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Activities and Reduction Strategies of Empty Container Repositioning

A Regional and Inter-Regional Perspective to the Liner Shipping Industry in Sweden

Master's Thesis in Supply Chain Management

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Cover: A container ship leaving APM Terminals in Gothenburg (Assner, n.d.).

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Abstract

Containerised trade has during the last decades increased significantly and today 90% of all international trade is facilitated by maritime transportation. One of the most important issues in the liner shipping industry is empty container repositioning (ECR), which accounts for a substantial part of shipping line's running costs.

This master's thesis project aims to extend the understanding of how ECR is managed and can be reduced in the liner shipping industry, from a regional and inter-regional perspective. Key areas of investigation are the activities in the ECR management process, performance measurements, effects of COVID-19, and potential strategies to reduce ECR. Connections between shipping lines' ECR activities and various potential strategies to reduce ECR are also evaluated to explore possible interrelations.

A frame of reference has been created from existing literature in order to develop a theoretical basis for the study. Interviews have been conducted with representatives of eighth of the world's largest shipping lines, holding positions within container operations in connection to the Port of Gothenburg. The empirical findings have been analysed in relation to the frame of reference in order to recognise any connections or discrepancies and further develop the understanding of the subject.

The report presents a model of the ECR management process consisting of five key activities, and explores the use and suitability of different performance measurements connected to ECR. The impact of COVID-19 pandemic to ECR practices is highlighted, and six strategies applicable by shipping lines are investigated in terms of their potential contribution to reduced ECR at a regional and inter-regional level.

Results indicate that shipping lines manage ECR through a series of interrelated and iterative activities, repositioning containers to fulfil a container export or import need. Measurements to guide and evaluate the ECR management process are used in moderation as many activities are still performed manually, decreasing the ability to assess ECR performance. Furthermore, the results highlight the complexity of ECR and indicates that the potential strategies contribute to reduced ECR in multiple ways and overcomes different imbalances in the container transport chain.

Keywords: Empty Container Repositioning, Liner Shipping Industry, ECR Strategies, ECR Management Process, Regional and Inter-regional Repositioning.

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Rebecca Hellekant
Gothenburg, 2021

Malin Rudal
Gothenburg, 2021

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1

Introduction

This chapter provides an introduction to the subject of the study, describing the context and underlying problem that the research project intends to highlight. The chapter also presents the study's aim and associated research questions, followed by the description and motivation of the project's scope and limitations.

1.1 Background

Decreased barriers for trade, improved means of communication, and increased vertical specialisation of production are some trends explaining the vast growth in international trade that has founded today's globalised economy. In this context, supply chains are becoming increasingly international as operations are outsourced and offshored (Riad et al., 2012). The globalisation process has resulted in a vast increase of maritime transports (Dong & Song, 2009). The development has created a surge in containerised movements and accelerated the overall containerisation of seaborne trade, making transport both faster and more efficient (Banderia et al., 2009). During the quarter of a century, containerised trade has increased almost threefold, reaching a volume of 152 million TEUs in 2019 (United Nations Conference on Trade and Development [UNCTAD], 2020).

Although this increased containerisation has created more efficient transport systems, it has also accentuated the directional imbalances of physical goods flows (Rodrigue, 2020). The directional flows in international supply chains reveal substantial imbalances between different geographical regions. Especially trade along the Trans-Pacific and Europe-Asia routes are characterised by large imbalances, much as a consequence of the high volumes exported from China. According to calculations by UNCTAD (2020), the eastbound container flow along the Trans-Pacific route and the westbound flow along the Europe-Asia route are more than double the flows in the opposite directions, resulting in a substantial container trade surplus in East Asia and a deficit in North America and Europe (imbalances of 61.3% and 57.1% respectively). The imbalances inevitably generate a need to transport containers empty between importing and exporting regions, so called empty container repositioning (ECR), leading to decreased asset utilisation (Zheng et al., 2015). With regard to different modes of transport, it is in this context notable that around 90% of international trade has been facilitated by maritime transport (C. Y. Lee & Meng, 2015). The impact of global trade imbalances to maritime transport can therefore not be underestimated. However, trade imbalances are not the only factor influencing ECR. D. P. Song and Carter (2009) present the following factors that affect ECR: dynamic operations, uncertainties, size and type of equipment, lack of visibility and collaboration within the transport chain, and transport companies' operational and strategic practices. The extensive repositioning has resulted in 24.7% of all maritime container shipments being transported empty in 2016 (Kolar et al., 2018). From a shipping line perspective, ECR has a negative impact on both economic and environmental performance. The movement of empty containers does not generate revenue and thus represent an underutilised inventory of capital equipment (Braekers et al., 2011; Li et al., 2014). The repositioning of empty containers also requires handling and transport work and thus contributes to increased costs. In relative terms, the cost of ECR has been estimated to 27% of the total world fleet running cost (Zheng et al., 2015). When analysing the main cost drivers, overseas transport account for around 25-35%, inland transport on the first- and final leg for 50-70%, and container throughput for 20% (Finke & Kotzab, 2017). The empty movements also give rise to environmental concerns as carbon emissions are generated from handling equipment and container transport. Through improved environmental performance, cost reductions can be achieved (Li et al., 2014).

Considering the scope of this problem, ECR as a topic has been well discussed in academic literature. Examples of such are Crainic et al. (1993) who early modelled the container allocation problem, and D. P. Song and Carter (2009) and Zheng et al. (2015) who more recently attempted to optimise repositioning in liner shipping systems. While these are mainly concerned with describing the ECR problem conceptually through quantitative models, fewer studies address current practices within the industry or the organisational process through which shipping lines manage the repositioning of empty containers. As noted by Braekers et al. (2011), there is also a gap in existing research where regional and inter-regional repositioning issues are relatively unexplored compared to global. This project therefore intends to develop the understanding of how shipping lines manage ECR activities by studying their current practices at a regional and inter-regional perspective, from a Swedish context.

1.2 Aim

This master's thesis project aims to extend the understanding of how ECR is managed and can be reduced in the liner shipping industry, from a regional and inter-regional perspective. The study intends to describe shipping lines' ECR activities, various potential strategies to reduce ECR, and explore possible interrelations.

To gain understanding of how shipping lines can decrease ECR, first, their current practices need to be outlined. This has resulted in the first research question. The research question has three sub-questions that address ECR activities, measurements of ECR, and particularities of the COVID-19 situation. RQ1a seeks to map shipping lines' ECR process by identifying container movements, information flows, and key operational activities. RQ1b seeks to describe how the shipping lines measure ECR and what key performance indicators are used to guide the process. RQ1c addresses the global COVID-19 pandemic and its consequences for ECR.

RQ1. How do shipping lines manage ECR at an operational level?

a. How are operational ECR activities planned and executed?

b. How do the shipping lines measure ECR?

c. How has COVID-19 affected ECR?

The second research question builds upon the first, in that it seeks to analyse shipping lines' potential for reducing ECR and evaluate the potential of different strategies to realise this potential. The research question conforms to the regional and inter-regional perspective of the thesis project.

RQ2. How can potential strategies contribute to reduced ECR by shipping lines in a regional and inter-regional setting?

1.3 Scope and Limitations

The scope of this study is geographically limited, focusing on ECR practices in Gothenburg and Sweden. Unlike many other studies, the project refrains from studying ECR on a global scale, using for example quantitative models to optimise international container flows. Instead, repositioning is discussed on a regional and inter-regional level. This could be of particular interest to shipping lines as the cost of container repositioning to a large degree is defined by regional and inter-regional operations, and not global overseas repositioning. The regional and inter-regional perspective also allows a more extensive consideration to the different modes of transport used to transport containers inland, which adds an interesting dimension to the repositioning problem.

With respect to the current situation of COVID-19, this study also reflects a highly specific point in time within global trade and container movements. The result of the research project should therefore be viewed with regard to this context. Through RQ1c the particularities due to COVID-19 are also made explicit.

2

Frame of Reference

This chapter begins with a presentation of container shipping, outlining industry characteristics and the container transport chain. It continues by introducing the concept of ECR and giving a detailed description of the activities involved in the container repositioning process. Subsequently, different performance measurements and methods to assess ECR are discussed as well as possible strategies to decrease ECR. The chapter ends by giving an account of the impact of the COVID-19 outbreak to the container shipping industry.

2.1 The Container Shipping Industry

The liner shipping industry has traditionally been characterised as an anti- competitive industry, controlled by a limited number of large trading companies that fixed prices on particular trading routes, through the operation of conferences. Industrial, structural, and regulatory changes have however radically altered the market conditions of the liner shipping industry, changing the way shipping lines organise and price their services (Rodrigue, 2020). Three important trends have emerged; a containerisation of global trade, the formation of strategic alliances, and vertical integration.

2.1.1 Containerisation and Globalisation

Containerisation is regarded as one of the most important innovations of the 20$^{\text{th}}$ century. With the first shipping container being introduced in the 1960's, cargo transport has become both faster and more efficient as multiple units of cargo can be handled simultaneously in a standardised manner (Banderia et al., 2009). The reference size for a standardised container is the 20-foot metal container measuring 20ft long, 8.6ft high and 8ft wide, commonly referred to as a Twenty-foot Equivalent Unit (TEU). A common variation is the 40-foot container, which has the same height and width dimensions as the 20-foot container but double the length. Another variation is the 40-foot hi-cube container, which measures one foot higher than the reference container (Rodrigue, 2020). The benefit of the standardised base and latching system of standardised containers stream from their potential to ease transshipment between different modes of transport. With a common standard, equipment, load carriers, and ports can be adapted similarly, smoothing the interfaces between especially maritime, rail, and road transport (C.-Y. Lee & Song, 2017; Rodrigue, 2020). The introduction of the standardised container has enabled global trade to increase and the world's economy to become globalised, which in turn has further accelerated the containerisation of maritime trade. Figure 2.1 presents annual containerised trade volumes 1996-2020, based on calculations by UNCTAD. According to these, containerised trade has demonstrated an average annual growth of over 5% during the last 24 years. The occurrence of a negative percentage change is demonstrated only twice, following the recession after the financial crisis in 2009 and the COVID-19 outbreak in 2020 (UNCTAD, 2020). In terms of value, containerised cargo makes up 70% of global international maritime trade (E.-S. Lee & Song, 2015).

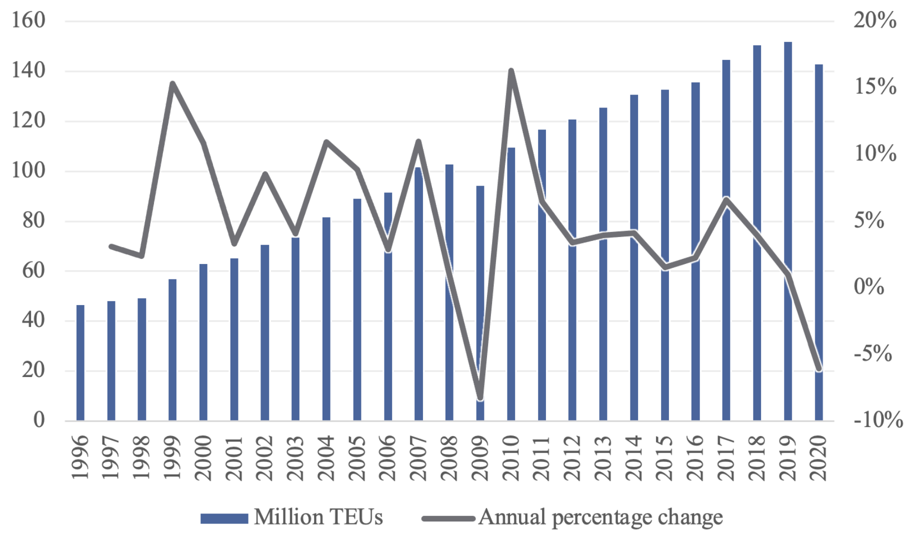


Figure 2.1: Global containerised trade, 1996-2020 (UNCTAD, 2020).

Containerised trade is predominantly achieved through the operation of liner services, which mean that vessels are employed to provide regular services between fixed ports of call (Rodrigue, 2020). In order to both provide frequent services and achieve cost rationalisations through the use of larger vessels and economies of scale, shipping lines have started to cooperate in the provision of joint liner services. This is possible through an exemption from anti-competition rules, where shipping lines are allowed to form strategic alliances under the condition that their collective market share does not exceed 30%, calculated as total goods volume in tonnes or TEUs (Regulation of the European Parliament and of the Council (EU) 906/2009). Three large strategic alliances have in recent years been formed on the basis of this exception, controlling in total 80% of the world's container shipping capacity as of 2019. These are the 2M Alliance between Maersk and MSC, the Ocean Alliance between CMA-CGM, Evergreen, and COSCO, and THE alliance between Hapag-Lloyd, HMM, Yang Ming, and ONE (Rodrigue, 2020). The coexistence between horizontal cooperation and competition is a singularity that defines the container shipping industry altogether (C.-Y. Lee & Song, 2017).

While the shipping lines mainly operate within maritime transports, an increasing number of companies also seek to benefit from economies of scope by extending their operations vertically. The trend over the last decade has been for container shipping companies to integrate shipping, terminal operations, and inland logistics in order to increase the control over freight rates and capture new revenue streams by providing door-to-door logistics solutions, as opposed to only port-to-port (UNCTAD, 2020). Recent examples of shipping lines extending their businesses vertically include CMA-CGM's acquisition of the Swiss freight service provider Ceva Logistics and Maersk's integration of APM Terminals' Inland Services portfolio (CMA-CGM, 2019; Maersk, 2019). According to Theofanis and Boile (2009), shipping lines also prefer to extend their service network inland to ensure better equipment visibility and more efficient management of ECR. However, under some circumstances shipping lines may limit their door-to-door service network to avoid the cost of inland transports, often when operating under low margins (Theofanis & Boile, 2009). Subject to these developments and vertical integrations are the contractual agreements that stipulate the party responsible for final delivery to a consignee. Under what is commonly referred to as carrier haulage, the door-to-door responsibility resides with the shipping line, but under merchant haulage, the final leg delivery is passed on to the consignee or a third-party freight forwarder upon the container's arrival at its port of destination (Theofanis & Boile, 2009). Irrespective of these, the shipping lines can settle freight rates and commercial agreements with either the consignee or a freight forwarder, where the latter has grown more common with the growth of many powerful logistics companies such as DHL, DB Schenker, and UPS (D. P. Song & Dong, 2015).

2.1.2 The Container Transport Chain

The flow in which containers move commonly span multiple nodes, actors, and modes of transport. Some of the most important actors are shipping lines, terminal operators, depot operators, container owners, freight forwarders, consignors, consignees, and public authorities (D. P. Song & Dong, 2015). Public authorities are often an important stakeholder in port activities because of ports importance to the economic development of a country. The involvement commonly consists of financing of ports and intermodal connections, as the infrastructural development projects are very capital intensive and often fall under the responsibility of the public sector (Neise, 2018).

To describe the flow of containers in the container transport chain, illustrated in Figure 2.2, one possible point of departure is the consignor. A consignor needs empty containers to be able to ship goods to a specific destination. The empty containers can be allocated either from a depot area used to store containers, from a consignee that wants to dispose of a container, or from a port which handles and ships empty containers. From the consignor, laden containers are transported to a port either directly or via a depot area for transshipment. From the port of origin, the laden container is then shipped to a port of destination either directly or after passing a transshipment port. The laden container is unloaded and transported to its destination either directly or by passing through a container depot, moving in a pattern that mirrors the transport chain of the origin side. After having received their goods, the consignee sends back the empty container in a reversed flow (D. P. Song & Dong, 2015). The transport between the consignor, depot, port, and consignee, can be made either by truck, ship, barge, or train, but often a combination of several modes is used to access both sea and land areas more efficiently (Neise, 2018).

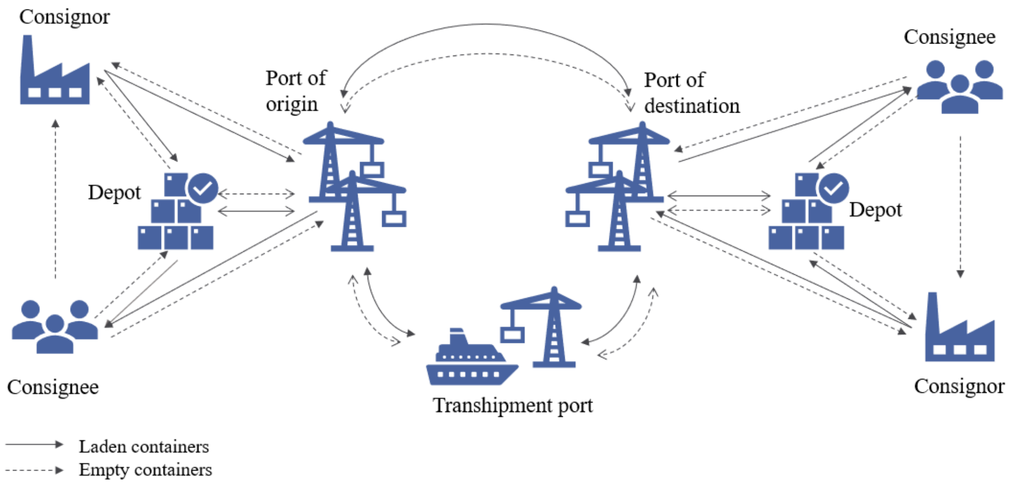


Figure 2.2: The container transport chain (D. P. Song & Dong, 2015).

The container transport chain is special in that it consists of two supply chains, one forward flow which contains the laden containers and one backward flow which contains the empty containers (D. P. Song & Dong, 2015). Furthermore, both laden and empty containers are stored and moved within the same shipping network and therefore utilise the same resources, such as vessels, trucks, trains, and facilities. This creates interdependencies which makes the two flows difficult to separate and view in isolation. However, the source of the demand of the two container flows are different, as the demand of laden containers is driven externally by customer demand and empty containers are driven internally by the shipping lines that own the containers, presenting an important difference between the two (D. P. Song & Dong, 2015).

2.1.3 Imbalances Affecting the Container Transport Chain

There are several factors which contribute to the imbalance of both the goods and resources flow, leading to reduced resource utilisation within the supply chain. As aforementioned, structural imbalances are an inherent part of the container transport chain because of global trade patterns (Lumsden, 2007). These imbalances occur due to the fact that the demand volume of goods transported between two locations is not the same in both directions, causing containers to be moved empty from container surplus to deficit locations both on a regional, inter-regional, and global level (Boile et al., 2008).

Technical imbalances affect the container transport chain because different load carriers are adapted to different types of goods (Lumsden, 2007). This means that the same containers cannot be used to fulfil the transport needs of all types of goods (D. P. Song & Carter, 2009). Rodrigue (2020) mentions five different types of containers that are designed to carry different types of goods; standard, tank, open top, flat, and refrigerated containers. Classifications of containers are also made with respect to their current structural and aesthetics condition, indicated as letter grades. Grade F asserts that the container can be used to transport food, with a high internal cleanliness and no previous transport of toxic chemicals; while grade A, B, C, and D indicate structural conditions with minimal levels of rust, marks, and dents, asserted in descending order (XChange, n.d.).

Another factor affecting the container transport chain are operational imbalances, emerging because different actors and operations in the supply chain are not adapted optimally to each other (Lumsden, 2007). Multiple actors in the supply chain network make the flow of goods and resources more difficult as the incentives, management, and visibility is separated by company borders. Lumsden (2007) further notes that operational imbalances can exist as a consequence of time restrictions or scheduling decisions. Even if trade imbalances are low when aggregated over a longer time-period, there can be hourly, daily, or weekly imbalances that, depending on the flexibility of operational activities, can have a limiting effect on resource utilisation. A time restriction can for example be that goods for import are unloaded in the afternoon while goods for export are loaded in the morning, which means that the same resource cannot be used. Containers need to be available in close proximity, in sufficient quantities, within the right time span (Rodrigue, 2020). The imbalances in trade, technical design, and operations have a negative impact on ECR as increased imbalances escalate the need to reposition containers (D. P. Song & Carter, 2009).

2.2 Empty Container Repositioning

As an inherent part of the containerisation of maritime trade, ECR constitute around 24.7% of all maritime container movements globally (Kolar et al., 2018; Zheng et al., 2015). Besides overseas repositions, many empty container movements are made inland, performed either by the shipping line, a customer, or a freight forwarder. If considering the 10-15 year life-time of a container, 56% of its time is spent idle or being empty repositioned (Rodrigue, 2020). The need to perform ECR is created by the movement of laden containers in an unbalanced pattern where the forwarding of a laden container cannot be paired with an equal demand for transport on the return leg (D. P. Song & Carter, 2009). To ensure that consignors have access to empty containers even if they are located in regions characterised by a container deficit, efficient and timely repositioning of empty containers is therefore crucial (Shintani et al., 2007). To manage this process, Crainic et al. (1993) suggest a three-level planning approach consisting of a strategic/tactical planning model, a container allocation model, and a routing model, illustrated in Figure 2.3. This is used to describe the underlying planning activities of the ECR management process in the sections below.

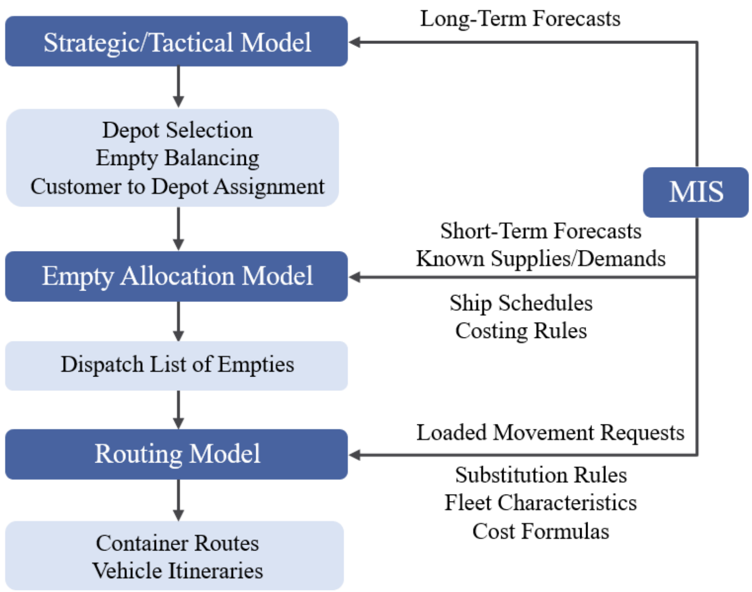


Figure 2.3: A three-level planning approach (Crainic et al., 1993).

2.2.1 Strategic and Tactical Planning

At the first level, long-term forecasts of trade patterns and volumes are used as a basis for multimode and multicommodity network configuration including port and depot selection, customer allocation to depots, and interdepot flow balancing. Here, Crainic et al. (1993) highlight the identification of trade patterns and flow imbalances with regard to different types of container types and seasonal variations as key. C.-Y. Lee and Song (2017) state that pricing strategies set at a strategic level are important for demand balancing and that tactical issues relating to network design and routing may consider ECR as a sub-problem as both laden and empty containers are moved in the same network. Furthermore, they state that such models require correct data, timely communication, and centralised management, which in practice can be difficult to achieve. This is something put forward also by Robles et al. (2007), which in summary conclude that advanced systems for information exchange and cooperation between geographically dispersed shipping line agencies and departments is often needed to manage the dynamic nature of operations planning and the scope of activities. The general policies and decisions made at the strategic and tactical level set the boundaries for decisions and activities at the operational level (Braekers et al., 2011).

2.2.2 Operational Planning: Container Allocation Model

The second level is focused on operational planning, using short-term forecasts, and known supply and demand levels to determine the distribution of empty containers that best satisfy known and forecasted demand (Crainic et al., 1993). To estimate the container repositioning need, the difference between import and export flows is calculated and compared to available containers at the port. According to a study by Darabi and Suljevic (2015) a net container repositioning need appears when a predicted container surplus or deficit exceeds an internally decided threshold value. The threshold can be set as a safety margin in deficit areas and stock volume limit derived from storage cost and space availability in surplus areas.

Planning on this level is made exceedingly difficult by some industry characteristics. First, the maritime shipping industry is characterised by high volatility and uncertainty, seen in the extreme variations of freight rates, the unreliability of container ship's schedules, and the short notice in export bookings (C.-Y. Lee & Song, 2017). The consequence of these factors is that the time-frame available to manage bookings is very limited. According to estimates of an export manager at one of the world's largest shipping companies, around 60% of container bookings are received in the form of spot bookings, meaning that they are placed within a few days before vessel closing. Other bookings are made based on tender agreements or service contracts, where the shipping line asserts a larger volume of cargo to be transported over a longer period of time, although not specifying specific times and quantities until a few weeks in advance (Darabi & Suljevic, 2015). Depending on the ratio between these types of bookings, operational planning can be made with varying accuracy. According to Ng (2012), forecasting difficulties have an adverse effect where the inability of shipping lines to allocate empty containers in time because of forecasting uncertainties has led customers to double book containers from multiple shipping lines in order to hedge against delays, leading to last minute cancellations that increase the uncertainties even further. Zurheide and Fischer (2015) describe that the liner shipping industry commonly not apply cancellation fees for no-shows, contributing to the situation where 30% of placed bookings result in no-shows. Some shipping lines have however tried to implement cancellation fees (Zurheide & Fischer, 2015). The output of the container allocation model is a dispatch list of empty containers, used as input to the next step in the model (Crainic et al., 1993).

2.2.3 Operational Planning: Routing Model

After recognising an imbalance in the container flow, the concerned shipping line is faced with the decision of how to fulfil the empty container need. According to Crainic et al. (1993) this decision should ideally be made simultaneous to the primary distribution of containers at the second level. However, because of the complexity of the problem and the insufficient technologies at the time the authors' model was developed, a single mathematical model for the optimisation of short-term land operations was not feasible and a distinction was made between the two processes. Regarding the routing model, Theofanis and Boile (2009) mean that the shipping line can choose to either reposition empty containers internally within its own port network, such as between different continents or different regions, or to allocate empty containers from external sources. If choosing to reposition containers within an existing port network, three options exist. As presented in Figure 2.4 containers can be repositioned at global, inter-regional, or regional level (Boile et al., 2008). At a global level, repositioning is made overseas between foreign ports in areas of surplus and areas of deficit, for example between Europe and Asia. At an inter-regional level, repositioning is made on a leg leading finally to global repositioning or between larger regions of importation and consumption, either intermodally or through short sea transport. At a regional level, empty containers are repositioned between consignors, consignees, depots, and marine terminals, mainly using trucks.

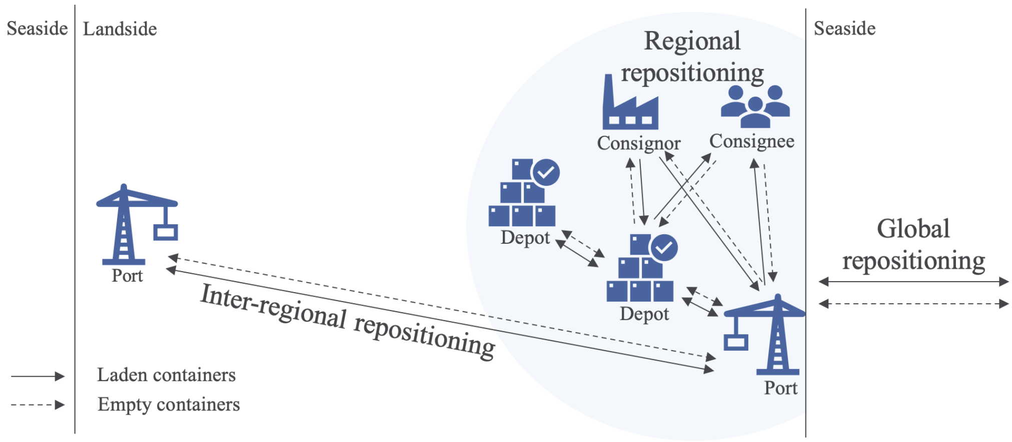


Figure 2.4: Levels of repositioning (Boile et al., 2008).

If deciding to allocate containers from external sources, the shipping line can first choose to even out some of the imbalances by leasing containers in deficit areas and off-hire containers in surplus areas, transferring the ownership and cost of repositioning to lessors (Theofanis & Boile, 2009). However, this option is limited by the fact that lessors tend to increase prices or even fix the number of acceptable on- and off-hires to restrict imbalanced leasings, such as off-hires in container surplus areas (Ng, 2012). Secondly, the shipping line can purchase new containers to increase the container pool in deficit areas, if available at the local market (Theofanis & Boile, 2009). This is foremost true for the East Asian market, as China accounts for 85% of the world's shipping container production (XChange, 2020) and simultaneously represents a major container deficit area. In container surplus areas, containers can instead be stored at depots while waiting for cargo demand to augment or overseas repositioning to take place. The shipping line can also choose to sell or scrap old containers to manage the container excess in surplus areas. The third option for the shipping line is to collaborate horizontally or vertically to match its needs with other load carriers, and thus allow higher-level optimisation of the empty container allocation. As most shipping lines experience the same imbalances and in addition prefer to use their own containers for branding purposes, horizontal collaboration is however seldom used in practice (Theofanis & Boile, 2009).

With regard to the highlighted issues in operational planning, the described container allocation options are suitable in different contexts. If time is a constraint, global repositioning may be impossible as the transit time between for example the Port of Gothenburg and Beijing's main maritime gateway the Port of Tianjin is 42 days (Maersk, 2021). On the other hand, the marginal cost of shipping lines to transport an extra container is very low (Cullinane & Khanna, 2000). Considering external allocation alternatives such as leasing or purchasing containers, the allocation time may be lower but the cost higher. Although conforming to tight time constraints, shipping lines are left in disadvantageous positions when interacting with external parties in the container market, such as when negotiating leasing agreements or collaborating with other shipping lines. The pricing mechanism for these external container allocation strategies is thus of particular concern, especially given the spontaneous nature of spot bookings (Lopez, 2003). The output of the routing model is itineraries for container repositions, which are often passed on to subcontractors such as hauliers or train operators for execution (Crainic et al., 1993). As part of the planning and control process, continuous evaluations are needed to assess performance and find areas to improve.

2.3 Measuring ECR

According to van Donselaar et al. (1998) it is in general important to measure performance in order to know which operational factors that are important for success and which factors that are less important. Measuring performance can thereby provide a basis for continuous improvements, however it can also be used for internal and external benchmarking and to set incentives (Naslund & Williamson, 2010). When those factors that have a strong effect on performance are identified, management can narrow their focus to achieve better performance. To align indicators, it is important for organisations to link the performance measurements to a business and operational strategy (Otheitis & Kunc, 2015). If considering the shipping industry, shipping lines have been slow to adopt performance measurement systems in practice. This is mainly due to the absence of a unique framework that considers all particularities of the industry (Otheitis & Kunc, 2015). The sections below describe both general performance indicators and measurements specific to the container shipping industry, divided in four areas; economy, operations, environment, and forecasting.

2.3.1 Economic Factors

As owners of a majority of the world's containers and responsible for the maritime transport of containers, shipping lines are heavily affected by the issues of ECR (Shintani et al., 2007). While there is little difference between the cost of transporting a laden container and an empty container, there is a large difference in who bears the cost; the cost of a laden container transport is often not born by the shipping line while the cost of an empty container transport is (Finke & Kotzab, 2017). According to Sanders et al. (2015), the unit cost of repositioning a container is \$500, amounting to an annual total cost between \$15 billion and \$20 billion across the industry. This can constitute as much as 8% of the total operating cost of a shipping line (Sanders et al., 2015), creating a clear case for efficient handling of ECR.

2.3.2 Operational Indicators

For shipping lines it is important to measure operational performance as many costs are generated operationally. According to Robles et al. (2007) performance can be evaluated both at a regional and global level by measuring indicators such as container dwell time, which is the time between two successive loads; cargo use level, in both volume and weight; container availability percentage; and time retained in maintenance or damage repair (Robles et al., 2007). Sarmadi et al. (2020) similarly suggest measuring empty containers' waiting time, although in the form of inventory turnover. In addition, the authors propose measuring the amount of empty container movements and service level, defined as the fraction of customer demand that can be met through available container inventory.

2.3.3 Environmental Measurements

A reduction of empty container movements will impact the environment both directly through reduced fuel consumption and associated emissions, and indirectly through reduced congestion and emissions of related activities (D. P. Song & Dong, 2015). Besides representing unutilised capacity, ECR also generates carbon emissions since empty containers utilise trucking equipment, container yard equipment, storage facilities, and container vessels along the container transport chain (Li et al., 2014). According to the European Environment Agency's greenhouse gas (GHG) emissions data, the shipping industry stands for 3.7% of the total CO_2 emission within the EU (European Commission, 2020). The International Maritime Organisation (IMO) has an ambition to reduce GHG emissions from international shipping by least 50% until 2050, compared to 2008. In order to reach the goal, mandatory measurements have been implemented to reduce GHG emissions (IMO, 2018). Li et al. (2014) suggest several performance measurements that could be used by the shipping lines to measure their environmental performance, such as average emission per ship or emission per container in terms of CO_2, SOx, NOx and PM emissions.

2.3.4 Forecast Accuracy

In order to improve ECR performance it is important to be able to make accurate predictions of future container flows. In order to identify eventual forecast failures and gain knowledge about their cause, shipping lines need to measure forecast accuracy (Pradita et al., 2020). According to Jonsson and Mattsson (2009), forecast errors should be measured and followed-up continuously. This can be made through several methods, for example by measuring mean errors (ME) or mean absolute deviations (MAD).

In the liner shipping industry, the systematic generation of forecasts is still not routine. According to a representative of the shipping line CMA-CGM, less than 50% of shipping lines forecast their capacity needs, and for those that do forecast, less than half forecast properly (Knowler, 2019). The difficulties surrounding the generation of accurate forecasts has had some worrisome effects. Poor forecasting of container flow volumes has created friction between shipping lines and cargo owners, resulting in cargo owners reserving more space than they actually need. This has in turn encouraged shipping lines to overbook vessels in order to maximise capacity utilisation and hedge against no-shows, as stated by the CEO of AP Moller-Maersk: *"For Maersk, on average 30 percent of bookings made don't show, and we try to estimate for that and overbook"* (Knowler, 2019). These practices however come with a risk of capacity shortage, as a lower no-show ratio than expected would result in the accepted container volume exceeding available vessel capacities. Subsequently, containers sometimes have to be rolled and shipped out with later vessels, further increasing the frictions.

2.4 Strategies to Reduce ECR

In order to reduce the need of ECR, different strategies can be applied. In the sections below, descriptions of six strategies proposed by Braekers et al. (2011) are presented. The strategies are all applicable at a regional level, and consist of the implementation of inland depots, street-turns, internet-based systems, container leasing, container substitution, and foldable containers.

2.4.1 Inland Depots

Braekers et al. (2011) describe that an inland depot refers to a location where empty containers can temporarily be stored while waiting to be allocated to a consignor. As illustrated in Figure 2.5, inland depots can be used as a substitute for port depots, with the advantage that empty repositioning distances and costs can be decreased as empty containers can be stored in closer proximity to the consignee and potential consignor. In the figure, the lines between the port depot and the consignee respectively consignor are thin for the inland solution, as the main flow of containers is shifted to the connection between the inland depot and the consignee respectively consignor. At the same time there is an increased flow of containers between the port and the inland terminal. Besides reducing ECR distances, inland depots may prevent congestion at ports by rerouting the pick-up and drop-off of empty containers. One reason suggested as an explanation for shipping lines' moderate use of inland depots is that the implementation of an inland depot could duplicate operations costs, as the shipping would have two storage points instead of one (Braekers et al., 2011). However, as Crainic et al. (1993) point out, most inland depots are offered by other transport modes, such as rail yards, of which the shipping lines can rent only the space they need, dynamically adjusting it to variations in flow. The cost incurred would thus only be that of the extra storage and not duplicate operations. Given the often higher priced container operations at ports, inland depots may therefore decrease total storage costs (Braekers et al., 2011).

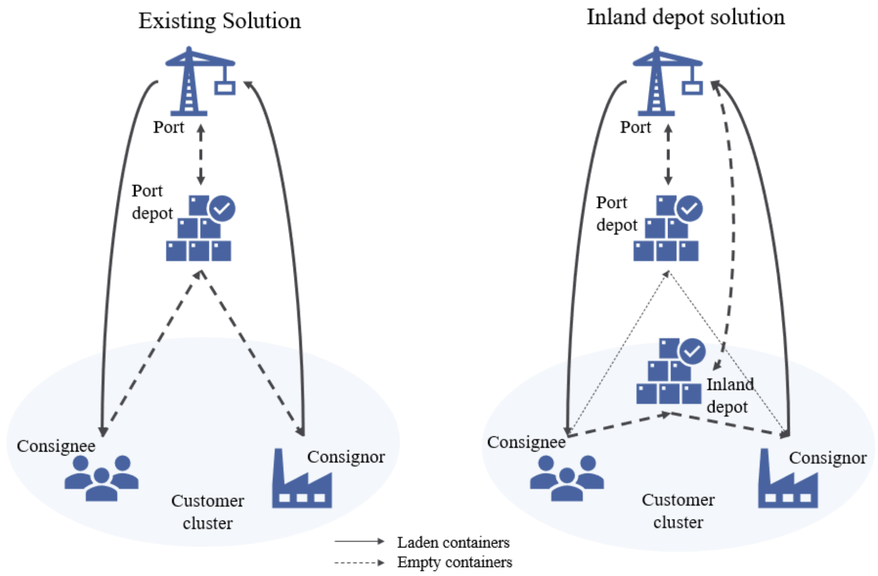


Figure 2.5: A system of inland depots (Braekers et al., 2011).

2.4.2 Street-turns

Street-turns are described as the movement of empty containers between a consignee and consignor, without any intermediary stop at a port or inland depot, as illustrated in Figure 2.6. According to Braekers et al. (2011), there are several benefits with street-turns. For one, the number of empty container movements can be reduced, and with that most often also total transport distances and associated transport costs. Second, congestion at terminals can be reduced as movements to and from terminals are cut in half. Moreover, street-turns enables the shipping lines to lower terminal handling costs. Even so, Deidda et al. (2008) state that it is a complex task for shipping lines to implement street-turns. This is because extensive information is required within a short time-frame or even in real-time. For example, shipping lines need to administrate last-minute bookings and coordinate truck routes between consignees and consignors, but also be prepared to handle eventual delays at the consignee without impacting the delivery to the consignor (Deidda et al., 2008). Moreover, Braekers et al. (2011) highlight that there besides the practical issue of matching pick-up and drop-off times and locations, container ownership and container types, are institutional barriers as well as commercial, insurance and liability issues surrounding the implementation of street turns. Institutional barriers consist of repair charge management, inspection and paperwork issues, lack of a common consistent procedure for interchange, and limited free time (the customer can in a normal situation contain a container several days free of charge between terminal pick-up and drop-off). Commercial, insurance and liability issues regard especially the responsibility of container damages that occur after the container has been released from a terminal (Braekers et al., 2011).

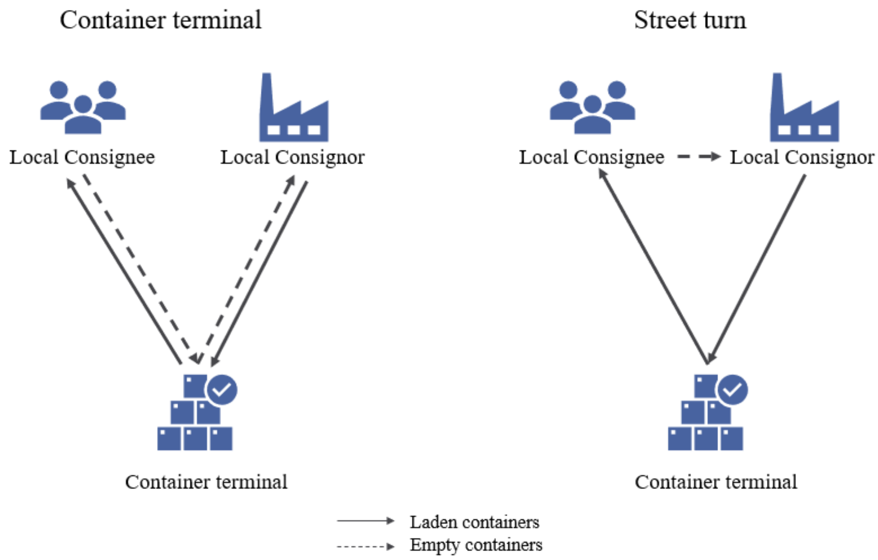


Figure 2.6: The street-turn approach (Braekers et al., 2011).

2.4.3 Container Substitution

Container substitution refers to the fulfilment of the request of one type of container with another type of container (Chang et al., 2008). The benefit of this is an increased flexibility to the ECR system as an exact match of container types is not needed, with subsequent opportunities to reduce empty container movements and costs (Braekers et al., 2011). The potential to reduce empty movements stream from the ability to overcome technical imbalances in the container transport chain (Lumsden, 2007). Container types can be distinguished according to three aspects; purpose, dimension, and ownership. The first details the intended use of the container (dry cargo, refrigerated, etc), the second the physical size of the container (20ft, 40ft, high-cube, etc), and the third the party currently in possession of the container (shipping line or other entity) (Chang et al., 2008).

2.4.4 Internet-based Systems

Internet-based systems are often identified as a key means to the implementation of many of the noted ECR reduction strategies (D. P. Song & Dong, 2015). Coordination between shipping lines, hauliers, and terminals is for example reliant on effective information exchange and data collection, a prerequisite of which often is the use of internet-based systems (Braekers et al., 2011). One technology commonly used in the container shipping industry is RFID, which can improve visibility and control by enabling container movements to be tracked inside ports and depots (D. P. Song & Dong, 2015). However, there are many technologies that have yet to be adopted across the industry. Internet-based platforms for information or market exchange, such as virtual container yards or online markets, can for example allow shipping lines to share information about current container deficits or surplus and upcoming export loads to match empty containers needs (Braekers et al., 2011). The main barrier to the adoption of these technologies is the resistance of shipping lines to share private business information (Theofanis & Boile, 2009).

2.4.5 Container Leasing

Container leasing is another alternative with potential to reduce empty repositioning. Instead of permanently owning containers, a shipping line can on-hire containers where they have a shortage of containers and off-hire containers in surplus areas. In this way, the shipping line can reduce its need to reposition empty containers globally (Braekers et al., 2011). Today, 43.4% of the world's marine (ISO) containers are owned by container leasing companies and 56.6% by shipping lines (Neise, 2018). Containers can be leased both on long-term and short-term, where long-term leased containers are handled the same as owned containers in most respects connected to ECR as opposed to short-term leased containers. As described, the ability to move containers in or out of a regional system by operational on- and off-hires can contribute to reduced ECR as container shortages and abundances can be handled through leasing rather than repositioning, given that a lessor exist in close proximity. Although this would reduce ECR distances, the potential for the shipping lines to reduce costs is limited by the fact that container lessors face similar imbalances as the shipping lines and therefore price the leases accordingly (Braekers et al., 2011). Within the container leasing industry efforts have been made to introduce common container pools, sometimes referred to as grey boxes, in order to facilitate capacity exchange between shipping lines. However, because of the sensitivity of sharing information between shipping lines these initiatives have been unsuccessful (Boile et al., 2008). As stated in the previous section, internet-based platforms for container exchange and leasing have also started to emerge in order to facilitate container sharing between otherwise competing shipping lines, as well as other actors (D. P. Song & Carter, 2009).

2.4.6 Foldable Containers

Foldable containers have the potential to reduce ECR by minimising the space needed to transport empty containers. By folding containers during transport, five containers can be transported in the same space as one unfolded container (Konings, 2005). Foldable containers can thus decrease transport and storage costs, but also add costs, since the folding and unfolding of containers requires extra manpower and equipment (Braekers et al., 2011). Braekers et al. (2011) argue that regardless of the additional costs to some parts of the container transport chain, the costs of ECR throughout the entire system would be reduce by the implementation of foldable containers. Foldable containers are not infrequently used today and according to Moon et al. (2013), some of the main problems with foldable containers are high production and maintenance cost, and an increased vulnerability to damages. Additional disadvantages are the complexity and time-consumption of folding and unfolding operations (Braekers et al., 2011).

2.5 Impact of COVID-19

Today, many manufacturers have adapted the concept just-in-time, increasing the vulnerability to disruptions within their supply chain network. Because of this, Di Francesco et al. (2013) argue that shipping companies need to develop proactive strategies to become more resilient and able to continue to serve their customers' needs despite disruptions. According to Notteboom et al. (2021), each new disruption triggers different ramifications in the container market and reveals the weaknesses of a system by testing its resilience.

Pandemics can be considered as low probability and high impact events (Notteboom et al., 2021). According to the European Maritime Safety Agency ([EMSA], 2021), COVID-19 has had a major impact to the shipping industry, at a regional, inter-regional, and global level. In mid-January 2020 China experienced a supply shock because of a lockdown that affected the country's production capabilities. Mid-March 2020 was characterised by more national lockdowns and restrictions on movement that decreased global demand because of limited retail activity and lower consumer and industrial confidence. This time was also characterised by increased unemployment and labour market uncertainties, government stimulus, and market volatility (Notteboom et al., 2021). With the dropped volumes, a large number of sailings from China to Europe were cancelled in the beginning of 2020, affecting both laden and empty container movements (Knowler, 2020). This caused challenges for ECR at a global level, since the cancelled sailings led to reduced numbers of containers arriving to Europe and the US. When production eventually started again in China much of Europe and the US still faced lockdowns and consequently faced slower container throughput at ports, containers did not return to China quickly enough leading to a shortage of containers also on a regional level (Hillebrand, 2021). One reason for the reduced container throughput was that many ports suffered from reduced manpower due to illnesses or potential illnesses, causing delays and congestion. Compared to many other European ports, the Port of Gothenburg however managed the disruptions caused by the pandemic relatively well. According to Törnquist (2021), the main reason for this is the fairly equal balance between import and export flows through the Port of Gothenburg. Another reason is that there have not been any cancelled sailings on the direct lines from locations in the Far East to the Port of Gothenburg during the pandemic. This has not been the case for many other European ports which instead experienced many cancelled sailings at a global level on the routes from the Far East. At an inter-regional level, feeder line traffic has continued with the same frequency as before the disruptions which further has contributed to the stable import flows to Sweden (Dagens Logistik, 2020).

In the third quarter of 2020, many industries started to recover or adapt to the highly uncertain conditions and possible new waves of COVID-19 (Notteboom et al., 2021). According to Wacket (2020), order volumes increased from July, mostly driven by a switch of consumer expenditure from travels to e-commerce purchases. During the second half of 2020, the container volumes on major trade routes increase significantly, as illustrated in Figure 2.7.

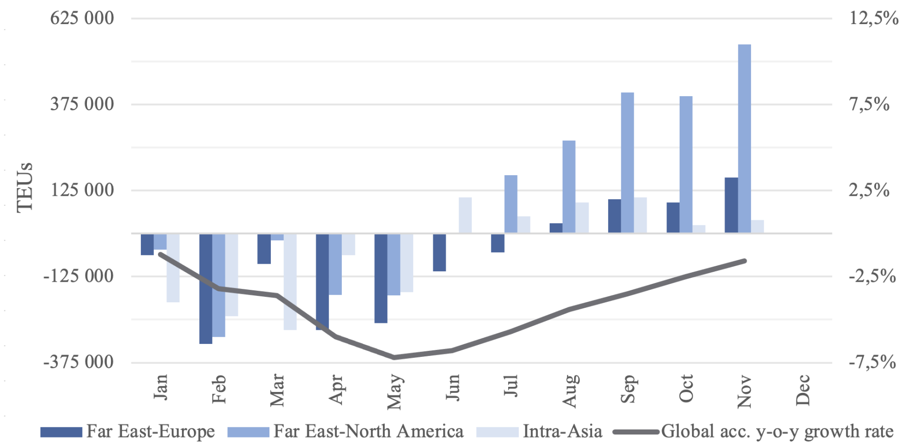


Figure 2.7: Change in container volumes on major trade routes, 2020 compared with 2019 (Holmstad, 2021).

During the fourth quarter of 2020, the increased demand combined with a shortage of containers contributed to increased freight rates for westbound containers on the Europe-Asia route. In a few months, freight rates more than doubled, reaching an all-time high by the end of 2020 (Hillebrand, 2021). According to the CEO of a Nordic agency for the shipping line Evergreen, freight rates continued to increase during the first quarter of 2021, rising from $2000 to $10 000 on the route from China to Sweden (SVT, 2021). In addition, the possibility to make export shipments from some ports in Sweden been restricted by shipping lines, as they have focused on transporting containers back to China as fast as possible in an effort to rebalance container flows and profit from the increased freight rates, even if it means transporting containers empty on eastbound routes (Österberg, 2021).

Congestion issues, container shortages and high freight rates have continued throughout the spring of 2021, not at least as a consequence of the blockage of the Suez Canal following the stranding of a container vessel in the middle of the canal, adding on to previous disruptions caused by COVID-19. According to a representative of the Port of Gothenburg, the issues are likely to continue to affect the global container system at least until the third quarter of 2021 (Cederblad, 2021).

3
Methodology

In this chapter the method used to conduct the research project is described and motivated. The chapter begins by introducing the research approach and process for the project. Thereafter, each phase of the project is described, detailing the methodology applied during research preparation, data collection, and data analysis. Finally, the research quality is evaluated.

3.1 Research Approach

Research strategy is by Bryman et al. (2019) referred to as *"the general approach to research adopted"* (p.17). Selecting an appropriate strategy entails making a choice of the methodology used during the course of the project that influences the design and possible methods for conducting a study (Creswell & Creswell, 2018). This study is of qualitative nature, meaning that the collection and analysis of data was focused on verbal descriptions and human factors rather than hard data and quantifications (Bryman & Bell, 2015). Furthermore, an abductive approach was used throughout the project as it provides the flexibility to move back and forth between theoretical and empirical findings. The research could thus be adjusted towards the empirical findings and new interesting topics could continuously be added to the theoretical framework (Bryman & Bell, 2015). The research process is illustrated in Figure 3.1 and consists of three phases; preparation, data collection, and analysis.

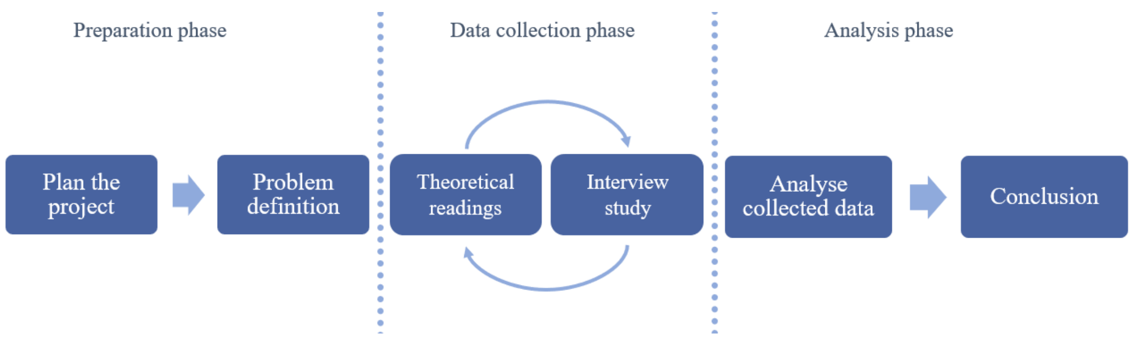


Figure 3.1: The process of the research project.

3.2 Research Preparation

In preparation of this research project a project plan was drafted, outlining how the research should be carried out and what it should include. This entailed making decisions about the overall focus of the study, the methodology to proceed with, and the time-line of the project, expressed through a written planning report. The report included a brief background to the selected research topic, a preliminary statement of the study's purpose, and a description of the method to use for the theoretical readings and collection of empirical data. Furthermore, internal as well as external deadlines were set for when the different parts of the project would be finalised. As a result of the preparation phase, the scope and limitations of the project were defined, enabling the research to continue into the next phase.

3.3 Data Collection

During the second phase, data was collected through an iterative process that combined theoretical readings and collection of empirical data. The empirical data stream from interviews with local representatives of shipping lines active in the Port of Gothenburg and the collection of secondary data. In order to gain an understanding of the interview context, a description of the Port of Gothenburg is provided.

3.3.1 Research Context

The Port of Gothenburg is the largest container port in Scandinavia, handling over 770,000 TEUs in 2019 and almost 60% of Swedish containerised trade. The port is strategically important as a gateway for Swedish industry, with almost 30% of Swedish foreign trade passing through the port which has direct connections to 130 destinations in Europe, Asia, the Middle East, Africa and North America. The port is also accessed through commercial feeders, trafficking the routes to the main transshipment hubs in Europe as well as other Swedish ports (Göteborgs Hamn, 2021a, 2021b). The main national seaborn connections are to Halmstad, Helsingborg, Malmö, Åhus, Norrköping, and Gävle (Santén et al., 2017). By railway, the Port of Gothenburg is connected to many Swedish and Norwegian inland destinations with a daily arrival of 70 freight trains. The port is also connected by road to major European highways leading to cities such as Oslo, Copenhagen, Stockholm, and Karlstad (Göteborgs Hamn, 2021b).

3.3.2 Theoretical Reading

The theoretical reading that formed the basis of the frame of reference started with a literature search initiated by some seed resources which cascaded to deeper search results. To access literature, databases such as Emerald, SpringerLink, SienceDirect and Scopus, provided by Chalmers University of Technology and Google Scholar, were used. Searches were made based on keywords such as container logistics, ECR, container transport chain, container management, and liner shipping. In order to limit the readings, the research refrained from studying areas such as warehouse management, forecast modelling, and quantitative optimisations.

3.3.3 Interview Study

Different methods of qualitative data collection are available, such as observations, interviews, and documents. The selection of a specific method should be based on the research aim and is influenced by contextual factors, making it difficult to generalise on the prominence of any one in particular (Bryman et al., 2019). According to Simons (2009), in-depth interviews enable quick and deep access to core issues by allowing personal motivations and follow-up questions. Given the context of this report, interviews have therefore been selected as the main method of data collection.

A semi-structured design was furthermore chosen for the interviews, as this provided a flexibility to introduce new questions and adjust the focus of the research in accordance with information retrieved from preceding interviews and research (Bryman et al., 2019). During the interviews an interview protocol consisting of a list of questions relevant to the research questions was used for guidance, drawing on literature from the theoretical readings. The protocol can be found in Appendix A, however given the iterative adjustments made during the data collection phase not all questions were asked to all respondents. Because of the restrictions enforced as a consequence of COVID-19, all interviews were conducted remotely through the use of video conference platforms. The interviews were carried out in pairs, with one interviewer asking questions and one taking notes of the key points. Audio recordings were furthermore made of all interviews. This approach is recommended by Simons (2009) because it enables subsequent transcription of what was said, but also encourages better understanding and early analysis. After the interviews, some additional questions on ECR strategies were sent to the respondents via email for clarification and complementary purposes, see Appendix B. The replies to these questions were in the form of written responses.

The interviews were conducted between the 2^{nd} and 11^{th} of March with employees or agency representatives of eight international shipping lines, together accounting for a total of 80% of the world liner fleet based on TEUs (Statista, 2021). Contact with the interviewees was established via email through a process of snowball sampling using a list of equipment and logistics managers provided by a representative of the Port of Gothenburg as an initial sample. Snowballing is a common sampling method when knowledge about the studied organisation or group is limited, as it facilitates access to further participants (Etikan & Bala, 2017). The characteristics of the shipping lines as well as the roles of the respondents and interview durations are presented in Table 3.1.

Table 3.1: Characteristics of the interviews and shipping lines represented.

Company	Base	Fleet size	Gbg rep.	Role of interviewee	Time [min]
Company A	Europe	1.5-3.0	Local office	Equipment Operator Equipment Operator	60
Company B	East Asia	>3.0	Local office	Logistics Manager	45
Company C	East Asia	<1.5	Agency	Managing Director	65
Company D	Europe	1.5-3.0	Local office	Operations Director Equipment Operator	65
Company E	Europe	>3.0	Local office	Logistics Manager	45
				Equipment Operator Equipment Operator	70
Company F	Europe	>3.0	Local office	Logistics Manager	70
Company G	East Asia	1.5-3.0	Local office	Operations Director	80
Company H	East Asia	<1.5	Agency	Logistics Manager	60

3.3.4 Secondary Data

Public and organisational documents were also used to collect data. Bryman and Bell (2015) mean that public authorities are a great source of information as they produce a significant amount of textual material and statistical information. In this research, public sources such as Trafikanalys, UNCTAD, and Eurostat have been used to gather information about maritime transport in Sweden and globally. Unpublished quantitative data has also been gathered and subsequently analysed as part of the research. This consists of a file provided by the Port of Gothenburg that documents the number of loaded and empty containers imported to and exported from the Port of Gothenburg between 2019 and 2021, according to quarter and container type. Furthermore, Bryman and Bell (2015) state that public organisational documents can provide researchers with valuable information and background to an organisation. For this research, annual reports, sustainability reports, and press releases were used in order to widen the perspective of the studied companies.

3.4 Data Analysis

The interview notes, transcripts, and written responses that together with the documents constituted the research data was analysed thematically. As one of the most common methods of qualitative data analysis, Bryman et al. (2019) describe thematic analysis as *"the extraction of key themes in one's data"* (p.597). The formulation of main themes and sub-themes is made through the identification of areas related to the research questions that are in some way accentuated in the data. This can for example be through repetition, similarities, differences, transitions, or missing data (Bryman et al., 2019). In this study, the collected data from the interviews was first broken down into segments and sorted with respect to their relevance to the respective research question. This formed five main areas of analysis, consisting of the categories current container flow, the ECR management process, performance measurements, COVID-19 effects, and strategies to reduce ECR. The written replies to the complementary questions on reduction strategies did not need any sorting as each strategy was asked separately and thus related to the formed categories. In each category, key elements were distinguished, originating both from theoretical readings and the interviews, as presented in Table 3.2. The interview transcripts were highlighted in different colours according to associated category and element, thereby structuring the findings. For example, the element central planning was highlighted in the following two interview segments:

> *"The empty equipment is divided between Swedish ports as well as ports in Denmark, Germany ect. by the HQ. These different needs are weighted against each other to determine where the best income will be generated"*

> *"If there is so much booked we have to receive containers from the continent, either Hamburg or Rotterdam /... / we don't control that ourselves, it it our headquarter"*

Another example from two interview segments, highlighting the element idle time:

> *"We get feedback on the idle time for the containers, often when the containers have been standing still too"*

> *"Idle time is important, the goal is to have 10 days which means that the containers should not standing still any longer"*

As highlighted by Simons (2009), this approach results in a systematic analysis that gradually generates insights through a comprehensive review of the collected data. The evaluation of the respective strategies' ECR reduction potential in terms of impact and feasibility to implementation was based on an analysis of both literature and empirical findings. Adaptions to the theoretical readings were made following the identification of new elements during the interviews, in line with the research's abductive approach.

Table 3.2: Template for the analysis of empirical data.

Category	Element	Original source
ECR management process	Strategic/tactical model, empty allocation model, routing model	(Crainic et al., 1993)
	Regional, inter-regional and global repositioning	(Boile et al., 2008; Theofanis & Boile, 2009)
	Central planning, equipment, demand planning, container allocation, container repositioning	Interviews
Measurements	Performance measurement adoption	(Otheitis & Kunc, 2015)
	Cargo use level, dwell time, availability	(Robles et al., 2007)
	Amount of empty movements, service level, stock index	(Sarmadi et al., 2020)
	Emission per container/ship: CO_2, SOx, NOx, PM	(Li et al., 2014)
	Forecasting accuracy	(Jonsson & Mattsson, 2009)
	Unit cost of repositioning, percentage of operational costs	(Sanders et al., 2015)
Current container flow	Container transport chain	(D. P. Song & Dong, 2015)
	Trade, technical, and operational imbalances	(Lumsden, 2007)
COVID-19 effects	Container shortage freight rates	(Hillebrand, 2021)
	Regional effects	(Österberg, 2021)
	Double bookings, freight rates, cancelled sails, increased flow volumes, reposition to East Asia	Interviews
ECR reduction strategies	Inland depots, street-turns, container substitution, internet-based systems, container leasing, foldable containers	(Braekers et al., 2011)
	Impact potential, feasibility to implementation	Interviews

3.5 Research Quality

To ensure that this study holds a high research quality, three criteria of trustworthiness, described by Creswell and Creswell (2018), have been evaluated in connection to the methodology applied. The criteria of validity, reliability, and generalisability, are chosen because of their relevance to qualitative research.

3.5.1 Validity

Creswell and Creswell (2018) state that qualitative validity entails determining the soundness of findings in the view of researchers, participants, or readers. There are several methods available to validate results in qualitative research and Creswell and Creswell (2018) argue that it is best to use multiple validity procedures. The use of multiple sources, also known as triangulation, is a common way to strengthen the evidence of key claims in qualitative studies (Creswell & Creswell, 2018). In this research different sources of data are used in order to converge the perspectives from the interviews, academic literature, public documents, and organisational documents. Furthermore, multiple shipping lines were interviewed in order to validate that the findings are representative for the liner shipping industry as a whole and not just a single shipping line. Another method used to ensure validity is member checking, which means that results are taken back to the participants to verify if the information is accurate (Creswell & Creswell, 2018). In this research, specific descriptions and report segments have been shown to respondents in order for them to confirm that the information is interpreted and presented correctly.

3.5.2 Reliability

Creswell and Creswell (2018) mean that it is important to determine if the research approach is reliable. To do so, the authors suggest several qualitative reliability procedures, among others the recording and transcription of interviews. In this study all interviews were conducted by both researchers and transcriptions made from recordings of the interviews. The transcriptions were then checked by both authors in order to avoid any obvious mistakes or misconceptions. Furthermore, qualitative researchers need to document the process of the study for others to be able to understand and trust the methodology taken to reach the findings (Bryman & Bell, 2015). For this reason, the report provides a description of the questions posed during the data collection, the strategy taken to analyse empirical data, and the type of respondents and shipping lines represented.

3.5.3 Generalisability

Creswell and Creswell (2018) describe that generalisation is limited in qualitative research, as it can be difficult to exactly repeat the study's findings in another context. However, to ensure that the findings of the study can be used, compared, or applied to other situations, detailed documentation of the context of the study needs to be provided (Creswell & Creswell, 2018). For this reason, the conditions under which the research has been conducted as well as the boundaries of the research has been described in the report as part of Chapter 3 and 4. The generalisability of this study is particularly affected by the global spread of COVID-19, which has had a profound effect on society and the liner shipping industry, creating a unique setting for the study. These aspects are important to include in order to understand for which contexts the results are valid and can be achieved. In the report, the findings that relate to the particularities surrounding COVID-19 have therefore been distinguished from those that relate to more general situations.

4

Empirical Findings and Analysis

This chapter consists of the study's empirical findings and analysis. It begins with an account of the shipping lines' physical flow of containers, followed by a description of planning activities in the ECR management process. Thereafter, measurements used by the shipping lines in connection to ECR are highlighted and the potential of six different strategies for ECR reduction are outlined. Throughout, the findings are related to the frame of reference and analysed through comparisons and contrasts.

4.1 The Container Flow

In order to describe the physical flow of containers, a natural starting-point is the arrival of a container vessel to a port, in this case exemplified with the Port of Gothenburg. According to the interviews, both empty and laden containers arrive to the Port of Gothenburg via maritime transport. From the port, four different container flows have been identified, as illustrated in Figure 4.1.

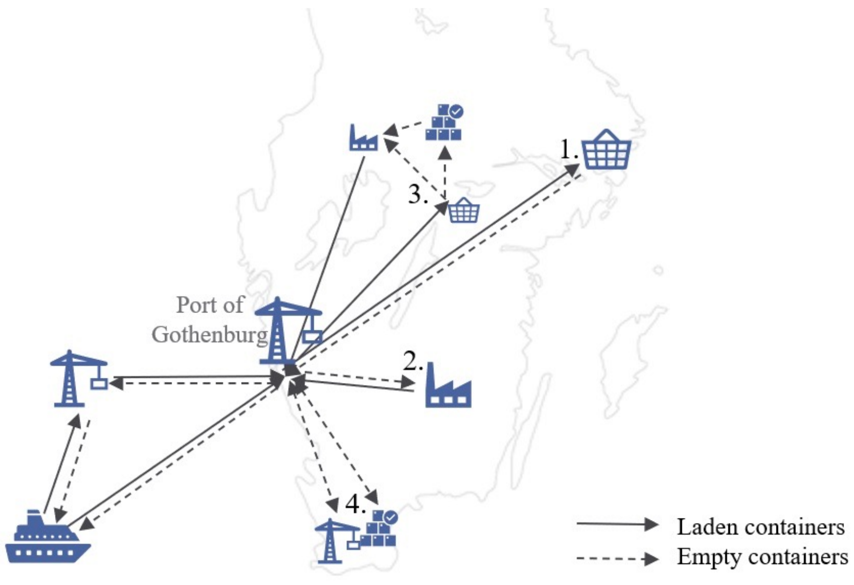


Figure 4.1: Visualisation of the container flows from the Port of Gothenburg.

1. The first flow illustrates the most simplest case of a laden container arriving at the Port of Gothenburg. From the port, the laden container is transported to a consignee positioned at an inland location, which empties the container on its cargo and then transports the empty container back to the Port of Gothenburg, or another depot according to what has been agreed upon.

2. The second flow illustrates an empty container arriving at the Port of Gothenburg destined to a specific recipient. After arriving at the port, the empty container is transported directly to the consignor for loading and then transported back to the port laden, to be placed on a container ship for export.

3. The third flow is initially similar to the first, illustrating a laden container transported to a consignee located inland. After being emptied, the container is however transported either directly to a consignor or indirectly passing an inland depot located nearby, as opposed to being transported back to the Port of Gothenburg. The container is then loaded by the consignor and transported to the Port of Gothenburg to be shipped out for export. This creates a triangular flow that can be seen as a form of triangulation or street-turns.

4. The fourth flow illustrates the empty container movement between different ports or depots, for the purpose of balancing import and export from different locations in Sweden.

The responsibility to carry out the container transports of the four flows can reside with different actors, partly depending on whether the container is hired under carrier or merchant haulage. According to a majority of the shipping line representatives, merchant haulage is dominant. Based on estimates from one interview, port-to-port shippings make out approximately 90% of all shippings. The shipping line can in either case specify the location at which a container should be returned, in most cases being the same depot or port as the customer picked up the container. In general, customers have seven to ten days to return the container before being charged an additional fee.

The container flows illustrated in the first and second alternatives are similar to the model described by D. P. Song and Dong (2015), where laden and empty containers are each other's reversed flows. The size of the different flows depends on the import and export flows to different regions, both in terms of trade volumes and in container types used. According to the shipping line representatives and statistical data presented in Table 4.1, the Gothenburg region is fairly balanced in terms of import and export volumes compared to some other regions in Sweden. Although the table only presents information about container volumes loaded and unloaded from vessels, and not other modes of transport, it gives an indication of the general trade imbalances to different regions.

During the interviews, almost all shipping lines exemplified the imbalances by highlighting Gävle and Åhus as heavy in export and poor in import, in line with data presented in Table 4.1. Accordingly, those regions need to reposition in empty containers, achieved through the creation of flows illustrated by the second alternative

Table 4.1: Container volumes loaded and unloaded in Swedish ports 2019, per region of source and recipient.

Port Region	Laden		Empty	
	Unloaded	Loaded	Unloaded	Loaded
Haparanda–Skellefteå	1,511	6,903	6,246	793
Umeå–Sundsvall	3,617	25,376	31,683	1,802
Hudiksvall–Gävle	24,473	85,738	78,393	3,726
Norrtälje–Nynäshamn	30,907	11,258	1,617	17,967
Uppsala–Eskilstuna	6,991	4,765	1,018	2,877
Södra ostkusten	55,599	48,021	8,311	15,738
Karlskrona–Trelleborg	1,221	10,009	4,855	446
Malmö–Helsingborg	132,701	91,109	18,388	45,522
Halmstad–Varberg	27,081	25,185	7,474	11,410
Göteborg	296,278	342,724	80,946	42,954
Stenungsund–Strömstad	1,533	4,232	1,836	81
Total	581,910	655,319	240,767	143,316

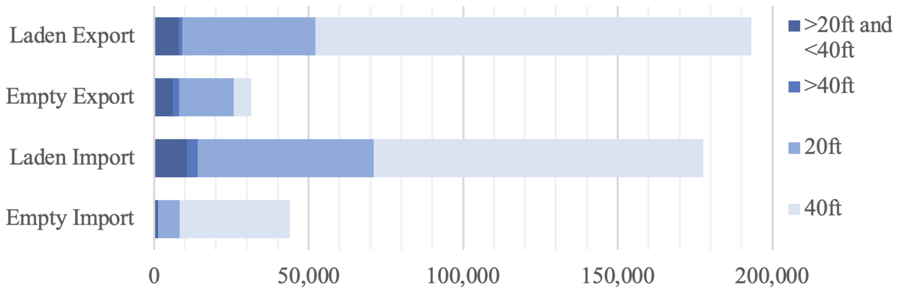
* Volume measured in corresponding TEUs.

(Developed based on data from Trafikanalys, 2020)

described above. Stockholm faces the opposite imbalance with high import and less export, meaning that empty containers instead need to be repositioned out from the region, as is illustrated by the first flow. This shows that trade imbalances between different regions are a key source of empty repositioning need, in line with Boile et al. (2008). As mentioned during the interviews, the trade imbalances are also difficult to influence by the shipping lines, as they cannot create additional export from container surplus areas or additional import to container deficit areas. During 2019, Sweden imported a volume of 240,767 empty TEUs and exported 143,316 empty TEUs (Trafikanalys, 2020), amounting to 29% of the total import volumes and 18% of the total export volumes. This percentage of empty movements corresponds well to the estimated global ratio of empty container transports at sea which Kolar et al. (2018) found to be 24.7%.

The need to reposition empty containers increases as the import and export flows to Sweden utilise partly different container types. Much of the goods imported from East Asia, as an example, are lightweight consumer goods that are loaded in

20ft containers. Much of the goods exported is however heavy industrial material, such as paper and wood, which is loaded in 40ft containers or 40ft high cubes. This unbalanced flow resulted in an import of 35,695 empty 40ft containers and an export of 17,591 empty 20ft containers to the Port of Gothenburg during 2019 (Göteborgs Hamn, 2020), illustrated in Figure 4.2.



(Developed based on data from Göteborgs Hamn, 2020)

Figure 4.2: Number of containers loaded and unloaded in the Port of Gothenburg 2019, per container type.

From the interviews and data collection it could be found that empty containers are mostly repositioned inter-regionally to Sweden. During 2019, 29% of all empty container movements to ports in Sweden concerned national inter-regional repositions and 71% streamed from international repositions, mostly inter-regionally within Europe (Eurostat, 2021). As seen in Table 4.2, the main sources of empty containers outside of Sweden are the Netherlands, Germany, and the United Kingdom.

Table 4.2: Volume and percentage share of empty containers unloaded in Swedish ports 2019, per country of source.

SE	NL	DE	UK	BE	DK	NO	EE	PL	Rest
70,434	41,371	36,737	21,028	18,705	10,335	7,434	7,201	7,087	20,566
29.2%	17.2%	15.3%	8.7%	7.8%	4.3%	3.1%	3.0%	2.9%	8.5%

* Volume measured in corresponding TEUs. (Developed based on data from Eurostat, 2021)

4.2 The ECR Management Process

When asked to describe the process of managing empty containers, the respondents of each shipping company irrespectively characterised some activities mutual to the entire group. These key activities have been outlined as the main components of the ECR management process, consisting of central planning, equipment planning, demand planning, and container repositioning. The activities have been used as a basis for comparison and the generation of a generic model, presented in Figure 4.3. Earlier literature has not described the activities in as much detail at the operational level, and for that reason this section draws mainly from the empirical findings. A summary of the respective shipping lines' ECR management process is provided in Appendix C, detailing specific findings from the interviews under each activity.

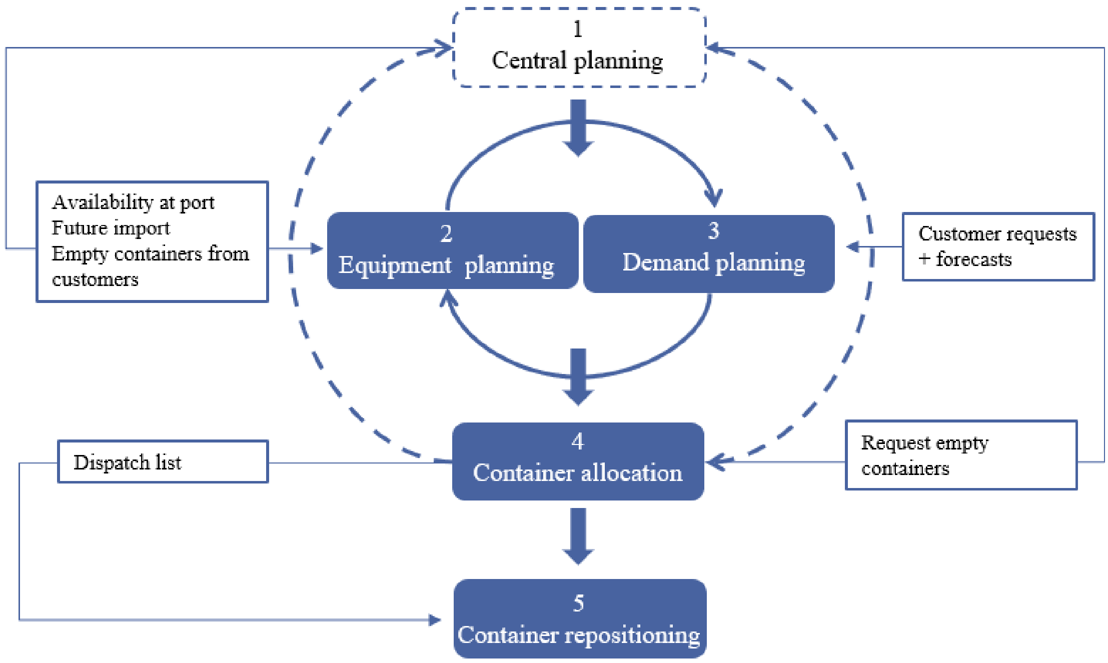


Figure 4.3: Generic model of the ECR management process.

The first activity, central planning, was identified by the respondents as the higher-level tactical and operational planning of the company's global operations and flow of containers. Although functional responsibilities differed among the interviewed companies, all shipping lines organised their planning activities hierarchically based on geography with lower-level local offices reporting to higher-level regional and global headquarters. The first identified activity thus refers to the activities undertaken by people located at offices and divisions other than those of the interviewed and often outside of Sweden. The second activity identified was equipment planning, describing the decisions and judgements made by local logistics or equipment managers concerning the number of empty containers needed at specific depots. This sort of planning was during all interviews described with reference to the activities of other functional or geographical divisions dealing with import and export container bookings, as the demand versus supply processes are strongly interrelated and performed partly simultaneously. In order to separate the two, a distinction has been made based on the functional association of activities, with activities relating to sales, customer relations, and booking requests being grouped together under demand planning. Another activity discussed during the interviews was container allocation, which in this report encompassed the process of choosing how to allocate containers and the application of different ECR strategies after a specific need has been identified. The final activity considered by the interviewees was container repositioning, which refers to the executive process of allocating the empty containers to the right location, in the right quantity, at the right time.

4.2.1 Central Planning

In order to coordinate global operations, centrally located planning divisions, described by the interviewees as headquarters, area offices, or logistics centers, create an overview of the company's global flow of containers. Although the focus of this report is on regional and inter-regional repositions, the central planning activity is included in the model as it sets the framework for the other operational activities in terms of for example timetables, network designs, and ship allocations. Many of the respondents mention that the outlay of this is highly strategic as vessels are allocated to the ports and routes where they can make the most earnings considering both import and export flows, described by C.-Y. Lee and Song (2017) as the strategic level of the planning process.

Considering the dynamic nature of the shipping industry with both fluctuating demand and capacity, more or less substantial trade-offs between the empty equipment allocated to for example Swedish ports and those allocated to neighbouring countries such as Norway, Denmark, Finland, Poland, Germany, and France are required. These were found to be guided by either policy decisions; some interviewees classifying Sweden as an outport state that they do not import empty equipment as a rule, inter-level decisions; some respondents describe that they send regular requests for empty containers to a central headquarter which then weight that request to the request of other local offices, intra-level coordination; for some shipping lines the equipment planners could directly access the plans of other local offices to find a suitable container distribution, or lower-level judgements; one shipping line mentioned that decisions on container allocations could be made almost independently by the division in Gothenburg as a result of its functional as well as geographic responsibility and an unarticulated but seemingly high commercial priority within the shipping line.

Combinations of and exceptions to the four were also registered, not least as a consequence of the turmoil surrounding COVID-19. During 2020 many of the shipping lines adopted strict policies regarding the handling of empty equipment as a consequence of capacity constraints and price surges following congestion issues and lockdowns. As an example, it was mentioned that empty containers as a rule were repositioned to East Asia during a specific period, making local offices unable to import or contain empty containers in the same way as previously. In one case, a company's regular intra-level collaboration was replaced by a higher-level policy decision enforced on the local offices.

> *Since HQ has taken a strategic decision to move as much equipment as possible back to China, because of the high freight rates, we of course do so. Locally then, every single container that is empty is repositioned. It is difficult, but it is what it is.* (Equipment operator, Company D).

4.2.2 Equipment Planning

While similar to central planning in its function, equipment planning is done at a much lower and detailed level. The goal according to the interviewees is to manage containers at a regional and inter-regional level by repositioning containers between specific ports and depots in an optimal way. The notion of an optimum is in this context used somewhat ambiguously as no interviewee claimed to have the information or tools needed to make a truly optimal decision, but rather working to find a feasible solution that fulfilled the most evident objectives.

Although there are some differences between the companies regarding how they plan equipment, some activities remain similar as a consequence of industry characteristics. All interviewed companies describe that they review equipment plans on a daily basis using a two to six weeks planning horizon, similar to what Crainic et al. (1993) describe as a short-term forecast. The upper limit of six weeks refers to import volumes and corresponds to the transit time of liner vessels coming from the Far East, as container movements within a port (loading/unloading) or depot (entry/exit) are registered through the use of RFID-tags. This means that the number of containers arriving at a port can be known well in advance and thus used as an invariable parameter for the number of containers imported when planning equipment. The import containers are in general available to the shipping line to use for export customers one to two weeks after arrival at the port. This interval is directed by a number of free days during which the importer can empty and return the container to the shipping line before an incremental fee is issued. The lower limit of the planning horizon, two weeks, refers to export volumes which according to the interviewees are much more difficult to plan ahead as there are substantial variations because of unfavourable booking practices, explained further in the next section. Although the handling of these mostly falls within the demand planning activity, the consequence for equipment planning is that volumes are highly uncertain, especially multiple weeks in advance but even a few days. In this context, there is no use in making plans stretching more than two to three weeks ahead. To manage the uncertainties, the shipping lines try to make forecasts for the export volumes, in some cases quantitatively generated from historical sales data and existing bookings but more commonly developed qualitatively by assessing historic booking patterns of major accounts and making experience-based judgements. If export bookings differ a lot from the predictions, some of the companies compare the bookings of existing accounts with their contracted volumes and contact the customer to understand the deviation.

The parameters used by the companies when planning equipment was found to be similar for the represented shipping lines. Calculations are made summarising available non-allocated containers at depot (registered using RFID-tags and adjusted for containers needing repairs or maintenance) and number of containers imported (containers on sailing vessels and containers returning from import customers), subtracted by planned number of export containers (existing bookings and forecasts), for each container type. In the end a positive or negative number is found, illustrating if containers need to be repositioned in or out. This is then the input to the subsequent activity of container allocation.

Many respondents mean that the equipment planning process is highly manual, often performed without any computer system. This conforms to the discrepancy between theoretical and practical applications of sophisticated flow models noted by C.-Y. Lee and Song (2017). Instead, a compilation of data manually extracted from different systems was often made using self-generated templates in excel.

> *Today we do not have a computer system that links export and import or optimise a solution. We basically add data from both sides into a home-made excel document.* (Logistics Manager, Company H)

However, a few shipping lines had implemented more advanced system support for the planning of empty equipment, allowing them to change between different time-horizons, aggregation levels, and forecasts more easily. These companies were also more inclined to quantitatively generate forecasts and make data-driven decisions in the succeeding activities, through which the border between equipment planning activities and container allocation was less pronounced. Crainic et al. (1993) stated that the combination of these two activities improve decision-making as it allows consideration of multiple factors simultaneously, however it was seen as too complex with the technologies at the end of the 20$^{\text{th}}$ century. As found during the interviews, such considerations are now made possible through the use of more advanced support systems. Although the activities are not joined in the generic model, as the majority of the interviewed shipping lines still described these activities as separate, the continuous diffusion of advanced support systems may alter the model to become less sequential in the near future.

With regard to recent developments, the shipping lines have a similar view of how the outbreak of the COVID-19 pandemic has affected their planning processes. Most interviewees mean that they have not changed their way of working and planning containers at all. However, the market is more unstable, experiencing disruptions more frequently, which require faster responses both by customers and equipment planners. The unpredictability is, according to the respondents, caused by congestion in transshipment ports as a result of lockdowns and increased sick leave or absence related to COVID-19 of terminal operators. Although these disturbances have mainly occurred outside of Sweden, the tight interconnection between global, inter-regional, and regional container flows has nevertheless meant that Sweden has been affected. For example, some interviewees mentioned that unfavourable booking practices have escalated during the pandemic as a consequence of unpredictable container vessel arrival and departure times. Several also stated that they had not been able to receive the same import flows as usual because of cancelled sailings to European ports, affecting the total number of containers available in the region. As a consequence, central planning divisions had to make more trade-offs between empty containers repositioned to Sweden and to other countries. Local planners therefore had to manage with fewer containers repositioned in and, in addition, defend the keeping empty containers from being repositioned out when stored at ports and depots for future use, as they received top-down instructions to limit the number of standstill containers because of the shortage. One respondent summarised the situation by stating that the container repositioning process itself has not changed, but the difficulties faced by the equipment planner has grown exceptionally.

> *It's practically pure hell when I talk to my colleagues. I think everyone have had to work maybe not twice as hard but incredibly much harder and fight for every unit to get the pieces together.* (Managing Director, Company C)

4.2.3 Demand Planning

The activity of demand planning is performed in parallel to equipment planning, in an iterative and interrelated process with the joint goal to match supply and demand. When the customers request a certain number of containers, the sales department can choose to accept it directly if they know that there are empty containers available, or they can pass on the question to the equipment planners in order to see if additional equipment can be allocated. Many of the companies interviewed stated that they have a shared excel document in which the equipment planners can input the number of containers available at each location for the sales personnel to access. However, when the availability is close to zero or there are exceptionally large bookings, the sales department often sends direct questions to the equipment planners about the availability of containers, to see if it is possible to accept the order anyway.

The objective of the iterative process between equipment and demand planning is viewed somewhat differently by the studied companies. While some of the shipping lines state that they adjust their sales of export bookings to exactly match import volumes, in order to avoid ECR, most shipping lines accept discrepancies and subsequent empty repositioning based on profitability potential. Nevertheless, all interviewed companies experienced regional imbalances to a certain degree as a large portion of export volumes are based on long-term contracts, stretching between some months to a full year, which cannot be terminated instantly in case of declining import volumes. In the contracts, the shipping lines commit to handle a specific container volume during the contracted time period and the export customer commits to make bookings corresponding to the same amount. The specific time of the bookings are on the other hand not specified in detail, meaning that volumes can fluctuate significantly between weeks, possibly complicating the equipment planning. However, as the bookings are normally placed five to six weeks ahead according to the interviewees, they are easy to plan for. Besides long-term contracts, spot bookings are important to improve customer offerings. The interviewed shipping lines expressed varying ratios between contracted volumes and spot bookings, mostly with a surplus of contracted volumes, although equal quotes were also mentioned. Darabi and Suljevic (2015) mentioned in their study that almost 60% of the bookings are spot booking which is even higher than what the shipping lines expressed during the interviews. The spot bookings are often made a much shorter time ahead, sometimes as short as one to two days before vessel departure, which makes them difficult to plan. It is these bookings that normally cause the sales department to directly ask the equipment planners if they can be accepted.

A key problem for demand planning is also that changes to placed bookings may appear close to departure, which negatively affect the planning of containers as fewer container repositioning or allocation options are viable at such short notice. Changes by the customers could be caused by delays in production or material shortages at the customer, however another common cause was double bookings.

> *A customer places the same order at one, two, or three different shipping lines in order to ensure space at a container vessel. Then, when a shipping line has accepted the order, loaded the containers, and the vessel is about to leave, the customer forgets to cancel the booking with the other shipping lines.* (Operations Director, Company G)

According to the interviewees the maritime shipping industry stands out from other industries in that it does not apply cancellation fees as a standard, enabling customers to cancel bookings without consequence. As highlighted by Zurheide and Fischer (2015), this causes significant planning difficulties for the shipping lines, as also reported during the interviews. In addition, some respondents viewed the unfavourable booking practices as a self-inflicted problem, caused by the liner shipping industry's inability to implement suitable incentive structures and uphold predictable supply of containers. This view is shared by Ng (2012) who describes how forecasting uncertainties give rise to adverse effects such as double bookings, that cause even larger uncertainties. Historically, dead freight payments used to be common in the industry, according to one of the more experienced interviewees, but in order to gain competitive advantages these were discarded. The problem today is therefore how to reintroduce cancellation fees without losing customers. A few interviewees stated that they had managed to introduce cancellation fees in some customer contracts, but not throughout. According to the estimate of one respondent, around 30% of bookings are changed with short notice.

Double bookings have recently increased further, much as a consequence of the COVID-19 pandemic. Because of increased consumption and congestion issues, there is a shortage of containers. This has led customers to place bookings with several shipping lines to ensure that their cargo will be loaded, making predictions and equipment planning more complex. It was also mentioned by some companies that due to the COVID-19 pandemic, it has been more important to match import and export bookings more precisely. If the shipping line does not have any booking, the containers should be shipped out, to be used somewhere else where it is needed.

4.2.4 Container Allocation

Container allocation is the fourth activity in the ECR management process, aiming to deciding how empty containers should be repositioned or allocated to the right place at the right time. The interviewed companies describe somewhat different priorities between existing repositioning alternatives, in terms of mode of transport and repositioning levels, and between other allocation strategies, such as container leasing, purchasing, and collaboration. Considerations are made to operational scope of control, time, price, and availability. Most of the local planning divisions decide by themselves how to move empty equipment within Sweden, meaning that it is easier to reposition containers regionally and inter-regionally within their geographical planning area compared to other inter-regional areas in Europe or globally.

Within Sweden, repositioning along the coastlines are according to some respondents often made using vessels, while repositions inland or across coasts are made with train or truck. The ability to use vessels for repositioning however require inexpensive access to feeder lines and longer planning horizon as it is a time-consuming mode of transport. Not all shipping lines have their own feeder lines or perceive the commercial feeder's price as competitive, and therefore choose other modes of transport. The key benefits of seabound transport, as explained by the interviewees, are lower costs and environmental impact. Where maritime transport is not possible, a choice between rail and road transports are made. As trains can cover long distances and handle large volumes at a low cost, many respondents stated that railbound repositioning is often favoured over trucks when possible. However, because of inflexible time-tables and few departures, road transport was mentioned to be used for the repositioning of low volumes and emergency transports. One respondent estimated that 60% of laden and empty containers left the Port of Gothenburg by train and 40% by truck. This is somewhat in contrast to normal regional repositioning practices, which according to Boile et al. (2008) commonly deploy mostly trucks, something that may be explained by the good rail connections to the Port of Gothenburg. From the interviews it was clear that the cost perspective was given considerate prioritisation in the selection process, with time and availability requirements functioning as primary constraints. Although many interviewees stated that environmental considerations were important, they were generally interpreted as positive side-effects rather than actual determinants.

In those cases where containers could not be repositioned within Sweden, the local equipment planners proceed to request empty containers from neighbouring ports or the larger hubs in Europe, such as Rotterdam or Hamburg. As the operations director of Company G stated, *"Rotterdam has a constant surplus of empty containers"*, meaning that the shipping lines in normal situations can expect to receive some empty containers to use for export. However, as a consequence of COVID-19 and the container shortage, the local offices do not receive the volume they ask for, according to many of the respondents. Because of the shortage of containers, centralised planning offices need to prioritise between different local divisions in order to optimise the shipping line's total container usage, which often resulted in fewer containers being received compared to the number of containers needed. In the normal case, some companies are more flexible than others in repositioning empty containers inter-regionally from the ports in Europe, often as a consequence of having their own feeder network.

> *If a customer calls and asks, 'we want to book 200pcs of 40ft in Gävle next week is it possible?'. Right now, we say no, everyone does, but in a normal situation, we can say wait, we'll just check some things. Then we can respond in the afternoon and say, 'yes we can come in with these empty containers on Monday'.* (Logistics Manager, Company F)

Besides repositioning containers, Theofanis and Boile (2009) mention that containers can be leased. While a few shipping lines considered container leasing as an option for container allocation, it was not commonly used in Sweden. Rather, decisions relating to container leasing were often made on a central and more strategic level. As Theofanis and Boile (2009) further describe, containers may be allocated through purchases of new containers, however this was not found to be a solution on a regional level for any of the interviewed shipping lines. Similarly, cooperating horizontally with other shipping lines to match container needs were also found to be absent as a consequence of regulatory constraints set against anti-competitive behaviour. Vertical collaboration could be used within the container transport chain in order to reduce ECR (Theofanis & Boile, 2009), however many of the respondents mention that this collaboration with other actors is limited because it requires the actors to share sensitive data with each other.

Regarding container allocation, it was also mentioned during the interviews that some shipping lines seek to avoid repositioning altogether. For long-term customers, this was done either by phasing out imbalanced contracts, finding an equivalent flow in the opposite direction, or convincing exporters to ship from other ports. This could imply that the empty repositioning distance from the consignor to the port increases, however if a more balanced flow can be achieved the total empty repositioning distance may decrease. In the short-term, another way to avoid ECR mentioned during the interviews was to prioritise between export customers if having too few containers or not accepting any unbalanced bookings. Examples of inherently imbalanced regions are Gävle and Åhus, which both have a large export flow but a small import flow. Some of the shipping lines mentioned that they therefore have decided to phase out their contract shippers in these regions in order to avoid having to perform empty repositioning.

> *Earlier we have transported a lot of Absolut Vodka from Åhus to the North American market. There is no import to Åhus, so then 99% of the containers were repositioned empty in order to maintain the contract.* (Managing Director, Company C)

4.2.5 Container Repositioning

During the interviews it was frequently stated that the shipping lines did not commonly move empty containers before having received an actual booking that required repositioning. Repositionings were then made as close to when the container was needed as possible, given a certain safety margin and aspects of convenience, in order to avoid unnecessary empty movements. This was only exempted by one of the companies, which was found to occasionally move containers based on forecast. The key reason given by the others was that it costs too much to move empty containers based on forecasts, especially as the forecasts are not accurate enough. These practices seemed to have developed in the last years, as many interviewees noted that they historically often moved containers based on forecasts. This was motivated by tighter control by centralised planning offices, diminishing container overcapacity, and cost rationalisations, in line with the structural changes noted by Fusillo (2013).

> *The large number of containers that we operate, either that we own or lease, are associated with substantial costs. This means that we cannot take in empty containers to Gothenburg now in week 9 because we see a need week 14. It is just not reasonable to prepare in that way.* (Logistics Manager, Company F)

Moreover, the interviewees mentioned that the COVID-19 pandemic accentuated the underlying trend of not allocating containers before there is a booking. As the global container shortage has affected the whole container transport chain, the importance of short dwell times was furthermore recognised by many of the respondents, as the containers could not be afforded to be standstill. Another important trend discussed was the vast increase in freight rates, which on the Asia-Europe route rocketed from \$2,000 to \$10,000 in the beginning of 2021 in response of the high demand and container shortage. Because of the potential of financial gains from shipping containers from the Asia, empty containers were shipped out of Sweden much sooner than during normal situations, meaning that they were not allowed to be stored while waiting for a booking. This was also seen in the levels of safety stock set by some companies which were much lower than regular. Even so, some respondents seemed comparably unaffected by these events and had received other directives about how fast containers should be shipped out of Sweden.

> *Regardless of whether it is empty or loaded, we want the container back to mainport China to support exports if there are good freight rates.* (Managing Director, Company C)

4.3 Measuring Empty Container Repositioning

From the interviews it can be concluded that the use of performance measurements was not as prevalent as expected. Many of the respondents indicated that evaluations are often made at higher levels, and that personnel at more strategic or centralised positions probably used a wider set of indicators to assess the shipping line's performance on ECR. Multiple shipping lines also stated that the industry is rather analogue and that much work is done manually at local levels. The use of quantitative performance indicators is therefore moderate, and the indicators mentioned below should be viewed in light of this.

When asked about performance measurements, almost all of the respondents featured a discussion about the costs of empty repositioning carried by the shipping line. While recognising that repositioning of empty containers is necessary for operational reasons, the interviewees also highlighted that empty repositioning is capital destructive as both the moving and idling of empty containers amount to considerate direct and indirect costs. As described in a BCG report, empty repositioning costs can amount to around 8% of a shipping line's total operating costs (Sanders et al., 2015). According to the interviews, direct costs can arise when a shipping line reposition containers using commercial feeders or inland hauliers that charge a direct transport fee. Indirect costs can arise when a shipping line use its own vessels, as the empty containers then may compete for capacity with laden containers and thus possibly constrain the ability to sell more export bookings. A shipping line often know these costs in order to decide a commercially viable price for customers, sometimes including the cost of repositioning and sometimes not, depending on the availability of return flows and competitive factors.

As aforementioned, dwell times of containers was found to be measured without exception by the interviewed shipping lines, as was advised by Sarmadi et al. (2020). The interviewees explained dwell time, or idle time, as the time the container was standstill at a depot or port location. The primary motive for measuring this was that the containers only generate revenue when they move and accumulate high storage costs when standstill. A large number of the shipping lines mentioned that they have a dwell time breaking point at ten days, after which the containers should be repositioned to a location where they could be better used. In practice, this often meant repositioning the containers to European container hubs or destinations in the Far East, but it could also be to a new customer. Repositioning of containers is preferably made in order of first-in-first-out, however as the containers are stacked it can often be difficult to apply and containers at the bottom may accumulate long dwell times. The dwell time information is generated through RFID-reporting and often transmitted weekly from higher-level offices to local planners in the form of lists of containers with too long idle times. This shows that the performance measurement is not only collected but also followed-up and used to improve operations, which Robles et al. (2007) points out the importance of.

> *We do not work that much with different performance measurements, but one is that we don't want long idle times. You don't want the containers to stand still too long. Instead, you want the containers to move as much as possible, as it makes more money the more it moves.* (Equipment Operator, Company A)

Although this performance measurement is reasonable from a cost-perspective, it may affect repositioning of empty containers in a negative way. The performance measurement dwell time could lead to increased ECR since it contributes to movements of containers that have not been moved lately. Since the measurement aims to have the containers moved continuously regardless of whether the containers are empty or laden, planners may be incentivised to increase empty container movements rather than the opposite.

Another performance indicator that was used by some shipping lines was a stock index that stipulated how many containers that the planners were allowed to store at different depots. While some shipping lines related this number dynamically to their demand during lead time, others based it on the amount of export bookings. A few also had set more fixed levels based on the historic container flow. As an example, one shipping line had a stock index of 1.5, indicating that it could have 1.5 containers in storage for each export booking due in three weeks. Another shipping line with the same empty stock index during normal circumstances said that their allowed levels had changed during the last weeks, as a consequence of container shortages caused by disturbances related to COVID-19.

> *I would say that our empty stock index is actually closer to 1.0 because of the global container shortage. If we only have 100 containers bookings we are only allowed 100 containers in storage. We cannot keep another 20 containers or anything.* (Operations Director, Company G)

Environmental performance measurements are according to the interviewees mostly done at a higher level within the organisations, and normally do not regard empty container movements at a regional level. However, environmental perspectives are becoming increasingly important even in the otherwise highly traditional maritime shipping industry (Yang, 2018), which can explain why some local offices reported to receive increasing pressure to include environmental perspectives in the planning of empty containers. One respondent highlighted that he was likely to put more emphasis on environmental indicators in the coming years, as that shipping line was in the process of gaining an ISO14001 certificate for environmental management. Any specific indicators were however not discussed as the project had only just started. Furthermore, some of the shipping lines mentioned that they tried to utilise rail- and seabound modes of transport instead of trucks to decrease the environmental impact of repositioning, however this was in many cases secondary to operational- or cost-related performance objectives.

As part of their planning process some shipping lines also evaluated their forecasting accuracy, commonly on a monthly basis, by comparing the forecast to actual outcome. However, as many companies did not systematically generate forecasts at all, the evaluation was in many cases found to be non-existent or possibly on a low level by manually assessing predictions and subsequent outcomes. Pradita et al. (2020) argue that it is important to have knowledge about the accuracy and efficiency of the planning processes, which most of the shipping lines at a local level are lacking. Nonetheless, one shipping line affirmed that they had evaluated the forecasting accuracy and performance of the plans created by operational personnel more systematically. When comparing the plans to computer-generated plans they had found that the computer outperformed the human-generated plans in almost all situations. Humans were only found to be better at planning unusual container needs, such as those for infrequent container types, as the small historic samples of infrequent container types caused outliers and other deviations to impact the result too much. For this reason, the task of the operational planners of that specific company was to check the computer-generated plans and, if needed, make smaller adjustments. In addition, most of the shipping lines collected data on for example physical damages to containers, turnover times for depots, idle times in total and per container, and turnaround time at customer, in order to improve forecasts even though not always using them for evaluation at local levels.

4.4 ECR Reduction Strategies

Braekers et al. (2011) describe six strategies to decrease ECR; inland depots, street-turns, container substitution, internet-based systems, container leasing, and foldable containers. Table 4.3 presents the extent to which the strategy is currently used by the studied shipping lines, as well as their respective strengths and weaknesses based on answers given by the interviewees. The potential of each strategy is also summarised based on an analysis of both empirical findings and literature, and evaluated both in terms of expected impact and feasibility to implementation.

4.4.1 Inland Depots

Today, several of the shipping lines interviewed use different inland depots located in Sweden, in many cases owned by public authorities or a private actor other than the shipping line. The foremost reason for using inland depots, as interpreted from the empirical data, was the shipping lines' potential to save transport costs because of the reduced empty travelling distances between the depot and customers. A second reason mentioned was the high cost linked to container handling at the ports, which according to some shipping lines could be reduced by relocating some containers to inland depots as these offered lower storage fees. These reasons were highlighted also by Crainic et al. (1993) and Braekers et al. (2011), however a third argument issued by the authors, the potential to reduce congestion at the port, was not mentioned by the interviewees. The reason for this may be that port congestion is foremost an issue for hauliers or shippers that try to pick-up or drop-off containers at the port, and not the shipping lines.

The main argument expressed against additional inland depots was that their use requires high and stable flows of import and export. This is because multiple warehousing locations are associated with a higher total stock volume for a given service level. If variations are high, forecasting is more complex, and empty containers may need to be moved back and forth between different depots to make up for unexpected container shortages or surpluses.

> *The economy crumbles with too many terminals or depots. The best thing for us would be to have one terminal in the country. The risk with too many terminals is that we just send empty containers between all depots in order to meet the export need.* (Managing Director, Company C)

Shipping lines thus need to balance the cost and planning difficulties of additional storage points with the savings from shorter transport distances out to customers

Table 4.3: Strengths, weaknesses, impact potential, and feasibility to implementation of the ECR reduction strategies.

Strategy	Strengths	Weaknesses	Impact	Feasibility
Inland depots	Shorter transport distance Avoids high port storage costs	Multiple storage locations Increased planning complexity	Medium	High
Street-turns	Shorter transport distance Reduced idle time	Juridical barrier Increased planning and coordination complexity Interdependencies decrease resilience	Medium	Medium
Container substitution	Reduced technical imbalance	Customer requirements only viable for some cargo and container types	High	Low
Internet-based systems	Improved visibility and coordination ability	Sharing sensitive data	Medium	Medium
Container leasing	Flexible fleet sizing for individual shipping lines	Same trade imbalances	Low	High
Foldable containers	Space efficient empty transports	High investment, handling, and maintenance cost Time-consuming to fold and unfold Vulnerable to damages	High	Low

and possibly lower storage fees, to reduce their overall cost of ECR. While this trade-off normally resulted in the use of a handful of inland depots, the number may have been higher if carrier haulage and door-to-door contracts would have been more common, as the savings from shorter transport distances to customers then would have a greater impact. In line with this, the shipping lines that provided more inland and logistics services were also perceived as more inclined to open more inland depots than those that did not.

The potential to reduce empty container movements by the use of inland depots is thus dependent on multiple factors connected to variations in the container flow. Sweden is a large country to its area, which favours the use of inland depots for regional repositioning because of reduced transport distances to customers, but low volumes at the dispersed locations constrain the use of inland depots because of weakened economies of scale and flow predictability. However, as inland depots were found to be well incorporated as a strategy to optimise the empty container flows of the interviewed shipping lines today, the feasibility of implementation is nevertheless regarded as high. That said, the potential to reduce ECR by the use of further inland depots is deemed reasonably low as most of the shipping lines considered their present network of inland depots as balanced.

4.4.2 Street-turns

Street-turns were found to be seldom used by the interviewed shipping lines, however many stated that their associated haulers were more inclined to use the strategy on their own initiative. When used by the shipping lines, it was often the haulier, or sometimes the customer, that were the initiating party. This shows that the strategy has a pronounced potential to reduce costs for several actors in the container transport chain besides the shipping lines. In line with Braekers et al. (2011), the shipping lines explained their limited involvement by highlighting the juridical aspects of container shipping, where the shipping line is liable for the quality of the container when it is sent to an export customer. Any damages that occur during import thus need to be repaired and the containers inspected before the container is exported. While hauliers in some situations can carry out these inspections, the shipping lines prefer terminal operators to do it at depots for quality assurance. Furthermore, linking suitable import and export flows requires much administrative work and planning, the cost of which in the end may exceed possible savings. Moreover, one interviewee expressed a fear that possible delays at the import customer would affect the export customer negatively if the two were linked directly without any intermediary buffer, which Deidda et al. (2008) pointed out as problematic for implementation. This could risk affecting the relationship with the export customer and in extension hamper further affairs.

Despite the many barriers to implementation, the feasibility potential of street-turns is considered to be medium. The main facilitators for the solution, as given by the interviewees, is the introduction of a common standard for the juridical aspects and further operational collaboration with hauliers and customers. The potential of street-turns to impact ECR at a regional level is also regarded as medium. This is mainly supported by the arguments brought forward by Braekers et al. (2011) regarding reduced transport work, but to some extent also discussions during the interviews relating to triangulation of transports between different nodes in the container transport chain. One interviewee noted that although street-turns were not commonly used, the shipping line had started a project that aimed to increase triangulation activities between a customer and different depots in Europe, analogues in structure to street-turns which instead triangulate transport between a depot and different customers. The perception was that this project had been successful in reducing empty repositioning distances as the flow through the two depots became more balanced, and that street-turns were likely to have a similar impact.

4.4.3 Container Substitution

From the data collection it was found that the substitution of different container types was practiced to a varying degree by the interviewed shipping lines, depending on the dimensions of the container requested. Most shipping lines acknowledged that substitutions between standardised 40ft containers and 40ft high-cube containers were frequently made at a regional level and generally accepted by the customers. The substitution of dry containers with refrigerated containers was less prevalent, although existent, at any repositioning level because of the difference in price between the two. According to the categorisation of Chang et al. (2008), substitutions are thus made both with reference to dimension and purpose of the container. Substitutions with reference to ownership are discussed in the section container leasing. The substitution of 40ft containers with 20ft containers was also made on occasion, preferably the import of 20ft containers was substituted for 40ft containers to suit the characteristics of goods exported from Sweden. Substitution of export containers was however not as viable an option sometimes, as explained by one interviewee.

> *There are some products that we can transport in 20ft instead of 40ft containers, which we do. But if the Swedish wood industry sells sawed wood products to Japan, and they want them to be 12 m, we cannot split them in two pieces and use duct tape to piece them together again.* (Logistics Manager, Company F)

If considering the difference between laden import and export volumes for the Port of Gothenburg, a gap of 15,500 containers was identified during 2019 (Göteborgs Hamn, 2020). However, if accounting for different container types in terms of physical dimensions, the gap rises to over 53,400 containers. This shows that technical imbalances explain a considerate portion of the empty repositioning need, as noted by Lumsden (2007). The impact of container substitution at a regional and interregional level would therefore be considerable, as much of the empty repositioning need would be reduced if the same container types could be used for all cargo in Sweden. Regarding the feasibility potential of container substitution, emphasis has been put on the particular substitutions that would generate the largest impact. For the Port of Gothenburg, this is the substitution between 20 and 40ft containers as these make out the main types of containers imported and exported (see Figure 4.2). Considering the aforementioned differences in characteristics between goods generally transported in 20 and 40ft containers, the feasibility to implementation is regarded as low. The same conclusion can be drawn if evaluating the substitution between dry and refrigerated containers, however if evaluating the substitution between 40ft and 40ft high-cube containers the feasibility and impact assessments would be the opposite.

4.4.4 Internet-based Systems

The interviewed shipping lines all used different types of internet-based systems in order to control the repositioning of empty containers at global, inter-regional, and regional levels. For example, RFID-technology was used throughout the industry as a means to locate containers and be able to plan empty container movements. Although the information from this technology is rather limited, only registering moves at discrete locations, many interviewees felt that this information was enough to plan ECR. Braekers et al. (2011) point out that many technologies have not yet been adopted across the industry, and during the interviews only a few companies stated that they had integrated the use of container GPS-trackers with planning systems to increase their visibility. However, this was mostly seen as a way to increase the customer experience and let cargo owners track their containers in real-time, not improve the planning process. Even so, GPS-trackers should enable the shipping lines to position containers more exactly and as a result gain insights that improve forecast or planning abilities. This would be especially advantageous for inland transports, since the shipping lines lose visibility after the container has been released to a customer or haulier at the port, and therefore do not know how it is moved. Internet-based systems are therefore assessed with a medium potential to impact ECR.

Furthermore, many shipping lines described that data is mostly shared with hauliers, in order to improve transport operations. As described previously, one interviewee spoke about the company's collaboration with hauliers in Europe, which was implemented through the use of a shared computer-system. The system contained information about pick-up locations for import containers and different alternatives for drop-off locations from which the haulier could choose to use. By sharing this information, the company could increase the flexibility of the container system and allow hauliers to optimise empty transports by choosing different drop-off locations depending on future needs. Although they saw a potential to reduce empty repositioning through such a system, as it facilitated triangulation between depots and a customer, it had yet not been adopted in Sweden. To share information with other actors in the network can nevertheless be highly sensitive, and another interviewee expressed a distinct fear of sharing what he saw as possible trade secrets.

> *Information is to a large extent power. To share information with your partners and customers is difficult - as it can potentially be used against you, for example to reduce freight rates.* (Logistics Manager, Company H)

As Theofanis and Boile (2009) mention, shipping lines are reluctant to share sensitive information with other actors in the network. This is the strongest factor that hampers the use of internet-based systems, however another issue is how to align incentives of the participating actors so that all are to benefit from the shared system. In the example above both the shipping lines and hauliers could benefit from a more efficient container repositioning, for the shipping line though improved container balance in the ports and for the haulier through more efficient transport work. However, according to one interviewee the wills of different shipping lines are often too divergent and flawed by selfish interests to allow for horizontal cooperation. The feasibility of implementing internet-based systems is with reference to this regarded as medium.

4.4.5 Container Leasing

All shipping lines mentioned that they lease containers for both long- and short-term use at a global level. The respondents that felt comfortable with answering more detailed questions stated that the percentage share of the shipping line's container fleet leased versus owned was equally divided, both amounting to around 50%. However, some shipping lines perceived the percentage of owned versus leased containers as sensitive information and therefore chose not to respond more precisely than noting that they have both. The shipping lines commonly lease containers on long-term, often several years, meaning that they are handled in the same way as owned containers with regard to handling and repositioning. Therefore, this type of leasing does not have an influence on ECR. A few shipping lines however had some short-term leasing contracts that allowed them to off-hire containers in Sweden, in order to handle the imbalance of 20ft containers between export and import. One shipping line stood out by also on-hiring containers as a means to fulfil export requests besides repositioning. In most cases it was however highly unusual that the local offices in Gothenburg initiated short-term leases for the inter-regional and global movements of containers from one port to another, rather the leasing contracts were negotiated at company headquarters and used to handle global imbalances at a larger scale.

In order to reduce reposition through container leasing, a prerequisite is that the leasing parties have flows that are oppositely unbalanced and that the container change leasing party frequently (Braekers et al., 2011). If not, container leasing would mainly shift the cost of repositioning between different actors and does not address the repositioning problem itself. Because of the long-term nature of leasing agreements, leased containers are handled almost the same as owned containers and therefore do not change hands frequently. In addition, the shipping lines generally face equal problems with shortages and surplus in the same areas according to the interviews, as the container repositioning problem to a large extent is affected by global production and consumption patterns. These two factors mean that the potential to reduce ECR through container leasing is low. Shipping lines may however face opposite imbalances at some specific locations, in which case container leasing can prove useful, and individual shipping lines can reduce ECR on a company-level through short-term container on- and off-hires.

4.4.6 Foldable Containers

From the interviews it could be concluded that foldable containers were virtually non-existent in the maritime shipping industry. A few shipping lines had a limited number of foldable containers on trial, but none of the interviewees had themselves been involved in the operations of these. The main argument against foldable containers stated by the respondents was their extremely high cost, both to buy and maintain but also to handle as the folding and unfolding require considerable work.

> *They are a nightmare to maintain /.../ The container's absolute advantage is that it's simple, rigid, and standardised. The more parts that need maintaining and testing, the smaller its potential and effectiveness.* (Logistics Manager, Company H)

Despite this, foldable containers have a high potential to impact ECR at global, inter-regional, and regional levels, as empty transports can be made more efficient. However, in view of the seemingly strong but sound resistance towards its further use, the feasibility is assumed to be relatively low. As mentioned by both respondents and Braekers et al. (2011), foldable containers require a lot of investments for many actors within the container transport network. It also takes extra time to handle and requires special equipment, which means that the barrier to implement foldable containers is very high.

5

Discussion

In this chapter, the findings and analyses made in the previous chapter are discussed further, initially highlighting key similarities and differences to the theoretical framework. For each research question, the discussion also relates the findings to the specific characteristics and context of research project. Lastly, connections between the study's two main research questions are made, discussing causal relations between the ECR process and ECR reduction strategies.

5.1 The ECR Management Process

This report has identified five operational activities in the ECR management process and proposed a generic model, presented earlier in Figure 4.3. The model is in many ways similar to the model developed by Crainic et al. (1993), presented earlier in Figure 2.3, which depicts two operational activities when outlining the overall planning approach. However, there are some key differences which impact the understanding of how shipping lines manage ECR activities.

First, the proposed model puts emphasis on the dynamics of ECR management by outlining two iterations that contrast the sequential relations of the activities. The most central iteration is the one that connects supply and demand activities, indicating that equipment planning, and demand planning are interdependent processes that require coordination in order to be matched. Demand plans are in the proposed model therefore not viewed as static input, but rather a variable that is modified in the demand planning activity to achieve less empty repositioning of containers. The second iteration connects the activities of global planning and container allocation, aiming to illustrate how local offices need to adjust their allocation strategies to global plans and vice versa. The iteration may be of particular importance to the specific case context, which partly holds Gothenburg as an outport to larger European container ports. As many of the shipping lines interviewed were reliant on transshipment and indirect connections to main trade regions in the Far East, adaptations to other regions and countries may have been more pronounced than if the studied flows would have been more independent. Another specificity impacting the iteration may be the level of study. By mapping the activities of local offices operating at a lower level, authority to take decisions that extend beyond the predetermined geographic scope of control is low, and interdependencies with central planning increase. The second iteration may therefore be less pronounced in different contexts.

Second, the findings revealed that the introduction of new technologies may have the potential to bind some activities closer. It was for example found that equipment planning, and container allocation activities were made more simultaneously by shipping lines that used more planning systems in their management process. Further research is needed to analyse how the integration of technologies affect the activities and performance of the ECR management process. The findings furthermore found the industry to be highly manual, a reason for which may be that the study centred around operational planning at a regional and inter-regional level. Despite the manual practices, many of the respondents perceived the current information was sufficient to perform their work and therefore did not see a reason to incorporate technologies such as GPS that could render new information when questioned about information systems. However, when describing the planning practices for inland repositions, multiple respondents also pointed out that they had little visibility and control over the containers once released from a depot, as most bookings exercised merchant haulage, complicating their ability to plan future container availability. These contradicting perspectives may indicate an uncritical view on current practices, which as seen in the study also have implicated the respondents view on future improvements. Another interpretation is that the shipping lines still have a maritime perspective to ECR, meaning that they have not adapted information systems and processes towards inland container transports. Inland transports may require more advanced information systems given the involvement of multiple and dispersed actors, modes of transport, and shorter time-frames compared to maritime repositioning which is entirely controlled by the shipping lines and commonly operates on a perspective of weeks rather than days or hours. In order to connect the maritime and inland operations and become more digital, better planning and information systems would have to be introduced on a global level, both to connect dispersed geographical offices and to form consensus around the strategic investment decision. This transition had begun for some of the shipping lines, however the process was described as very time-consuming and administered top-down.

Sweden's consumption and production areas contribute to how repositioning is carried out. The import to and the export from Sweden is fairly balanced in terms of number of containers. However, the consumption areas are not located at the same places as the export areas, which makes the trade imbalance within Sweden relatively large. The imbalance further increases because of technical characteristics of import and exports, augmenting the need for empty repositioning of containers. While these factors are likely to remain the same regardless of the shipping lines desire to reduce ECR, the individual shipping lines can choose to disregard those unbalanced flows in order to reduce its ECR at a company level. This however does not reduce ECR in the whole system, as economic incentives will ensure that some shipping lines are willing to perform the reposition. The shipping lines' individual performances on ECR can therefore not be used as a sole indication of the level of

ECR or reduction potential of the entire system.

Boile et al. (2008) describe that there are different repositioning approaches for different levels, where inter-regional repositionings are made intermodally. This is similar to the findings of this study. However, Boile et al. (2008) also mean that regional repositioning is mostly achieved with trucks, which is somewhat different to the result of this study, indicating the characteristics of the Port of Gothenburg and Sweden's import and export areas provides a special case. As described in Chapter 4, containers are by some shipping lines repositioned along the coastlines owing to the good coastal access of the Swedish geography which makes it possible to move containers between different ports by boat instead of other transport modes. For repositions further inland, the extensive train network from the Port of Gothenburg allows inexpensive transport of larger volumes compared to trucks, the reason for which most shipping lines said to prefer railbound transports. However, under carrier haulage last-mile deliveries are naturally made using trucks and many of the shipping lines also expressed that trucks are used for emergency transports. The specific modal characteristics of this case should contribute positively to environmental and economic indicators of ECR, as economics of scale means that sea- and railbound transports are often less costly and generates less emissions per container compared to road transports. However, the time-requirements and inflexibilities of these modes may complicate the ECR management process as they cannot be achieved at the last minute and require coordination with external actors.

5.2 ECR Measurements

The study found that some factors relating to container handling are measured at an operational level by local equipment or logistics offices. These included occurrence of physical damages to containers, turnover times for depots, idle times in total and per container, and turnaround time at customer; several of which are highlighted in academic literature (Robles et al., 2007; Sarmadi et al., 2020). However, the use of predefined measurements was not as prevalent as expected and manual qualitative performance assessments were common. This is consistent with the findings of Otheitis and Kunc (2015) that suggest that the shipping industry is slow at adopting adequate systems for performance measurement. The slow adoption may also be an explanation for why benchmarking against other shipping lines was also found to be uncommon, despite being a common goal of performance measuring in other industries (Naslund & Williamson, 2010). During the interviews, several of the shipping line representatives expressed an interest in the answers of other shipping lines, indicating a wish to know more about the performance of their competitors. If the shipping lines would more openly benchmark performances, best-practices could be developed and used by the entire industry. The maritime shipping industry's characteristics of fierce competition, tradition, and reluctance to share data, may however be important as explanatory variable to why this was yet not done, as well as the notion that such evaluations may be more common on higher organisational levels.

While the described measurements are important for the operative handling of containers, they say little about ECR per se. As stressed by Otheitis and Kunc (2015), performance measurements need to be linked to a business or operational strategy in order to align incentives. With many indicators centred around the utilisation of containers, the effect on empty repositioning may be divergent or even contradicting. For example, the measurement of idle times may increase repositioning as containers cannot be stored too long, while the measurement of storage levels and setting of appropriate stock indexes may decrease the same as improved distribution of containers between depots may decrease emergency repositions. If the goal of the shipping lines' operational strategies is to decrease ECR, other indicators may therefore be more efficient. Suggestions of such are the amount, distance, cost, and environmental impact of empty container movements. These are more closely tied to the actual empty repositioning and could for example be used to assess the locality of repositioning costs according to the four areas distinguished between by Finke and Kotzab (2017); throughput at ports and depots, main leg transport over sea, first final leg transport in hinterland, and else. However, to use such indicators, the shipping lines are required to have updated and accurate data on for example the transport modes used to transport the containers, the energy sources used to fuel the transports, the distances empty travelled per container, and the cost of empty repositions. For the shipping lines, these areas are most easily measured for transports overseas as this is entirely controlled by the shipping line. Inland transports are however often executed by other and often multiple actors, both contractors or hauliers employed by the shipping line, and freight forwarders and customers owning the cargo transported. This strongly limits the shipping lines' ability to collect data. Furthermore, if the data should be collected per container, a system of GPS-trackers, transponders, and applications for data analysis need to be implemented and information shared between the actors in the empty container transport chain. As the management of empty containers is still highly manual the step to achieve this can be substantial.

Connected to the issue of how to collect data, the shipping lines also have to decide the boundary of measurements, in terms of what to measure. The question is whether to measure only empty container repositions performed or organised by the shipping line, or include also all empty repositions performed by a freight forwarder or customer. From a cost perspective, the shipping line is likely to only be interested in its own part of the container transport chain, however from an environmental perspective, a holistic perspective is often more important, and the scope of measurements may be extended to include all empty repositions for the container fleet. This decision is also important as it may impact the strategies applied to reduce ECR, as some may prove efficient on a company level but not reduce repositioning overall and vice versa. For example, some shipping lines mentioned that they had asked their customers to drop-off containers at another port or terminal that better suited the needs of the shipping line. The effect of this could be merely a shift in the responsibility over the empty repositioning and not an actual reduction of empty repositioning overall.

5.3 ECR and COVID-19

EMSA (2021) describes that the shipping line industry has been heavily affected by the outbreak of COVID-19. However, according to the interviews the Swedish offices have not been affected as much at a regional level, the reason for which can be that Sweden did not have a lockdown. Many respondents mention that they carried on with business as usual, as opposed to many other countries. The planning process was not changed during the pandemic, however the container transport chain became more uncertain and volatile which affected the repositioning of empty containers.

At a global scale the cancelled sailings had a large impact on the repositioning of empty containers, which Knowler (2020) stated caused shortages and surplus of containers at different locations. Furthermore, the abrupt lockdowns implemented by different countries also affected the flow of empty and laden containers. However, it is mentioned by this study's respondents that the effect on ECR in Sweden was much lower than they initially thought it would be. Yet, the ability to allocate empty containers was complicated from the beginning of July 2020, when consumption recovered from the initial shock and empty containers then were shipped heading eastbound to support exports from East Asia. At a later stage, the increased demand created by the pandemic led to a global container shortage, causing freight rates to considerably increase. As a consequence, many shipping lines decided top-down that empty containers should be repositioned as fast as possible back to East Asia, a decision that was outside the control of the local equipment planners. Still, the new policy affected their planning process, which became less flexible as they struggled to allocate empty containers from the hubs in Europe. As a result, planners were forced to prioritise between customers as the number of containers was not enough to serve all. In addition, the planning of empty containers was also affected by the increase in double bookings, which added to the uncertainty of the planning process. The planning process itself did however not change and the shipping lines still allocate and plan the empty container demand as before the pandemic, but with greater difficulty.

If applying a regional and inter-regional perspective to the issues experienced, it can be understood that ECR practices in Sweden are heavily affected by global developments. Even though Sweden did not experience a lockdown or any greater changes during the pandemic, external changes such as the container shortages and increased freight rates affected the repositioning of empty containers within Sweden. Mostly, Sweden was affected by not receiving the number of containers needed for export from the inter-regional network in Europe. When containers arrived at the ports in Sweden, the regional repositioning was not affected by the pandemic since both road and rail transport continued to operate as usual. However, the shipping industry has a global impact which led to Sweden being affected by the other countries' lockdowns. The container transport chain has been affected by the pandemic and regardless of the decisions made in Sweden, other countries' decisions have affected the container transport chain both at a global and inter-regional level and thereby affecting the import and export of empty and laden containers to Sweden.

A difference compared with many other countries in the beginning of the pandemic was that all ships from the Far East to the Port of Gothenburg continued as usual when the rest of the world was facing a huge number of cancelled sailings. This contributed to the fact that the shipping lines with direct lines could continue to import cargo as normal.

5.4 ECR Reduction Strategies

The strengths and weaknesses of the strategies stated by the respondents are mostly consistent and correspond well to what has previously been noted in academic literature, with no striking differences. The obstacles involved with implementation were however emphasised further by the respondents than in literature, arguing that administrative and juridical barriers, collaborative issues, planning complexities, and financial concerns means that many strategies would be difficult to implement. Looking solely at the impact potential of the different strategies, the study found that the strategies contribute to reduced ECR by reducing different imbalances, as presented in Figure 5.1.

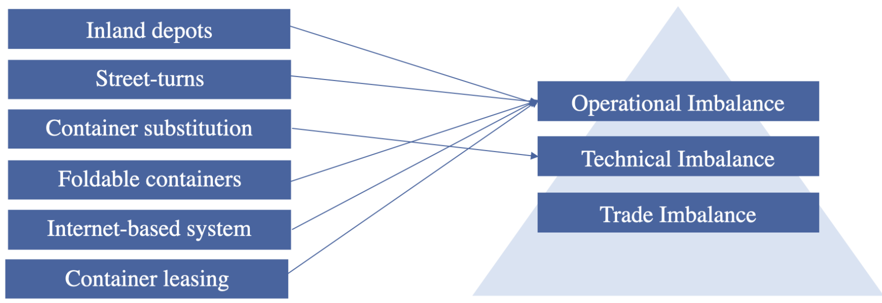


Figure 5.1: Influence of the ECR reduction strategies to the imbalances in the container transport chain.

From the interviews it was understood that the foremost obstacle to efficient container transports, as viewed by the shipping lines, was trade imbalances. These were however seen as being outside the control of the shipping lines, why the figure presents no relation between the strategies and this imbalance. It should however be noted that the shipping lines tried to overcome trade imbalances through balancing their contract portfolios, as described earlier. Second to trade imbalances as a perceived important cause of ECR was technical imbalances. The sole strategy with a potential to overcome this type of imbalance is container substitution, which consequently also is identified with a high impact potential. The relation would be especially important to Sweden, as the country's large discrepancy between import and export container types (import of 20ft and export of 40ft) could be managed with said strategy. The imbalance understood as having the least effect on ECR in the container transport chain in proportion to the other imbalances, were operational imbalances. Despite this, most of the strategies contribute to reduced ECR by managing operational imbalances, something that most likely can be explained by the notion that they are within the control of the shipping lines. The strategies contribute to reduced operational imbalances differently; street-turns and inland depots by decreasing transport distances, internet-based systems by improving control and planning abilities which in turn decreased the number of transports, and foldable containers by making transports more efficient. With the exception of foldable containers, these strategies are all assessed with a medium impact as they have the potential to reduce operational imbalances, but not technical or trade imbalances. Despite being unable to reduce any other imbalances, foldable containers are deemed to have a high impact potential. The reason for this is the order of magnitude in which transports can be made more efficient, where five containers can be transported as one. The only strategy given the lowest impact potential is container leasing, both as it is already used to a large extent today and as it in practice mostly shifts the responsibility of ECR.

The strategies can also be used in combination to supplement each other, leading to positive synergy effects. One such synergy may exist between street-turns and internet-based systems as the improved control achieved through more advanced system support can facilitate coordination which is a prerequisite for street-turns. Likewise, inland depots may enable the use of foldable containers as the folding and unfolding of containers can then be done further inland to achieve a more space-efficient inter-regional transport. In other cases, customers need to manage the folding and unfolding of containers at their site in order to improve the regional ECR. Furthermore, container substitution can create positive synergy effects if combined with inland depots and street-turns as the decreased technical imbalance facilitates balancing the inventory of different container types at inland depots and matching the demand of more customers for street-turns.

5.5 Connections Between the ECR Management Process and Reduction Strategies

If comparing the strategies to reduce ECR and the ECR management process, it can be seen that different strategies can be applied at different stages in the process. The purchase of containers is made centrally and is viewed as a strategic decision by the shipping lines. This means that the implementation of foldable containers and container leasing are dependent on higher-level decisions by shipping lines, outside the control of local planning offices. This is also true for internet-based systems as these often require common standards implemented throughout the entire shipping line. Strategies such as inland depots, street-turns and container substitution, are on the other hand easier to implement at a decentralised level. To a certain degree, this may also explain why they have been assessed with a higher impact potential following the interviews with local representatives. Had the interviews been held with personnel working on a more central or strategic level, other strategies may have been deemed more important. Besides being applied at different stages in the process, the implementation of the strategies may in turn also influence multiple activities in the process, as illustrated in Table 5.1.

Table 5.1: Influence of the ECR reduction strategies to activities in the ECR management process.

Strategy	Equipment planning	Demand planning	Container allocation	Container repositioning
Inland depots	Additional planning points		Additional allocation points	
Street-turns	Additional synchronisation and coordination needed	Additional synchronisation and coordination needed	Direct allocation between customers	
Container substitution	Fewer container types to plan	Check customer's requirements and flexibility		
Internet-based systems	Increased visibility and coordination ability	Increased visibility and coordination ability	Suggested allocation options	
Container leasing	Additional planning of on-/off-hires		Additional allocation option (leasing)	
Foldable containers	Additional container types to plan		More space-efficient allocation	Additional handling and equipment for actors

Foldable containers add a new dimension to the equipment planning activity as it has other specifications than the regular container types, that need to be considered when planning empty equipment. If foldable containers do not reduce or replace some container types, the equipment planning process becomes more complex because of the additional type of container to consider. The implementation of foldable containers also affects the container allocation process, as the containers require less space when stacked, which would reduce the number of vehicles needed when transporting empty containers. However, it may obstruct the container repositioning process, especially at a regional level, as foldable containers require special handling equipment that multiple actor would need to integrate and make adaptions to.

Therefore, it is important to ensure that the actors that handle the containers have the equipment needed to be able to capture the advantages of foldable containers.

As container leasing is already commonly used by the shipping lines, further implementation of long-term container leasing would not alter the ECR management process. However, if the shipping lines would increase the possibility of on- and off-hires at a regional level through short-term container leasing the equipment planning activity could be affected. Then, the equipment planning needs to consider the changing container fleet size and characteristics caused by on- and off-hires. Demand planning would as a rule be left unaffected since the customers are not involved in the ownership of the containers or their allocation strategy. The only exception is if the customers decide to buy the containers by themselves as a one-way trip, however as this option is already used on a low scale the activity would not change. Furthermore, if the shipping lines decide to on- and off-hire at a regional level, the container allocation activity could be affected as the allocation options would depend on whether the leasing companies have containers readily available or not.

Internet-based systems would have a facilitating effect on the entire ECR management process as algorithms can be applied to optimise the distribution and flow of empty containers. By integrating information such as sales forecasts and customer details, the iterative process between the equipment and demand planning activities may also improve in terms of efficiency and reliability, compared with today's often highly manual systems. An internet-based system could also support the container allocation activity by increasing visibility of container locations and equipment availability as well as enable coordination between actors. As aforementioned, algorithms could also be used to provide solutions for not only the container need but also when, how, and from which location containers should be moved, integrating the equipment planning and container allocation activities tighter.

The implementation of inland depots necessitates more detailed equipment planning, as the number of planning points for storage increases. It would also affect the alternatives for how to allocate containers regionally, as the number of pick-up and drop-off locations for empty containers increase. However, as inland depots are commonly used today all shipping lines already have the structures to enable this, and the ECR management process should therefore not change.

Street-turns are used to some extent, but many shipping lines mention that they struggle to plan suitable street-turns. The equipment and demand planning process must be highly synchronised in order to implement street-turns, and for this a high level of planning accuracy and reliability is needed to make sure that the many activities fit together. As it is today, with a lot of manual planning of empty containers, this is a time-consuming pursuit and the time needed to perform the equipment planning activity would likely increase considerably if implemented further. However, it is not only the time-aspect of the ECR management process that would be affected by the implementation of street-turns. A new process step would be needed for the identification of import and export customers with similar but reversed container flows in terms of container types and demand variations. Today, this is often initiated by hauliers, which was perceived positively by the shipping lines as they did not need to spend time on identification. If the shipping lines were to administrate street-turns at a larger scale, the new step in the ECR management process would increase the workload for the shipping lines. Alternatively, the initiation of street-turns could stream from other actors in the container transport chain, such as consignors and consignees that identify similar but opposite directional flows. From the perspective of the shipping line, the enlarged role and insight of customers might however result in a loss of control and information advantage that could negatively impact their operations. Regardless of the initiating party, the consequence to ECR would however be positive as repositioning distances would decrease.

Container substitution is used on a low scale by the shipping lines today, as it is not possible to substitute all kinds of containers. Container substitution would make the equipment planning activity much easier and efficient since it results in fewer container types and thus reduced planning complexity, however an additional step would have to be integrated in the process for making the substitution decisions. Container substitution would also affect the demand planning activity as it constitutes the interface between the shipping lines and customers in terms of container management. The shipping lines therefore need to implement a procedure to ask the customers if they are able to switch between different container types without affecting the transport of their cargo. This information therefore has to be gathered as part of the demand planning activity and then used in the equipment planning process, which further increases the interdependence of the two activities in the ECR management process.

6
Conclusion

This final chapter revisits and reflects upon the aim of the thesis, summarising key findings and conclusions drawn from the information collected during the study. It further highlights academic and practical contributions, as well as provides suggestions for future research.

This master thesis project aims to extend the understanding of how ECR is managed and can be reduced in the liner shipping industry, from a regional and inter-regional perspective. The study has identified five activities in the ECR management process at an operational level; central planning, equipment planning, demand planning, container allocation, and container repositioning. To plan and execute ECR activities in the liner shipping industry, the findings indicate that plans for the allocation of both laden and empty containers are first made centrally and then developed in detail at an operational level through equipment and demand planning at local offices. The developed model is iterative in its nature in that equipment and demand plans were found to be refined simultaneously, in an interrelated process to match the supply and demand of equipment as well as import and export flows for the reduction of ECR and fulfilment of customer requests. The non-sequential flow of activities indicates the complexity of ECR management, as consideration is needed to multiple variables and the activities interface with multiple planning divisions. Despite this, the process is to a large degree still managed manually, possibly resulting in a need to simplify the model and make assumptions based on experience when making decisions. In the view of this, a more data-driven process would enable consideration of multiple factors in a more time-efficient, predictable, and direct manner. The result of this may be better decision-making in the ECR management process and subsequently reduced ECR.

This study focused on ECR in connection to the individual shipping lines, however for the purpose of reducing ECR in the entire system a higher perspective is needed. This adds to the complexity of ECR, as improvements to ECR made by the individual shipping lines may not correspond to equal improvements to the entire container transport chain. Depending on perspective, performance indicators may therefore reflect improvements either to the individual actors or the container transport chain as a whole. Even if taking only the first, the report further found that the measurements used by the shipping lines as part of the ECR management process are unsuitable for the evaluation and assessment of empty container repositions as they are focused on the utilisation of containers rather than empty movements. Additional and more purposeful performance measurements are therefore needed in order to evaluate current performance and areas of improvement moving forward.

The study found that ECR has been affected by the COVID-19 pandemic mostly in terms of a shortage of containers at a global scale. While the activities in the ECR management process itself remained relatively unaffected, the container transport chain became more uncertain and volatile which affected the repositioning of empty containers. The findings also indicate that the shipping lines' local offices in Sweden have been less affected than some of their global counterparts, mostly due to the strategy taken by public authorities in Sweden to not implement a national lockdown.

The study furthermore aims to describe various potential strategies to reduce ECR. Six strategies (inland depots, street-turns, container substitution, internet-based systems, container leasing, and foldable containers) for ECR reduction applicable at a regional and inter-regional level have been analysed and evaluated in terms of impact potential and feasibility. Most of the strategies that were assessed with a high impact potential also had a low feasibility to implementation, and vice versa, implying that the problem is complex to solve. The two strategies, foldable containers and container substitution are believed to have a high impact through their potential to overcome technical or operational imbalances, however they appear difficult to implement regionally as the first requires the involvement of higher-level decision-makers and the second is complicated by Swedish trade characteristics. Container leasing on the other hand has a higher implementation feasibility as it already exists, but the impact is regarded as low as it in many cases only constitutes a shift in container ownership and not handling. The strategies that are assessed with the highest overall potential in terms of both implementation feasibility and impact potential are inland depots, street-turns, and internet-based systems. The potential of these lies in their ability to overcome operational imbalances in a regional and inter-regional setting. The results also indicate that some interdependencies between the strategies exist. The implementation of inland depots and street-turns may necessitate more advanced internet-based systems to support the current manual ECR management process, and the absence of such systems may thus be a hindrance to the implementation of some strategies. In conclusion, the reduction of ECR in the shipping line industry can to a certain degree be achieved through the implementation of the six strategies at a regional and inter-regional level, however to reduce ECR throughout the entire container transport chain potential improvements need to stretch beyond any sole strategy or actor.

6.1 Academic and Practical Contribution

This research has contributed to an improved understanding of how ECR can be reduced in the liner shipping industry by outlining how the ECR management process is performed at a regional level today. The perspective has been of relevance as most decisions relating to regional and inter-regional ECR were found to be taken at an operational level and several interrelations exist between planning at a global and regional level. The regional and Swedish perspective has also illuminated practices specific to the selected research environment, and can therefore be used to compare regional dynamics in different contexts. The results indicate that the ECR management process did not differ considerably between the studied companies and the generic model of the ECR management process can thus be used by all shipping lines to visualise connections between key planning activities. Furthermore, the perspective has provided insights about the effects of COVID-19 to ECR, as perceived by personnel managing ECR at a regional and inter-regional level. In addition, the study has revealed a scarcity of measurements used by the shipping lines to guide and evaluate ECR at a regional level, indicating that the slow adoption of performance indicators within the liner shipping industry is true also for Sweden. As performance measurements are centred around the utilisation of containers, and not specifically empty repositioning, the report has concluded that new indicators need to be implemented in order to be able to evaluate current performances. This could be valuable for the shipping lines as it would allow them to benchmark their performance against other shipping lines as well as measure improvements gained from implementing different strategies.

Different strategies to reduce ECR have also been evaluated from a regional perspective, in order to gain an understanding of how they can be used to reduce ECR. In this context each solution has been analysed in terms of their feasibility and potential impact of implementation, the way in which they contribute to reduced ECR, and the relation between the strategy and the management process of empty containers. Knowledge regarding the potential of each strategy to reduce ECR from a both regional and inter-regional perspective, provides shipping lines with a better understanding of how ECR can be reduced in Sweden. Furthermore, by identifying how each strategy affects the different activities in the planning process of empty containers, the shipping lines may gain further insights regarding which strategy to implement in order to reduce ECR and how this implementation may affect the shipping lines' internal processes.

6.2 Suggestions for Future Research

In the study, performance measurements were found to be only moderately used to guide decisions and evaluate performance at an operational level. As previous research on the topic have been difficult to find and it was not clear how this impacted ECR or the ECR management process, further studies focusing on performance measurements in the context of the container shipping industry are needed. For future research it would therefore be interesting to investigate which performance measurements that could be used by shipping lines to evaluate the ECR management process and the movements of empty containers. In line with this, it would also be interesting to analyse how certain performance measurements are affected by the implementation of potential ECR reduction strategy to assess their impact quantitatively.

Furthermore, it was found that some of the potential reduction strategies required the involvement of decision makers placed at higher levels in the organisations, outside the control of those studied in this thesis. In order to understand how these strategies can be implemented globally, it would be interesting to study how shipping lines work with ECR at a strategic level and how potential strategies are tested and evaluated. This could also provide further understanding of the interaction between different planning levels.

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A

Appendix - Interview Template

- Kan du beskriva din position inom företaget och hur länge du har jobbat här?
- Hur ser ert containerflöde av tomma containrar ut?
- Hur ser informationsflödet ut när ni planerar containerbehovet?
  - Vilka aktörer och avdelningar ingår?
- Vilka aktiviteter ingår i er process för att planera containerbehovet?
  - Hur initieras behovet av kund?
  - Hur prognostiserar ni containerbehovet?
  - Vilka tidshorisonter finns i processen?
- Hur ser beslutsprocessen ut för hur containrar sedan ska allokeras?
  - Vilka avdelningar berörs?
  - Vilka olika sätt har ni att välja på för att allokera containrar? (förflyttning mellan hamnar, leasing, köpa containrar etc)
- Använder ni er av KPIer kopplade till containerhantering?
- Är tompositionering ett problem för er?
  - Vilka hinder finns för att minska tompositioneringen?
  - Hur arbetar ni långsiktigt för att minska tompositionering?
  - Ser du något sätt att minska tompositioneringen som ni inte använder idag?
- Hur har tompositionering påverkats av COVID-19?
  - Hur har era planeringsprocesser påverkats av COVID-19?
  - Har ni förändrat era arbetssätt på något vis?

B

Appendix - Follow-up Questions

- För följande strategier, kan ni förklara:
  - om/när/i vilken utsträckning ni använder strategin idag?
  - om/hur/varför/varför inte ni tror att den skulle kunna användas för att minsta tompositionering i framtiden?

Strategi	Förklaring
Street-turns	Den tomma containern flyttas mellan importör och exportör direkt utan att gå via en terminal
Inland Depots	Den tomma containern förvaras på en inlandsterminal istället för i hamnen Container leasing En tom container hyrs där det finns ett behov och lämnas när den inte längre behövs
Container Substitution	Byta ut en containertyp mot en annan för att tillgodose ett behov
Internet-based Systems	Information om tomma containers (position, lagerstatus, kommande transporter, etc.) registreras digitalt och kan delas med andra aktörer (speditörer, terminaler, etc.) för att öka synlighet och koordinera hantering
Foldable Containers	En container med hopvikbara väggar som tar mindre plats vid transport och förvaring

C

Appendix - ECR Activities

	Company A	Company B	Company C	Company D
Global planning	Respond to requests of empties within Europe	Respond to requests of of empties within Europe		
			Collaborate with European office in Rotterdam and HQ	Collaborate with office in Poland if repositining within Europe needed
Equipment planning	Daily overview looking 5-6 weeks ahead and planning 2 weeks ahead	Daily planning 2-3 weeks ahead Forecast export 4 weeks ahead	Daily overview of import looking 5-6 weeks ahead	Daily overview looking 30 days ahead Weekly review of quantitative forecast with qualitative adjust.
	Calc. non-allocated containers at depot + import - export	Calc. non-allocated containers at depot + import - export	Calc. non-allocated containers at depot + import - export	Calc. non-allocated containers at depot + import - export
Demand planning	Match import with export to reduce ECR	Match import with export to reduce ECR	Match import with export to reduce ECR	Match import with export to reduce ECR
	Dialog with sales dep. to verify that booking can be accepted if empties can be allocated		Bases export bookings strictly on incoming volumes, both at longer and shorter contracts	
ECR requirements	(1) Maritime repositioning along coastline (2) train (3) truck	Reposition (1) within Sweden (2) within Europe - request empties from Rotterdam hub Export empties not allocated 4w ahead	Avoid ECR by prioritising customers and not accepting unbalanced bookings that requires repositioning within Sweden	Reposition (1) within Sweden (2) within Area (3) from other Areas - send request to surplus ports. (1) Truck or ship (2) train
ECR execution	Move empties first when export booking exist	Move empties first when export booking exist	Move empties first when export booking exist	Move empties first when export booking exist

	Company E	Company F	Company G	Company H
Global planning		Respond to requests of of empties within Europe		Respond to requests of of empties within Europe
	Close collaboration with Scandinavian office		Plan together with colleagues in Poland if repositioning within Europe needed	Overviews the container flow and monitors idle times
Equipment planning	Daily planning looking 2-4 weeks ahead Forecast volumes qualitatively looking at historic sales and bookings	Daily review comparing bookings with contracted volumes Predict demand 5 weeks ahead based on historical data from the past 3 months	Planing a few weeks ahead and review comparing bookings with contracted volumes - contact customer to understand ev. deviation Forecast volumes quantitatively based on sales and qualitatively based on experience	Daily overview looking at imports a few weeks ahead
	Calc. non-allocated containers at depot + import - export	Calc. non-allocated containers at depot + import - export	Calc. non-allocated containers at depot + import - export	Calc. non-allocated containers at depot + import - export
Demand planning	Match import with export to reduce ECR	Match import with export to reduce ECR	Match import with export to reduce ECR	Match import with export to reduce ECR
		Accept booking, and instead move equipment to meet customer needs		
ECR requirements	(1) Maritime repositioning with own vessels if planned in advance (2) feeder network, truck, or rail	Large feeder network provides flexibility for maritime repositioning	Avoid structural ECR by phasing out imbalanced contracts or convince exporters to ship from other ports Temporary imbalances solved by (1) maritime repositioning and (2) train (3) truck	Reposition (1) within Sweden (2a) within Europe - send request of empties from Hamburg/Rotterdam hub (2b) on-hire leased containers
ECR execution	Move empties first when export booking exist	Move empties first when export booking exist	Move empties first when export booking exist	Move empties first when export booking exist

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