduced ECR is made. Based on this, the solution is believed to have high potential regarding impact for reducing ECR.

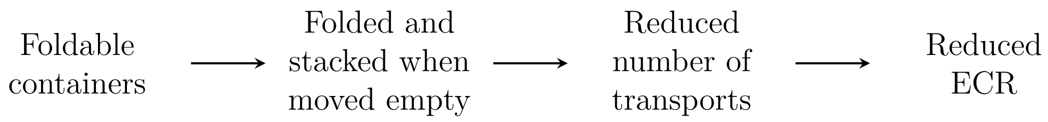

Figure 5.9: *Explanation of how foldable containers can reduce ECR.*

Previous research, done by Konings (2005), have proven that it is hard to implement these containers due to increased handling costs, high purchase price and low durability. These challenges are supported by all actors involved in this report, and even if none of them have actual experience using them, they still argue that this solution is impossible to implement due to the challenges. Two of the shipping lines argue that the moving parts of a foldable container definitely would increase the risk of damage. They further discuss the risk of a reduced carrying capacity due to the moving parts. None of the respondents from the shipping lines know the purchasing price for a foldable container but say that it probably is more expensive than a regular container, which is supported by the literature. Furthermore, the terminal operators realize that the handling of foldable containers would increase their costs. One terminal operator argues that not just handling when folding and unfolding would increase costs, but also the amount of space that this would require. Based on these challenges, the solution is assumed to have low potential regarding feasibility to implement.

Correlation between Barrier and Foldable Containers
Apart from the challenges associated with foldable containers the solution could be implemented in order to manage the barrier *strategies and operational practices*. Since shipping lines are the ones owning containers, they are the ones who could benefit from the implementation of this solution. By introducing foldable containers in the container fleet, the number of transportations would be reduced for empty containers, resulting in less ECR for shipping lines.

5.1.9 Tworty Boxes

Tworty boxes are 20ft containers designed to be combined, creating 40ft containers (Malchow, 2015) (see section 2.5.9). According to the literature, this solution can be used to reduce technical imbalance in areas with a mismatch of 20ft and 40ft containers, resulting in reduced ECR (see figure 5.10). The respondents in this report believe tworty boxes, theoretically, would be a good solution for reducing technical imbalance, and thus supports the argument made in the literature. The solution is therefore believed to have high potential regarding the impact for reducing ECR.

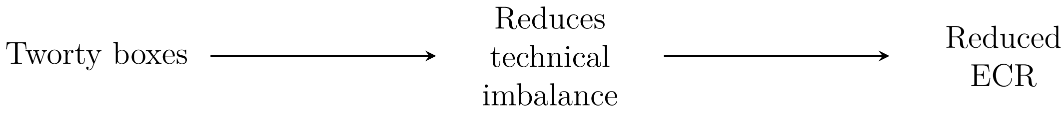

Figure 5.10: *Explanation of how tworty boxes can reduce ECR.*

The same challenges, as explained with foldable containers, can be assigned to the tworty box as well. All actors argue that the carrying capacity would be markedly reduced when combining two 20ft containers to a 40ft container, due to the notch created between the containers. One shipping line also discussed the complexity created when merging two containers. What identification number does the "new" container have? How can the quality of the 40ft container be secured if the 20ft containers differ in quality? According to the shipping line, these questions would require a lot of administration to be managed. Based on these challenges, the solution is assumed to have low potential regarding feasibility to implement.

Correlation between Barriers and Tworty Boxes
Tworty boxes can potentially manage two of the barriers identified in this report, and as already mentioned, one of them is *technical imbalance*. The other barrier it can manage is the *container fleet size*. Tworty boxes can be used to remove the correlation between a small container fleet size and a high utilization of a single container. If containers are able to be combined with each other it can result in a small container fleet size with a high degree of utilization, but without the need to increase ECR.

5.1.10 Container Substitution

Container substitution refers to the flexibility of switching between different types of containers, according to Braekers et al. (2011) (see section 5.1.10). One shipping line confirms that this solution is being used occasionally to reduce ECR, by using available containers (see figure 5.11). For example, they might ask a customer if it is willing to use a 40ft HC container instead of a standard 40ft container, if the shipping line have run out of standard ones. They further explain that this type of solution entails challenges and thus becomes difficult to implement. They specifically mention two things: (1) customers usually require a specific type of container for their goods, and (2) customers have to carry the (potentially) increased cost for the "substituted" container. Furthermore, the shipping line talks about how this solution, when being implemented, usually leads to reduced customer satisfaction. If a company, for example, promise something they cannot deliver and then offer a new, more expensive, solution, the customer will not be pleased. The difficulty of implementing container substitution has been discussed in the literature as well, where Braekers et al. (2011) stated that certain types of substitution rules regarding the weight, nature and destination of the cargo needs to be defined and applied by everyone. The main difference is that actors interviewed in this study focus on their own costs and reputation whereas the literature focus on defining common substitution rules for everyone. Because of the challenges mentioned above, the solution is assumed to have medium potential regarding impact for reducing ECR. However, as the solution is being used occasionally by some actors, the solution is believed to have medium impact regarding feasibility to implement.

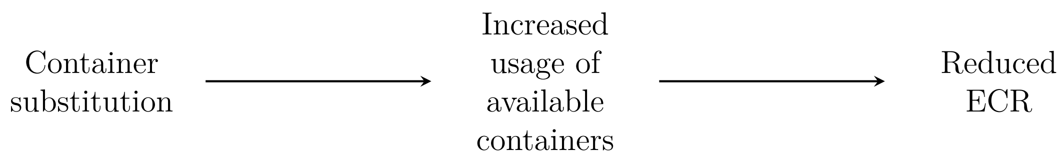

Figure 5.11: *Explanation of how container substitution can reduce ECR.*

Correlation between Barrier and Container Substitution
When analysing barriers, container substitution can possibly manage the problem with *technical imbalance*. By asking customers if they are willing to change their demands and use a container type that is available, the technical imbalance can be reduced. However, this requires increased communication and collaboration between the customer and the company responsible for the transportation of goods.

5.1.11 Container Leasing

Leasing containers instead of owning them, is a way for shipping lines to reduce their ECR (Braekers et al., 2011) (see section 2.5.11). These containers are used to transport goods one way, before the leasing company then is responsible for them again. This supports the argument that ECR can be reduced for shipping lines if they lease containers. However, it still fails to prove if the overall ECR is reduced. Braekers et al. (2011) explain, there is a risk that the surpluses and deficits of containers are just being moved from one actor to another, in this case from shipping lines to leasing companies. Container leasing might therefore only reduce ECR for a single actor (see figure 5.12). This could potentially lead to sub-optimization of the container transport chain where the same amount of ECR still is performed. When interviewing shipping lines, two of them mentioned that they lease containers in areas where they have a deficit of containers. One of the shipping lines also added that this solution have an insignificant impact on ECR due to the small share of leased containers used by the shipping lines today. Because of this sub-optimization, the solution is assumed to have low potential regarding impact for reducing ECR. However, since leasing of containers are available today the solution is believed to have high potential regarding feasibility to implement.

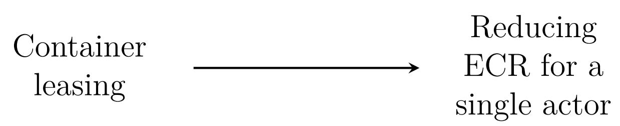

Figure 5.12: *Explanation of how container leasing can reduce ECR.*

Correlation between Barriers and Container Leasing
As a potential solution to the ECR problem, container leasing will obviously affect the barrier *container fleet size* since the fleet size consists of both owned and leased

containers. Having a fleet of entirely leased containers would, from an ECR perspective, reduce a transport company's need to perform ECR. However, as already pointed out by Braekers et al. (2011) in the section above, container leasing might just transfer ECR from one actor to another, leading to sub-optimization in the container transport chain. To ensure the effect on owning versus leasing containers, further research must be done.

Furthermore, the barrier *uncertainty factors* could be mitigated through the implementation of container leasing. In order to cover up for unexpected shortages of containers, shipping lines can lease containers from leasing companies. In that way, empty containers will not have to be retrieved before goods can be transported, which ultimately would help reduce ECR. The leased containers would in this example be used as a safety stock.

5.1.12 Increased Transport Price

According to representatives from a transport operator, an increased price for transporting goods could potentially help reduce ECR. Because of the low transportation cost today, goods are shipped around the globe for handling and processing. As an example, shrimps from Norway are mentioned. The shrimps are first transported to Asia for peeling, then they are transported to the Baltics for packaging before being transported back to Norway, where they are being sold. Thus, an increased price of transportation might lead to less wasteful transports between countries and more handling and processing of goods being done in one and the same country. The representatives further argue that this can be done by increasing the power and awareness of consumers. For example, if the new Iphone 11 Pro costs 23'200 SEK in Sweden, the price could be increased by 0,5 SEK to 23'200,5 SEK to cover the increased transportation cost. Hence, an increased price for each product could lead to increased transport revenues, which in turn could lead to investments in better transport solutions to reduce ECR (see figure 5.13).

Figure 5.13: *Explanation of how an increased transport price could lead to reduced ECR.*

Other actors involved in this study were more reluctant to this idea and found it very difficult to implement. Two shipping lines mentioned competition as the main challenge. They both mentioned how a competitor, offering a lower price, would sweep in and steal customers if they increased their prices. One shipping line doubted that an increased transport price would lead to a reduction in ECR. Instead, they believed the money would go to other areas of improvements. Moreover, a 3PL argued that a solution like this would not lead to any improvements, neither for a single company nor the container transport chain in general. Instead, the 3PL believed that more incentives existed for actors to reduce the price further, as it would lead to increased competition, which would foster better inventions and more development. No argument was found in the literature for this kind of solution. Based on the challenges related to increased transport price, the solution is assumed to have low potential regarding impact for reducing ECR and low potential regarding feasibility to implement.

Correlation between Barrier and Increased Transport Price
By changing the transport price for a transporting company, their strategy is inevitably changed. An increased transport price would potentially increase the income for a company, as long as customers still buy the service. This increased income can be spent on new investments to reduce ECR and consequently, this is a solution to manage the barrier *strategies and operational practices*. However, it can also be discussed that an increased transport price would make ECR more economically feasible, thus increasing ECR.

5.1.13 Standardization of Containers

Standardization of containers are used to facilitate transportation and handling of goods (van Ham and Rijsenbrij, 2012) (see section 2.1). According to one shipping line, further standardization of containers would help reduce ECR. They believe that through standardization, the storage of containers would decrease at all ports and depots, thus leading to reduced technical imbalance and less ECR (see figure 5.14). For example, they have seen a reduction of ECR since the 20ft container was standardized. Before then, the 20ft container was available in two different designs, having different restrictions in maximum load. The same opportunity is now approachable for the 40ft containers, which increasingly are turning into HCs. A terminal operator also believe standardization of containers would be a good idea, as it would make their planning process easier. Based on the success of the previous standardization of 20ft containers, the solution is believed to have medium potential regarding impact for reducing ECR.

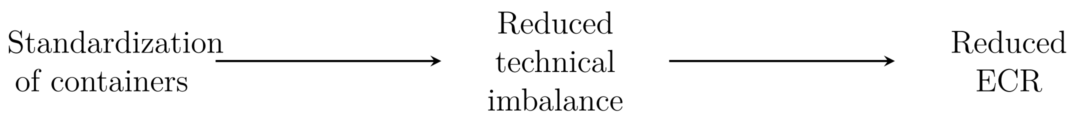

Figure 5.14: *Explanation of how standardization of containers can help reduce ECR.*

Branch (2006) argues that different types of goods are better suited for different types of containers (see section 2.4.2). For example, meat or fresh fruit needs to be transported in a refrigerated container, making it a challenge to standardize containers while still being able to transport all kinds of goods. This is of course true, and the impression after interviewing the shipping lines is that they understand this and do not want to develop a single standardized container for all types of goods. However, they see a benefit in reducing containers with essentially the same design. The example with a standard 40ft container and a 40ft HC container above, is a great example of what they want to achieve through standardization. A challenge with this solution, mentioned by all shipping lines, is the time it takes to phase out old containers and add new ones. A shipping line's container fleet is estimated to consist of hundreds of thousands containers, making it a major investment for them. According to multiple actors in this study, a container's lifetime is estimated to be around 8-10 years, on average. Thus, swapping out old containers for new ones will require both time and money. In other words, this solution cannot be done overnight. Based on these challenges, the solution is assumed to have low potential regarding feasibility to implement.

Correlation between Barrier and Standardization of Containers
As mentioned in the beginning of this section, standardization of containers has already proven to manage the barrier *technical imbalance*. However, further standardization can be done to reduce the technical imbalance more in the future.

5.1.14 Shipper Owned Containers

Shipper owned containers (SOC) are containers owned by the importer/exporter, as explained by Manaadiar (2018) (see section 2.1.1). It has not been found as a solution to reduce ECR in the literature. Nevertheless, it has been discussed as a possible solution when talking with some of the actors. One shipping line says that they transport some SOCs today. According to this shipping line, SOCs simplifies the matching of import and export for a company as they control the flow of goods in a closed system (see figure 5.15). Together with another shipping line, they explain that a prerequisite for this, to reduce ECR, is that the importer/exporter have a big and even volume flow of goods in opposite directions between two areas. And it is up to the importer/exporter to make sure all containers are loaded with both import and export. In this scenario, the shipping line merely become a transport operator, offering transportation from point A to point B. Volvo is brought up as an example of a company capable of owning SOCs. If they buy 200 containers and load them with machine parts and components from Sweden, they could use a shipping line's vessels for transport to China, where the containers are being unloaded and re-filled with components needed for the car production in Sweden.

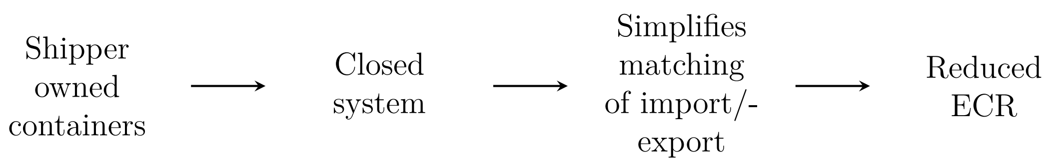

Figure 5.15: *Explanation of how SOC can help reduce ECR.*

A challenge to this solution is to find importers/exporters that are willing to own their own containers, as mentioned by two shipping lines and a terminal operator. They all believe that the demand from importers/exporters to do this is very low, mainly due to high investment costs for containers and machines to handle them.

Transportation of containers are not part of a producing company's core competence. Importers/exporters are expected to rather buy the transportation service from shipping lines and/or 3PLs instead of trying to handle this themselves. Based on this challenge, the solution is assumed to have low potential regarding feasibility to implement. The potential regarding impact for reducing ECR is also assumed to be low due to the fact that companies rarely have even flows of import/export between two areas.

Correlation between Barrier and Shipper Owned Containers
As promised volumes of delivered containers to customers must be fulfilled due to *contracts* (see section 4.3.8), they have proven to potentially increase ECR, thus acting as a barrier for reduced ECR. If customers instead own their own containers, it will be their job to match the size and number of containers available for their import/export demand. A contract between, e.g a shipping line and an exporter, would therefore not be needed and SOCs are consequently a way to manage this barrier.

5.1.15 Non-applicable Solutions

When conducting the interviews, the respondents were asked to think freely regarding possible solutions for reducing ECR. This resulted in proposed solutions that, according to the authors, most likely will be impossible to implement in reality, even though they might have a major impact on ECR. These solutions will be compiled in this report with the knowledge that they are not applicable in reality. However, they show the complexity of the problem and what is needed in order to improve ECR on a larger scale.

The first non-applicable solution was extracted from the interview with a shipping line and relates to the reduction of ports in Sweden. According to them, an increased number of ports and depots increase the requirement of having containers available in several places at once. Instead of being forced to perform ECR to several places, the reduction of ports would gather the repositioning to few ports, potentially reducing the total need for it. Further discussion indicates that the shipping line do not believe that the solution is applicable as ports have underlying driving forces. A port is either owned by the municipality, who wants to attract people and revenue to an area, or a company, whose objective is to increase profits. The driving forces from these actors will, with reason, make a reduction of ports impossible.

The second non-applicable solution, also mentioned by a shipping line, is an increase of ports outside of Sweden. This would result in less impact of the existing congestion at big ports today. When a port is congested, an increase of ports would result in possibilities to stop somewhere else, avoiding the delay that otherwise would arise. Avoiding delays would in turn result in less need for ECR in Sweden. However, the ECR would increase outside of Sweden with an increased number of ports, as mentioned in the paragraph above. This solution would therefore be counterproductive even though it might serve Sweden positively.

The third non-applicable solution was mentioned by both a shipping line and a transport operator, and relates the implementation of monopoly or oligopoly. As competitors affect one another when it comes to matching import and export, a reduction of actors would increase the possibility to find these matches. The shipping line also mentioned how the existing shipping lines could divide Sweden into three areas and let each shipping line be responsible for one area. Without competition from the other shipping lines within the area, a sub-optimization of the imports and exports can be done. However, this solution is difficult to implement in multiple ways. First and foremost, it is illegal in a free market as it impedes competitiveness but it would also affect consumers, as prices can be raised freely from the dominant actors.

The last non-applicable solution was discussed by a transport operator and responds to the problem of matching import with export. According to them, the big problem is that Sweden's population is located in the south while a lot of the exporting industries are located in the north. To be able to match import with export in a better way, the population of Sweden therefore has to move to exporting areas, evening out the existing imbalance. It is however impossible to force people to move in a democracy making this solution non-applicable.

5.2 Potential of Different Solutions

The potential of each solution has been described in section 5.1. Based on this potential, the solutions can be compared to each other. In order to facilitate this comparison, different clusters are formed to group solutions with similar potential. These clusters are presented in figure 5.16, and further analysis regarding differences between the solutions are made. The matrix contain two different dimensions; feasibility to implement a solution and impact of the said solution. These two dimensions are focusing on the system at large and not just a single actor's potential in implementing a solution.

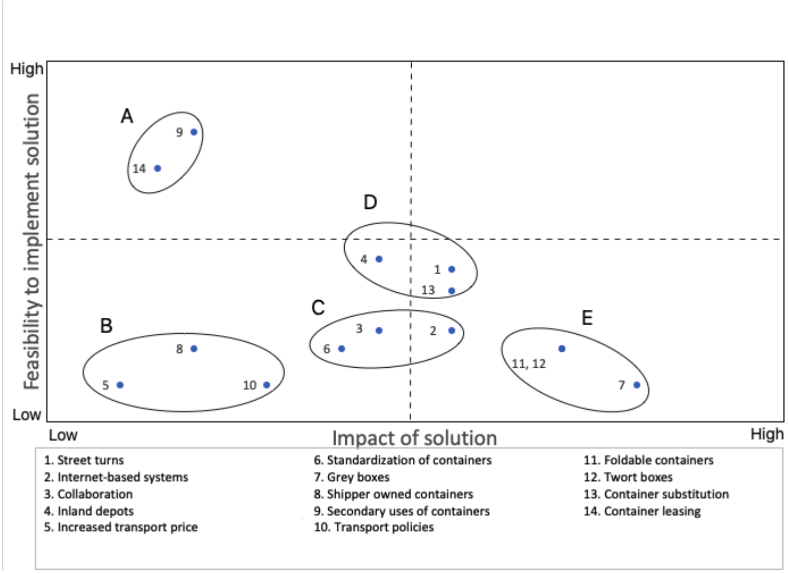

Figure 5.16: *Potential of different solutions, divided into clusters.*

Cluster A
The two solutions secondary use of containers and container leasing can be found in the top left corner of the matrix (cluster A). Both solutions are assumed to have high potential regarding feasibility to implement. This can be explained by the fact that both solutions already exist today and are being used by container owners, which in this study refers to shipping lines. As these two solutions only concern one actor group, it might explain the limited potential the solutions have regarding impact for reducing ECR. Container leasing is believed to have a slightly lower potential regarding impact for reducing ECR, compared to secondary use of containers. This is related to the risk that ECR only is transferred from one actor to another. Secondary use of containers, on the other hand, actually reduces ECR. The thing that limits this solution's potential regarding impact for reducing ECR, is that it only concerns a container's last voyage, and thus not occurs regularly.

Cluster B
The three solutions with lowest overall potential are increased transport price, SOC, and transport policies. These solutions can be found in the lower left corner of the matrix (cluster B). Increased transport price is considered to be the least effective solution for reducing ECR. This is mainly related to the big uncertainty surrounding this solution. Increasing the price of a product will not necessarily lead to increased transport revenues. And even if revenues related to transportation increased, it would not necessarily lead to improvements for reducing ECR. Another solution that is surrounded by a big uncertainty is transport policies. Even if the uncertainty itself is not the same, it causes the same type of problem. Transport policies can, according to both literature and empirical findings, lead to unintended consequences. This uncertainty justifies for the solution's low potential regarding both feasibility and impact for reducing ECR. However, if the policies are successful, they are believed to have a larger impact on reducing ECR, compared to an increased transport price.

The third solution in this cluster is SOC. This solution is not surrounded by the same uncertainty. The solution already exists in the container industry today. However, it requires a big and even flow of goods, which limits the number of companies capable of implementing this solution. Furthermore, these companies need to be willing to invest in both containers and handling equipment, which are typically not involved in their core competences, limiting the number of companies even further. Hence, the solution has a low potential both regarding impact for reducing ECR and feasibility to implement and belongs with the other two in the lower left corner of the matrix.

Cluster C

Cluster C consists of the solutions internet-based systems, collaboration and standardization of containers. They are all hard to implement because they cannot be implemented by solely one actor in the container transport chain. The actors are instead dependent on other actors to make the solution applicable, reducing the possibility to make it work. Looking at the solutions' impact for reducing ECR, they are all considered to have a medium impact. This is due to their reduced ability to be implemented without violating laws and affecting the possibility to transport certain goods in certain container types.

Internet-based systems and collaboration are assumed to have the same potential when looking at feasibility to implement. However, this might be changed depending on the type of collaboration that is about to be implemented and the size of the internet-based system. In this report, however, collaboration is supposed to be comprehensive and the internet-based system is supposed to be used by all actors, making the solutions similar. When analyzing their impact for reducing ECR, collaboration's impact is assumed to be lower. This is because collaboration, according to the empirical findings in this report, is limited to the rules of the free market. The solution internet-based systems, on the other hand, aims at improving information sharing and transparency, which can lead to a reduction for ECR. These systems can be designed in different ways. The literature describes a common internet-based system as a "virtual container yard" where actors can share information regarding container availability and upcoming transports. However, the actors must be willing to share this information to others. From the empirical findings, the block chain technology is mentioned as an up-coming internet-based system. This technology is in its' start-up phase today, and its' impact for reducing ECR is therefore moderate at the moment. However, this potential is unexplored and could as well be a lot higher.

Standardization of containers is assumed to be harder to implement and have lower impact for reducing ECR than both internet-based systems and collaboration. The impact is lower due to the fact that standardization of containers is assumed to be limited to certain container types. The most obvious example are the standard 40ft container, which is about to be standardized to a 40ft HC container. Standardization of other container types would potentially reduce the opportunity to transport certain goods, and the solution would consequently be counterproductive. Also, containers are today created to match goods (Branch, 2006). The solution is therefore hard to implement because of customers' demand for different container types. However, if customers instead are willing to match their goods to containers, the feasibility and impact would increase.

Cluster D

In cluster D, three different solutions to reduce ECR are found: street turns, inland depots and container substitution. These solutions are all, more or less, applied in today's container transport chain to reduce ECR. However, the solutions are usually facing resistance when used, thus making them medium feasible to implement. Customer requirements of certain containers and when they are needed also reduce the potential regarding the impact of these solutions, giving them a medium, instead of a high, impact for reducing ECR.

When analyzing street turns and inland depots to each other, street turns are assumed to have a higher impact for reducing ECR than inland depots. This can be explained by just looking at the empty vehicle kilometers travelled between an importer and an exporter. With street turns, the container is moved directly between the importer and exporter. However, when using inland depots, an extra movement between the depot and the importer/exporter is made, thus increasing ECR. When analyzing these solutions regarding how feasible they are to implement, however, inland depots take the lead. This is due to the fact that inland depots can be used when street turns are unable to be performed, which usually is the case. Inland depots are therefore reducing the challenge regarding time windows, which street turns are dependent on, making inland depots easier to implement.

Container substitution is considered to have the same impact for reducing ECR as street turns. This is because empty containers, if container substitution is not performed, needs to be moved long distances to meet the demand. The solution is assumed to be harder to implement than both inland depots and street turns. This is due to customers' unwillingness to change container, which is not strange when price and/or difficulty in matching the goods with the container is increased.

Cluster E

Finally, cluster E includes the three solutions foldable containers, tworty box, and grey boxes. These solutions all have high potential regarding impact for reducing ECR, but low potential regarding feasibility to implement. Hence they can be found in the lower right corner of the matrix. The two solutions foldable containers and tworty boxes have a lot in common. They are both related to the modification of a single container, and as such they are dealing with the same type of problems. Folding a container, or combining two containers, might increase the risk of damage. A container that breaks, often costs more in term of reparation costs. Both types also require more handling, which increases costs as well. This explains why the two solutions are believed to have the same potential regarding feasibility to implement. One thing that separates the two solutions is how it reduces ECR. Foldable containers can be stacked on top on each other, leading to more empty containers being transported at the same time. This is believed to reduce the number of transports of empty containers. Tworty boxes are, on the other hand, believed to reduce technical imbalance between 20ft and 40ft containers. Even if the two solutions reduce ECR in different ways, their overall potential regarding impact is believed to be the same.

The third solution in this cluster is grey boxes. This solution is different, compared to the other two since it wants to introduce a common container fleet by removing the ownership of containers. If the solution could be implemented, the impact for reducing ECR would be huge, since it optimizes the overall container fleet. However, therein also lies the problem of the solution. Removing the ownership of containers would be devastating for shipping lines since their mean of competition is their containers. Hence, it will be very difficult to persuade this actor group. And since they are the ones owning containers, they need to be involved for this solution to work. A number of questions have been raised, both in the literature and empirical findings, for example, in times of container shortages, which company is most entitled to use the shared containers? Overall, there are many challenges associated with grey boxes, which justifies the low potential regarding its' feasibility to be implemented.

6 Discussion

The previous two chapters have answered the research questions in this report by presenting drivers, barriers and solutions for reducing ECR. Furthermore, the correlation between solutions and barriers, and the potential for each solution has been presented. The findings and analysis are further discussed in this chapter, focusing on drivers vs barriers, combinations of solutions, managing barriers with possible solutions, solutions and their potential, complexity of the container transport chain and actor groups in the container transport chain. The four first sections are in line with the research questions of this report, and discusses ideas and thoughts on the findings and analysis. The two last sections discusses the container transport chain and the actors within it. This further elaborate on how the complexity of the chain and its' actors complicates the ECR problem.

6.1 Drivers vs Barriers

Two drivers and nine barriers for reducing ECR have been identified in this report. This could be an indication that the amount of barriers complicates a reduction for ECR more than the drivers facilitates it. However, it is equally likely that the various drivers and barriers impact the possibility to reduce ECR differently. Further research is therefore needed to show how much each driver and barrier affects the possibility to reduce ECR.

The empirical findings indicate that the financial aspect of ECR can act as both a driver and a barrier to reduce ECR for actors. All actors within the container transport chain recognize the savings that can be made if a reduction of ECR is obtained. However, at the same time, many actors acknowledge that they have to perform unnecessary ECR to earn money and stay competitive. As mentioned, the industry is characterized by very low margins and if actors can make profit while performing ECR, they do not care about the empty movement. This proves that actors' behavior regarding ECR is controlled by the market, making it hard to reduce ECR without risking a negative financial impact.

Previous research, e.g. Song and Dong (2015), together with empirical findings, demonstrate that customers' actions are a great barrier for reducing ECR. Customers' location and demand of containers can either facilitate or make it more difficult to reduce ECR for transporting actors. This proves that transporting actors alone cannot solve the ECR problem, but help from customers are important to achieve a positive development. Future research can therefore analyze customers' possibilities to facilitate reduction of ECR.

The empirical findings of this report has proven that the subject of ECR often gets lost when talking about environmental improvements. Instead actors tend to focus on solutions that makes the transport mode itself more sustainable (bigger vessels, more efficient engines), which not directly reduces ECR. To increase the environmental matter, customers could instead demand sustainable transportation with reduced ECR. The environmental driver regarding reduced ECR can then be more important than it is today. However, the argument can also be reversed. Thus, shipping lines could introduce environmental initiatives that reduce ECR. The customers will then understand that if they buy this service, they will contribute to a more sustainable solution.

Some of the barriers for reducing ECR can also be seen as drivers for other things. A company's strategies and operational practices can, for instance, act as a driver to make a company more profitable. However, as proven, this might reduce the possibility to reduce ECR. It can therefore be discussed if the company acts wrongly just because they do not consider a reduction for ECR to be the most important factor when making decisions.

6.2 Combination of Solutions

In chapter 5.1, 14 different solutions for reducing ECR are presented. Each solution is described separately but in reality, a number of these solutions can be combined to either strengthen or weaken the potential reduction of ECR. Below, some examples of combinations are presented and the potential effect these combinations can have to reduce ECR.

The four solutions street turns, inland depots, collaboration and internet-based systems are all interrelated and could, if combined properly, have a positive effect on each other. Street turns are, as described by Braekers et al. (2011) and confirmed by the empirical findings, difficult to implement. One way to improve this solution is to strengthen collaboration between different transporting actors. Collaboration can also be improved between actors transporting goods and their customers (importers/exporters). In areas where street turns are possible but hard to implement, inland depots could be used instead. Even if inland depots lead to an extra movement between the depot and the importer/exporter (compared to street turns), it still helps to reduce the overall ECR in a region. Finally, an internet-based system can be applied to increase the utilization of both street turns and inland depots, as it helps increase both information sharing and transparency between actors. Furthermore, a successful internet-based system requires extensive collaboration between involved actors.

Two solutions that have a positive effect on each other, if combined properly, are standardization of containers and secondary uses of containers. Standardization of containers is used to reduce the number of container types available to transport goods, which ultimately would help reduce technical imbalance and thus reduce ECR (see section 5.1.13). A challenge related to standardization of containers is the time it takes to phase out old container types. Secondary uses of empty containers could help mitigate this challenge. If container types that needs to be phased out are prioritized when selling containers, the phase-out process would be more efficient and less time-consuming, resulting in a faster standardization process.

Two other solutions that could have a positive effect on the reduction of ECR, if combined properly, are container substitution and collaboration. Container substitution relates to a customer's willingness to switch between container types (see section 5.1.10). One way to improve this solution is to increase the collaboration between companies transporting goods and their customers (importers/exporters). A negative side effect related to container substitution, discussed in the empirical findings, is reduced customer satisfaction. If customers could be more included in the transportation process, they might understand why container substitution is being used (as it helps reduce ECR). Hopefully the increased collaboration could help mitigate the reduced customer satisfaction and thus improve container substitution.

All solutions do not, however, have a positive impact on reducing ECR if combined. For example, standardization of containers would be negatively affected if the solutions tworty boxes and foldable containers are being implemented. Tworty boxes and foldable containers introduce more container types in the container transport chain. Introducing more container types would increase the negative aspects of the barrier technical imbalance, which the solution standardization of containers tries to mitigate.

6.3 Managing Barriers with Possible Solutions

Table 6.1 presents the correlation between identified barriers for reducing ECR and possible solutions that could help manage these barriers. The correlation between barriers and possible solutions has been made in section 5.1.

Barrier	**Solutions**
Trade Imbalance	None
Technical Imbalance	Standardization of Containers Secondary Uses of Containers Tworty Boxes Container Substitution
Number of Actors	Collaboration Internet-based Systems
Contracts	Internet-based Systems Shipper Owned Containers
Uncertainty Factors	Container Leasing Inland Depots
Dynamic Operations	Internet-based Systems Collaboration Inland Depots
Blind Spots	Internet-based Systems
Strategies & Operational Practices	Street Turns Inland Depots Foldable Containers Increased Transport Price Transport Policies
Container Fleet Size	Grey Boxes Tworty Boxes Standardization of Containers Container Leasing

Table 6.1: Summary of barriers and solutions to manage them.

The empirical findings in this study confirms previous research made by Boile et al. (2004) and Olivo et al. (2005), stating that trade imbalance is the underlying reason to why ECR exists. Local trade imbalance in Sweden occurs due to an uneven balance between import and export in certain areas. These imbalances are, in turn, believed to originate from Sweden's geographical layout, with most of its' population in the south and most of its' industries in the north. Determining the root cause behind local trade imbalance helps describe the complexity of the barrier. How do one change the geographical layout of a country? Or decide where people should live? There are no easy solution to deal with trade imbalance, neither locally nor globally. A correlation between trade imbalance and possible solutions regarding ECR is therefore not presented in section 5.1. The best way to mitigate the effects of trade imbalance and its' implication on ECR is instead to focus on other barriers related to ECR.

The correlation in the table above is supposed to work as a framework for actors in the container transport chain. The idea behind the framework is that an actor can use the table for guidance and inspiration on how different barriers for reducing ECR should be managed. If an actor, for example, wants to manage the barrier technical imbalance, they can choose between standardization of containers, secondary uses of empty containers, tworty boxes and container substitution. However, some solutions are only relevant for certain actors. Secondary uses of empty containers are for example only of importance to shipping lines, since they are the ones owning containers. A 3PL could instead choose to focus on container substitution in order to manage technical imbalance from their perspective.

Previous literature has dealt with barriers and solutions as two separate entities. Song and Dong (2015) present both causes and solutions for ECR. Likewise, Braekers et al. (2011) describe the ECR problem in general and list six different solutions for reducing ECR. However, none of these authors make a correlation between barriers and solutions. This demonstrates that there is a gap between research and literature, which this report intends to fill. However, further research needs to be performed in order to confirm the findings in this report.

6.4 Solutions and their Potential

When trying to define the potential of each solution related to reducing ECR, it is important to point out how difficult it is to actually define potential. In this report, potential refers to mainly two things; (a) how feasible it is to implement a possible solution and (b) how big impact the possible solution will have. In section 5.1 each solution is given a potential based on this. However, the potential does not take into consideration how multiple solutions could be combined in order to positively, or negatively, influence the reduction of ECR, as discussed in a previous section above. It can be argued that a solution that can be combined with other solutions, to influence the reduction of ECR positively, should be given a higher potential. Collaboration could be an example of that, as the solution can be combined to several other solutions and are believed to strengthen many of these other solutions even further. In the same way, it can be argued that a solution that can be combined with other solutions, to influence the reduction of ECR negatively, should be given a lower potential.

Another aspect that is not taken into consideration when defining the potential of each solution is the number of barriers each solution is believed to handle. It can be argued that a solution that can handle several barriers should be given a higher potential compared to a solution that can handle only one barrier. The solution internet-based systems is, for example, believed to deal with four different barriers (see section 5.1.3), which arguably could give it a higher potential. However, as the correlation between barriers and possible solutions for reducing ECR have not been defined in this way in the literature before, further research needs to be conducted before this assumption can be made. Different barriers can have different impact on the ECR problem. For example, is technical imbalance affecting ECR more compared to container fleet size or dynamic operations?

In figure 5.16, each solution is divided into five different clusters (A-E). These clusters do not necessarily include solutions that could be combined to each other. Instead, every solution in each cluster is believed to have similar potential, which helps simplify the comparison between them. In the matrix, the box in the top right corner corresponds to solutions with high potential (both in terms of feasibility to implement and impact). It is currently empty, which emphasizes how difficult it is to deal with barriers related to ECR. The goal, however, is that this study can help increase the understanding of the ECR problem and the correlation between barriers and solutions. If more research are made regarding the potential of each solution, and also, if a combination of solutions can increase/decrease the potential, one or more solutions could hopefully be moved into the top right corner in the future.

The authors of this report believe that solutions in cluster D have the highest potential. These solutions have already proven to reduce ECR to some degree, but there are still challenges to overcome to increase their impact further. The solutions in cluster A and E contain extremes on each continuum (feasibility and impact), which makes them less likely to reduce ECR in a greater perspective. However, if further research can affect the challenges that reduce the feasibility for solutions in cluster E, these solutions could have great potential in changing the transport industry. The same can be said about cluster C, however, the potential for these solutions is assumed to have less impact. Finally, cluster B contain solutions with an overall low potential (both in terms of feasibility to implement and impact). These solutions could potentially be ignored. However, further research needs to be performed in order to confirm whether or not this is true.

6.5 The Complexity of the Container Transport Chain

The container transport chain has proven to be complex: the industry is dealing with low margins, many actors affect one another and time is a crucial factor. Changeable environments and unforeseen events within the chain therefore reduce the possibilities to act as planned, presumably resulting in ECR when it should not be needed.

The whole transport industry is characterized by low margins (see section 4.2.1). This is a result of having many different actors within the transport service industry. Customers buying services therefore have the opportunity to outplay different actors towards each other, driving down the prices. Actors consequently have to be very competitive to win deals while still being profitable. This competition has proven to result in increased ECR, as long as it is economically feasible to perform it. The amount of actors therefore affects the margins of the industry, which in turn leads to unnecessary ECR.

Another thing that potentially could increase actors' competitiveness, except from offering a low price, is to match customers' time windows of delivery. Customers want their goods at a certain time in order to match their production schedules or time windows of delivery etc. Finding suitable time windows between an importer and an exporter is hard, and therefore the possibilities to reduce ECR, by using street turns, are limited. Similar limitations are also a result of the contracts issued between customers and transporting actors. The container transport chain is characterized by short contracts between actors (see section 4.3.8). The customer base is consequently changeable and customers come and go between different transporting actors. Having an even flow of importing and exporting goods, facilitating the use of street turns and inland depots, is therefore hard to achieve for different actor groups. The time aspect of customer demand and contracts, consequently affecting the possibility of achieving stable flows, results in increased ECR.

The complexities are further affected by the unforeseen events that usually occur in the container transport chain. A container is likely to pass by several different actors and nodes before it is delivered to the customer. Delays affect the possibility to coordinate a container's movement between these actors and nodes, increasing the complexity that the amount of actors already cause. In the same way, unforeseen events affect the possibility to meet customer demand of when goods are supposed to be delivered, resulting in a deteriorating customer relationship. This, in turn, can result in losing customers and worsen the possibilities to achieve even flows.

6.6 Actor Groups in the Container Transport Chain

Analyzing each actor group on its' own can increase the understanding of the container transport chain. Starting with shipping lines, they have opinions about all solutions discussed in this report (see figure 5.1). This is most likely because they are the owners of containers. Owning containers (which is the mean of competition in the container transport chain) gives shipping lines a special position compared to other actors. It lets them control the backward supply chain, i.e. the flow of empty containers (see section 2.1). This results in a greater overview of the system and lets them define the terms in the chain. They are also an actor working globally, and this probably results in better knowledge about possibilities and challenges for implementing solutions to reduce ECR.

3PLs are, just like shipping lines, an actor group with global presence. They perform door-to-door solutions for customers and usually have their operations in different locations around the globe. However, as they do not own containers, some of the solutions cannot be performed by them. This limits their ability to reduce ECR compared to shipping lines.

Transport operators perform their services at a regional level. As transport operators are responsible for the inland transportation they can be seen as customers to shipping lines and 3PLs. Their ability to reduce ECR by themselves is therefore limited. However, as they act as customers for several actors, they might see where possible solutions should be implemented in order to benefit the container transport chain as a whole.

As terminal operators just perform movement of containers at terminals, they can be seen as a local actor group. During the interviews, it appears that they have opinions about several solutions, and they also tend to be more positive to implement these solutions to reduce ECR. However, many times, a terminal operator comments on a solution without having the possibility to actually be able to affect the outcome of the solution. The reality is that this actor group needs to adapt to other actors within the transport chain and thus, have a pretty low ability to create real change. Being a local actor in a global value chain might not only be a negative thing however. By not having the big overview, new ideas to improve the system can flourish without thinking too much about the challenges they imply. Hence, as an actor group they can still contribute to solutions regarding reducing ECR.

When comparing all actor groups with each other, an internal ranking can be made. The actor group with shipping lines is most powerful, mostly due to their ownership of containers and their global presence. The actor group containing 3PLs comes in second place due to their global presence. The actor group containing transport operators is considered to be the third most influential, mostly due to their regional presence and their customer relationship to other, more influential, actor groups. Finally, the actor group containing terminal operators are considered as the least influential actor group, since it only has a local presence and often needs to adapt to the other actors.

Based on this ranking it might be possible to draw the conclusion that, in the end, it is the owner of containers (i.e. shipping lines) that can affect ECR the most. Furthermore, other actor groups depend on shipping lines and their decisions regarding the movement of empty containers. Hence, solutions for reducing ECR should be driven by shipping lines. However, the other actor groups all play important parts in this process of change. If shipping lines are allowed to decide which solutions should or should not be implemented the risk is that they only will make decisions that are beneficial for them. 3PLs act on a global level as well, and perform many of the same tasks as shipping lines, which allows them to contribute with valuable information. Transport operators and terminal operators are more dependent on the other two actor groups, but from an ECR perspective their input can be valuable when it comes to solutions and impact of solutions on a regional and local level. In order to reduce the overall ECR in the container transport chain, the mentality between involved actor groups needs to be changed. The goal should be to come up with solutions that benefit the container transport chain as a whole, i.e. all actor groups, and not just a single actor group within the chain.

Furthermore, a discussion has to be made about the global versus local perspective on ECR. What level should ECR be adjusted to? Is it worth sub-optimizing ECR on a local/regional level if it has a negative impact on the global level? Take the solution with inland depots as an example. Increasing the number of inland depots locally will not alone help reduce ECR. As two shipping lines explained in chapter 5.1.4, more depots does not automatically lead to an increase in the number of available containers, instead it divides the existing number of containers. For this solution to be effective there has to be enough containers available in an area so that these can be spread out on a number of depots. However, for a shipping line, it might be hard to justify why a local area should have an excess of containers available. To conclude, it might be hard to convince shipping lines to reduce ECR in a local area if it has a negative impact on their utilization on a global level.

7
Conclusion

The study has identified two drivers, nine barriers and fourteen possible solutions to reduce ECR. There is a unilateral identification of the drivers, and all actors emphasize the importance of the financial driver over the environmental one. As long as the actors make money on transporting an empty container, the environmental perspective is disregarded. Furthermore, the subject of ECR often gets lost when talking about environmental improvements. The barriers highlight the complex environment of the container transport chain. The chain consists of many actors, who all act in ways that makes reduction of ECR difficult. External factors that cause delays, such as bad weather and congestion, are also obvious problems for reducing ECR. In this study, the conclusion can be drawn, that all barriers are present simultaneously and affect different actors differently. Shipping lines, as the owner of containers, are identified as the actor group most affected by the barriers. Furthermore, this study indicates that many solutions to the ECR problem currently only exist theoretically. The applicability and usefulness of the solutions consequently vary. However, much indicates that the solutions require widespread collaboration between actors to achieve a major impact on ECR.

This report has presented a correlation between barriers and possible solutions for reducing ECR (see table 6.1). This correlation is believed to facilitate the management of barriers by connecting each barrier to one or more solutions. The idea is that actors within the container transport chain can use this framework as a guide and inspiration to help tackle problems related to ECR from multiple angles. Furthermore, some actors within the chain have a greater opportunity to implement this framework and influence the process of change. Shipping lines have more power compared to other actor groups within the chain, mainly due to their ownership of containers and global presence. Thus, the container transport chain would benefit from shipping lines being a driving force when managing barriers for reducing ECR.

In order to facilitate a comparison between each solution and their potential, a matrix has been created (see figure 5.16). The matrix showed that many solutions had a relatively low overall potential as no solution was found in the top right corner. This proves that it is hard to find solutions that are both feasible to implement and have a high impact for reducing ECR. The two solutions container leasing and secondary uses of empty containers are believed to be most feasible to implement as they already exist to a certain degree today. Furthermore, grey boxes, tworty boxes and foldable containers are believed to have the highest potential when it comes to impact. However, both literature and empirical findings confirmed that these solutions only would work in theory. The most promising solutions, when it comes to overall potential, are the ones in the middle of the matrix (i.e. street turns, inland depots, container substitution etc.).

7.1 Academical and Practical Contribution

The existing literature address barriers and possible solutions as two separate entities within the area of ECR, but does not identify the correlation between them. In this matter, there has been a gap in research and literature on how possible solutions can help overcome existing barriers regarding ECR. This thesis has contributed to fill this gap of literature and research. Furthermore, input from different actors within the container transport chain has, together with previous research, helped define the potential of each solution. In this context, high potential solutions refers to (a) how feasible it is to implement a possible solution and (b) how big impact the possible solution will have. The potential of each solution is also contributing to the academical research.

By identifying the correlation between barriers and possible solutions for reducing ECR, actors within the container transport chain can get a better understanding on how these barriers can be managed. Furthermore, defining a potential for each solution might help actors decide which solutions are worth pursuing in order to reduce ECR. However, it is important to point out that the aim of this thesis has been to examine the ECR problem from a societal perspective. This means that no solution has been adapted to favour a single actor. In order to reduce ECR on a local and/or regional level the authors believe the mentality between involved actor groups needs to be changed. The goal should be to come up with solutions that benefit the container transport chain as a whole, i.e. all actor groups, and not just a single actor group within the chain.

7.2 Suggestions for Future Research

Reducing ECR has proven to be a hard problem to solve. A suggestion, from the transporting operator, was instead to reduce the environmental impact by looking at different transport modes used in the container transport chain. Instead of reducing ECR, the movement of empty containers should be performed by the best type of transport. According to this actor, the movement of containers within Sweden could, preferably, go by train. However, the effect that this would have on the environment and the system at large must be investigated further. It is therefore proposed, in future research, to analyze different modes of transport for container movement and the effects they result in. Which modes are best to use in Sweden to reduce the environmental impact that the container movement entails? How can different modes of transport be used without affecting the system negatively? And what development for the transport modes is done to reduce future environmental impact?

The potential for each solution has been estimated by the authors of this report, based on previous research and empirical findings. However, these estimations involves uncertainties. Future research is therefore required to confirm or deny the estimations done in this report. As mentioned in section 6.4, combinations of solutions can potentially affect the outcome of reducing ECR, both positively and negatively. Furthermore, a solution's effect on different barriers can affect the outcome of the potential. Due to restrictions in time and scope, these things have not been examined in this report. However, it is proposed to examine the potential for each solution further in future research, in order to get a more reliable result.

In this report, only actors within the container transport chain have been interviewed. However, customer behavior has proven to have a great impact on the container transport chain (see section 6.5). Customers have the potential to either increase the complexity of the chain, or decrease it. In future research, it would therefore be interesting to interview some of the big importers and exporters in Sweden to examine feasible actions to reduce their negative impact on the ECR problem.

One of the contributions that this report provides is the correlation between barriers and possible solutions. The correlations have been developed by the authors of the report and are assumed to be reasonably accurate. However, the assumptions made need to be confirmed by future research.

Reference List

Aharonovitz, M. C. S., Vieira, J. G. V., & Suyama, S. S. (2018). How logistics performance is affected by supply chain relationship. *The International Journal of Logistics Management*, *29*(1), 284–307.

Alphaliner. (2020). Top 100 shipping companies. https://alphaliner.axsmarine.com/PublicTop100/

Boile, M., Mittal, N., Golias, M., & Theofanis, S. (2006). Empty Marine Container Management: Addressing a Global Problem Locally, In *Transportation research board 85th annual meeting*, Washington DC, United States. Transportation Research Board.

Boile, M., Mittal, N., & Theofanis, S. (2004). Empty Intermodal Containers - A Global Issue, In *Annual forum of the transportation research forum*, Evanston, Illinois, Northwestern University, Transportation Center,

Boile, M., Theofanis, S., & Mittal, N. (2008). Regional Repositioning of Empty Containers. *Transportation Research Record*, (2066), 31–40. https://doi.org/10.3141/2066-04

Braekers, K., Janssens, G. K., & Caris, A. (2011). Challenges in Managing Empty Container Movements at Multiple Planning Levels. *Transport Reviews*, *31*(6), 681–708.

Branch, A. E. (2006). *Export Practice and Management* (5th). London, Thomson Learning.

Bryman, A., & Bell, E. (2011). *Business Research Methods* (3rd). Oxford University Press.

Crainic, T. G., Gendreau, M., & Dejax, P. (1993). Dynamic and Stochastic Models for the Allocation of Empty Containers. *Operations Research*, *41*(1), 102–126.

Cruijssen, F., Dullaert, W., & Fleuren, H. (2007). Horizontal Cooperation in Transport and Logistics: A Literature Review. *Transportation Journal*, *46*(3), 22–39.

Di Francesco, M., Lai, M., & Zuddas, P. (2013). Maritime repositioning of empty containers under uncertain port disruptions. *Computers & Industrial Engineering*, (64), 827–837.

Dong, J.-X., & Song, D.-P. (2009). Container fleet sizing and empty repositioning in liner shipping systems. *Transportation Research Part E*, *45*, 860–877.

DSV. (2020). Flat rack container. https://www.se.dsv.com/sjofrakt/Transportenheter/Flat-rack-container

Ejvegård, R. (2009). *Vetenskaplig metod* (4:e upplagan). Lund, Studentlitteratur.

Engström, M., & Matsson, A. (2015). *Effektivisering av marina containerflöden* (Doctoral dissertation). Högskolan i Gävle.

Feng, C.-M., & Chang, C.-H. (2010). Empty container reposition planning for intra-Asia liner shipping. *Maritime Policy & Management*, *35*(5), 469–489.

GDV. (2020). High-cube containers. https://www.tis-gdv.de/tis_e/containe/arten/highcube/highcube.htm/

Green Cargo. (2019). *2018 helårssiffror* (tech. rep.).

Konings, R., & de Brito, M. P. (2008). *Container management strategies to deal with the East-West flows imbalance* (tech. rep.). Delft University of Technology.

Konings, R. (2005). Foldable Containers to Reduce the Costs of Empty Transport? A Cost–Benefit Analysis from a Chain and Multi-Actor Perspective. *Maritime Economics & Logistics*, *7*, 223–249. https://doi.org/10.1057/palgrave.mel.9100139

Kristiansen, T. (2010). Empty containers cost Maersk Line USD 1 billion a year. https://shippingwatch.com/articles/article4891909.ece

Lam, S.-W., Lee, L.-H., & Tang, L.-C. (2007). An approximate dynamic programming approach for the empty container allocation problem. *Transportation Research Part C*, *15*, 265–277. https://doi.org/10.1016/j.trc.2007.04.005

Li, L., Wang, B., & Cook, D. P. (2014). Enhancing green supply chain initiatives via empty container reuse. *Transportation Research Part E: Logistics and Transportation Review*, *70*, 190–204.

Lumsden, K. (2012). *Logistikens grunder* (3:e upplagan). Lund, Studentlitteratur AB.

Lumsden, K. (2007). Balances in the material flow, In *Fundamentals of logistics - a compendium of selected chapters*. Gothenburg.

Malchow, U. (2015). Tworty Box to Reduce Empty Container Positionings (A. Weintrit & T. Neumann, Eds.). In A. Weintrit & T. Neumann (Eds.), *Safety of marine transport: Marine navigation and safety of sea transportation*. London, Taylor & Francis Group.

Manaadiar, H. (2018). What is the difference between a shipper owned container and carrier owned container ?? https://shippingandfreightresource.com/difference-between-a-shipper-owned-container-and-carrier-owned-container/#

Monios, J., & Wang, Y. (2014). *Regional Stakeholder Solutions to Empty Container Repositioning Costs in Peripheral Regions*. Edinburgh Napier University, Transport Research Institute, STAR (Scottish Transport Applications and Research) Conference.

Notteboom, T., & Rodrigue, J.-P. (2020). Dry Ports, In *Port economics, management and policy*. New York, Routledge. https://porteconomicsmanagement.org/?page_id=629

Olivo, A., Zuddas, P., Di Francesco, M., & Manco, A. (2005). An operational model for empty container management. *Maritime Economics & Logistics*, *7*(3), 199–222.

Patel, R., & Davidson, B. (2011). *Forskningsmetodikens grunder: att planera, genomföra och rapportera en undersökning* (4:e upplagan). Lund, Studentlitteratur.

Rodrigue, J.-P. (2020). *The Geography of Transport Systems* (5th). New York, Routledge.

Rosa, A., & Roso, V. (2012). Dry port in concept and practice (D.-W. Song & P. M. Panayides, Eds.). In D.-W. Song & P. M. Panayides (Eds.), *Maritime logistics - a complete guide to effective shipping and port management*. Kogan Page.

Roso, V. (2009). *The Dry Port Concept* (Doctoral dissertation). Chalmers University of Technology.

Sandberg, E. (2007). Logistics collaboration in supply chains: practice vs. theory. *The International Journal of Logistics Management*, *18*(2), 274–293.

Santén, V., Alexandersson, M., Hörteborn, A., Rogerson, S., Svanberg, M., & Olsson, F. (2018). *Energieffektivisering genom ökad fyllnadsgrad i sjötransporter* (tech. rep.). SSPA.

Shintani, K., Konings, R., & Imai, A. (2010). The impact of foldable containers on container fleet management costs in hinterland transport. *Transportation Research Part E: Logistics and Transportation Review*, *46*(5), 750–763.

Song, D.-P., & Carter, J. (2009). Empty container repositioning in liner shipping. *Maritime Policy & Management*, *36*(4), 291–307.

Song, D.-P., & Dong, J.-X. (2012). Cargo routing and empty container repositioning in multiple shipping service routes. *Transportation Research Part B: Methodological*, *46*(10), 1556–1575.

Song, D.-P., & Dong, J.-X. (2015). Empty Container Repositioning (C.-Y. Lee & Q. Meng, Eds.). In C.-Y. Lee & Q. Meng (Eds.), *Handbook of ocean container transport logistics*. Springer.

Song, D.-P., & Xu, J. (2012). An operational activity-based method to estimate CO2 emissions from container shipping considering empty container repositioning. *Transportation Research Part D: Transport and Environment*, *17*(1), 91–96.

Song, D.-P., Zhang, J., Carter, J., Field, T., Marshall, J., Polak, J., Schumacher, K., Sinha-Ray, P., & Woods, J. (2005). On cost-efficiency of the global container shipping network. *Maritime Policy & Management*, *32*, 15–30.

Theofanis, S., & Boile, M. (2009). Empty marine container logistics: facts, issues and management strategies. *GeoJournal*, *74*, 51–65. https://doi.org/10.1007/s10708-008-9214-0

Trafikanalys. (2019). *Sjötrafik 2018* (tech. rep.). https://www.trafa.se/sjofart/sjotrafik/

Transporteca. (2020). The Shipping Process Explained. https://transporteca.co.uk/shipping-process/

Tworty Box. (2020). The TWORTY solution. http://tworty.com/index.php?p=2

van Ham, H., & Rijsenbrij, J. (2012). *Development of Containerization*. Amsterdam, IOS Press.

Vanovermeire, C., Sörensen, K., Van Breedam, A., Vannieuwenhuyse, B., & Verstrepen, S. (2014). Horizontal logistics collaboration: decreasing costs through flexibility and an adequate cost allocation strategy. *International Journal of Logistics Research and Applications*, *17*(4), 339–355.

Yin, R. K. (2009). *Case Study Research and Applications: Design and Methods* (4th ed.). London, SAGE Publications Ltd.

A

Appendix - Interview 1 template

Bakgrund

- Kan du börja med att berätta lite om företaget och vad det är ni håller på med?
  - Din position? Hur länge har du jobbat här?

Det här är vår första intervju så vi försöker mappa upp hur hanteringen av containrar ser ut så du kanske skulle kunna hjälpa oss att få en tydligare bild med hur allt hänger ihop?

- Vad är er roll i hanteringen av containrar?
  - Kan du ge ett exempel på en containers rörelse från det att den kommer till er till det att den lämnar?
  - Hur samarbetar ni med andra aktörer som hanterar containrar?
- Vad är anledningen till att tompositionering existerar enligt dig?
  - Vi har läst en del om detta men skulle vilja ha din åsikt på de största anledningarna till varför det finns?

Nuläge

- Är tompositionering ett problem för er?
  - Varför/varför inte?
- Arbetar ni för att minska tompositionering i dagsläget?
  - På vilket sätt arbetar ni (hur)? Själva/samarbete med andra aktörer?
  - Hur mycket känner ni att ni kan påverka hanteringen av tomma containrar?
- Händer det ofta att tomcontainrar inte finns tillgängliga?
  - Vad är orsaken till det?
  - Vad händer?
  - Händer det ofta?
- Vems ansvar är det att tomma containrar finns tillgängliga? (När?)
  - Vilken framförhållning måste kunderna ha för att få en tomcontainer i dagsläget?
  - Hur lång tid har ni på er att få fram en tom container? Finns avtal på tidskrav?

- Hur ser spårbarheten ut för containrar?
  - Delas denna informationen med andra aktörer?

Drivkrafter

- Vad är era drivkrafter till att minska tompositionering?
  - Ekonomiska
  - Miljön (utsläpp, kortare transporter etc.)
  - Hållbar för att öka konkurrenskraften
  - Samarbete med viktiga partners

Hinder

- Vilka hinder ser ni för att minska tompositionering?
  - Påverkar några aktörer tompositioneringen mer än andra?
  - Är avtal ett hinder?
  - Rivalitet mellan aktörer?

Lösningar

- Ser ni några potentiella lösningar för att minska tompositioneringen?
  - Vad hade underlättat för er för att kunna minska tompositioneringen?
  - Kan ni tänka er att använda ihopvikbara containrar/grey boxes?
  - Finns det andra användningsområden för en tomcontainer?
  - Lagar?
  - Street turn? Tomcontainrar flyttas direkt mellan en importör och en exportör
  - Är det möjligt att dela med sig av information så att till exempel containrar kan ägas gemensamt eller liknande? Delar ni information. . . ?
- Om du fick rangordna olika lösningar, vilken/vilka är enklast att genomföra och vilken/vilka ger störst effekt?
- Om du fick tänka bort alla hinder, vad finns det för lösningar?

B
Appendix - Excel file

Lösningsförslag	Förklaring av lösningsförslag	Lätt att genomföra (1-10)	Störst effekt (1-10)
Street turns	Tomma containers transporteras direkt mellan importörer och exportörer utan att passera en terminal. På så sätt minskas den totala sträckan som den tomma containern måste transporteras.		
Inland depots	En container kan förvaras på en inlandsdepå i väntan på en exportkund istället för att fraktas tom tillbaka till en hamn.		
Increased transport price	Vissa aktörer tror att ett ökat pris på transporten gör att transportbolagen har större möjlighet att utveckla nya lösningar för att minska tompositioneringen.		
Standardization of containers	Att minska antalet typer av containers kan minska tompositioneringen. Gav resultat när man minskade 20 fots containers från två till en modell. Samma sak skulle kunna göras med 40 fots som i dagsläget används som både high cube och standard.		
Grey boxes	Idén med grey boxes bygger på en gemensam container-pool för alla aktörer. På så sätt kan det totala flödet av containrar optimeras istället för att varje enskild aktör optimerar sitt eget flöde av containrar.		
Shipper owned containers	Större företag med stor volym av både import och export kan äga sina egna containrar och ansvarar då själva för att matcha import/export flödena. Rederier/speditörer anlitas endast för transporten av dessa containrar.		
Secondary uses of containers	Gamla containrar som befinner sig i slutet av sin livscykel kan säljas och användas till andra ändamål istället för att skickas tillbaka till Europa/Asien för reparation/återanvändning.		
Transport policy	Införa en statligt sanktionerad straffavgift för tompositionering.		
Foldable containers	Containers som kan vikas ihop och staplas på varandra för att ta mindre plats när de ska tompositioneras.		
Tworty box	En 20 fots container som är designad för att kunna sättas ihop med ytterligare en 20 fots container för att skapa en 40 fots container. Obalansen av 20 och 40 fots containers kan då minskas vilket i sin tur minskar tompositioneringen.		
Collaboration	Flera aktörer har nämnt hur samarbete mellan aktörer kan underlätta matchningen av import/export. Här betonas vikten av transparens och öppen kommunikation.		
Container substitution	Handlar om att öka flexibiliteten med att kunna ändra containersort hos varuägarna. Kan de exempelvis använda sig av två 20 fot istället för en 40 fot eller tvärtom? Obalansen av 20 och 40 fots containers kan då minskas vilket i sin tur minskar tompositioneringen.		
Container leasing	Handlar om att rederier ska kunna hyra containrar i områden där det finns brist och lämna containrar där det finns överskott för att minska tompositioneringen.		
Internet-based systems	En teoretisk lösning gällande tompositionering är att införa ett gemensamt (och neutralt) datasystem där information gällande antal tomma containrar och kommande transporter delas. Tanken är att en ökad transparens och informationsdelning ska leda till mer optimerade transporter.		

Vi vill att ni poängsätter de olika förslagen mellan 1 och 10.
1 är svårt att genomföra/ger en liten effekt.
10 är lätt att genomföra/ger en stor effekt.

C

Appendix - Interview 2 template

Frågor att ställa till varje lösning

- Känner ni igen denna lösning/dessa lösningar? Håller ni med om att denna lösning/dessa lösningar kan minska tompositioneringen? Om nej, varför inte?

- Har ni infört denna lösning/dessa lösningar idag? Vad kan man göra för att ytterligare förbättra denna/dessa?
- Planerar ni att införa denna lösning/ngn av dessa lösningar i framtiden? När, inom den närmaste tiden (inom 1-3 år)? På längre sikt (>3 år)?
- Vad är det som gör att denna lösning/en lösning anses vara lätt/svår att genomföra?
- Kan ni vara med och påverka att denna lösning blir genomförd?
- Vad är det som krävs för att genomföra denna lösning/en lösning?
- Vad är det som gör att denna lösning/en lösning anses ha en liten/stor effekt?

Att ställa efter man gått igenom alla lösningar

- Kan olika lösningar kombineras med varandra? Underlättar någon lösning implementeringen för en annan?
- Diskussion utifrån rangordning av lösningar. Varför sattes X som nr 1 i enkelhet? Varför sattes Y som 1 i effekt?
- Nu när du ser hela listan av åtgärder, saknar du någon åtgärd? Vad?

D

Appendix - Comparision of potential

	Shipping Line		Shipping Line		Transport Operator		Terminal Operator		Terminal Operator	
Possible Solutions	**Feasibility (1-10)**	**Impact (1-10)**	**Feasibility (1-10)**	**Impact (1-10)**	**Feasibility (1-10)**	**Impact (1-10)**	**Feasibility (1-10)**	**Impact (1-10)**	**Feasibility (1-10)**	**Impact (1-10)**
Street turns	6	8	3	7	1	4	1	7		
Collaboration	2	6	5	5	1	10	3	8	6	9
Internet-based systems	1	7	1	5	2	10	5	8	4	9
Inland depots	6	7	3	8	10	5	8	8		
Grey boxes	1	8	1	5	1	10	1	10		
Secondary uses of empty containers	7	4	10	5	1	2	1	1	10	10
Transport policies	1	5	1	1	1	1	1	1	2	10
Foldable containers	1	6	1	5	3	10	1	1	1	10
Tworty boxes	1	4	1	5			1	5	1	10
Container substitution	2	6	5	8	8	2	2	6		
Container leasing	5	8	5	5	2	10	5	5	10	10
Increased transport price	2	5	1	5	2	8	3	5	8	8
Standardization of containers	2	5	1	5	1	10	1	6		7
Shipper owned containers	2	8	1	5	1	5	1	4		

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